

The Exciting World of Science

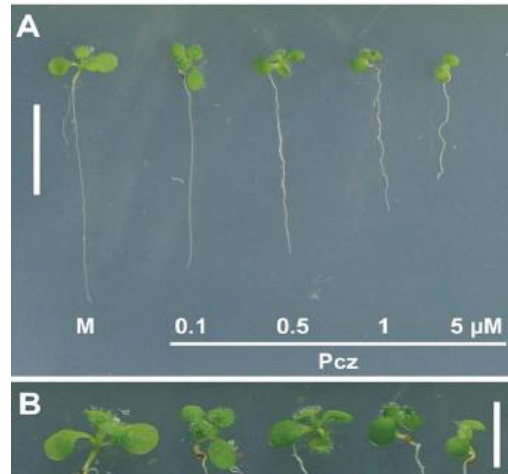
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1. AGRICULTURE

1.1 Dwarf Plants¹

With growing global water shortages and decreasing availability of cultivable land caused by the huge increases in the world population (that has now crossed seven billion), scientists are constantly striving to come up with new more efficient ways of growing food plants. These plants should have higher productivity but need lower amounts of water, fertilizer, nutrients and pesticides to grow.

An interesting solution to the problem has been found by the Purdue University researcher Burkhard Schulz. He has discovered that a certain chemical can be used to reduce the size of the plant without reducing the yield. Schulz found that propiconazole, a common fungicide, can be used to create smaller and sturdier corn plants that produce more kernels but consume less water, fertilizer and nutrients to grow. The fungicide is claimed to be harmless to humans as it is commonly sprayed on golf courses to treat fungal dollar spot disease. The chemical works by disrupting steroid production in the plants, responsible for their growth.



1.1a Small Plants: Responses of *Arabidopsis* seedlings to inhibitor treatments. Reproduced with thanks from: <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0036625>



1.1b Small Plants: Berkhard Schulz. Reproduced with thanks from: <http://blog.plantwise.org/2012/05/29/stunting-crop-plant-growth-to-reduce-resource-use/>

1.2 Planet Earth Drying Up!²

Scientists working on global weather patterns predict that the glaciers in the Himalayas as well as in Europe and other parts of

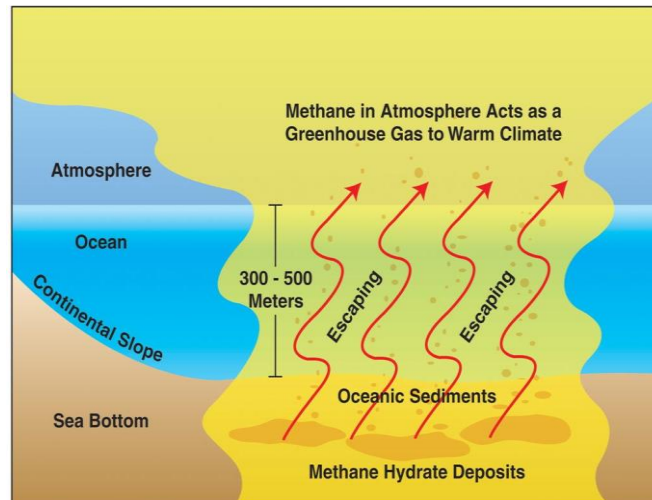
the world will melt causing major portions of Asia, Africa, USA and South American to turn into uninhabitable deserts. Extreme flooding will occur in some areas and severe droughts in others resulting in millions of deaths. Most animals and plants will vanish and the population on the planet will rise to 9 billion by the year 2050, but it may diminish rapidly thereafter due to mass famines and wars. This is a terrifying scenario if the average temperature on the planet increases by only 4°C. The last time that global temperature increases of this magnitude occurred was 55 million years ago when large amounts of frozen methane were released from deep oceans and caused temperature increases of 5-6°C. This resulted in tropical forests springing up in polar regions, vast areas from southern Africa to Europe turned into desert, and the dissolved carbon dioxide made the oceans so acidic that most sea life was wiped out.

1.3 Growing Food Crops----with Sea Water!³

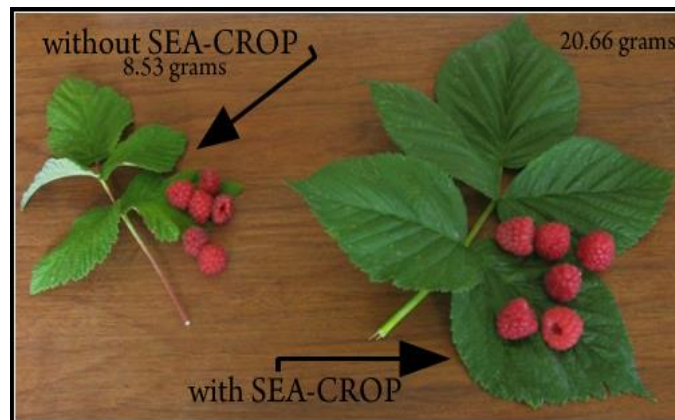
About 98% of water on our planet is sea water, another 1% is brackish water (having more salt than fresh water but less than sea water) and only about 1% is fresh water. As the world populations grow from the present 6 billion to 9 billion over the next 50 years, and as global warming results in increased water shortages, man must look for alternative ways to grow food crops. The depletion of fossil fuels will simultaneously result in acute shortages of oil. Both problems can be solved by growing salt tolerant crops.

Although the water near the sea shore is saline, you may have noticed that some plants can grow under those conditions. With the span of time, nature has evolved certain genetic mechanisms that make them salt tolerant. Certain plants, known as “halophytes”, can grow in coastal regions, deserts, marshes, brackish aquifers and even in seas and oceans, and can serve as sources of food and oil. Growing them in such areas will not compete with land used for food crops. The identification of salt tolerant genes and their incorporation into wheat, maize or rice can also impart the salt tolerance into food crops, thereby allowing them to be grown in sea water or brackish water. Some halophytes can also help remove salt from soils affected by salinity.

Methane Explosion Warmed Prehistoric Earth



1.2 Earth is drying: Methane explosion warmed prehistoric earth. Reproduced with thanks from: <http://www.giss.nasa.gov/research/news/20011210/>



1.3 Food crops production by Sea water. Reproduced with thanks from: <http://www.sea-crop.com/>

Certain halophytic algae can be sources of biofuels. An Israeli company 'Seambiotic' has succeeded in producing oil from algae which has a yield equivalent to over 5,600 gallons/year from each hectare of land. This compares favourably with palm oil yield of

1,187 gallons/hectare/year, Brazil ethanol yield of 1,604 gallons/hectare/year, and soy oil yield of 150 gallons/hectare/year. In the future, man will probably rely on the oceans for growing food crops and meeting energy needs.

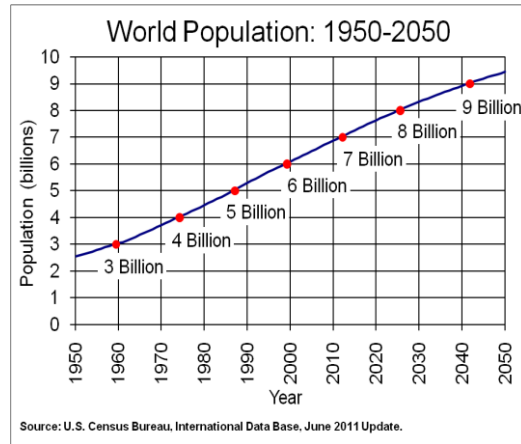
The unsustainable use of water and land has led to increased volume of food crops over the last several decades. This is a bubble, stretched to a point of bursting, and it could send the world spinning into a crisis of unprecedented magnitudes. The World Bank has estimated that about 175 million people in India are able to eat from grain crops only due to overpumping --- water being pumped from underground aquifers faster than it is replenished. The water table is therefore receding at an alarming rate. Saudi Arabia had become self-sufficient in wheat by using water from an aquifer. The source is however running dry, so the wheat production could stop within 2-3 years.

There are about 1.5 million new mouths to feed every week as the global population grows, aggravating the situation. The unpredictability of weather patterns is adding another serious factor which can send us over the precipice. The heat wave in Moscow of 2010 caused a loss of 40% of its hundred million tons of grain crop. Had this happened in India, China or USA, it could have had a devastating impact on the world grain production. Food prices have been rising at an alarming rate in most countries, making life miserable for the poor billions. The highly controversial building of dams in India, which would divert water from Pakistan, could eventually lead to a nuclear conflagration between these two nuclear states.

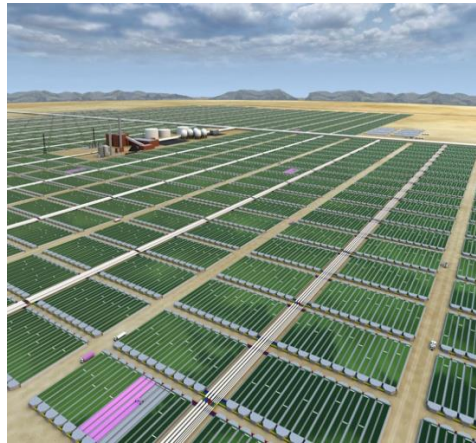
There is urgency to act before it is too late. Answers lie in promoting education, curbing population growth, adoption of modern and sustainable farming techniques, restoration of nature's balances by cutting carbon emissions, increasing forest, restoring soils, and adopting water conservation methods at all levels.

1.4 Sea Water for Farming in Coastal Deserts!⁵

Sea water cannot be used directly for irrigation of food crops because of its salt content---but the humid air from it can be, even



1.3a Food crops production by Sea water. Reproduced with thanks from:
<http://www.census.gov/population/international/data/idb/worldpopgraph.php>



1.3b Food crops production by Sea water. Reproduced with thanks from:
<http://www.lowtechmagazine.com/2008/04/algae-fuel-biof.html>

1.5 Is the Food Bubble about to Burst?⁴

In adjoining deserts! Three large greenhouses have been established in Tenerife, Abu Dhabi and Oman in which the sea water is pumped to evaporators installed in these greenhouses to create a humid environment for growing a variety of different plants. The humid air is condensed to afford pure water which is

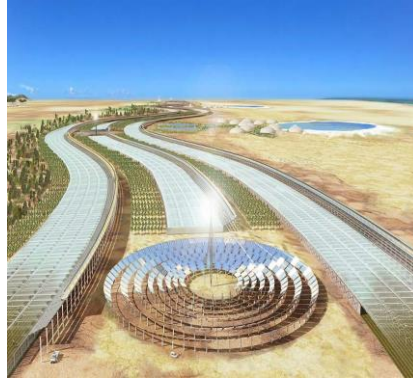
stored and then used for watering the plants. A British company, Seawater Greenhouse, is building these greenhouses for a low cost of US\$ 5 per square foot and has now added a concentrating solar power plant to run the generator and pumps and provide additional fresh water.

The Ministries of Science & Technology and Agriculture should start similar projects on our coast line.

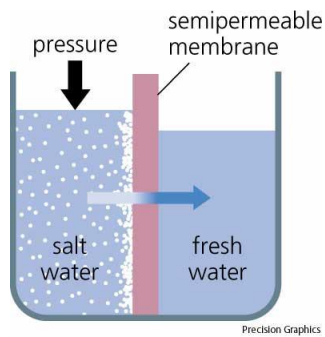
1.6 Sea Water for Agriculture: Advances in Reverse Osmosis Membranes!⁶

The world population is expected to reach 9 billion by 2050, creating enormous pressures for crops for food. As sources of fresh water shrink with rivers drying up due to global warming, a catastrophe lies ahead. There is an urgent need for science to find viable solutions to this enormous challenge.

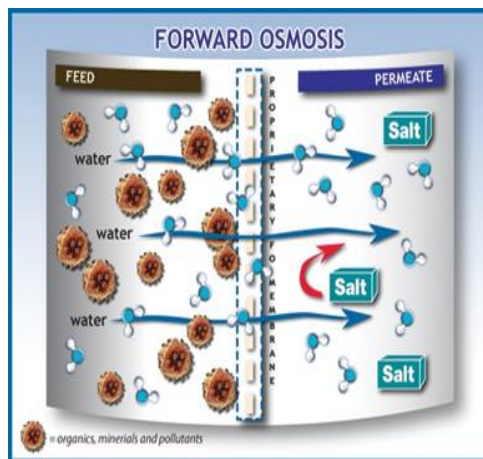
One way to convert saline water (sea water or brackish underground water) into salt-free fresh water, useful for drinking or farming, is by a process known as “reverse osmosis”. This involves pumping the saline water through a special polymeric membrane that allows only water molecules to pass through the pores of the membrane, but prevents salt, bacteria and dirt from doing so. However, a drawback of this process is that over a period of time, these particles clog up the expensive membrane and damage it. This results in the need of regular costly membrane replacements, increasing costs. Scientists working at the University of California, Los Angeles have now used nanotechnology to develop a new type of reverse osmosis membrane that is covered with small polymeric hairs (Nancy H. Lin, *J. Mater. Chem.*, 2010, DOI: 10.1039/b926918e). These surface hairs move around rapidly in the water pumping process, thereby acting as an in-built brush which prevents the deposition of impurities on the membrane surface. Once commercialised, it may reduce the cost of production of fresh water from sea water, opening up possibilities of its large scale use for agriculture.



1.4a Use of Seawater for Agriculture on Sea Side. Reproduced with thanks from: http://web.mit.edu/12.000/www/m2015/2015/hydro_agriculture.html



1.4b Use of Seawater in Agriculture. Reproduced with thanks from: <http://www.yourdictionary.com/reverse-osmosis>



1.7a Process of Forward Osmosis. Reproduced with thanks from: http://www.htiwater.com/technology/forward_osmosis/

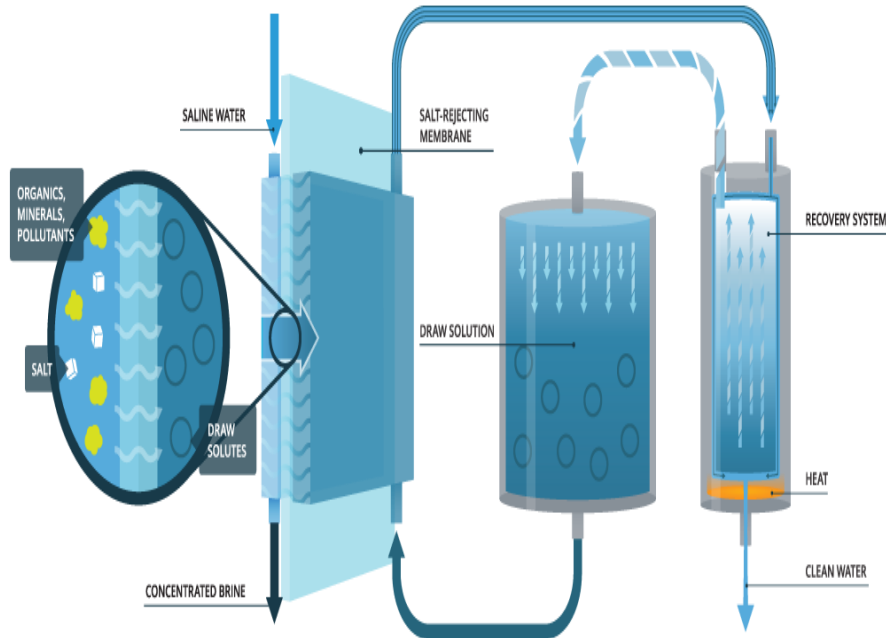
1.7 Forward Osmosis ---- Exciting Developments in Water Purification!⁷

As the population of our planet increases, and as the glaciers melt due to global warming threatening our future water supplies, there is growing interest in finding new ways to obtain pure water from sea water. According to 2006 UN report, 2 out of every 3 persons on our planet will be living under water stress conditions by 2025. The oceans cover about 70% of our planet and contain about 97% of the total water resources. Clearly, science has an important role to play in developing processes that will allow sea water to be converted to pure water at affordable cost with minimum use of energy.

Osmosis is a process that allows water to flow through a membrane from the side that has low solute (e.g. salt) concentration to the side that has high solute concentration. This natural tendency to equalize the concentrations of solutions on the two sides of the membrane results in a pressure on the membrane known as “osmotic pressure”. The reversal of this process by application of pressure by a pump so that water starts flowing in the opposite direction is known as “reverse osmosis”. It traps salt molecules on one side of the membrane, allowing pure water molecules to pass through. This leads to high concentrations of salt on one side of the membrane and pure water on the other side. The process of reverse osmosis has been widely employed for production of drinking water from sea water. However, there is a problem. The process is costly since it consumes a considerable amount of energy, and the membrane used is costly and has to be regularly replaced as it has a limited life.

An exciting breakthrough has occurred in this field, involving a “going with the flow” (“forward osmosis”) approach instead of trying to oppose it! This involves placing a high concentration of another solute (such as sugar) on one side of the membrane with salt water on the other side. This results in the natural forward flow of water from the side containing salt water to the side containing the solute, such as sugar, resulting in a process for the preparation of soft drinks from sea water through forward osmosis. This process which harnesses the energy gradient,

instead of opposing it, consumes up to 80% less energy because the pump pushes the water through the membrane in the same direction as its natural flow tendency.



1.7b Forward Osmosis. Oasys water evolutionary process. Reproduced with thanks from: <http://oasyswater.com/eo>

Hydration Technology Innovations in Albany, Oregon, USA was one of the first companies to use this technology. US soldiers started using “X-packs” that contain sugar and flavors on one side of the forward membrane. When such packs are dipped in sea water, or even in a dirty puddle of ordinary water, they suck pure water molecules into them leaving salt and dirt particles behind, thereby creating a pure sweet flavoured drink.

Another important development has been to use removable chemicals such as ammonium bicarbonate in larger plants which draw pure water across the membrane from the salt containing side to the side containing ammonium bicarbonate. This chemical can later be removed and recycled by simple heating, leaving pure water behind. Oasys, a company based in Cambridge, Massachusetts, is building the first demonstration

plant based on this process which will start functioning in 2011. (*Journal of Membrane Science*, Vol 355, p 158).

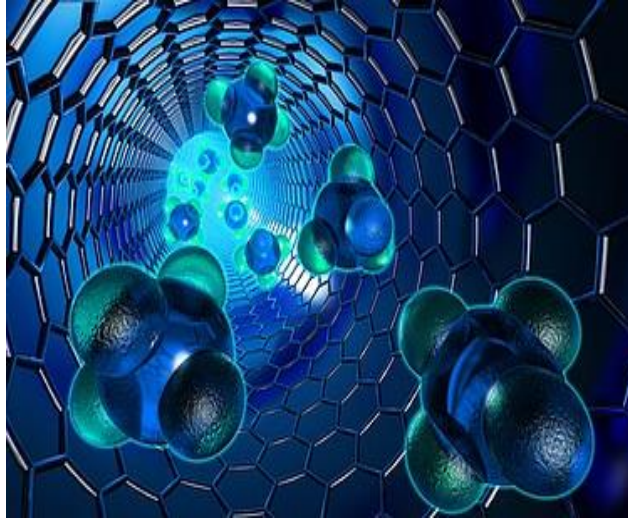
1.8 Water Desalination --- Employing Carbon Nanotubes!⁸

The two commonly used processes for removing salt from saline water (desalination) are thermal distillation and reverse osmosis. In the first process, the salt water is heated to boiling point and the steam generated is collected by condensation leaving the salt behind. In the second reverse osmosis process, the salt water is pumped through a special “semipermeable” membrane that allows only pure water to pass through while the salt is left behind. Both processes use a considerable amount of energy and are therefore not considered environmentally friendly.

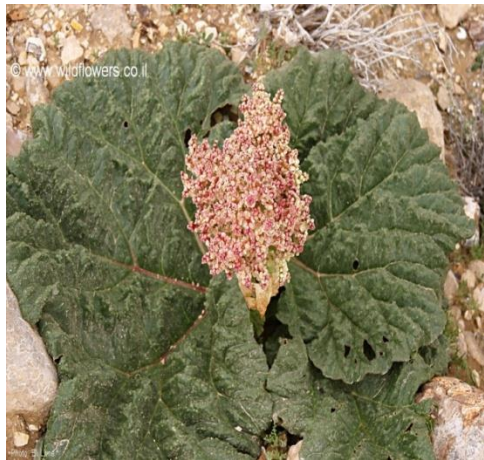
Now, scientists working in the New Jersey institute of Technology in USA have developed a process which can be considered to be intermediate between the two processes mentioned above. In this process, hot saline water is passed through a special semipermeable membrane that has built-in carbon nanotubes to allow greater permeability. The result is a process that allows flow rates that are six times higher than those achieved in conventional membranes.

1.9 A Self-Watering Desert Plant!⁹

The desert plant “Rhubarb” (*Rheum palaestinum*) found in the Negev desert of Israel has leaves which can reach one meter in diameter, whereas other desert plants have small and spiky leaves. Israeli scientists have discovered that it has a unique self-watering mechanism that allows this to happen. They claim that this is the first example of self-irrigation in a plant ever found. The waxy leaves of the plant have deep and wide channels resembling a mountainous range that allow the droplets of water to be captured and then guided so that they fall on the soil near the roots of the plant. Even in light rain, the water that fell near the roots was ten times more than that fell in other areas near the plant, due to this built-in water harvesting mechanism.



1.8 Use of Carbon Nanotube: To Remove Salt from Water. Structure of carbon Nanotube. Reproduced with thanks from: <https://www.llnl.gov/snews/newsreleases/2006/NR-06-05-06.html>



1.9 Self Water Spraying Plant. Rheum Palaestinum. Reproduced with thanks from: <http://www.wildflowers.co.il/english/picture.asp?ID=5130>

1.10 Our Wheat Crop --- at Risk!¹⁰

Our wheat crop may be threatened by a new virulent fungal attack from Iran. This fungal virus named as Ug99 wheat rust

was first discovered in Uganda in 1999, and has spread with the wind to Iran, where it was discovered two years ago. It is now poised to spread across the borders to Pakistan and Afghanistan. This new disease could spread across Asia, threatening famines for millions. In Pakistan, we need to develop and grow wheat varieties resistant to this fungus.

1.11 Cloning Plants by Tissue Culture!¹¹

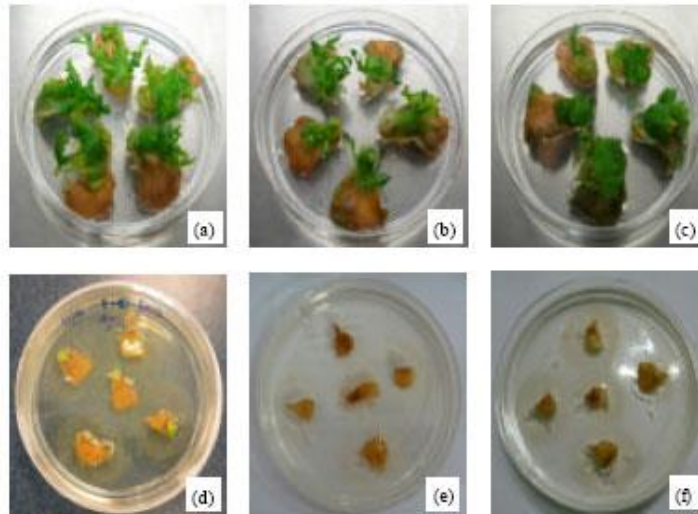
It is now possible to produce thousands of plants commercially without using seeds. A leaf is divided into small pieces, placed in a test tube in a chemical medium containing nutrients and growth hormones. After about 6-8 weeks, shoots start to develop which are cut off and placed in another medium. Once the roots have been formed, the plant is transferred to soil in an environment with high humidity, usually a green house. When the leaves have been formed, the plants can usually survive in less humid environment. Plants with certain desirable properties, e.g. colour of flowers, size or taste of fruits etc. can thus be multiplied, since the cloned products produced, being genetically identical, will have the same characteristics as the parent. The procedure works well in the manufacture of orchids, bananas and many other plants and is cost effective because of mass production of plants with desirable traits.

1.12 Biotechnology --- Can it Tackle Food Crisis?¹²

Food crises could start toppling individual governments as well as affect global civilisation. Increasing populations, lower crop yields due to global warming and shrinking arable land areas are combining to create a potentially huge problem that can affect us in profound ways. The world carry-over of stocks in 2008 was only for 62 days of consumption. The demand of food is rising much faster than its production, with the result that food prices are being pushed up. This is creating severe stresses in countries such as Pakistan with a low per capita income. The



1.10 Wheat on the danger to develop Ug99 Wheat Rust. Reproduced with thanks from: <http://b4tea.blogspot.com/2011/06/what-is-ug99-wheat-rust.html>



1.11a Cloning of Plants through Tissue Culture. Reproduced with thanks from: <http://scialert.net/fulltext/uc.php>



1.11b Cloning of Plants through Tissue Culture. Reproduced with thanks from: <http://galleryhip.com/plant-tissue-culture-cloning.html>

"green revolution" of the 1960s and 1970s became possible because of scientific agriculture, and the grain yield per acre grew at an average of 2% per year between 1950 and 1990. However, this increase has slowed to a little over 1 % per year after 1990. While genetically modified (GM) crops may result in increased yields in certain crops, it seems unlikely that we will witness the 2-3 fold increase in yields that we saw during the green revolution. The long term solutions may lie in controlling world populations, farmer education, better storage and distribution methods, and control of wastages caused by pest and fungus attack.



1.11c Cloning of Plants through Tissue Culture. Reproduced with thanks from: <http://www.plantcellculture.com/science.html>



1.12a Biotechnology: A solution to food crisis? Reproduced with thanks from: <http://home.allergicchild.com/possible-causes-of-food-allergies/>



1.12b Biotechnology: A solution to food crisis? Reproduced with thanks. <http://www.instablogs.com/can-biotechnology-help-solve-the-food-crisis.html>



1.12c Biotechnology: A solution to food crisis? Reproduced with thanks from: <http://www.thepotomacpost.com/science/biotechnology-in-the-food-world/>

2. BASIC SCIENCE

2.1 Even Nobel Laureates can be Wrong!¹³

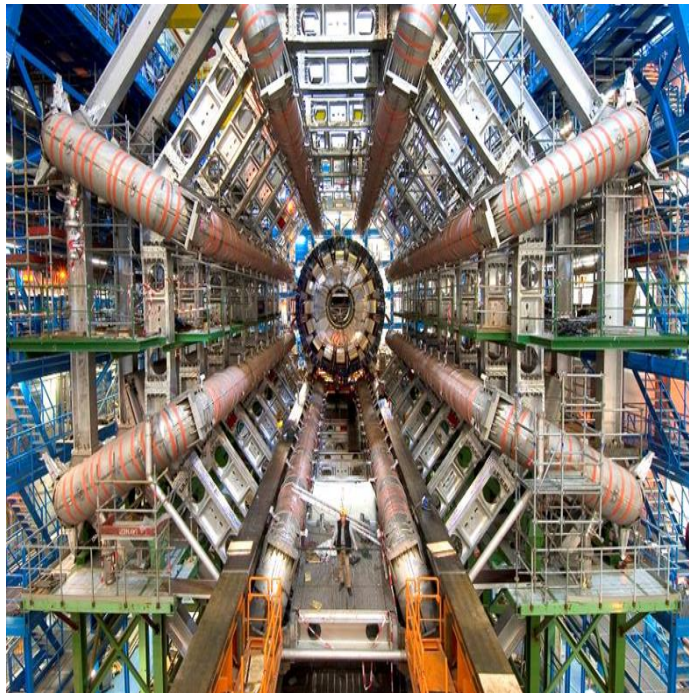
In 1972, something extraordinary happened. A young Pakistani scientist, working as a Don at Kings College, Cambridge University, disproved the joint work of 3 giants in chemistry, one of whom (Sir Robert Robinson) being a Nobel Laureate. The other two were Sir W. H. Perkin (after whom two of the top British chemistry journals, Journal of Chemical Society Perkin 1 and Journal of Chemical Society Perkin 2 are named) and Prof. R.H.F. Manske. The work involved the chemical transformations of a compound (harmaline) occurring in the seeds of a local plant "harmal". The work of these 3 giants of chemistry had been accepted as correct for almost 50 years till it was disproved by the young Pakistani scientist, whose paper was ironically published in the same top British chemistry journal (Journal of Chemical Society Perkin 1, page 736, 1972) named after the British scientist whose work was being disproved. The Pakistani scientist was later to become the Fellow of the prestigious Royal Society (London) and was invited to sign the 360 year old book of the Royal Society with a feather pen, once signed by Sir Issac Newton and Charles Darwin. Lesson: Even Nobel Laureates can be wrong --- so never believe the printed word blindly but always adopt a questioning approach. Guess who was the Pakistani scientist?

2.2 Faster than Light?¹⁴

Scientists working at CERN laboratories, Switzerland, have recently fine-tuned and repeated their earlier findings of September last year in which they found that neutrinos could travel at a speed slightly faster than light. Interestingly, they obtained the same results. The discovery, if substantiated by others, will shake the understanding of modern physics and show that Einstein's theory of relativity and the ideas on which modern physics is based were built on incorrect foundations.

Scientists at Fermi labs in USA and KEK labs in Japan are preparing to investigate the stunning results of the scientists at CERN. If the results are reproduced, the present understanding of modern physics will be turned upside down.

According to Jeff Forshaw, a professor of particle physics at Britain's Manchester University, if the results are correct, the time travel will become possible and information could be transmitted to the past.



2.2 Faster than Light. The European Organization for Nuclear Research known as CERN is a European research organization is world's largest particle physics laboratory. Reproduced with thanks from: <http://www.askamathematician.com/2009/11/q-will-cern-create-a-black-hole/>

2.3 What Are We Made Up Of?¹⁵

What are we made up of? Some may answer “flesh and bones”. Others may say that we are made up of atoms. Both are right. But what are the absolute fundamental building blocks ---- in other words, what are atoms made up of? Once, it was thought

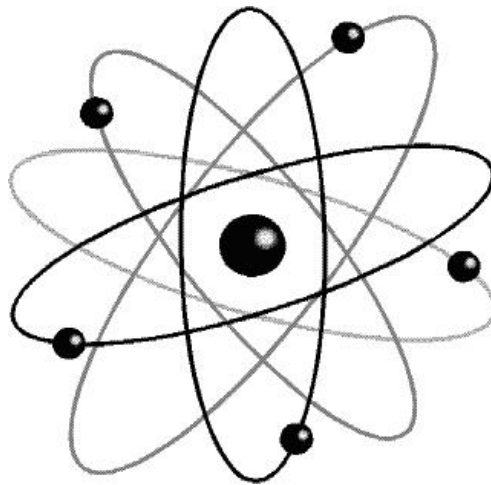
that atoms were made up of protons, neutrons and electrons. That was it. It soon turned out that there were far more mysterious forces at work. From 1960 onwards, a large number of other sub-atomic particles were discovered, and now there are hundreds of such particles known. A set of rules that describe how these sub-atomic particles behave and interact with each other is known as the “quantum theory”.

Things start becoming even more fascinating as we delve deeper. In the 1980s, a new theory was developed that envisages that we are all made up of infinitely small pieces of dancing strings! These strings have only one dimension, length but the other two dimensions (height and width) are absent. The strings are not stationary but exhibit exotic dances (vibrations), and it is the manner in which they vibrate that determines how they are seen by us---- as matter, light or gravity. Thus all matter or energy is an exhibition of the vibrations of these tiny dancing strings. This became known as the “string theory”.

There is a further twist to this fascinating tale. We are familiar with the three dimensions of length, width and height, and the fourth dimension, time. According to the string theory, there are further 7 dimensions, although we cannot sense them directly. Five major string theories were developed depending on how the strings behaved (whether they vibrated as open loops, closed loops etc.). Edward Witten of the Institute for Advanced Study at Princeton and other researchers finally developed the M-theory (“M” standing for membrane) thus unifying the 5 string theories under one banner. The M-theory hopes to explain everything ---- the ultimate riddles of our existence, and is therefore often described as “Theory of Everything”. It considers that the tiny dancing strings that we are all made up of are really one-dimensional slices of a two-dimensional membrane, which are dancing in 11-dimensional space!

This all now starts sounding like a fairy tale as at present the technology does not exist to prove its correctness, and it may never will. In his latest book entitled “*The Grand Design*”, the famous Cambridge physicist Stephen Hawking and co-author Leonard Mlodinow have considered the above theories and virtually given up. They now think that science offers incomplete windows to a common reality.

However, the next time you have an urge to dance when music is placed, just shrug your shoulders and accept it as just natural. After all modern science tells us that we are all --- at least in theory --- made up of these tiny strings which are dancing perpetually!



**2.3 What we are made from? Reproduced with thanks from:
<http://protondecay.blogspot.com/2010/04/protone-atom.html>**

3. BIOLOGY

3.1 *The Chemistry of Love!*¹⁶

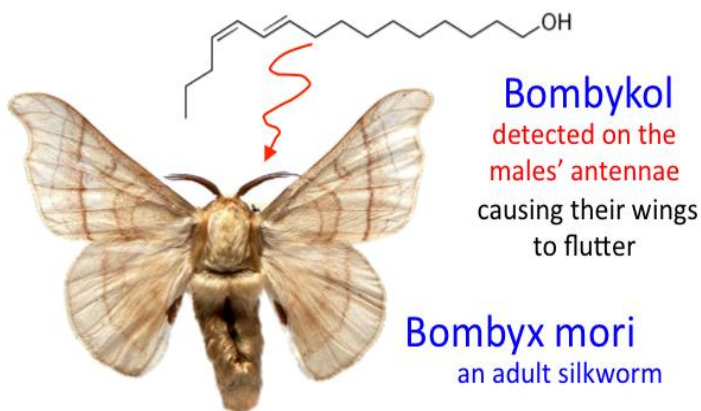
Can the opposite mate be attracted and sexual desires aroused chemically? In the animal kingdom, this is very common. In humans too, there is growing evidence that certain chemicals may serve as attractants to the opposite sex.

Bees have a very complex system of communicating through release of certain chemicals (“pheromones” or insect hormones) which convey special messages to other bees. Butterflies and moths are so sensitive that if certain sex attractant chemicals are released, the butterflies and moths will sense the sex hormones several miles away (10.6 km recorded). This sensitivity of insects has been exploited by farmers to develop traps which attract all the females to the trap from miles around, thereby eliminating the possibility of breeding.

What about humans? Are there chemicals that can sexually arouse men and women? Women with irregular menstrual cycles, when exposed to the smell of compounds in men’s armpits, had the cycles regularized. A compound (androstadienone) present in the sweat of males was found to increase the levels of cortisol, a stress hormone, in women (*The Journal of Neuroscience*, **27**(6): 1261–5. doi: 10.1523/JNEUROSCI.4430-06.2007). Sex drive can be increased by administration of the hormone “testosterone” in older males. Yohimbine, an alkaloid found in the bark of plants of genus Yohimbe, has been used for the treatment of impotence by increasing genital blood flow in males and enhancing sexual excitement and sensitivity. In August this year, a US based company reported positive phase 1 clinical trials of a compound (bremelanotide) when administered subcutaneously for erectile dysfunction, (<http://www.palatin.com/news/news.asp?param=221>).

Many compounds have been discovered which act as aphrodisiacs. Some really exotic chemistry underlies the phenomenon of sex in insects, sea urchins and humans ---- the ability to trigger uncontrollable attraction by using suitable hormonal sprays may be around the corner!

Pheromones of the Silk Moth



3.1 Chemistry of Love. Reproduced with thanks from:
<http://clearscience.tumblr.com/post/1115676451/pheromones-are-chemicals-given-off-by-organisms>



3.2 Molecular Jet Engine---in our body
Reproduced with thanks from:
<http://www.dreamstime.com/stock-photo-dna-3d-concept-image20080800>

3.2 Molecular Jet Engines ---- Within Us!¹⁷

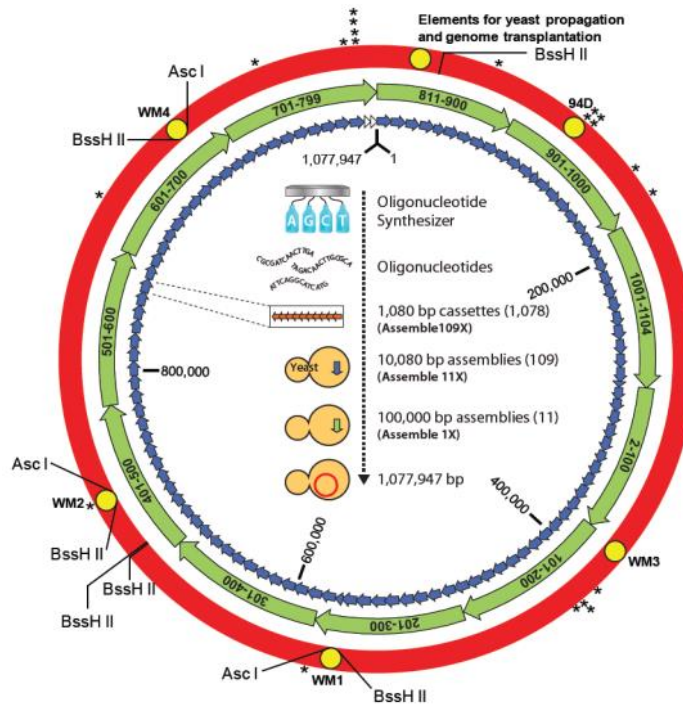
Imagine a long necklace with some 3 billion beads. Think also that these beads are only of 4 colours. This is the blueprint of life – the four types of beads representing four different molecules called “nucleotides”. It is the sequence in which these molecules are arranged which determines everything about you – be it the colour of your eyes, the structure of your organs or the composition of your cells. Imagine now that there are two separate strands of these “molecular necklaces” arranged anti-parallel to one other. These two strands are connected and held together by certain forces (hydrogen bonds) so that they resemble a long ladder. The ladder adopts a twisted form (the now familiar structure of the helical double stranded DNA). When a cell divides, the twisted ladder uncoils and opens up at an incredible velocity of 30,000 revolutions per minute, much faster than the fastest jet engine! The two strands come apart and new complimentary strands are synthesised for each of the two halves of the ladder. The result : one ends up with two ladders instead of one, and they twist back again at the same fantastic speed----akin to molecular jet engines working furiously but so quietly in our body. A new cell is formed, and all the coded information contained originally in a single cell is now contained in two daughter cells. All this goes on at the body temperature and we do not feel these molecular machines at work. This represents the miracle of life!

3.3 On Genome Sequencing and Synthetic Life!¹⁸

The first human genome to be fully sequenced cost about US\$ 60 million and was completed in May 2006, although the rough draft was announced in 2003 after 13 years of effort. Due to spectacular advances in sequencing technologies, the sequencing of the entire genome of James Watson was accomplished last year in just 2 months at a cost of US\$ 1 million. Machines are under development which may be able to do it in days for under a thousand dollars. A simpler form of genetic analysis which can cost only a few hundred dollars provides information about point



3.3a Genome Organization and Artificial Life Reproduced with thanks from: <http://knowingneurons.com/2012/11/16/unusual-suspects/>



3.3b Genome Organization and Artificial Life. Reproduced with thanks from: <http://www.smartplanet.com/blog/smart-takes/scientists-unveil-first-self-replicating-synthetic-bacterial-cell/>

mutations in a person's DNA which are linked to traits and susceptibility to diseases. This may allow us to take precautionary measures before the disease actually occurs.

Spectacular advances are being made in attempts to create life artificially. Dan Gibson and coworkers at the J. Craig Venter Institute in USA reported in a scientific journal "*Science*" last year the preparation of the entire bacterial genome, comprising a huge number of 582,970 base pairs artificially (by synthesis) modeled after a bacterium *Mycoplasma genitalium*.

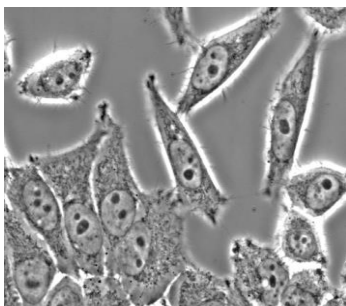
3.4 "Immortal" Human Cells!¹⁹

Is it possible for the cells that make up our body to continue to live and proliferate long after we have died? Indeed it is! One striking example is that of "HeLa" cells, named after a 31 year old African-American lady, Henrietta Lacks' from the cervix of whom these cells were taken in 1951 without her permission when she died of cervical cancer. These cells are still "alive and kicking" today. Some 50 million metric tons (!) of the living cells have been produced in laboratories all over the world, and over 60,000 studies using them published on a wide range of such topics as ageing, cancer, cellular effects of working in sewers, mosquito mating etc. What is so special about these cells is their ability to multiply in an abnormally rapid way as compared to other cancer cells, which makes them very useful in research. The children of Henrietta Lacks first received the shocking news that their mother was "alive" in the form of these cells in 1973. By then the HeLa cells had been taken to outer space and spread worldwide, even contaminating many experiments as far as Russia, because of their extraordinary proliferation abilities. Henrietta Lacks lives on in the form of her living body cells. Her HeLa cells continue to benefit virology, biotechnology and medical research.

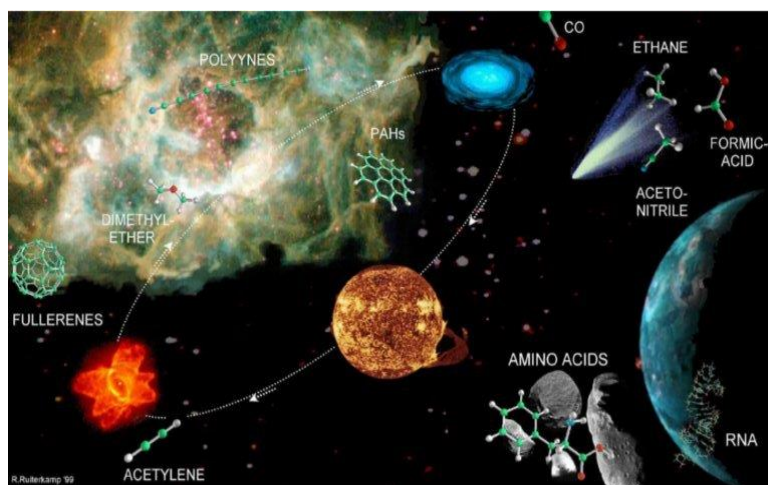
3.5 Life -- Did the Building Blocks Come from Outer Space?²⁰

Our bodies contain proteins which are built up of smaller molecules called amino acids. Amino acids can, in theory, exist in two forms which are mirror images of one another. They would

have identical physical properties except for the way they rotate light when it is passed through them. For some unknown reasons, only one set of mirror images (one “chiral” form) of these molecules exists naturally. This is a huge unsolved mystery about the origin of life ---why has nature chosen only one particular set of molecular building blocks? Life could equally well have evolved from the opposite (mirror image) set but, strangely, this has not happened. This has led to the theory that the molecules of life came from outer space where conditions could have existed to allow one set molecules to be formed.



3.4 Immortal---Human Cells. Reproduced with thanks from:
http://www.infobarrel.com/The_Origin_of_Hela_Cells



3.5 Does Life Building Blocks come from Space? Meteorite Contains Extraterrestrial Organic Molecules Never Found Before. Reproduced with thanks from: http://www.redorbit.com/news/space/1294383/building_blocks_of_life_found_in_ancient_meteorites/

Last year, Zita Martins and colleagues at Imperial College London found the first evidence of extraterrestrial molecules of life. While investigating the composition of a 4.2 billion year old meteorite which fell to earth in Australia in 1969, they discovered that the meteorite possessed two molecules, uracil and xanthine, which make up DNA and RNA. The extraterrestrial origin of these compounds was established from the carbon isotopic ratios. This discovery supports the hypothesis that life began on earth after it was seeded by certain molecules present in meteorites which bombarded our planet about 4 billion years ago.

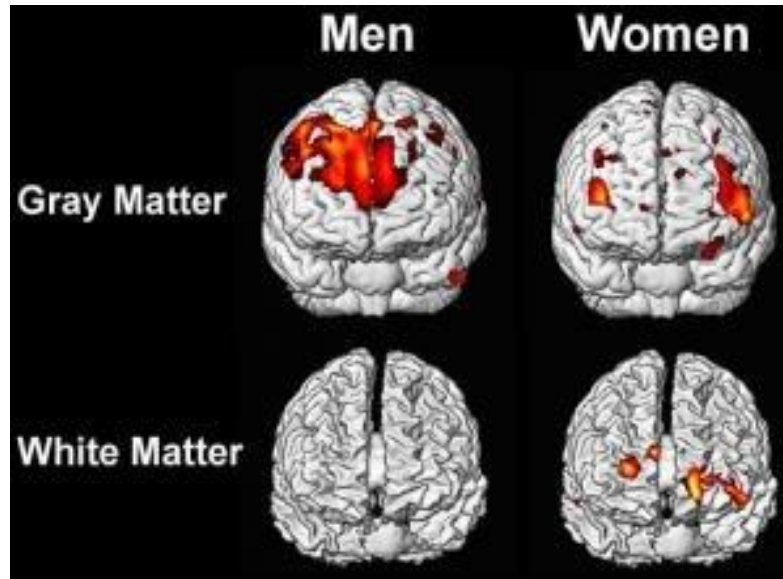
3.6 Is Thought Abstract and Is Intelligence Inherited?²¹

Is thought abstract? Most people would imagine that it is. Not true! The ability of the brain to store knowledge and to think is a chemical process, which can be chemically manipulated. Thus there are anti-depressant medicines which will help to cheer you up if you are depressed, and “truth drugs” which will make you tell the truth even if you do not want to. Atta-ur-Rahman and co-workers working at H.E.J. Research Institute of Chemistry, University of Karachi have proposed a new Theory of Memory (*Pure Appl. Chem.*, **74**(4), 511 (2002), USA). This theory states that learning may involve a process of formation of hydrogen bonds in the glycoproteins present in the human brain while forgetting may involve the breakage of these bonds.

Whatever be the basis of memory, one can state with certainty that thoughts have a molecular basis and thus a physically concrete existence.

The brain’s “grey matter“, which contains the processor cells, is heritable. The brain’s “white matter“, which is responsible for providing the connections between processors and which correlates with intelligence, is also heritable. Recently, Paul Thompson and co-workers at the University of California have shown that the protective myelin sheath (which governs the quality of the connections between the grey and white matter) is also determined genetically.

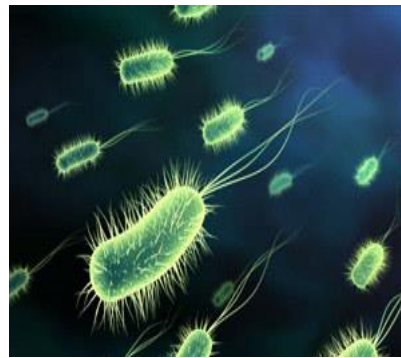
So can you improve your intelligence? The answer is yes, within limits, with mental exercises and training as we normally use only a small fraction of our brain's full capabilities.



3.6 Is Thinking Abstract and Intelligence Heritable. Intelligence In Men And Women Is A Gray And White Matter. Reproduced with thanks from: <http://www.sciencedaily.com/releases/2005/01/050121100142.htm>



3.8 Firefly and Fluorescent Flower. Reproduced with thanks from: <http://www.boywander.com/2012/09/magnificent-fireflies-in-puerto-princesa.html>



3.9 Obedient Bacteria. Bacteria in future may serve as Bio robots. Reproduced with thanks from: <http://topnews.in/bacteria-may-serve-future-biorobots-disease-diagnosis-292625>

3.7 Can Diet Enhance Memory?²²

Can you improve your memory by controlling your food intake? The answer seems to be yes! Eating less improves not only your physical health but also your mental capabilities. In a research finding published in the Proceedings of the National Academy of Sciences (USA), Agnes Floel and colleagues at the University of Munster in Germany have shown that when a group of persons of average age about 60 were kept on a diet with 30% less calories, they scored 20% higher in a word-based memory test. So take care how much you eat before your exams - dieting may get you those few extra marks that can make all the difference!

3.8 On Fireflies and Luminescent Flowers!²³

We have all probably seen fireflies glowing in the dark. How does this happen? There is some fascinating underlying chemistry involving a compound luciferin. Luciferin combines with oxygen, and light is emitted as a result of this reaction. The same mechanism exists in some deep sea jelly fishes which send out periodic flashes of light in the pitch dark depths of the ocean. A fascinating experiment conducted by some Israeli scientists was to transplant the genes responsible for the production of luciferin into orchids. The result was luminescent orchids which glow in the dark! The time may not be far when you will be able to sit in the evening in your garden surrounded by chemiluminescent roses and other flowers. This indeed is the strange and wondrous world of science!

3.9 Obedient Bacteria: Biological Robots!²⁴

We are all aware of robots ---- they are widely employed in industry. Much of the manufacturing in the automobile industry today is carried out by robotic machines. Household robots are also being developed which are gradually becoming more and more intelligent. Scientists are working on another exciting

frontier of this field---that of biological robots! This involves tinkering with the genetic machinery of biological organisms so that they can perform specific predetermined tasks.

Bacteria, usually regarded as organisms responsible for disease, have already been harnessed for a variety of useful purposes. These include conversion of such raw materials as molasses to citric acid, preparation of industrial enzymes and manufacture of drugs. This however was accomplished with natural organisms. Now “stripped down” bacteria (i.e. genetically altered organisms) are being developed which can act as micro-slaves, (biological robots or “biobots”), programmed to accomplish such tasks as imprinting nanoscale patterns on microchips by secreting certain chemicals along a predetermined pathway. Self-cleaning “living” fabrics are also under development. They are embedded with harmless strains of bacteria that can remove odour from sweaty armpits as they feed on the sweat and accompanying proteins. Other bacteria can secrete protective coatings that will extend fabric life or secrete chemicals with antiseptic properties which can be used in bandages.

Bacteria are already used to clean oil spills, degrade chlorinated hydrocarbons, and remove toxic metals from the soil. Efforts are now underway to develop genetically modified microbes which can accomplish specific industrial tasks.

***3.10 Animals---Their Fascinating Sense of Direction!*²⁵**

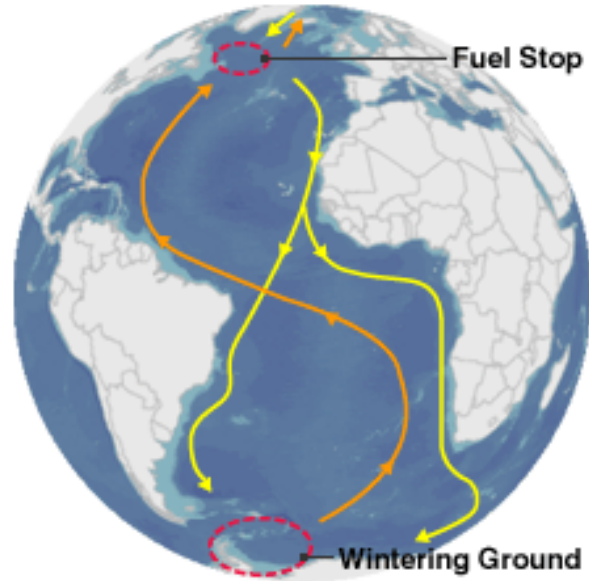
I had a pair of dogs in the 60s that were constantly bothered by a wild cat in the neighbourhood. One day, I had the cat captured, put it in a jute bag, locked in the dickey of my car and taken by a circuitous route to Hawk’s Bay at the other end of Karachi where the cat was released. Lo and behold, to my utter amazement, the following morning the cat was back, safe and sound!

Many animals have an amazing ability to find their way around. They include birds, rats and hamsters. Blindfolded and taken to another place by circuitous routes, golden hamsters can return straight home with ease. Geese, toads and spiders also have these skills. How do they do it? Some species have specialized senses that we do not possess and can find their

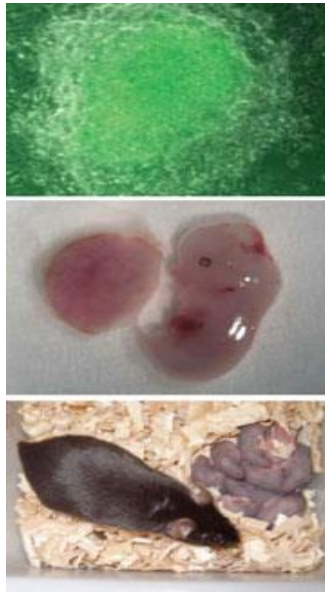
way about using these senses. Migratory birds use the earth's magnetic field for navigation. Some insects use gradations in the polarity of light to find their way about. Other animals such as rats, mice, monkeys and goldfish have special neurons in their brains dedicated to the sense of direction, allowing them to compute distance and direction with surprising accuracy. Many animals can travel huge distances using these remarkable navigation abilities. A bird, the Arctic tern, flies about 70,000 km each year from its breeding ground in the Arctic to its winter habitat in the Antarctic. Although it weighs only about 100 grams, over its life time it travels about 2.4 million kilometers which is equivalent to about 3 trips to the moon and back, using its extraordinary stamina and navigation skills.

3.11 Mice Born from Stem Cells!²⁶

Stem cells found in our body are responsible for repairing damaged tissues and organs. They are part of a powerful internal repair mechanism. Stem cells can be transformed into other specialized cells such as a heart, kidney, muscle or red blood cells. They are thus constantly replacing worn out tissues by fresh tissues. In 1998, scientists discovered how to derive these cells from human embryos and grow them in the laboratories. The use of embryonic materials for producing stem cells was highly controversial and the laws in many countries stood against the research in the field. However, two years earlier, in 1996, another important breakthrough had occurred when scientists found that it was possible to take specialized adult cells, such as normal skin cells, and "reprogram" them genetically so that they became converted into cells that resembled stem cells ("induced pluripotent stem cells"), (iPS cells). Such cells were first reported from mice in 2006 (Takahashi and Yamanaka, *Cell*. 2006 Aug 25;126(4):652-5) and in late 2007 from humans (Takahashi *et al.* *Cell*. 2007 Nov 30;131(5):834-5. and Yu *et al.* *Science*. 2007 Dec 21;318(5858):1865). The use of stem cells to regenerate damaged heart, kidney and other tissues promises to change the way we will treat diseases in the future.



3.10 Animals' Sixth Sense. Reproduced with thanks from:
<http://acanadiannaturalist.net/tag/salmon/>



3.11 Development of Rat by using Stem Cells. conversion of mouse fibroblasts into IPS cells that generate live pups. Reproduced with thanks from:
<http://www.nature.com/nchina/2009/090722/full/nchina.2009.155.html>

The first live mice have recently been created from mouse skin cells by Zhou *et al.* of the Chinese Academy of Sciences in Beijing, thereby establishing the potential of stem cells into all the body tissues (*Nature*, DOI: 10.1038/nature08267). If mice can be born in this manner, so can humans before long!

3.12 Shock treatment for Cancer!²⁷

A technology similar to that used in the “taser stun gun” is being explored for treating cancer. Nanosecond high voltage pulses, when applied to cells, can cause those cells to destroy themselves, offering a potential treatment for cancer. Such nanosecond pulses have longer lasting effects than the microsecond pulses used in taser guns, the effects of which wear off quickly.

3.13 A World Epidemic --- in Bee Colonies!²⁸

Something very strange is in the wind. A mystery disease is wiping out a large number of bees in various parts of the world, which could threaten certain types of crops that rely on bee pollination. The bees suffering from an affliction, known as Colony Collapse Disorder (CCD), have their memories affected, which makes them unable to get back to their hives. Some beekeepers in USA have reported the loss of 35-45% of their colonies, and it is thought that the disease seems to be affecting their immune system which results in memory losses.

3.14 Hardy Bacteria!²⁹

New hardy bacteria, called “extremophiles” have been discovered on earth which can survive under very extreme conditions, raising hopes that life may have evolved under much harsher conditions than hitherto considered possible on other planets. The South African extremophile bacteria live some 5 miles below the surface of the earth in the South African gold mines, and derive their energy not from surface water or sunlight but from an extra-

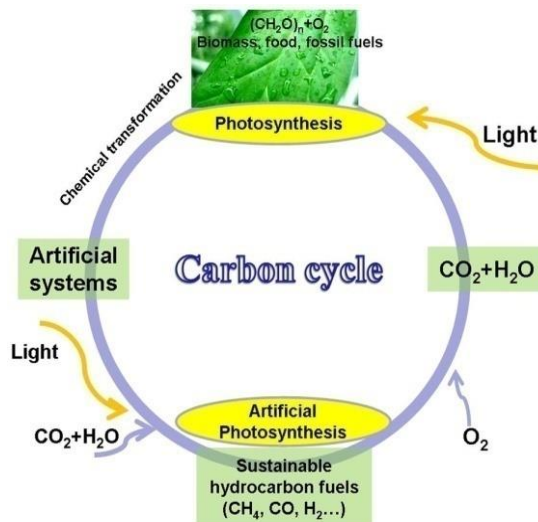
ordinary source, the radioactive decay of some unstable atoms present in the rocks.



3.13 International epidemic in Honey Bees Population. Who killed the honeybees? Reproduced with thanks from: http://www.salon.com/2007/05/29/missing_bees/

3.15 Artificial Photosynthesis³⁰

Natural photosynthesis involves the use (by plants, algae and many bacterial species) of sun light to convert carbon dioxide from the atmosphere into sugars. About 100 billion tons of carbon is converted into biomass each year. Some 100 terawatts of energy are thus captured, which is about 6 times the total power consumption on our planet.



3.15 Artificial Photosynthesis. Leaf-architected 3D Hierarchical Artificial Photosynthetic System of Perovskite Titanates Towards CO₂ Photoreduction Into Hydrocarbon Fuels. Reproduced with thanks from: <http://www.nature.com/srep/2013/130416/srep01667/full/srep01667.html>

Efforts have been made by scientists in the past to develop artificial photosynthetic processes with limited success. Researchers at the University of Cincinnati in USA have developed a process to create a photosynthetic material from a foam comprising enzymes derived from plants, bacteria, frogs and fungi. This foam is capable of converting sunlight and carbon dioxide into sugars. These sugars can then be converted to ethanol and other biofuels.

The idea to use foams came from the study of certain frogs (Tungara frogs) that produce stable long-lasting foams for developing tadpoles. These foams allow excellent penetration of light and air, and enzymes encased in such foams can be used for artificial photosynthesis. The foam is claimed to have several advantages. It does not need soil, and can therefore use sunlight to produce sugars without using soil needed for producing food crops. It is also claimed to be able to convert all the energy from the sunlight captured to sugars, whereas plants use some of this energy to maintain their life functions.

3.16 Are Criminals Prisoners of their Brains?³¹

There is growing scientific evidence that hardened criminals possess certain brain abnormalities which make them behave as they do. The argument that the criminal act is due to a neuropsychological impairment is being increasingly used in courts by defence counsels. This can be demonstrated by MRI scans of certain regions of the brain that show that there are some inherent physical abnormalities in the brains of the criminals as compared to those of normal persons, so that the extent of culpability can be reduced (Behavioural Sciences and the Law, Volume I 26, p 85). As the field of neuroscience grows, and the relationships between differences in the physical structure of the human brain with behaviour are better understood, such considerations will become increasingly important in criminal trials.

3.17 Test Tube Babies—from a Selection!³²

Test tube babies are made by uniting the egg from a woman with the sperm of a man in a lab dish. The egg then starts dividing and the early stage embryo is then transferred into a woman's uterus to develop. The technique is known as *In Vitro* Fertilisation (IVF). Some clinics, in order to increase the chances of success, implant more than one embryo into the uterus, resulting in the birth of twins, triplets, quadruplets, etc. These babies are often born early and can face health problems. Scientists have therefore been searching for methods whereby they could select the best embryos for implantation.

Now, Renee Reijo Pera and co-workers at Stanford University have developed a new test that allows the best embryos to be picked up for transplantation. An exclusive license has been acquired by a US company, Auxogyn, to commercialise the findings. In the US alone, there are some 500 companies offering IVF services and the total world market is estimated to be several million dollars.

Meanwhile, the Nobel Committee announced on October 4, 2010 that this year's Nobel Prize for Medicine will go to Bob Edwards, an 85-year-old British scientist who pioneered this method. The researches were carried out at Cambridge University and the first 'test tube baby' Louise Brown was born in northwest England by this procedure on July 25 1978. Since then some four million babies have been born by IVF.

3.18 Human Evolution Due to Dinosaur Extinction!³³

About every 100 million years, our planet is hit by a big asteroid which can change the course of evolution. If we were to be hit by such an asteroid now, most of life as we know it would be wiped out and the few insects, fish and bacteria/viruses that survive would begin the evolutionary process all over again.

About 200 million years ago, the lush green earth was inhabited by reptiles, many of which, such as the dinosaurs,

were huge in size. This reptilian era lasted some 160 million years. Then 65.5 million years ago a huge asteroid, about 10 kilometres across, slammed into Mexico. The result was a global catastrophe. The blasted rock layers released a huge amount of carbon and sulphur containing gases. Fires raged and darkness descended as the resulting dust blocked sunlight from reaching the earth. Acid rains followed and the earth cooled. Most life was wiped out, including reptiles, birds and plants and only about half of the most resilient mammals survived. The extinction of the dinosaurs and many other life forms changed the course of evolution.

The surviving mammals were generally smaller in size, versatile in their movements, could breed fast, and escape the fires and acid rain that ravaged the earth. There was a new burst of evolutionary creativity in this changed environment some 10 million years later, finally leading to humans, as is evident from the 'molecular clock' studies which are based on the reconstruction of the evolutionary tree from the study of the genomes of related species.

We may owe our civilisation to the extinction of the dinosaurs!

3.19 Grow Muscles --- in the Laboratory!³⁴

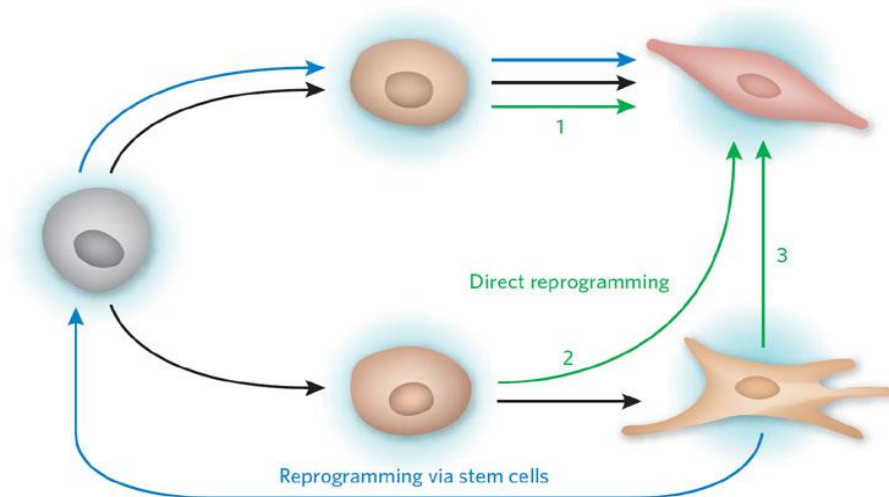
We all know how hard it is to develop muscles. It involves months, if not years, of hard exercise, perseverance and patience in the gym. Scientists at the Eindhoven University of Technology (TU/e) in the Netherlands have developed a method to develop muscle tissues, complete with blood vessels, through a process of bioengineering. The muscle tissues need to be organized in such a manner that they are aligned in the same direction, in order to produce strength, and each muscle should have an appropriate supply of blood vessels so that oxygen and nutrients could be transported to it. Previous attempts had failed as the tissues produced were disorganized.

The TU/e team succeeded where others had failed using stem cells and blood vessel cells to grow the tissues. The alignment in one direction was achieved by fastening the pieces of tissue in one direction using Velcro. The resulting tension in the

growth process resulted in the muscles and blood vessels being properly aligned, rather than growing in a disorganized manner. The scientists hope to apply this technique for growing muscles for patients who may have lost muscle tissue by accident, injury or in surgeries involving cancerous tumors.



3.18 Dinosaurs Extinction because of Human Evolution. Reproduced with thanks from: <http://www.listoid.com/list/149>



3.19 Making Muscles in Lab. Chemically reprogramming cell fates. Reproduced with thanks from: http://www.nature.com/nchembio/journal/v6/n2/fig_tab/nchembio.295_F1.html

3.20 New Form of Life Discovered!³⁵

A completely new form of life has been discovered by scientists working at NASA in USA which uses arsenic instead of phosphorus in the living process. For life to exist, certain elements have been assumed to be necessary: carbon, hydrogen, nitrogen, oxygen, phosphorus and sulfur. The discovery of a living organism that has learned to live without phosphorus is therefore an earth shattering discovery. Phosphorus is present in DNA which is vital to life. The bacteria discovered by NASA scientists learned to replace phosphorus with arsenic and were still be able to live.

The bacterium, code named GFAJ-1, was isolated from Mono Lake in USA by Felisa Wolfe-Simon. It was then grown in a medium with very little phosphorus but high content of arsenic. Analysis showed that the bacterium was remarkably capable of incorporating arsenic instead of phosphorus in its DNA backbone.

If the work by NASA scientists is found to be correct, it would mean that life may have evolved on other planets in our universe in completely different ways than it has on earth, by utilising other elements.

3.21 Turn into Juicy Mushrooms --- after Death!³⁶

Do you want to turn into a bunch of juicy mushrooms after your death? A suit invented by artist Jae Rhim Lee will accomplish that smoothly. The artist has been experimenting with environmentally friendly ways in which bodies may be buried so that they do not produce toxic materials when they decompose. The special suit is embroidered with a netting of one of different types of mushroom spores. So you have a choice too, which mushroom you would like to turn into! The corpse is wrapped in this suit and is then embalmed with a special slurry containing more spores and important minerals. The combination works wonders. The body is soon eaten away, and the organic matter breaks down into a nutrient rich compost that feeds the mushroom spores and also enriches

the neighbouring soil. In time, some excellent mushrooms will grow out of the dear departed ones, who may then end up on someone's dining table and be a source of pleasure and satisfaction.

The "Infinity Burial Project" has attracted a society around the concept --- the Decompiculture Society --- that is devoted to propagating such "green burials".

4. DEFENSE

4.1 Cyborg Beetles: A New Defense Weapon?³⁷

Scientists at the Tokyo University of Agriculture & Technology have developed “cyborg beetles” that have a pre-programmed remote controlled chip implanted in their brain or connected to their nerve cells. This allows the movement of these insects to be externally controlled. Tiny batteries are being developed, as a source to power the “stimulator chips”. Fitted with tiny microphones, these insects or small “cyborg rats” could become a new defense weapon to spy on important secret installations and listen in to secret conversations.

So watch it when you are next having a confidential meeting -- a cyborg fly may be listening and transmitting!

4.2 Insect Drones can Now See!³⁸

Certain insect sized military drone aircrafts developed in USA have now been successfully fitted with tiny eyes (mini-cameras) so that they can transmit both sound and photographs. These mini-cameras are fitted with a single micro-chip and are very light, making these surveillance “insect drones” very effective for espionage purposes, since they can be controlled by a secure frequency signal from a distance of over a kilometer. The device was developed by Caltech’s Jet Propulsion Lab in Pasadena, and has been funded by NASA (www.tinyurl.com/ojwmdq). So if a fly is sitting on your wall, watch out ---- it may be a surveillance drone recording all that you say or do!

4.3 The Cyborgs are Coming!³⁹

Is it possible to enhance our mental capabilities by hooking our brains up to machines? The answer is yes ---- this is now beginning to happen. While enhancing brain power by genetic alterations is still many years away, bionic persons in which

humans and machines are integrated to enhance human performance are under development. John Donoghue at Brown University USA has developed “BrainGate” technology that allows paralysed persons to have computers interfaced with their brains, thereby making it possible to operate TV or light switches, move a cursor on the computer or to open emails. The US military (Defense Advanced Research Projects Agency) is spending US \$50 million in a program to develop brain-controlled artificial limbs. Self-powered devices have been developed which will enhance the strength of arms or legs when worn.



4.1 Scientific Beetles--- A New Defense Weapon. Cyborg Insects: Real Bugs Customized With Clockworks. Reproduced with thanks from: <http://www.wired.com/2007/12/cyborg-insects/>



4.2 Drone Insects. Tiny, Hackable Quadcopter Drone. Reproduced with thanks from: <http://www.wired.com/2013/02/crazyflie-nano/>

4.4 Smart Weapons!⁴⁰

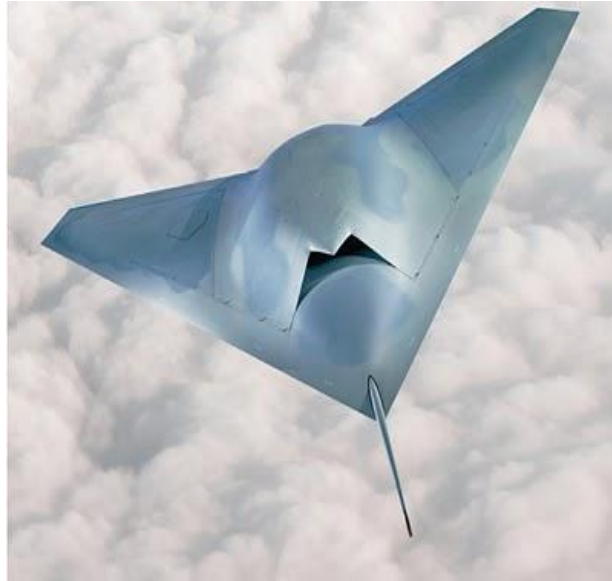
A problem faced by security and defense personnel is to shoot down enemy soldiers or fugitives hiding in bunkers, around corners or in buildings. As they are not in the line of sight, they cannot be shot at directly. The US army has solved this problem by inventing an XM25 rifle that fires radio-controlled bullets. The rifle has a laser range finder which calculates the precise distance of the target, and the soldier can then adjust the distance within 3 meters of the obstruction, so that the bullet (an "airburst shell"), explodes beyond or above the target, killing him/her. This special rifle thus behaves as a grenade launcher, with the additional capability of being able to control the exact point of explosion of the high explosive round. The 25 mm round contains a chip to which a radio signal is sent from the rifle gunsight, with the exact distance at which the explosion is desired.

Advances in microchip technologies are now making the development of such "smart" munitions possible. This new weaponry will be available for large scale deployment in Afghanistan and Iraq within 2 years.

4.5 New Stealth Weapon!⁴¹

If a nuclear blast is carried out several miles above enemy territory, the resulting electromagnetic pulse can not only disable the surveillance and other electronic equipment of the enemy but also cause huge collateral damage. The US Air Force has now developed a weapon which uses gigawatt bursts of electromagnetic pulses, 10 nanosecond-long, which cause a power surge in unshielded wires, resulting in the destruction of radars, satellite dishes and other electronic equipment, thereby blinding the enemy. The weapon can be fired from the antenna of a stealth unmanned aerial vehicle (UAV). Boeing has developed a special fitted stealth "Phantom Ray" UAV which can approach the enemy undetected for the purpose. Since the microwaves can travel through ventilation ducts and pipes leading to enemy bunkers, the electronic equipment concealed in bunkers is also destroyed. The US Air Force has allocated US\$ 40 million for the further development of even more powerful longer range weapons.

The Pakistan armed forces need to involve our engineering universities to develop similar weapons as well as protective electronic devices against such attacks.



4.5 New Stealth weapons. Ray Boeing phantom. Reproduced with thanks from: <http://deepbluehorizon.blogspot.com/2010/05/boeings-phantom-ray-revealedto-fly-in.html>

4.6 Laser Warfare: “Star Wars”- Style!^{A2}

On February 11, 2010, a ballistic missile was launched from a mobile launch platform on the sea. As the missile gained speed by firing rocket boosters, it was detected by on-board sensors on an aircraft equipped with a very powerful chemical oxide laser gun. The target was tracked by a low energy laser and then fired upon by the megawatt-class high energy laser, destroying the ballistic missile. This was the first demonstration of the destruction of a ballistic missile using high powered lasers from an air-borne platform, and has heralded the advent of a new generation of powerful weapons that may change the future course of warfare.

The program to develop these weapons was initiated by Ronald Reagan in 1983. Ground-based laser systems were developed

to knock down incoming missiles, but they suffer from the disadvantage that they can protect only a limited ground area. The second more ambitious programme was to develop a mobile air-borne laser gun system that could be deployed anywhere rapidly. A B-747 aircraft was modified in 2004 to house the high-powered laser gun.

The technology involves the deployment of Free Electron Lasers (FEL). These are different from conventional lasers which are limited by the wavelength of light that they emit (since that is dependent on the source of the electrons, gas or crystal, in the lasers). In FEL devices, the atoms are stripped of the electrons and they are then energised to huge energy levels by using a linear accelerator.

4.7 Sophisticated Aircraft---Designed to Fail!⁴³

Imagine that you are a pilot flying a fighter aircraft on a mission above enemy territory. Suddenly, you lose control for no apparent reason and the plane goes into a spin dive---forcing you to bail out. The reason ---- the plane was supplied with some special “adulterated” microchips which could be activated by external signals to disable important controls --- flight controls, guidance systems, firing mechanisms etc.

Engineers of Case Western University in Cleveland, Ohio and the electronics company Rockwell Automation of Milwaukee, Wisconsin, USA have shown how microchips could be converted into “Trojan horses” which could be activated by an external signal whenever required, disabling the equipment (arXiv:0906.3832 and 0906.3834). Such adulteration of chips is almost impossible to detect because of the huge complexity of the circuitry in the electronic equipment which contains millions of different circuits.

Countries which are unable to build their own sophisticated military equipment will soon find that they may be buying expensive “sitting ducks” with built-in time bombs ----- preprogrammed to fail if the supplier countries pass the trigger to the enemy country. A simple triggering radio message can cause the equipment to fail at a crucial moment.



4.8a Star wars is here-reusable military spaceship launched. Reproduced with thanks from: http://commons.wikimedia.org/wiki/File:X-37_spacecraft,_artist's_rendition.jpeg



4.8b Star wars is here-reusable military spaceship launched. Reproduced with thanks from: <http://www.eweek.com/storage/bae-systems-takes-government-grade-storage-to-enterprise.html>

4.8 Star Wars is Here—Reusable Military Spaceship Launched!⁴⁴

On April 22, 2010, a robotic spaceship was launched from Cape Canaveral Air Force Station in Florida, USA. The X-32B orbital test vehicle represents the next generation of space vehicles. Its real mission is being kept a closely guarded secret. It is not meant to carry people but contains new equipment, materials and sensors that can be incorporated into satellites. It is speculated that new weapon systems will be tested on it from space (low earth orbit) for the first time in human history. It can keep itself in space for as long as nine months and may represent the first of a convoy of many military space vehicles that will remain permanently in space to closely watch over possible military activities in enemy territories as well as have the ability to launch attacks against them.

The US agencies involved in its development include NASA, Defence Advanced Research Projects Agency (DARPA), and other US defence agencies. Besides intelligence gathering, the spacecraft may be able to launch small spy satellites over strategically important locations that will provide very sensitive 'eyes and ears'.

The spaceship can therefore have multiple functions for reconnaissance, communications, and space weapon. This latest development may well trigger a response from Russia and China to develop anti-satellite weapons against such spaceships—the US is already developing improved and more accurate versions of anti-missile missiles. So the arms race goes on!

4.9 An Exciting Military Development: Make Tanks Disappear!⁴⁵

In earlier articles, I have described the development of a new class of materials, “metamaterials”, that can bend light around them and cause objects made of such materials to become invisible. Now, another exciting advance has been made by researchers at BAE Systems, a global company specializing in making defense weapons and equipment with annual sales of over 22 billion pounds. A tank or another armoured vehicle can have a significant advantage over the enemy if it can somehow cloak itself so that it is invisible and blends in with the surrounding landscape. BAE engineers have developed a cloaking technology that involves covering the tank/vehicle with hexagonal sheaths of a material. These hexagons act as pixels that can change their temperatures and combine together to display an infra-red image that is formed by an onboard camera that records the surrounding landscape. The tank may thus appear as trees and bushes! Even a moving tank can rapidly change its image as the background changes. The hexagons on the surface are made of strong but light weight metal that offers protection against enemy gun fire. They are powered by the electrical system of the vehicle on which they are installed.

An onboard computer has a library of images stored in it so that if the tank is to appear as a rock or a bunch of animals grazing, it can project such an image. Besides the infra-red images, the technology can also be adapted so that other parts of the spectrum (eg. visible light) can also be manipulated, thereby allowing all-round stealth capabilities. The technology can also be used on ships, aircraft and helicopters.



4.9 Making war Tanks Invisible: Unlike conventional forms of camouflage, the images on the hull would change in concert with the changing environment always insuring that the vehicle remains disguised. Reproduced with thanks from: <http://www.telegraph.co.uk/news/uknews/defence/8247967/Invisible-tanks-could-be-on-battlefield-within-five-years.html>

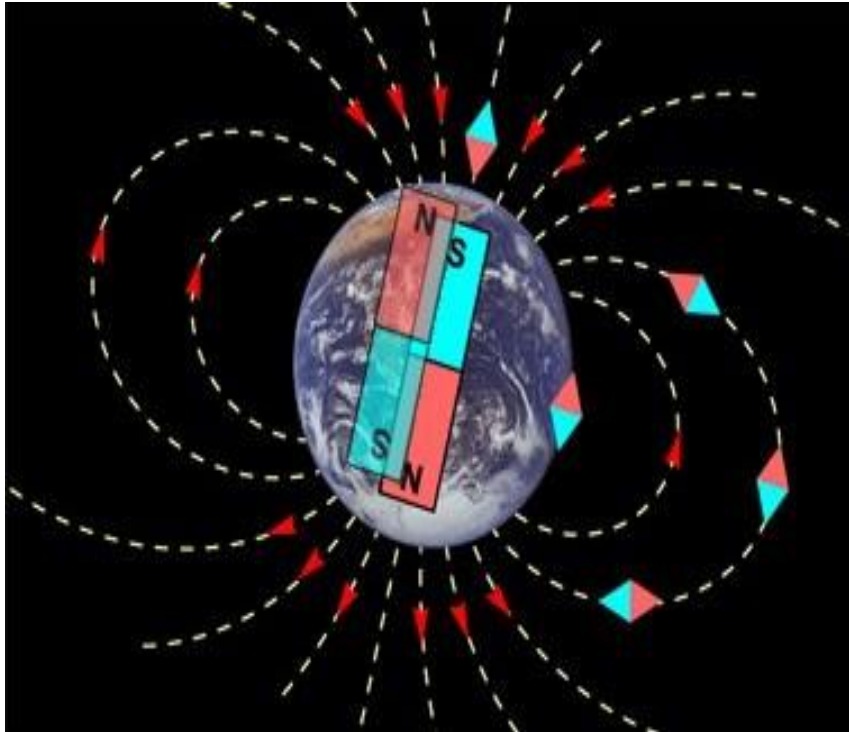
5. EARTH SCIENCE

5.1 Planet Earth: Two Easts, Two Wests!⁴⁶

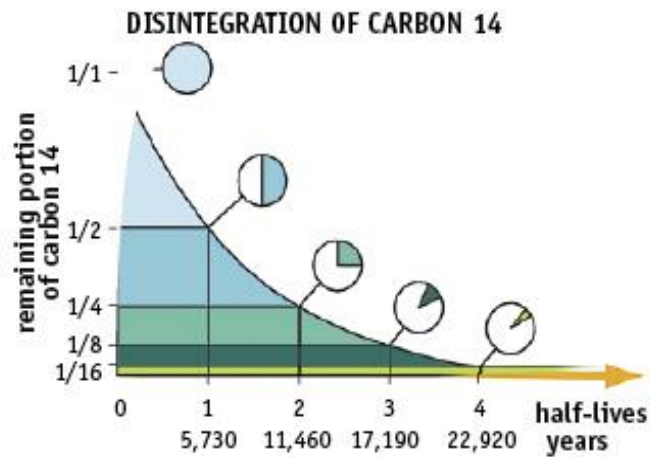
The earth's magnetic field is due to the circular movement of the earth's molten outer iron containing core around a solid inner core, creating a dynamo-like effect. The effects of the magnetic field extend to tens of thousands of kilometers into space above the earth. This "magnetosphere" protects the earth from the damaging effects of cosmic rays, and life would not have existed in its present form without this protective effect.

After a certain period of time, ranging from tens of thousands of years to a million years, the earth's magnetic field undergoes a reversal so that the positions of the north and south become interchanged. The process, known as a "geomagnetic reversal", last occurred about 780,000 years ago, but has occurred more frequently also (twice in 50,000 years). The timing of the reversal of the earth's magnetic field was first determined by a Japanese scientist, Motonori Matuyama, in the 1920s when he found rocks in Japan whose magnetic fields were reversed. Since then age related magnetic stripes have been found on ocean floors, indicating that reversals in the earth's magnetic field have occurred numerous times since its formation. The earth's magnetic field is presently getting weaker with a 10-15% decline in the last 150 years, indicating that the reversal of poles could occur before long.

Obviously, each time the reversal of north and south occurs, east becomes west, and the west becomes east. The planet earth has therefore had two easts and two wests many times over its life period. It is an interesting fact that in the Holy Quran, there is mention of "Rabbul Mashreqaine wa Rabbul Maghrebain" ---the Lord of the two Easts and the two Wests! The phenomenon of reversal of the earth's magnetic field was not known when the Holy Quran was revealed.



5.1 Earth- Two East Two West Geomagnetic Reversal. Reproduced with thanks from: http://www.fourwinds10.net/siterun_data/environment/earth_changes/news.php?q=1332860546



5.2a Fossils- Age determination of materials. Reproduced with thanks from: http://www.ikonet.com/en/visualdictionary/static/us/knowledge_of_geologic_time

5.2 Determining the Age of Fossils/Materials!⁴⁷

Fossils have been discovered which are hundreds of millions years old. How does one determine their age? The technique involves measuring the abundance of some elements. One method commonly used is called “carbon dating”. There are three forms (isotopes) of carbon: the stable forms are carbon-12 and carbon-13, while an unstable radioactive form which decays with time is carbon-14. These forms of carbon are incorporated into the plant kingdom by the process of photosynthesis (conversion of atmospheric carbon dioxide into more complex plant parts), and then, through the food chain, carbon is passed on to animals. The radioactive carbon-14 is being constantly formed in the atmosphere as a result of bombardment of nitrogen by cosmic rays. Live plants and animals have the carbon-14 being constantly introduced from the atmospheric carbon dioxide but once the living materials die, the amount of carbon-14 starts to diminish with time---the clock starts ticking. Carbon-14 has a “half life” of 5730 years i.e. its amount is reduced to half after this time. After ten half lives (about 60,000 years), the amount of carbon-14 diminishes to almost zero and it is therefore not possible to find the age of plant or animal fossils older than 60,000 years by radiocarbon dating.

For determination of age of fossils older than 60,000 years, one uses a potassium-argon dating technique. Potassium-40 has a half life of 1.3 billion years, thus allowing the age of rocks several billion years old to be determined. A more accurate “argon-argon” dating technique (determining the ratio between argon-39 and argon-40) has also been developed.



**5.2b Determining Age of Fossils/Materials. Reproduced with thanks from:
<http://galleryhip.com/carbon-dating-fossils.html>**

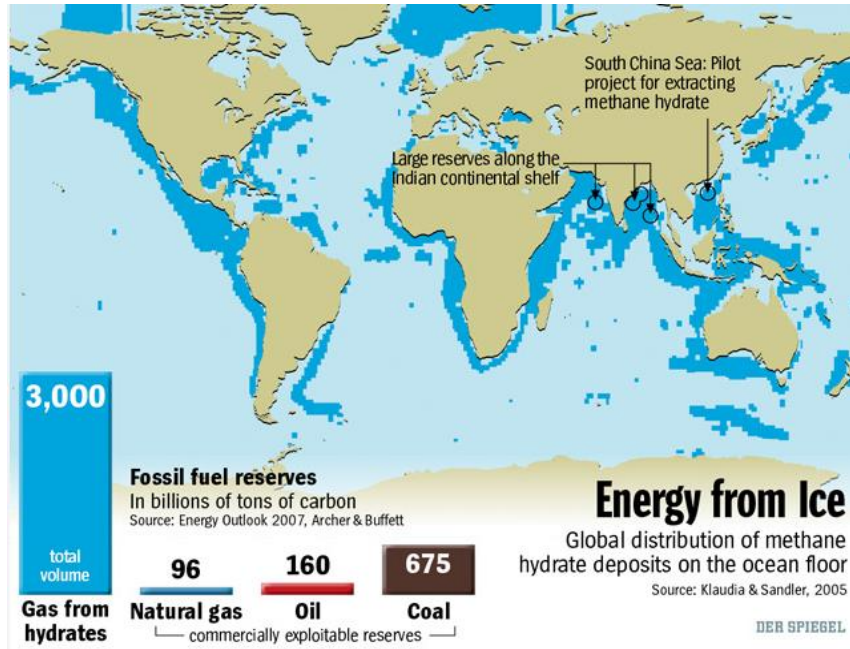
6. ENERGY

6.1 A Major New Source of Energy --- Methane Clathrates!⁴⁸

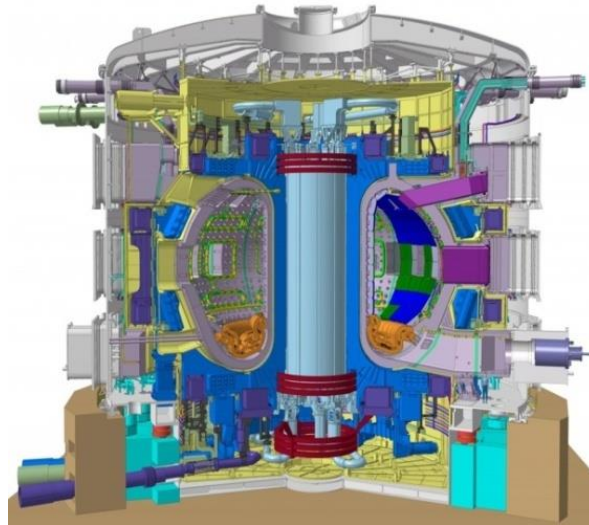
The energy resources in our planet, specially oil and gas, are being fast depleted. However, an exciting new source has been found which is estimated to have greater energy potential than all the present oil, gas and coal reserves taken together ---- some 3 trillion tons of methane, trapped under sea beds or in icy deposits in permafrost. These deposits, called “clathrates”, can meet the energy needs of the world for another hundred years. The existence of this energy resource has been known for decades but there was no attempt to commercially exploit it previously. The Russians accidentally tapped into a deposit of methane clathrates when they were pumping gas from under permafrost in Western Siberia. Their gas well which should have run dry by the end of the 70s is still pumping methane gas! The methane clathrate layers are often hundreds of meters thick, and the gas is present in a highly compressed state. Since the gas exists at high pressure, vast quantities can therefore be released. The best production technique used is depressurization--- a hole is drilled which releases the pressure, and methane gas comes out.

Chinese and German scientists have discovered large deposits under the sea off the coast of Taiwan, and Indian scientists have discovered methane deposits off the east coast of India (Krishna-Godavari basin). Japan has discovered deposits of 50 trillion cubic meters which could meet its energy needs for centuries and commercial production is expected to begin by 2016. Korea is expected to begin commercial production of another field by 2015, which could meet its energy needs for another 30 years.

Wake up Pakistan! In view of the Indian discovery, the land being not too far from us, as well the presence of these deposits in the Gulf of Oman, it is likely that vast deposits may exist near Karachi and off the coast of Baluchistan. These could meet the energy needs of Pakistan for the rest of this century and beyond. We should immediately start investigating this potential (further reading: *New Scientist*, 30-33, June 2009).



6.1 Methane Clathrates. Reproduced with thanks from:
https://www.wou.edu/las/physci/Energy/Gas_Hydrates.html



6.2 Creation of Small Sun on Earth. Nuclear fusion, JET and ITER.
 Reproduced with thanks from: <http://www.theengineer.co.uk/in-depth/the-big-story/nuclear-fusion-jet-and-iter-your-questions-answered/1014477.article>

6.2 Making a Mini-Sun ---- on Earth!⁴⁹

Preparations are under way in the south of France for one of the most exciting experiments ever undertaken in human history by man. Known as the International Thermonuclear Experimental Reactor (ITER), it aims to reproduce the way the sun and stars produce heat and light---- by nuclear fusion i.e. lighter elements fusing together to give heavier elements with the production of huge amounts of energy. Our planet has been warmed by the sun due to such fusion reactions for billions of years, and the stars also produce their heat and light through such fusion reactions. The project is expected to cost about Euros 10 Bln. and take 15 years to complete.

The fusion of two isotopes of hydrogen (deuterium and tritium) can occur with the formation of a heavier element, helium and the production of a huge amount of heat energy. The heat produced is expected to be 5-10 times greater than the heat energy required for the fusion reaction to take place. To achieve fusion, phenomenally high temperatures of about 100 million K must be achieved. This will require special vessels in which the fusing plasma will be magnetically suspended in the center to prevent the metal of the vessel evaporating due to huge temperatures.

By the end of the century, our cities may well be powered by fusion reactors, with sea water being used as the source of deuterium for the fusion reactions --- man made mini-suns on earth!

6.3 Energy from the Sun!⁵⁰

The sun bathes our planet with a huge amount of energy, about 85,000 terawatts, each year. Our annual consumption of energy, by comparison, is only about 16 terawatts. This means that the sun provides about 5,000 times more energy than the world needs today. It seems silly therefore that we are polluting our planet by burning fossil fuels whereas so much abundant energy from the sun is largely going waste. This situation is now beginning to change rapidly and new technologies are emerging that Pakistan needs to make use of.

Solar cells are normally made of silicon wafers. These crystalline materials have achieved a commercial efficiency of 22% but the solar panels made from them are expensive, and largely suitable for remote areas where the grid system cannot provide cheaper electricity. Thin-film solar cells, produced from amorphous, nanocrystalline and some other forms of silicon by chemical vapour deposition, have efficiencies of about 9% but they can be produced at one-fifth the costs and their efficiencies are improving rapidly.

However, the most attractive form of solar energy involves the simple use of thousands of mirrors that can focus the energy of the sun on boilers located on towers. The steam generated by this energy from this "Concentrating Solar Power" (CST) technology is heated to a temperature of up to 850°F, and used to drive turbines that generate electricity. Google has funded a 5-megawatt facility near Los Angeles that involves 24,000 mirrors arranged in arrays on 20 acres of land. They are controlled by computers that focus the sunlight on to the boilers. It is expected that the use of CST technology will double every 16 months worldwide, increasing from 457 megawatts in 2007 to 6,400 megawatts by 2012.

Pakistan has abundant sunshine and an acute shortage of electricity. All we require is a vision and a determination to act.

6.4 Electricity from the Sun!⁵¹

The sun is a huge source of energy for our planet. The amount of energy we receive in a fortnight on the surface of our planet is more than what we consume as electricity, petrol, coal and other energy forms in a whole year. While photovoltaic (PV) panels using solar cells to convert sunlight directly into electricity are being increasingly used in Europe, USA and other technologically advanced countries, the technology is expensive. A cheaper and more viable option is to trap the sun's energy in the form of heat, and then use it to generate electricity--- the so called "solar thermal" electricity generation plants. There are four main types of solar thermal power plants. Three of these use mirrors to focus the sunlight onto pipes suspended above them

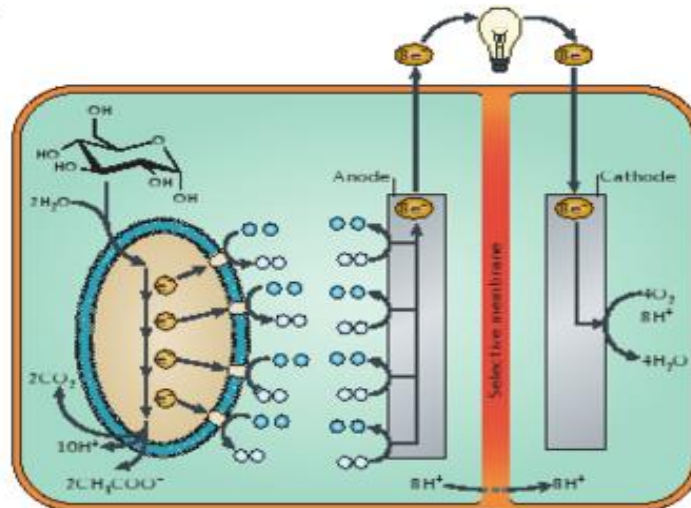
that may contain oil, water or molten salt. The heat is then used to generate steam that is employed to drive turbines for producing electricity. The mirrors can be parabolic troughs or arrays of flat mirrors. Nine interlinked power plants based on trough mirrors have been producing 300 Megawatts of electricity in the Mojave Desert in California for the last 20 years. The solar thermal power plant may also comprise a field of mirrors that focus the sunlight on to a ceramic heat absorber located on a tower. A fourth type of plant relies on focusing the sunlight by a dish on a sterling engine. A large number of solar thermal power plants are to be installed in US, China, Australia and Israel. Pakistan should urgently consider following this solar thermal power plant path also.

6.5 Electricity from Mud---- Microbial Fuel Cells!⁵²

The use of microbes for production of electricity is now possible! Certain microbes, such as *Geobacter*, have the ability to produce electricity from waste water and mud. Nature has imbued these microorganisms with the ability to transfer electrons, and hence to produce electricity under suitable conditions. Improved strains have recently been developed by Derek Lovely and co-workers at the University of Massachusetts that are eight times more efficient than those developed earlier for the production of electricity. The hair-like microorganism is 20,000 times finer than hair, and can be considered as a nanowire.

Fuel cells are already employed in cars but they are based on production of hydrogen from methanol or water using certain chemical processes. Microbial fuel cells, however, contain microorganisms that supply electrons (equivalent to an anode), and another electrode (cathode) that accepts these electrons and supplies oxygen to them. The flow of electrons that occurs between the anode and the cathode represents the electric current which can be used to power various devices.

Tomorrow, you may be charging your mobile phone, running your car, or powering your home appliances using these strange and wonderful creatures!



6.5 Microbial Fuel Cell. Glucose is being metabolized by the microorganism to yield electrons which are transferred to the cathode side where oxygen is reduced to water. Reproduced with thanks from: <http://2008.igem.org/Team:Harvard/Hardware>

6.6 Solar Cells Achieve Above 40% Efficiencies!⁵³

Solar cells are expensive and had efficiencies of less than 20% until a few years ago, making them too expensive except in remote villages not fed by the electricity grid. This scenario has now changed dramatically. The Sharp Corporation has developed new types of compound solar cells with efficiencies of over 40 % under lab conditions and of 35.8% in the field. This was achieved by replacing the germanium base layer by indium gallium arsenide. Meanwhile, the Fraunhofer Institute of Solar Energy Systems in Germany claims to have achieved a world record in solar efficiency cells by attaining a solar cell efficiency of 41.1%. They concentrated sunlight by a factor of 454 on a small area of a new type of solar cell made of gallium compounds. A special technique was used to reduce the defects in the crystals employed in the solar cells which resulted in increased efficiencies.

In Pakistan, the use of “solar thermal” units should be made compulsory in all building regulations to save gas and electricity. These solar thermal units do not involve expensive photovoltaic cells but water being heated while flowing through blackened metal

and glass surfaces by direct sunlight. These units are cheap, and can be installed in conjunction with gas- or electricity-fired water heaters to reduce energy consumption in homes and buildings for water heating by up to 50%. They can easily warm the water to 60°C, while the gas or electricity burners can come into action for additional heating only, thereby resulting in a huge saving.

6.7 Solar Energy Showing Explosive Growth in USA!⁵⁴

The solar energy industry is the fastest growing industrial sector in the energy field in USA. From about 1.5 gigawatts present capacity, it is expected to increase six-fold to about 10 gigawatts within the next five years. About 200,000 homes in the US will be fitted with solar panels this year, but this is expected to increase to two million new homes per year with solar power by the year 2015.

There is tremendous scope for both solar and wind energy plants in Pakistan—we should give tax breaks and provide incentives to manufacturers of solar panels and wind mills as well as offer them interest free loans to boost this manufacturing industry. The consumers should be offered major subsidies to install solar units as done in the West.

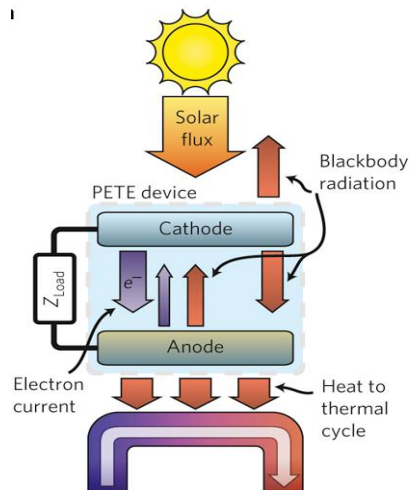
6.8 Exciting Breakthrough in Solar Cell Technology!⁵⁵

Solar cells have an efficiency of about 20% and they are expensive to manufacture. This makes them uncompetitive as compared to other forms of energy production which use oil, gas, fuel or even nuclear energy. A problem is that they use only a part of the light spectrum, while the remaining part of the spectrum which also produces heat is wasted. Now, Nick Melosh and coworkers at Stanford University have developed an exciting new type of solar cell that makes use of the heat produced by the sunlight and also converts it into electricity. The new technology (known as “photon enhanced thermionic emission”, PETE) can work at high temperatures, unlike currently available solar cells, and its utilisation of light and heat (produced by solar radiation)

can increase the efficiency of the new solar cells to above 50%, making them competitive to other forms of electricity production.



6.7 Rapid advances in the field of solar energy in America. Concentrated Solar Thermal Reproduced with thanks from: <http://www.abc.net.au/radionational/programs/scienceshow/s/4639974>



6.8 Important Advances in Technology of Solar Cells. Energy-flow diagram for the PETE/thermal tandem device. Reproduced with thanks from: http://www.nature.com/nmat/journal/v9/n9/fig_tab/nmat2814_F5.html

6.9 South Africa to Build World's Largest Solar Power Plant!⁵⁶

The world's largest solar power plant which will produce five Giga Watts (GW) of power is being set up at the edge of the Kalahari Desert in the Northern Cape Province of South Africa—an area which is amongst the sunniest three percent of regions in the world. The plant will start producing one GW of power by 2012 and five GW of power by 2020. The plant will use a combination of concentrating solar mirrors (power towers combined with parabolic and trough mirrors), with photovoltaic technologies.

If South Africa can do it, why can't we in Pakistan? All we need is a vision, decision making capability and honest leadership that can implement such an initiative without looking for kickbacks.

6.10 Solar Power --- Using Molten Salt!⁵⁷

Solar thermal power plants normally employ parabolic mirrors which focus the sunlight on to a boiler system. The steam generated is then used to drive turbines for producing electricity. The problem in this approach is that such plants can run only as long as the sun is shining, but they stop operating at night. There is therefore a need for developing heat storage systems so that the heat generated in the day time can also be used after sun set. The use of storage batteries offers such a possibility but this option is expensive. Now, a US company SolarReserve is setting up a plant in California which stores the heat from the sun in the form of molten salt. A mixture of sodium nitrate and potassium nitrate is heated to above 1000 degrees Centigrade by sunlight concentrated by thousands of tracking mirrors. The molten salt is then used for electricity generation by being piped into a steam turbine as and when required.

The molten salt technology was previously successfully demonstrated in the Mojave Desert to produce 10 MW of electricity. Now, a 150 MW solar power plant will be established in California over the course of the next 13 months.



6.10 Solar Energy---Use of Melted Salt. Molten salt keeps solar power flowing. Reproduced with thanks from: <http://www.cnet.com/news/molten-salt-keeps-solar-power-flowing/>

6.11 Solar Powered “Flower Windows”⁵⁸

Beautiful glass windows that have floral designs but which can also produce electricity ---- sounds like a fairy tale, but Sony demonstrated a prototype of such a window at the Eco 2010 exhibition held in Tokyo recently. The window uses a dye sensitized solar cell (DSSC) which has an energy conversion efficiency of 10%. Screen printing is used to develop aesthetically pleasing custom designs. A fan was demonstrated to operate as long as the window was exposed to sunlight.

6.12 Solar Panels --- that Use Light and Heat!⁵⁹

Less than half of the heat contributed by the sun to the earth’s surface is contributed by infrared light while the rest of the heat

is contributed by visible light. When bright sunlight is falling on a surface at sea level, the irradiance provided is a little more than one kilowatt per square meter of surface area.

Solar panels normally require visible light from the sun to generate electricity, but they cannot use all the heat produced by the sunlight for harvesting energy. However, new devices are being developed that will allow infrared radiation (that is available even at night) to be harvested for energy.

The technology is based on billions of nano-scale light-sensitive antenna arrays that can capture this hitherto elusive source of energy. About half the total energy in the sunlight lies in the infra-red region. Infra-red light is reflected by the earth's surface even after the sun has set. This energy in the form of heat can be captured at night.

Steven Novack at the US Department of Energy's Idaho National Laboratory, USA has calculated that this will allow the efficiency of this new breed of solar cells to rise to 46%, as compared to the present 25%. Some scientists are skeptical if significant energy can be produced at night, but the capture of the extra heat energy in the day time may add to the efficiency of the solar cells as they will be able to use both light and heat as sources of energy.

6.13 Spray-on Films as Solar Panels!⁶⁰

Truly amazing developments are taking place in new solar technologies. A Norwegian company EnSol has developed a film that can be sprayed on window glasses and converts them instantly into solar panels! The film contains metal nano particles in a composite matrix. It has been developed in collaboration with the University of Leicester's, Department of Physics and Astronomy. The windows become slightly tinted as part of the light falling on the windows is absorbed by the film. The researchers hope to reach an efficiency of 20% with this new solar cell technology.

Just imagine: your windows converted to clean electricity generators!

6.14 Advances in Biofuel Technologies!⁶¹

While cars operating on fuel cells are already on the market, they are relatively expensive. A number of companies have developed technologies for the production of biodiesel from algae that can be grown in open ponds or fermentation tanks in excellent yields, thereby avoiding the use of large areas of precious land for growing oil producing crops that can be used for growing food crops.

A well known process for production of ethanol relies on the fermentation of glucose with yeast. However, the process normally involves yeast strains that are unable to convert another sugar, xylose, also present in the plant biomass. Now, scientists at the University of Illinois, Lawrence Berkeley National Laboratory, University of California and energy company BP have developed a new yeast strain that can convert both glucose and xylose into ethanol, thereby increasing the overall yield of ethanol. The strain was also able to convert another material, cellobiose (which consists of two glucose units linked together) into ethanol. Alcohol is already used as a fuel of choice in cars and buses in Brazil, and with more efficient strains of yeast being developed, the cost of production should decrease considerably with time.

6.15 Solar Powered Plane Sets World Record!⁶²

A carbon-fiber ultra-light unmanned aircraft flew at a height of 5,000 ft for over 14 days to set a new world record for the longest duration flight powered by solar cells. The record set in July 2010 was confirmed by the Fédération Aéronautique Internationale. The aircraft manufactured by Qinetiq was powered by very thin lithium ion batteries which were charged during the day by an array of solar cells installed on the wings, and allowed the aircraft to fly at night. The aircraft, named Zephyr, can be produced at relatively low cost and can be flown for months, thereby allowing constant aerial surveillance at very low cost as compared to satellite and other technologies.

6.16 Wind Turbines? No, Wind Stalks!⁶³

In Masdar city, Abu Dhabi, a new idea is being explored for generating electricity from wind. This is to use wind stalks instead of wind turbines. A problem associated with wind turbines is the noise they generate which can be disturbing for nearby residents. The wind stalks will be long poles, about 180 feet high made from carbon fiber. They will be about a foot in diameter at the base and taper to a couple of inches at their upper ends. As they sway in the wind, they will generate electricity since they will be packed with piezoelectric discs that will convert the mechanical energy (from the compression of the discs by the swaying process) into electrical energy. Although the efficiencies of these stalks are lower than that of wind turbines, it is claimed that they will produce a similar amount of energy as wind turbines as they can be packed closer together. The tips of the stalks will be fitted with LEDs, the brightness of which will be a visual indicator of the extent of electricity being produced. The effect of stars shining bright in the sky and swaying with the wind should produce an interesting psychedelic effect. The project is still at a conceptual approval stage.

6.17 Wind Energy---from the Oceans!⁶⁴

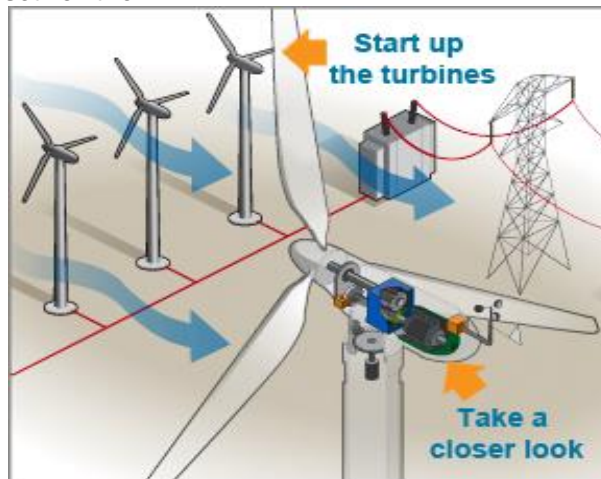
You would have noticed when you visited the sea side that usually there is a strong wind blowing over there. The sea can therefore be an excellent choice for installing floating wind mills for several reasons. The wind speeds are generally greater on water than on land, floating wind mills do not consume valuable land that can be used for agriculture or construction, and they do not bother residents unhappy with wind farms blocking their views.

The new technology has been applied on the sea about 6 miles off the coast of Norway. This has resulted in the installation of a 2.3 megawatt turbine, weighing 152 tons, on a floating platform which is tied to the ocean floor by cables to avoid excessive turbulence. The project "Hywind" has been implemented by the Norwegian energy giant Statoil, and the first floating wind turbine was installed in September last year. It will be tested over a two

year period and then commercial floating wind farms will be installed on oceans.



6.15 Solar Power Plant making Records. Solar Powered Zephyr. Reproduced with thanks from: <http://diydrone.com/profiles/blogs/new-record-was-set-for-the>



6.16 WindTurbine without wind: A group of wind turbines can make electricity for the utility grid. Reproduced with thanks from: http://www.windpoweringamerica.gov/what_is_wind.asp

The world energy consumption is mainly from oil (37%), coal (25%), gas (23%), nuclear (6%), biomass (4%) and hydro (3%). Wind accounts for only 0.3% and solar heat only 0.5% of the total energy consumption. With the development of new

technologies, renewable energies based on sun and wind, are likely to contribute increasingly to the world energy profiles. Pakistan must invest in such technologies instead of buying hugely expensive electricity from obsolete power plants that benefit a few vested interests.

6.18 Wind Energy—from the Sea!⁶⁵

Winds tend to blow stronger over open sea than they do over land, due to the obstructions caused by buildings, etc. They are fairly strong near the seashore but populations living near the beaches object to the construction of near-shore wind farms there. There is clearly a strong case for building windmills in deeper waters, a few miles away from the shore. However, there are certain technical problems to be overcome. As the blades of these wind mills are quite heavy, they can make the structures top-heavy and unstable so that they topple easily in rough seas. The challenge has therefore been to stabilise them so that they can operate safely in the roughest of seas.

A consortium of US universities and companies, called 'DeepCwind' has been formed to tackle this problem. Three different prototypes are under investigation. In the first one, the platform of the windmill is tied by metal ropes to the ground under the sea, just as in oil rigs. In the second design, there is a large floating tube with a huge keel underneath, with anchors imparting additional stability. The third design employs two balanced semi-submersible platforms which are kept in place by cables. By 2012, the full size wind turbines are expected to be installed with each producing 5MW of electrical power which will be transferred to the shore by means of undersea cables. This will be the beginning of a new era of production of electricity from a free and huge energy source, ocean winds.

In Pakistan, this is a project that our Planning Commission should sponsor in collaboration with Wapda, to be executed with the involvement of our Navy, and selected engineering universities and organisations such as Nust, UET, NED and Nescom. The facilities for large-scale manufacture could be

made available at the Naval dockyard or the Heavy Mechanical Complex. An investment of only 10 million dollars today in developing our own wind turbines and ocean platforms where they could be installed could yield billions tomorrow, both through local consumption and export earnings.



6.18 Wind Energy from Sea. Wind farm in the North Sea. Reproduced with thanks from: <http://www.evwind.es/2014/01/16/construction-begins-on-amrumbank-west-wind-farm-in-the-north-sea-2/41761>

6.19 Aircraft—fuelled by the Sun!⁶⁶

On July 7, 2010, something truly extraordinary happened. Andre Borschberg climbed into a plane and flew it from the Payerne airbase in Switzerland. It climbed to a height of 8564 metres over a 10-hour period. It then began a slow descent and remained in the air for 26 hours before landing back again. What was extraordinary was that it represented the first-ever manned night flight, powered entirely by the sun! It had 12,000 solar panels in its 63-metre long wing span which collected the energy in the day time and stored it in its batteries to fly at night. It also broke all previous records of solar-powered piloted flight in altitude and duration. The Swiss company 'Solar Impulse' that built this marvellous plane is now planning to build a bigger plane. Its next model is scheduled to fly across the Atlantic by

2011 and then circumnavigate the globe by 2013, using nothing but the energy from the sun.

6.20 Thermal Energy from the Oceans!⁶⁷

The temperature of the water on the surface of the sea is usually warm while it tends to be much colder at the ocean depths. This temperature difference can be exploited for production of electricity through Ocean Thermal Energy Conversion (O.T.E.C.). The technology involves pumping the warmer surface water through a heat exchanger. The heat is used to evaporate a low boiling liquid such as ammonia, and the vapourised gas is used to drive turbines, resulting in the production of electricity.

The ammonia gas is piped through a condenser which is cooled by the cold water pumped from ocean depths, thereby liquefying it. The cycle is then repeated by pumping the liquid ammonia to the surface where the warm water heat exchanger evaporates it. For the process to work, the temperature difference between the surface water and that at the ocean depths needs to be at least 20 degrees Celsius (68 degrees Fahrenheit) which is commonly encountered in tropical oceans. Every additional degree difference results in a 15% increase in energy production. The technology can provide stable, continuous and reliable energy round the clock, unlike wind or solar energy that depends on the vagaries of the weather.

While the feasibility of this process has been demonstrated in several pilot plants, it is yet to be commercialised. Now, a number of companies are planning to initiate projects in this exciting field including Lockheed Martin, Vanuatu, Xenosys, Pacific Otec and some other companies. The first small plants with a capacity of 10-15 Megawatts will be installed by 2014, and will then be followed with plants of greater than 100 Megawatts capacity.

6.21 Hydrogen Energy---from Sea Water!⁶⁸

Water molecules are made up of hydrogen and oxygen bonded together. If somehow one could efficiently cleave the hydrogen-

oxygen bond, for instance of sea water, this could provide hydrogen gas that can be a huge source of clean energy since burning of hydrogen gas releases energy and produces water as a by-product. Nature has developed certain enzymes (hydrogenases) that can cleave the hydrogen and oxygen bonds during the process of photosynthesis, but the process cannot be applied on an industrial level because these enzymes are unstable when removed from their natural environment. A number of metal catalysts have been developed that achieve this reaction but they are based on expensive metals such as platinum. Scientists at UC Berkley's chemistry department have recently reported a cheap molybdenum catalyst that is seventy times cheaper, and which promises to be used in industry. Many companies are developing cars running on hydrogen, and networks of hydrogen filling stations exist in USA, Europe and Japan for cars and buses that operate on hydrogen instead of petrol.

We may well be using hydrogen from sea water instead of fossil fuels to meet our energy needs on this planet by 2050.

6.22 Energy from Hot Rocks!⁶⁹

A project has been launched recently in Cornwall, UK to extract energy from hot rocks that have a temperature of well above 150°C. The three-megawatt commercial thermal energy plant will extract heat from 3.5 kilometres below the Earth's surface. The project will involve drilling a hole below ground and then injecting water into the hole under high pressure. This causes the small cracks in the hot rocks to expand, resulting in the creation of a network of capillaries in the rocks. The steam generated by passing water through the capillary network of naturally heated rocks can be used to drive steam turbines that produce electricity. One commercial project based on this hot rock technology is already in operation in Landau, Germany. However, the technology is not free from associated risks as the construction of a similar plant in Basel, Switzerland triggered earthquakes.

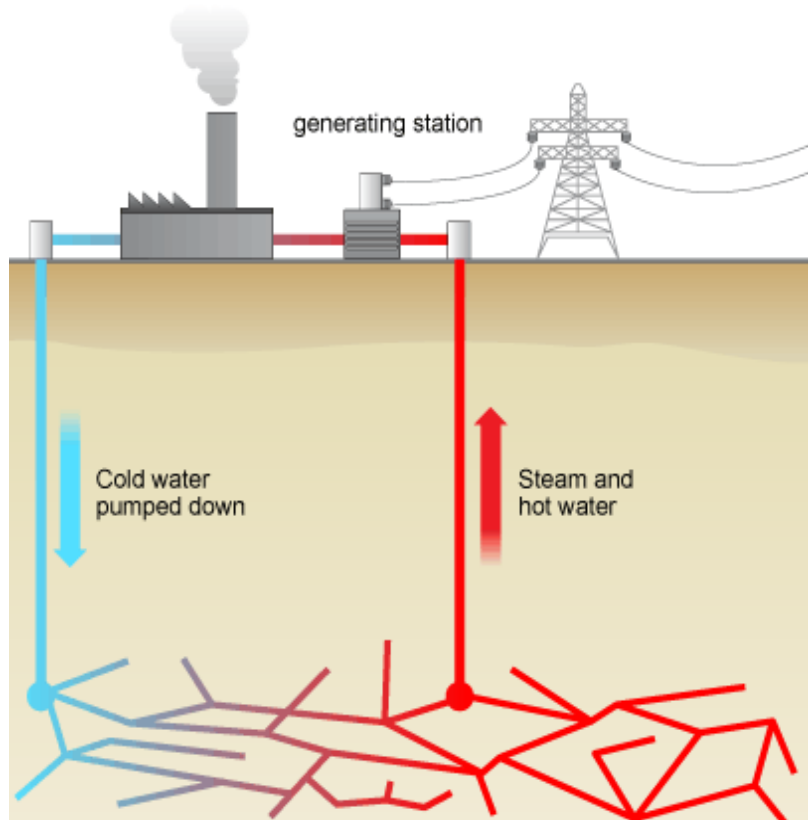
6.23 Fuel from Microbes!⁷⁰

The limited availability of fossil fuels has attracted the attention of scientists to develop “biofuels” which you can use to drive your cars or run generators. These “biofuels” however are usually derived from plants which need arable land as well as fresh water and therefore compete with other cash crops. The “second generation biofuels” are derived from algae. Algae are simple organisms that may be unicellular or multi-cellular (such as sea weeds). Algae that have high oil content can be grown in vessels, and then harvested for their biofuel content. In the process of photosynthesis, algae capture carbon dioxide and sunlight, giving biomass (including the precious oil) and oxygen. The cost of biofuels produced from algae remains high as compared to that of fossil fuels, and intensive research efforts are underway to bring down the costs by developing high yielding and fast growing algae.

One factor that contributes to the cost of biofuels is the process of extraction of the precious oil. Scientists at Arizona State University went round this problem by developing certain blue green algae which were genetically modified so that these single cell organisms would self-destruct releasing the oil within. They have now further engineered the process so that there is no need for the organisms to self-destruct as so much oil is produced that it starts oozing out from the cell spontaneously, and can be readily collected.

6.24 Gasoline? --- No, “Grassoline”!⁷¹

The first commercial refinery to convert grass into petroleum will come into production in USA by 2011. According to a study carried out in USA by the U.S. Department of Agriculture and Department of Energy, the U.S. can produce over 100 billions of gasoline from about 1.3 billion dry tons of cellulosic biomasses. The grasses from which the cellulosic biomass will be generated can even be



6.22 Energy from Hot Rocks. Hot Dry Rock geothermal energy. Reproduced with thanks from: http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/energy/mainselectricityrev5.shtml



6.24 Grassoline, not Gasoline. Proof of concept sketch for article on alternative 'green' fuel options. Reproduced with thanks from: <http://www.mondolithic.com/?p=817>

grown on soil on which normal food crops cannot be. Cellulose contains thousands of glucose molecules linked to one another to form chains. The challenge has been to break down the cellulose into smaller components and remove the bound oxygen. The technology involves a flash heating process by which cellulose is rapidly heated (in less than 1 second) to 500°C. This results in the formation of smaller oxygen rich molecules. A catalytic process then removes the oxygen, resulting in the formation of aromatic compounds found in petroleum---- “grassoline” has been born!

6.25 Recovering Energy from Vehicles!⁷²

Engineers at MIT have developed a shock absorber that will convert the energy generated on bouncy roads into electricity, sufficient to charge the battery or run the electronics of the vehicle. A number of energy harvesting systems are under development to recycle wasted energy from vehicles for improving performance. The energy lost by braking can now be recycled through a process of regenerative braking. BMW and Honda are developing devices that will capture the heat energy from engine exhausts. But perhaps the most fascinating project being considered is the UK and Israel plans to embed roads with electricity generators, so that energy of vehicles travelling above can be used for generating electricity. Tens of thousands of vehicles pass above roads each day, and if that energy could be recovered and recycled for use in road lighting or for supply to the electricity grid, then even the roads could become sources of energy production!

6.26 New Ways of Reducing Petrol Consumption⁷³

A number of new and innovative methods are being developed to reduce petrol consumption in vehicles. When you are travelling over a bumpy road, the shock absorbers in your car absorb the bumps. While this makes for a smoother ride, this energy is wasted. A US company (Levant Power of Boston) has developed a system to convert this energy into electricity and use that for

charging the battery and use it for other purposes, resulting in fuel savings of up to 5%. Another company, E-Traction in the Netherlands, has fitted motors on the two rear wheels of trucks, eliminating the heavy transmission and gearing that soak up power--- the result is an amazing 40% decrease in fuel consumption. Another technique being used is to fit rounded flairs or fins at the back of trucks that result in 6% decrease in fuel consumption due to improved aerodynamics. Wasted engine heat has also been recycled to produce electricity by a number of companies in UK and USA, resulting in significant fuel savings.

6.27 Polaritons: New Light-matter Hybrids!⁷⁴

The advent of lasers some 50 years ago heralded a new era in technology. Lasers are used in a multitude of applications ranging from CDs, DVDs and Blu-ray devices in our homes to cutting and welding of metal sheets, removing eye cataracts, burning cancerous tissue or knocking down satellites.

Another even more exciting revolution may now be round the corner: "polaritons". These are particle like packets of energy that are neither light nor matter but exhibit some properties of both. Unlike electrons which repel one another, polaritons can get close to each other readily, thereby allowing coherent laser light to be produced.

In 2007, researchers at the University of Southampton produced gallium arsenide polariton lasers which required only about one-tenth the energy as normal lasers. This could lead to improved and more reliable Blu-ray devices. New power saving LEDs and more sophisticated computers are also under development based on this exciting new technology which uses these "matter-light hybrids".

6.28 Nuclear Fusion—A Quest for “Limitless” Energy!⁷⁵

The stars, including our sun, produce energy by nuclear fusion. This is a process in which two or more atomic nuclei (such as hydrogen)

can fuse together to give a heavier atom (such as helium) with the accompanying production of huge amounts of energy. It is through nuclear fusion reactions occurring in the sun that heat is produced that warms our planet and allows life to exist on it.

Now scientists at the Lawrence Livermore National Laboratory's National Ignition Facility (NIF), US, are building a huge laser, about the size of three football fields, to try and copy what the sun does. The laser will fuse two forms (isotopes) of hydrogen (deuterium and tritium). A huge laser beam will first be charged by bouncing it back and forth over a distance of about a mile. It will then be split into 192 beams and focussed in a concentrated manner over a tiny space that contains deuterium and tritium.

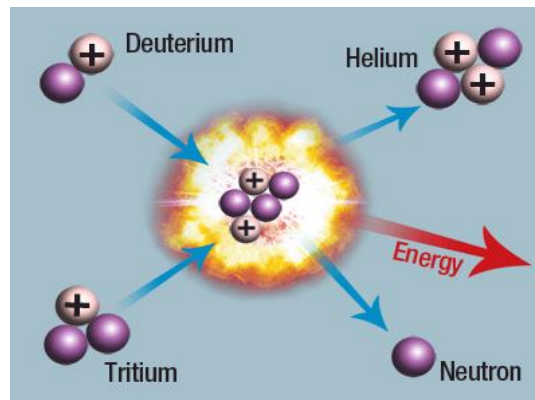
The temperatures from these concentrated beams will reach 100 million degrees centigrade, much hotter than the sun, and pressures of more than 100 billion atmospheres of pressure will be generated. The resulting fusion reaction should generate far more energy than that supplied by the laser. If this works, then sea water, which is the source of hydrogen and its isotopes, will become the key resource of energy on our planet.

The future may involve the creation of thousands of such mini-suns (fusion energy plants) in each country to supply electricity to a national grid system, replacing fossil fuels as the present main source of energy on our planet.

6.29 New Wind Turbines—Jet Engine Designs!⁷⁶

Scattered across countrysides in Europe and the US, you may have seen large wind mills, each with three huge blades generating electricity. These wind turbines are not very efficient as about half the air does not go through the blades but around them, with a corresponding loss in their capacity to generate electricity. A US based company, FloDesign, has now developed a new type of wind turbine which draws on the design used in jet engines. It produces the same amount of electricity although the blades are half the size of conventional turbines. The blades are surrounded by a shroud that directs the air through the blades, thereby increasing the power output. Due to their smaller size, there could be many more wind turbines packed in an acre of field, another added benefit.

A small prototype is presently undergoing wind tunnel tests, and this will be followed by a larger 12 feet diameter version capable of producing 10 kilowatts of power. The megawatt production models are expected to follow.



6.28 Nuclear Fusion- Curiosity for Infinite Energy. Nuclear Fusion diagram. Reproduced with thanks from: <http://www.ustudy.in/node/3161>



6.29 Wind turbine with a design of Jet engine. Innovative wind turbine design triples output. Reproduced with thanks from: http://www.businessweek.com/investing/green_business/archives/2009/10/innovative_wind.html

6.30 A New Hydrogen Fuel - Cheaper than Fossil Fuels!⁷⁷

Intensive researches in developing alternative fuels are finally yielding exciting results. Cella Energy in UK has announced a

completely new type of fuel which is based on hydrogen. Liquid hydrogen is an excellent fuel with a specific energy density of 143 megajoules per kg, as compared to kerosene which has much lower energy density (about 43 megajoules per kg). However, liquid hydrogen has to be stored at -253°C . The advantage in the new hydrogen fuel developed by Cella Energy is that it is in the form of microbeads containing a hydride compound, prepared using nanotechnology. The car engine does not require any modification and the new fuel can be filled from a normal petrol pump.

The synthetic fuel was developed in a highly secret project involving scientists at the Rutherford Appleton Laboratory near Oxford. It is expected to cost about \$1.5 per gallon.

6.31 Hydrogen Fuel --- from Spinach!⁷⁸

While spinach is a healthy food to eat, being rich in iron and vitamins, amazing developments in science have made it possible to convert these enzymes into hydrogen which can be used as a fuel for running a car! Researches carried out at *US Department of Energy's Oak Ridge National Laboratory (ORNL)* in Tennessee, USA have shown that the process of photosynthesis can be copied to produce hydrogen by the action of sunlight on a membrane prepared from a spinach protein.

Efforts are also being made, with some success, to split water into hydrogen and oxygen using sunlight and metal catalysts. Oil may be used in the future not for powering cars or running electricity generators but as a source of valuable raw material for the pharmaceutical and other industries.

6.32 Air Hybrid Cars!⁷⁹

When the car engine is idling or when you are driving down a slope with no power needed from the engine, the energy of the engine is wasted. This energy can be used to fill an air cylinder and then supplement the power of the engine, leading to saving

in fuel consumption. Such pneumatic systems can be built into vehicles and the engines serve to compress air during vehicle deceleration when engine power is no longer needed to propel the vehicles forward. Similarly, the energy in the braking process can be stored in an air compressor and used later. Such air-hybrid systems can work with gasoline, diesel or natural gas engines and would be much cheaper to manufacture than the electric hybrid systems requiring expensive battery packs.

Researchers at the Lund University in Sweden have now successfully tested a prototype of such a system. This was the subject of a PhD thesis of Sasa Trajkovic at Lund University, who showed that buses running in cities could save up to 60% fuel consumption if they used their engines simultaneously as air compressors. The technology is particularly beneficial during slow and jerky driving.



6.33 Street Lamps Generating Energy Reproduced with thanks from:
<http://www.yoursunyourenergy.com/Street-lighting.htm>

6.33 Street Lamps that Generate Electricity⁸⁰

Street lamps have always been considered as consumers of energy. Now, new types of street lamps have been developed by Scotia, based in Aarhus, Denmark, that generate electricity from sunlight during the day which is fed into the national grid. At night, they use electricity from the grid. These lamps are covered with photovoltaic solar cells to give maximum surface area, and these solar cells can generate electricity even on cloudy days. The street lamps generate more electricity than they consume and are therefore considered to be environmentally friendly.

6.34 Biofuels --- from Cellulose Munching Bacteria!⁸¹

With the rising prices of oil affecting the economies of many countries, there is a growing need for alternative sources of fuel. Certain types of bacteria with an appetite for cellulose may provide the answer. Cellulose happens to be the most common organic compound on our planet. Cotton is about 90% cellulose while wood contains up to 50% cellulose. Indeed, plant matter comprises about 33% cellulose, since it is the main component of the primary cell wall of green plants. Cellulose consists of linear chains of hundreds or thousands of linked glucose units. Much effort has been successfully exerted to convert cellulose into biofuels such as ethanol in the past but the challenge has been to do so economically. This is because it is more difficult to break down cellulose into its component sugar units than starch, because of the manner the glucose units in it are linked together. Now, a breakthrough has been made by scientists at U.S. Department of Energy's BioEnergy Science Center (BESC) who have succeeded in converting cellulose directly into isobutanol using a genetically modified strain of a cellulose-degrading microbe (*Clostridium cellulolyticum*). Isobutanol is a more desirable biofuel because it can be used directly in car engines without any engine modification and has similar heat value as that of standard petrol. Once the product is successfully developed commercially, you may be driving cars on a biofuel produced from grass!

6.35 Extinguishing Fires --- with Electricity!⁸²

Electricity is normally associated with causing fires through short circuiting. However, George Whitesides and coworkers at Harvard University are using electricity to extinguish fires! While the ability of electricity to extinguish flames has been known for a long time, the science behind it was not well understood. It is now thought that the electricity beams cause the soot particles in the flames to become charged, thereby destabilizing the flames and resulting in the fire to be extinguished.

If beams of electricity are fired at flames, the flames quickly go out, as if water had been sprayed on them. A 600 watt amplifier connected to a wand is used to deliver the electrical beams. On the basis of the work carried out, backpacks are being developed for firemen who could be shooting electricity beams at the fires of the future. Similarly, buildings can be fitted with electricity amplifiers on roofs, instead of water sprinklers, to put out fires. Such a system could save huge amounts of water wasted in extinguishing fires and avoid damage to buildings and contents caused by the massive amounts of water.

6.36 Jets Fly --- on Biofuels!⁸³

Biofuels are fuels that can be produced by microorganisms or may be derived from organic or food waste products. They can be in the form of solid biomass, liquid biofuels or biogases. Since the materials from which they are produced are usually derived through photosynthetic processes, they can be regarded as a solar energy source.

On Friday 18th March 2011, there was an exciting development in the field of aviation. An F-22 Raptor fighter jet aircraft flew using a 1:1 blend of conventional jet fuel and biofuel derived from a plant of the mustard family, *Camelina sativa*, or simply known as "camelina". The fighter aircraft flew at speeds 50% greater than that of sound (Mach 1.5) and successfully completed the test. Passenger airlines such as KLM and Japan Airlines have already used blends of the biofuel derived from camelina in their aircrafts, but this was the first time that this was successfully used in the

sophisticated F-22 fighter jet aircraft. Camelina is widely grown in USA, usually as a rotation crop with wheat. Biofuel derived from camelina is competitive in price (about \$ 70 per barrel) as compared to conventional fuels (above \$ 100 per barrel).

6.37 Artificial Leaves⁸⁴

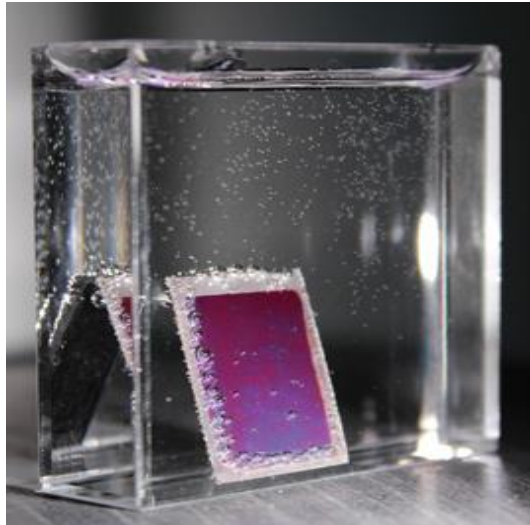
Leaves along with certain algae and many species of bacteria are able to carry out photosynthesis. The process of photosynthesis involves the conversion of carbon dioxide present in the atmosphere into organic compounds such as sugars by using the energy from sunlight. Oxygen is released as a by-product of the reaction. This maintains the level of oxygen in the atmosphere, removes carbon dioxide from it thereby reducing global warming, and provides food so necessary for our survival. The annual rate of energy captured by the process of photosynthesis is about 100 terawatts --- which is about six times the annual power consumption on our planet.

Scientists have been trying to develop “artificial leaves” for many years ---- devices that could use sunlight to split water into its elements, hydrogen and oxygen. The hydrogen thus produced can then be stored in fuel cells and used for energy production. Nocera, Professor of Chemistry at MIT and coworkers have now developed a material which is thinner than a leaf and contains a couple of cheap catalysts that do the trick --- nickel borate along with a cobalt compound on a silicon electronic system. When this leaf is placed on a gallon of water under sunlight, and connected to a fuel cell, it can supply enough electricity for a day for a small household in a developing country. The material is claimed to produce 10 times more energy than a natural leaf.

6.38 Biofuels from Sunlight and Green House Gases⁸⁵

Normally, burning of petroleum and other fossil fuels leads to the production of green house gases such as carbon dioxide. This is a major cause of global warming. Can we do the reverse i.e. use carbon dioxide to produce biofuels? Removal of carbon dioxide in this manner would be good for our environment. This can be

achieved by growing of crops that produce biofuels. Now, however Prof. Larry Wackett and coworkers at the University of Minnesota have found that this can be achieved using two bacteria. The first bacterium (*Synechococcus*) converts carbon dioxide into sugars using sunlight. These sugars are then converted by a second bacterium (*Shewanella*) into certain compounds that can be used as fuels. The product has been named as “renewable petroleum”.



6.37 Artificial Leaflets. Scientists harnessing photosynthesis to produce fuel cells via artificial leaf. Reproduced with thanks from: <http://www.geek.com/geek-cetera/scientists-harnessing-photosynthesis-to-produce-fuel-cells-via-artificial-leaf-1448863/>

6.39 Used Motor Oil --- as Car Fuel!⁸⁶

About 8 billion tons of used motor oil is produced each year from automobiles across the world. Most of it is discarded while some is recycled by processes that are not environmentally friendly. These processes involve heating the oil to very high temperatures in the absence of oxygen (pyrolysis) which breaks it down into some gases, liquids and solids. The gases and liquids that result can then be used as fuels, but the process is

not very efficient due to uneven heating. Researchers at Cambridge University have now found that by adding a microwave absorbing material to the used oil and then heating it with microwaves, a 90% conversion can be achieved to conventional gasoline and diesel. Science is thus offering novel ways to convert waste products into useful materials.

6.40 Capturing Wind Energy --- from Moving Trains!⁸⁷

Fast moving trains generate a considerable amount of wind energy as they whoosh past. This energy is simply wasted. Now, the Chinese industrial designer Qian Jiang and the Italian designer Alessandro Leonetti Luparini have come forward with an exciting concept of harnessing this energy for production of electricity. The concept involves the installation of devices on the tracks under the passing train, which can utilize the wind produced as the train goes past to drive a turbine that generates electricity. Some 150 of such devices can be installed on every kilometer of track. The electricity thus generated could be supplied to the grid system or to nearby villages.

6.41 Wind turbines—Learning from Dragonflies!⁸⁸

Micro wind turbines must work well in light winds, but they must also be stable and not spin too fast during stormy winds. This has been a challenge for engineers. In the case of larger wind turbines, this is catered for in the blade designs, making them stall in high winds. Sensors send the needed signals to computers, thereby controlling the turbine speeds. For micro turbines, these solutions are too expensive.

However, nature has provided the answer. The dragonfly is remarkably stable in its flight, even under high wind speeds. This is due to the design of its thin flexible wings which have small protrusions on their surfaces. These create a number of swirling vortices that lead to special aerodynamic stability of the dragonfly. Now Akira Obata of Nippon Bunri University, Japan,

has invented a micro turbine, learning from nature, and designed on the basis of the wings of the dragonfly. These micro turbines are far better than those available previously. Nature is, after all, the best teacher!



6.40 Wind Energy- from Moving Train. A speeding train produces tremendous gusts that can just as easily be converted into electricity. Reproduced with thanks from: <http://www.smartplanet.com/blog/thinking-tech/moving-trains-can-produce-wind-power-but-will-it-ever/>



6.41 Wind turbine- A lesson from DragonFly. Dragonfly's stability in flight inspires micro wind turbine design. Reproduced with thanks from: <http://www.topnews.in/law/dragonflys-stability-flight-inspires-micro-wind-turbine-design-249349>

6.42 Flexible Solar Cells—Exciting Advances!⁸⁹

Commercially available silicon-based solar cells have efficiencies of about 18 per cent. This limits their commercial use

because of the high cost of electricity production. The present cost of electricity produced from solar cells comes to about \$4 per watt. This is about 10 times higher than electricity produced by other means, making it uneconomical except in remote areas where the grid system may not exist and it may be cheaper to provide electricity through solar cells. Silicon wafers used for production of solar cells can be replaced by polycrystalline silicon which has lower efficiency but is cheaper to produce.

The next generation of solar cells involves printed materials which can be mass produced at very low costs. These are based on new materials (copper-indium-gallium-selenide, cadmium-telluride, amorphous silicon and micromorphous silicon). They have 10-15 per cent lower efficiencies but because of their lower production costs, they are competitive. It is expected that they will soon overtake the first generation silicon wafer-based cells.

An exciting recent development has been the discovery by Swiss researchers of flexible solar cells (made from copper indium gallium [di] selenide [CIGS]).

These have about the same level of efficiency of 18.5 percent as that of the silicon wafer cells. These flexible cells can be produced cheaply and they may dramatically change the solar cells market, once they are mass produced. The breakthrough was achieved at the Swiss Federal Laboratories for Materials Science and Technology (Empa) Thin Film and Photovoltaics lab. A new start-up company FLISOM has been formed to produce and market these new solar cells.

The new generation of cells will be incorporated on roll-out transparent sheets that will be placed on windows and walls, to absorb and provide electricity.

6.43 Biological Batteries!⁹⁰

Biological fuel cells have been the subject of research for almost a century. They mimic bacterial processes and have been investigated for production of electricity. The first person to produce electricity from bacteria was a professor of botany at the University of Durham in UK, who succeeded in producing electricity from a strain of *E. coli* about a century ago.

The work was later further developed by a Japanese scientist, Suzuki, in 1976. Microbial fuel cells have an anode chamber and a cathode chamber and electricity is produced by the degradation of organic matter. The exact mechanism of how electricity is produced was, however, not well understood.

A major breakthrough was made in May 2011 when a team of scientists at the University of East Anglia, UK reported that they have unraveled the exact structure of bacterial proteins that produce the electrical current. Nature has designed the structure in such a manner that facilitates the movement of electrons from inside the bacterial cell to the outside, thereby creating the electrical current.

The work was published in Proceedings of the National Academy of Sciences (USA) (www.pnas.org/content/early/2011/05/16/1017200108.abstract) and is likely to lead to rapid advances in biological batteries, now that we have begun to understand how nature is able to perform such functions inside a bacterial cell.

6.44 A “Battery Crude” for Electric Cars!⁹¹

A major problem with electric vehicles is the time required for charging batteries. Now a solution is in sight. It involves refilling the batteries quickly with a previously charged battery fluid. The discharged battery fluid can be pumped out and replaced by newly charged fluid in a jiffy, just as if you would be filling petrol in an empty tank! The technology developed at MIT involves the use of semi-solid flow batteries which are much better from the present bulky and expensive “flow batteries”. The new batteries are much lighter, cheaper and use a new liquid developed at MIT which is 10 times more energy efficient than that used in the older batteries. The MIT researchers have termed it as “Cambridge crude”, analogous to the crude oil from which petrol is derived for petrol-driven cars.

Electric cars are no longer the slow laborious vehicles that were originally manufactured. The fastest electric sports car can go from 0 to 60 miles per hour in 3 seconds flat! Indeed, very few petrol driven cars can match the performance of the fastest electric cars.

6.45 An Electric Car to Beat All Others!⁹²

The advances being made in battery technologies have made exciting electric sports cars a reality.

The rapid developments in electric cars are illustrated by an exciting new sports vehicle that was on display at the Frankfurt motor show in September 2011. The “Concept_1” car has four electric motors, one on each wheel and can achieve a speed from 0 to 62 mph (0 – 100 kph) in a stunning 2.8 seconds! It has a top speed of 190 mph and a range of 370 miles (600 km). The car will be commercially available as a limited edition production model in 2013.

6.46 Bamboo Wind Turbines!⁹³

Walking down a dark street alone can be a nerve-racking experience. Now the designer Alberto Vasquez has developed a novel concept in which a vertical bamboo is fitted with air catching bamboo blades that spiral around the central axis of the bamboo. The blades are fitted with LED bulbs at the tips, and as the bamboo spins in the wind, it creates a spectacular effect of unbroken bands of moving light. The vertical wind turbines installed on road sides not only light up a dark street but also create a magical and exotic effect. The bamboo turbines have been installed in the Colombian city of Cartagena, a city known for sustained high wind speeds.

6.47 Batteries Powered with Paper and Wind!⁹⁴

A new bio-battery, that is powered only by paper, has been developed by Sony! The battery contains an enzyme in water solution. When paper is added, the enzyme breaks down the paper producing glucose that is harvested to provide power to the battery. The process is comparable to a termite that eats up wood, and then breaks down the cellulose (that is common in both paper and wood) to give glucose. The glucose produced is then used by the termite for meeting its energy needs. The bio-battery working on the same principle was demonstrated at the recent Tokyo's Eco-Products 2011 exhibition. Paper was fed into it and the power produced was sufficient to operate a fan.



6.46 Bamboo Wind Turbine. Flow bamboo lighting works on the principle of vertical wind turbine. Reproduced with thanks from: <http://www.designbuzz.com/flow-bamboo-lighting-works-on-the-principle-of-vertical-wind-turbine/>



6.47 Wind Charged Batteries. Wind-powered iPhone battery charger concept. Reproduced with thanks from: <http://www.gizmag.com/veenhoven-ifan-wind-powered-iphone-charger-concept/17176>

In another related development, the Dutch designer Tjeerd Veenhoven has developed a wind powered battery charger. The Apple iPhone can be charged by placing it into a small rubber casing with fan blades at one end. As the blades rotate in the wind, the energy is captured and used to charge the Apple iPhone.

6.48 Capture that Energy!⁹⁵

As you sit in a room watching TV, listening to a radio, talking on a mobile phone etc., there is a significant amount of electromagnetic energy floating around you. Can we capture all this wasted energy and put it to good use? Now Manos Tentzeris, a professor at the Georgia Institute of Technology has found a novel way of doing just that. They discovered that using inkjet printing technology, combined with suitable sensors and antennas, they could scavenge this electromagnetic energy. An ultra-wide band antenna was employed to capture the ambient electromagnetic energy. This energy is converted from AC to DC and then stored in capacitors or batteries. The captured energy builds up in a battery-like device and can be used for powering small devices once it has reached a certain point. The researchers succeeded in powering a temperature sensor using the captured energy, and the approach could be used to power devices of up to 50 milliwatts.

6.49 Car Using Organic Wastes Sets New Speed Record!⁹⁶

Gasification of biomass can lead to a gas that can be used in the combustion engine of a car. The desired combination of the gas comprising hydrogen, methane, carbon dioxide and carbon monoxide is achieved by treating the biomass with oxygen or steam at high temperatures. The organic waste used was thus transformed into the biogas and the car powered with this gas could achieve an average speed of 66.5 miles per hour, thereby making its way into the Guineas Book of Records. As the car could be run on used coffee grounds obtained from coffee shops, it was aptly named as a "Coffee Car". The car was

developed by Martin Bacon and colleagues of the Teesdale Conservation Volunteers group at Durham, UK.



6.50 Drive Free—Using Solar Panel. Volvo pavilion protects your car while pumping it full of solar power. Reproduced with thanks from: <http://www.dvice.com/2013-7-17/volvo-pavilion-protects-your-car-while-pumping-it-full-solar-power>



6.51 Electricity Generation through Human Respiration. AIRE Mask Uses the Power of Human Breath To Charge Gadgets. Reproduced with thanks from: <http://inhabitat.com/aire-mask-uses-the-power-of-human-breath-to-charge-gadgets/>

6.50 Drive for Free ---Using Solar Panels on Garage!⁹⁷

The claim made by electric car manufacturers that they are “green” is nullified when one considers that in order to charge

the batteries used in such cars, one needs to use electricity which is itself produced by burning hydrocarbons. Now, Ford has come forward with an interesting solution. You can have solar panels installed on your garage at cheap rates that will generate enough electricity to charge the batteries. This will allow you to drive a car free all your life without paying for any electricity costs or burning hydrocarbons as fuel!

6.51 Electricity --- from Human Breathing!⁹⁸

A major issue in biological implants is to have a reliable source of power that can keep the implants functioning. If batteries are used, the patient has to undergo surgery periodically when the batteries require replacement. To tackle this problem, researchers have focused their efforts on utilizing the body's own mechanical movements to generate electrical power by employing "piezoelectric devices". Piezoelectricity is the charge that is accumulated into certain materials when mechanical stress is applied. This charge can then be used to power a number of useful devices.

Now researchers at the University of Wisconsin-Madison led by Materials Science and Engineering Assistant Professor Xudong Wang have discovered a novel way of producing electricity---using the energy from human breathing. The technology used involved developing a very thin material with piezoelectric properties that could be implanted in the human nose and then used to generate microwatts of electrical energy from the air flow when breathing. This energy could then be used to power sensors. The device developed uses a plastic microbelt made of the piezoelectric material that produces electrical power from its vibrations caused by the breathing.

6.52 Electricity from Paints: Dye Sensitised Solar Cells!⁹⁹

Rapid developments are occurring in the field of new types of solar cells. One really exciting development is to generate energy from paints, since solar cells are embedded within the

paint. The problem with earlier types of such cells was that their efficiency was low and not comparable to conventional silicon-based solar cells. All that is now changing with the advances being made in dye-sensitised solar cells that have achieved an efficiency comparable with that of commercially available silicon cells.

Swiss scientists working at the Laboratory of Photonics and Interfaces in École polytechnique fédérale de Lausanne (EPFL) under the leadership of Professor Michael Grätzel, have achieved this remarkable feat by improving the efficiency of the now famous Grätzel solar cells to 12.3%. The scientists used porphyrin and cobalt to achieve this high efficiency, thereby mimicking the property of photosynthesis used by plants. The cells have a greenish tint reminding us of how nature converts solar energy. These cells can be used both in solar panels as well as in paints. A paint based on such cells has been developed by researchers at Swansea University UK.

6.53 Energy from Sea Weeds!¹⁰⁰

With increasing fuel prices over the past two decades, there has been growing interest in using biofuels as sources of energy. Biofuels are fuels that derive their energy by conversion of carbon dioxide to organic compounds, (a process known as “carbon fixation”) through the involvement of organisms. A simple example is that of bioethanol – an alcohol produced by fermentation largely from carbohydrates found in sugarcane or corn. Ethanol can also be produced from grass, leaves and other cellulose containing materials. However, if wheat, corn or sugarcane is used to serve as the biomass for fuel production, valuable land area that can be used for producing food crops has to be diverted for the production of biofuels. With a growing world population that has now crossed the 7 billion mark, and with large areas of our planet suffering from water stress and desertification, we can hardly afford to set aside large land areas for growing biofuel producing crops instead of food crops. This has been a major criticism against the production of biofuels.

Now scientists working at Bio Architecture Lab (BAL) at Berkley have carried out some biochemical wizardry to circumvent this problem --- they have succeeded in transforming common sea weed into biofuels! The discovery has triggered the formation of a start-up company in Chile that is carrying out off-shore farming on 200 acres to produce large quantities of sea weed (brown micro-algae) that can then be converted into ethanol using a fermentation process with a microorganism. According to BAL scientists, about 3% of coastal waters globally are sufficient to produce 227 billion liters of biofuels annually. In tomorrow's world, the sea shores may well become the energy producing reservoirs of our planet.

6.54 Energy from Waste Water!⁰¹

Scientists at Pennsylvania State University have developed a process, microbial electrolysis, that can convert the organic matter present in waste water to hydrogen by microbial decomposition. The cells, dubbed "Microbial Electrolysis Cells" (MECs) produce hydrogen that is burnt to generate electricity directly from waste water. Some electrical input is required in the process which is met by extracting energy from the ionic differences between sea water and fresh water. The process therefore requires a supply of sea water. The work was carried out by Bruce E. Logan, Kappe Professor of Environmental Engineering and postdoctoral fellow Younggy Kim. The scientists claim that this could offer an almost inexhaustible source of cheap energy.

6.55 Flying --- on Sunlight!⁰²

Last year, three world records were set by an ultra-light carbon fiber aircraft that travelled to a height of 5000 feet and continued to fly for 14 days, powered only by sunlight. Known as "Zephyr", the Long Endurance High Altitude Endurance Unmanned Aerial Vehicle was built by a British aerospace firm, QinetiQ. The aircraft has paper-thin amorphous silicon solar cell arrays covering its wings, and the power is stored in special lithium ion

batteries, that allow it to fly continuously day and night. The company is now developing more advanced versions of Zephyr that can fly continuously for years. These unmanned aircraft can be used for surveillance, communication, light-weight transport and research.



6.55 Flying with the help of Sunlight. Flight powered solely by solar energy. Reproduced with thanks from: <http://www.mynewsdesk.com/dk/bayer/pressreleases/bayer-deepens-involvement-in-futuristic-solar-powered-aircraft-799972>



6.56 Generating Electricity through walking. Reproduced with thanks from: <http://technabob.com/blog/2011/08/26/instep-nanopower-shoes/>

Now, the Germans have joined the race. They are building solar powered aircraft that can fly in the stratosphere at a height of 15 kilometers for years continuously. The maiden flight of this aircraft "ELHASPA" was made recently to demonstrate the viability of the technology used. With a wing span of 23 meters and a length of 10 meters, the aircraft has photovoltaic cells covering the upper surface of its wings. However, the British Zephyr is still in the lead as the German unmanned aerial vehicle has still to demonstrate what it can do.

These High Altitude Long Endurance (HALE) aircrafts are expected to replace satellites as they can be manufactured at only 1% of the cost of manufacturing satellites. They should be able to perform most of the functions of expensive satellites at a small fraction of the cost.

6.56 Generate Electricity: By Walking!¹⁰³

A team of scientists at UK's Cranfield University, University of Salford and University of Liverpool have developed a novel device that harvests energy from your knees while walking and converts it into electricity! The energy can then be used to power various devices such as heart rate monitors and GPS systems. The circular cup shaped device fits on the outside of the knee. It has an outer ring with 72 metal strings that vibrate as the person walks. These vibrations are then converted into electricity. A cost effective version of the device that will cost about \$ 15 is now being developed under the leadership of Cranfield University's Dr. Michele Pozzi.

The industrial designer Kyle Toole had developed another device a few years ago that produces energy not from the bending of the knee but from the energy harvested when the heel hits the ground. He used the principle that if magnetic fields are changed, an electric current can be created (Faraday's Law). The device, called Etive, employs repelling magnets and can charge a 2000mAh lithium-ion battery in about five hours.

6.57 Harvesting Energy and Water -- by Wind Turbines!¹⁰⁴

Wind turbines have been used for production of electricity, but they have not been used for harvesting water from the air. This is

about to change. Now the French inventor Marc Parent has developed a novel design for a wind turbine that can harvest water from the air. A demonstration of this capability was made recently in Abu Dhabi when the wind-powered refrigeration/condensation unit was seen to extract 130-200 gal (approx. 500-800L) of clean, fresh water from the dry desert air.

The wind turbine is connected to a water condenser system that is located on top of a 78 ft (24m) mast. It is powered by a 30 kW wind with a 42 ft (13 m) diameter rotor. The wind turbine is used to generate electricity to cool the on-board cooling units so that the moisture condenses out. If water is not needed, then it can be used to provide electricity to the surrounding localities. It can be ideal for desert locations, remote islands or sites of natural disasters where constant supply of electricity and/or fresh water could be needed for survival.

The units have been robustly designed to last for up to 30 years. In areas where wind may be lacking but there is plenty of sun, an alternative version fitted with 30kW Solar Panel is available to operate the condensation/filtration equipment.

6.58 Hungry Termites --- for Biofuel!¹⁰⁵

Termites are such a nuisance, attacking wood and causing havoc in many houses. Could you ever imagine that they may be useful in biofuel production? It turns out that the hunger that termites have for wood can be put to good use ---- for production of biofuels.

Ethanol can be produced by fermenting sugar or starch. Molasses from the sugarcane industry is an excellent raw material as are the sugars or starch present in corn, beet root and wheat. It has been more difficult to convert cellulosic materials present in leaves, grass or wood into ethanol. The main obstacle has been the presence of protective lignin in the cell walls of the cellulosic biomass that prevents easy access to the sugars present within the cells. An exciting breakthrough has now been achieved by Dr. Mike Scharf and coworkers at Purdue University who discovered that a cocktail of enzymes, present in certain organisms (protozoa) that live in the gut of termites, has the remarkable property of breaking down the lignin. This allows

the release of sugars present in the sawdust and other cellulosic biomass that can in turn be fermented to afford ethanol!

6.59 Hydrogen from Water--- Using Algae!¹⁰⁶

Hydrogen is the most common element found around us, comprising about 75% of our universe. The stars contain mainly hydrogen, existing in a state of plasma. Huge amounts of light and energy are produced by fusion reactions that occur when atoms of hydrogen fuse together to produce larger atoms. Indeed, the flowers in your garden are due to the light from the sun produced by such reactions. The sunlight is used in photosynthesis to help plants grow (by the chlorophyll present in plants converting carbon dioxide into organic compounds). Photosynthesis may be rightly considered as that marvelous natural engine that drives life on earth. Hydrogen can be an important source for energy production as it readily burns in air, producing water as a by-product. It occurs only in traces in our atmosphere (about 1ppm by volume).

Hydrogen is found in a bound form in the molecules of water. A huge source of this important element could become available from our oceans if we can break off hydrogen atoms from water molecules. This can be achieved using sunlight in photo-electrochemical (PEC) cells in the presence of certain catalysts. This produces pure hydrogen from water. Now, scientists from the Swiss research institute EMPA, along with colleagues from the University of Basel and the Argonne National Laboratory in Illinois have been able to boost the efficiency of the PEC cells using a light harvesting protein from blue-green algae. The plant-assisted boost to the production of hydrogen may become a source of truly green energy of tomorrow, with water from our oceans and not oil serving to power your cars.

6.60 Laser Headlights for Cars!¹⁰⁷

BMW is introducing laser headlights on cars that will use less energy than normal headlights. To prevent the deleterious



6.58 Biofuel production---hungry nuisance. Termites' gut reaction set for biofuels. Reproduced with thanks from: <http://www.abc.net.au/science/articles/2007/11/22/2097855.htm>



6.59 Getting Hydrogen from Water using Algae. Efficient algae – the next biofuel. Reproduced with thanks from: <http://www.ecosmagazine.com/?paper=EC10041>

effects of lasers from affecting passengers in other approaching cars, the light produced by lasers will be “softened” and converted into pure white light by passing through a fluorescent phosphor material inside the headlight. The emitted light would be comfortable to the eye, being bright and white, and safe for humans and animals. Laser lights can produce an intensity about

thousand times greater than that by LED lights and consume less than half the energy.

6.61 Mobile Phone Batteries --- 10 Times Longer Life!¹⁰⁸

Our mobile phones often run out of power when we most need them --- a frustrating experience. Now, a new technology has been developed by Harold H. Kung, professor of chemical and biological engineering at the McCormick School of Engineering and Applied Science at North Western University in USA. In a paper published in the journal *Advanced Energy Materials*, Prof. Kung has reported that they have found a method to extend the battery life of lithium ion batteries by 10 times. The batteries can be charged with 15 minutes and run for over a week of regular use. The scientists developed an anode by sandwiching silicon between a layer of graphene. Graphene is a single layer of carbon atoms, tightly packed in a honeycomb structure, and arranged as planar sheets. The technology has also potential to be applied to batteries used in electric cars.

6.62 New Advance in Renewable Energy Sector!¹⁰⁹

As the cost of fuel rises, and global warming begins to take its toll in terms of changing weather patterns, there is increasing interest in turning to renewable sources of energy. A problem associated with solar or wind energy is to have a sustained source of power even when the sun goes down or the wind slackens. It is during these periods that the efficiency and capacity of the battery storage systems become important. Large storage and supply of power to grid systems has been a challenge. Now, Dr. Yi Cui, an associate professor of materials science and engineering at Stanford University and colleagues have made an exciting discovery that can provide a solution. They have developed a new high power electrode that is cheap, efficient and capable of being employed in batteries that can store large amounts of power for grid systems.

Existing batteries fail because of the damage caused over time to the electrodes in them by the movement of ions. The new electrode (made from nanoparticles of copper hexacyanoferrate) developed by Stanford researchers uses nanotechnology to construct an open structure for the electrode that permits ions to move in and out without damaging it. In view of its open structure, ions can move in and out of the electrode rapidly, thereby allowing very fast charge and discharge. The electrode appears to be a wonder material for use as a high voltage cathode. The scientists are now developing the corresponding anode so that the complete battery can be built for use.

6.63 New Solar Power Technologies!¹⁰

There have been rapid developments in the use of solar technologies in recent years. The Council of Scientific and Industrial Research in Newcastle, Australia has come up with an interesting technology that uses just the sun and air to generate electricity. This "Tower of Power" employs an array of some 450 mirrors that heat compressed air. This hot air is then expanded through a tower that is about 30 meters tall, and the expansion process is used to drive electricity turbines ("Brayton Cycle" turbines) directly. The power generated is sufficient to power over a hundred homes, though the system will be initially used for research purposes.

In another development, researchers at Oregon State University and Yeungnam University in Korea have succeeded in the use of continuous flow microreactors to produce thin film absorbers for solar cells. The technology involves depositing "nanostructure films" on various surfaces (such as copper indium diselenide) in a continuous flow microreactor system. This innovative technology has the potential of significantly reducing the cost and increasing the commercial development of new types of thin film solar cells.

Another development has been the use of silicon ink solar cells. A US company DuPont Innovalight has achieved a 19% conversion efficiency, in contrast to normal solar cells that usually have efficiencies of about 15%. The proprietary material comprises

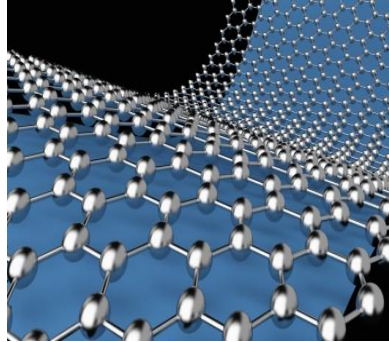
silicon nano-particles that are dispersed in an environmentally friendly blend of chemicals to form the solar ink. This low cost process allows silicon ink to be printed on solar cells using thinner substrates as compared to traditional solar cells.

Graphene is a special material that has a honeycomb structure of a single layer of carbon atoms. Recently, researchers at the University of Florida have found that a graphene, when doped with a special chemical (trifluoromethanesulfonyl-amide, TFSA), increases the efficiency of the solar cells made with this combination to 8.6 percent. This is a huge improvement over the previous efficiency of graphene solar cells that was at 2.9% at best. The prototype solar cells comprise a rigid wafer of silicon coated with a single layer of graphene that has been chemically treated with TFSA.

6.64 Powering Electronic Devices --- with Your Blood!¹¹

Implantable medical devices, such as pace makers, can save lives. However, they require a battery to run them. The battery of a pace maker runs out of power after about 8 years, and surgery is then needed to replace it. Similarly, heart pumps are powered by batteries that can be charged from outside the human body, but this requires a wire to protrude through the patient's skin. It would be wonderful if a method could somehow be developed to power these devices with the body's own internal energy systems. Now, Dr. Sven Kerzenmacher of Freiburg's Department of Microsystems Engineering in Germany is developing such a system. This is based on using the glucose present in the blood of the patient as the source of energy for providing power to the batteries in the implanted medical devices.

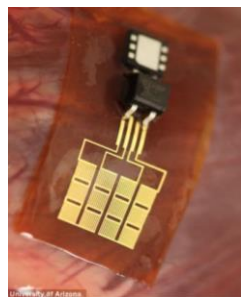
New types of solar cells have been developed by scientists at the University of Southern California (USC) that are suspended in liquid and can therefore be painted or printed on glass or plastic surfaces. The tiny solar cells are so small that you cannot see them with the naked eye --- just four nanometers in size -- so that some 250 billion such cells can be fitted on the head of a needle. Since they are so tiny, they can be printed like a newspaper so that mass production is possible very cheaply.



6.63 New Technologies of Solar Power. Graphene based solar cell. Reproduced with thanks from: <http://www.gizmag.com/graphene-solar-cell-record-efficiency/30466/>



6.63 New Technologies of Solar Power. Reproduced with thanks from: <http://inhabitat.com/almeisan-tower-a-solar-concentrating-skyscraper/>



6.64 Providing Energy to Electrical Appliance from Your Own Blood. Implantable battery of pace maker that can charge from the movement of our organs. Reproduced with thanks from: <http://www.dailymail.co.uk/sciencetech/article-2544882/Will-phone-powered-HEARTBEAT-Scientists-reveal-implantable-battery-charge-organs.html>

6.65 Printable Liquid Solar Cells¹¹²

One of the problems with their use was to increase their efficiency and allow individual nanocrystals to communicate with one another. This problem was tackled by Richard L. Brutchey and coworkers, assistant professor of chemistry at the USC Dornsife College of Letters, Arts and Sciences, and USC postdoctoral researcher David H. Webber, who found a synthetic material that helps to stabilize the nanocrystals and builds tiny bridges between them in order to help transmit an electric current. This allowed a stable liquid to be created that can conduct electricity. Before long, we may have solar powered windows and walls instead of solar panels!

6.66 Printed Solar Cells!¹¹³

An exciting recent development in solar technologies is that of printed solar cells --- that can be printed on a standard inkjet printer! Although the efficiency of these printed cells is only about 5%, the very low cost of production makes them highly cost effective. The researchers at Oregon State University, who developed this printing technology, hope to increase the efficiency of the cells to 12% soon. The cells are "CIGS" solar cells, so called because they contain copper, indium, gallium and selenium. The ultra thin film solar cells can even be built into roofing materials to convert the sunlight into heat and electricity for house lighting/heating and water heating.

Solar cell technologies are expanding by leaps and bounds. Spectrolab, a subsidiary of The Boeing Company, announced that it had started production of the most efficient solar cell in the world with a conversion efficiency of 39.2% about 7 months ago. These cells have more than double the energy conversion efficiency than the normal commercially available solar cells. About 60% of the world's satellites are powered by solar cells manufactured by Spectrolab, and the International Space Station is also powered by them. The US military might owe its technological leadership to the high quality research that it funds in universities and government research establishments. The related company Boeing Defense,

Space & Security has an annual budget of \$ 34 billion and some 68,000 employees. It is through such gigantic efforts in sophisticated research and manufacturing that USA continues to remain a major world power.



6.66 Solar Cells for printing. Reproduced with thanks from: <http://www.cnet.com/news/solopower-rolls-out-flexible-rooftop-solar-panels/>

6.67 Quantum Dots: Next Generation Solar Cells!¹⁴

Solar cells use the energy from the sun to produce electricity. The sun's energy is in the form of photons. The photons excite the electrons in the solar cells from one energy level to a higher energy level, resulting in the flow of electrons through the material. The electricity thus produced is direct current (DC) that can be used to light bulbs or operate other electrical devices such as fans *etc.* that can operate with DC electricity.

Commercially available solar cells are normally made up of crystalline wafers of silicon and have efficiencies between 14-18%. The latest "multi-junction" solar cells developed use other materials, and have much higher efficiencies --- between 38%-42%--- but they are more difficult and expensive to produce. There are therefore two important competing considerations: the price at which solar cells can be manufactured and installed and their efficiencies.

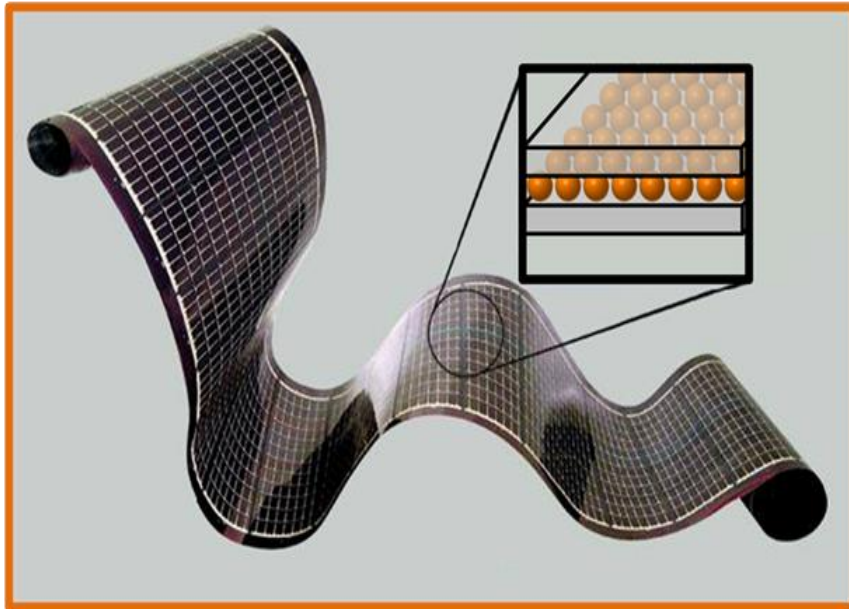
A recent break-through in this field has been the development of low cost “quantum dot” solar cells with improved efficiencies that can be sprayed on surfaces such as roofs or windows. Quantum dot solar cells are made of tiny particles (nanoparticles) of semiconductors. These can be readily painted on surfaces and do not need the formation of cumbersome and expensive solar panels for installation and use. Initially, researchers at Stanford had used organic materials for preparing the nanoparticles but now scientists at the University of Toronto in collaboration with scientists at the King Abdullah University of Science & Technology have found that more efficient quantum dot solar cells can be produced with inorganic materials. A world record of 6% efficiency has been created with such solar cells. It is expected that the development will be commercialized before long.

6.68 Robotic Jelly Fishes --- Water Powered!¹⁵

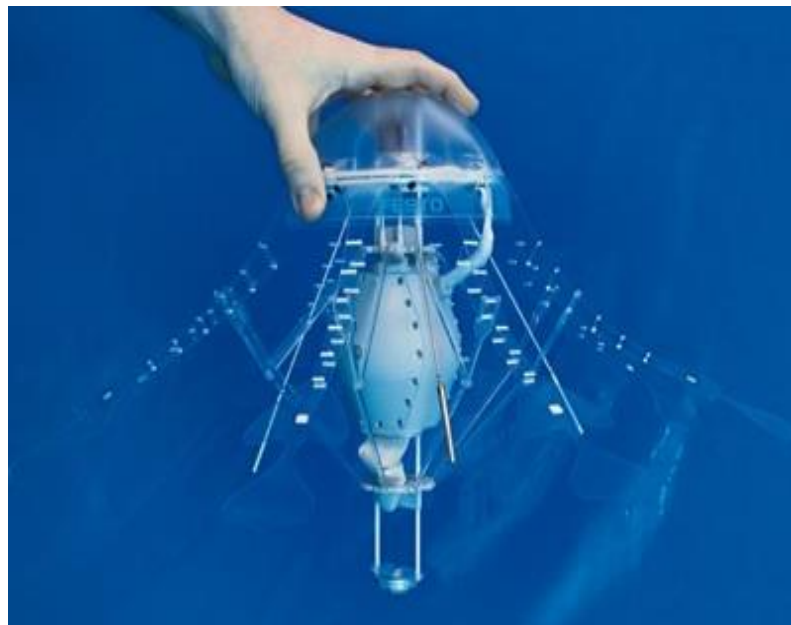
Scientists at Virginia Tech in USA have invented an amazing robot that resembles a jelly fish. It is powered by water and can swim in it indefinitely. Named appropriately as “Robojelly”, it is coated with a layer of platinum on its surface that reacts with the water around it to create heat. This heat energy is used to provide power so that it can flex its artificial muscles and swim swiftly through water. The Robojelly has been developed under a project funded by the Office of Naval Research in USA and it is the prototype of future unmanned surveillance submarines that will scan the oceans unnoticed. The Robojelly has been designed on the moon jellyfish (*Aurelia aurita*).

6.69 Round the World --- on Solar Power!¹⁶

On 4th May 2012, the first round of the world trip was completed by a boat running exclusively on solar power. The 102 ft long and 49 ft wide boat, named "TÛRANOR PlanetSolar", took 18 months to complete the trip when it reached Monaco after circumnavigating the planet. The boat is covered with solar



6.67 Quantum Dots—Next Door Solar Cell. Reproduced with thanks from: <http://nanocluster.mit.edu/research.php>



6.68 Robotic JellyFish—with Power of Water. Reproduced with thanks from: <http://kk.org/thetechnium/2008/05/loving-robotic/>

panels that have an area of 537 square meters. They provide power to the four electric motors, and allow the boat to run at a speed of 14 knots per hour.

As solar cells become more efficient with advances in technology and as lighter, cheaper and more efficient solar panels are produced, more boats, cars and airplanes will run on solar panels.

6.70 Running Cars --- on Old Newspapers!¹⁷

As fuel prices rise and the search for green technologies intensifies, scientists are constantly looking for new sources of clean energy. One of the most abundant raw materials found on our planet is cellulose. This is a major constituent of wood, leaves, cotton and most plant materials. Scientists have for long been on the hunt for bacteria that could convert cellulose into butanol. Butanol could then be used as a biofuel to power car engines. Now, the breakthrough has occurred. A team of scientists at New Orleans' Tulane University has discovered a biofuel producing strain of bacteria, code named TU-103 that can convert cellulose, such as that found in old newspapers, into butanol.

Butanol has several advantages as compared to ethanol as a biofuel. It can be used directly without modification of the engine. It is cheaper, produces more energy on combustion, is less corrosive, and can be pumped through the pipelines that are presently installed. Its use will also lead to a significant reduction in smog and in the production of carbon dioxide, a green house gas.

6.71 Running Cars --- on Orange Peels!¹⁸

The rising prices of petroleum products, particularly during the last two decades, have forced scientists in many countries to find novel solutions to energy needs. Fossil fuels are mainly used for powering combustion engines in vehicles. Now Dr. -Ing. Ursula Schließmann, head of department at the Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) and



6.69 Around the World by means of Solar Energy. Solar Turanor Planetree. Reproduced with thanks from: <http://qz.com/122378/say-hello-to-the-worlds-largest-solar-powered-boat/>

her colleagues in Germany have found a novel way to run cars --
- using orange peels and other fruit/vegetable wastes! As these materials have a low content of lignocelluloses, they are well suited to fermentation that results in the generation of methane. The methane can then be compressed in cylinders for use in vehicles.

The "ETAMAX" project, as it is called, is being conducted with the participation of the energy company Energie Baden-Württemberg (EnBW), which employs membranes to process the generated biogas. Daimler is also collaborating in the project by developing experimental vehicles designed to run on natural gas. The project has been funded by the German Federal Ministry of Education and Research (BMBF) with an amount of about eight million dollars.

6.72 Running Fuel Cells ---on Coal!¹⁹

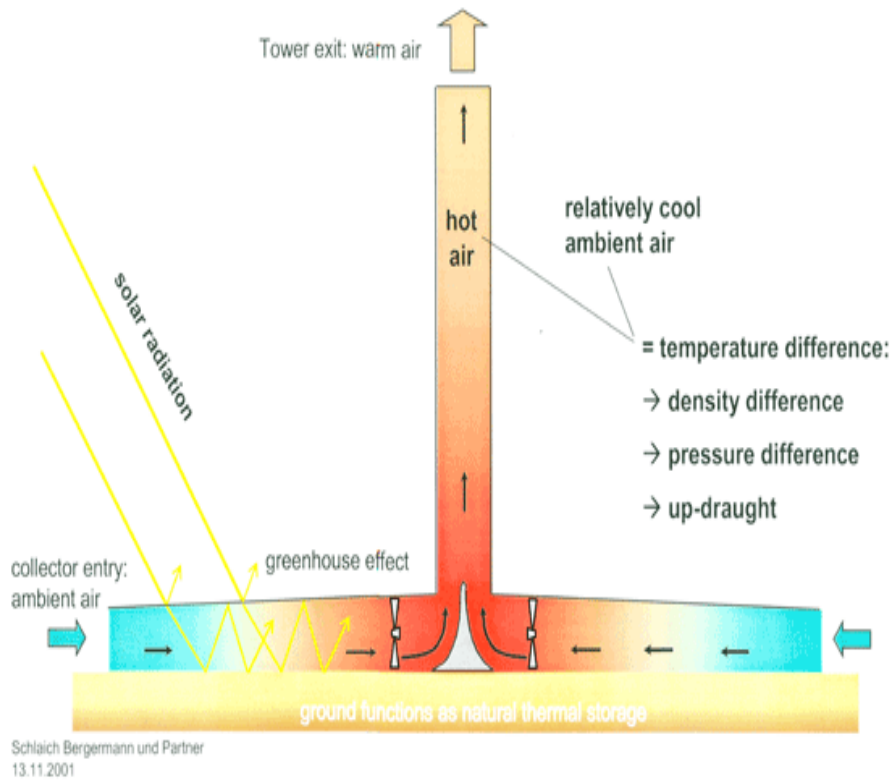
Fuel cells convert chemical energy into electrical energy that can then be used for various purposes. There are various types of fuel cells available, such as hydrogen cells that generate energy by oxidising hydrogen with oxygen to form water, generating electricity in the process. The cost of electricity produced by fuel cells has dropped from about \$1000 per kilowatt in 2002 to about \$ 50 per kilowatt at present, and new technologies are being constantly explored to bring down the costs further. Fuel cells are used to run cars and buses, boats and submarines.

Now, researchers at Georgia Tech in USA have developed an exciting new type of fuel cell which uses coal gas for its operation. Coal is first gasified and the resulting coal gas is then used in the fuel cells. The new fuel cells promise to provide electricity more cheaply and efficiently than hitherto possible.

6.73 Solar Powered Umbrellas!²⁰

Vodafone has financed the development of a solar powered umbrella that will not only shelter you from the rain or the sun but also provide power to your mobile phone or other devices. The umbrella has been developed by PhD students at University College London under the leadership of Dr. Kenneth Tong, their supervisor in the field of antennas and microwave technology. The umbrella, known as "Booster Brolly", has solar panels stitched on its exterior surface and a battery that is charged by the sun's energy on its handle. A Smartphone can be charged within 3 hours and any excess energy can be employed to light an LED torch that is also fitted on the handle. To overcome the problem of weak signals, the umbrella can collect signals from the nearest mobile phone transmitter by using a combination of high-gain antenna and a low power signal repeater. The signal shower created as a result allows the user and nearby persons to connect to the network.

The Booster Brolly will be demonstrated at the forthcoming 2012 Isle of White Festival in June 2012.



6.74 Solar Tower—Energy from Hot Air. Reproduced with thanks from: <http://www.geek.com/geek-pick/solar-tower-in-arizona-to-power-150000-homes-for-80-years-1406459/>

6.74 Solar Towers --- Electricity from Hot Air!²¹

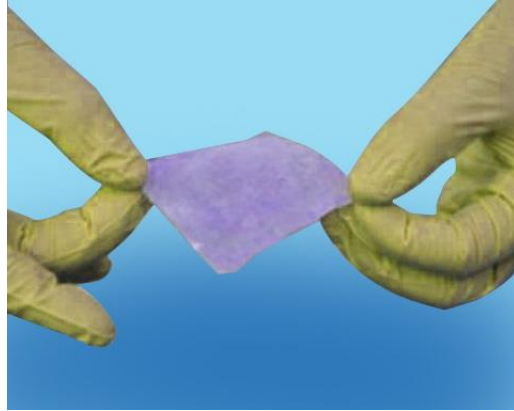
A huge solar tower is to be constructed in Arizona by a company, Enviromission, that will produce 200 Megawatts of electricity, just from hot air! It will not use solar cells or mirrors, but rely only on direct sunlight falling on a large area under a very tall tower, about 800 meters high, to produce hot air. The solar tower technology was successfully demonstrated in Spain over a decade ago to produce electricity. The technology involves the sun beating down on a large surface with an area of several hundred square meters. The hot air, having a

temperature of about 80-90 degrees celsius, is collected and allowed to escape through the tower. The tower needs to be tall, as for every hundred meters in height, one gets a temperature drop of 1degree Celsius. The hot air rises up rapidly through the tower. The larger the temperature difference between the hot air at ground level and the top of the tower from which it is escaping, the greater will be its upward speed, and the more electricity will be produced due to the corresponding increase in the rotation speed of the turbines.

Pakistan could build similar towers in its desert areas in Sind and use desert land that is otherwise useless, and produce huge amounts of electricity at low cost. In many areas in Sind and Balochistan, such partial funnel shaped structures already exist, created by natural erosion of mountain sides. They could be readily transformed into electricity generating towers at low cost.

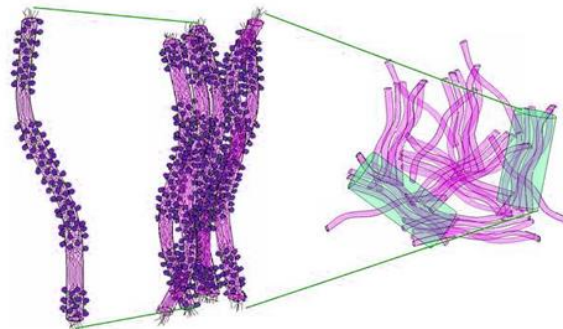
6.75 World's First Energy Storage Membrane!¹²²

Using nanotechnology, scientists at the National University Singapore have succeeded in what is claimed to be the world's first membrane capable of storing energy. The membrane is made of a polystyrene- based polymer that is sandwiched between two metal plates. The researchers claim that the membrane system is more cost effective than traditionally used rechargeable batteries, such as lead-acid or lithium ion batteries, and can store more energy. It avoids the use of liquid electrolytes used in traditional batteries that can spill out when damaged.



6.75a World's First Energy Storage Membrane. Reproduced with thanks from: <http://www.printedelectronicsworld.com/articles/3806/worlds-first-energy-storage-membrane>

Membrane Nanostructure



6.75b World's First Energy Storage Membrane. Reproduced with thanks from: http://www.nist.gov/mml/msed/functional_polymer/fuelcell.cfm

7. ENVIRONMENT

7.1 *Global Warming—a Looming Catastrophe for Pakistan!*¹²³

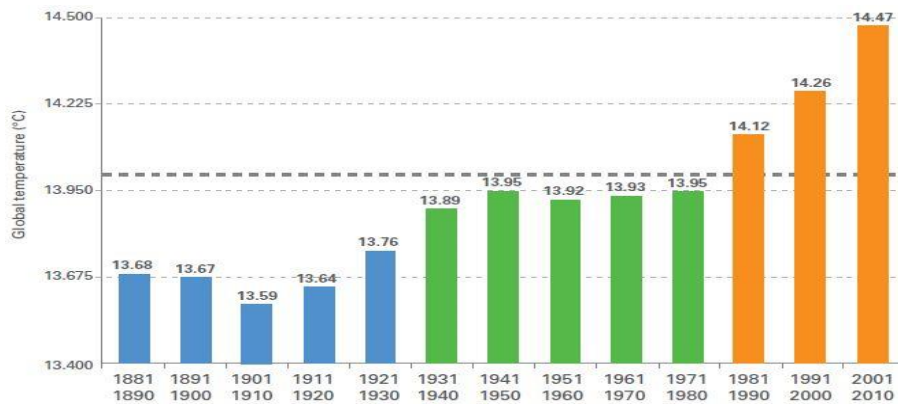
The UN Secretary General has recently warned that the world is “heading towards an abyss”. Rising sea levels will inundate many coastal cities such as Karachi. Pakistan and some other south Asian countries are at extreme risk. With only a 2 to 3 degree rise in average global temperature over the next 50 years, most of Pakistan could become uninhabitable, and tens of millions could die due to mass famines caused by failures of crops due to lack of water. The possibility of a nuclear confrontation between Pakistan and India over water disputes cannot be ruled out as large populations suffer from hunger and death.

India has wisely constructed a large number of dams over the last few decades but Pakistan seems to be bent on committing mass suicide due to criminal negligence by successive governments to construct large dams and reservoirs. Modeling studies predict that as the glaciers melt rapidly during the next 20 years, we will face vast flooding of rivers. This precious water must be captured and stored rather than to cause devastation and just go waste. After 20-30 years, as the rivers dry up, the country could face long periods of drought. We must therefore, over the next 10-15 years, create enough water storage capacity to meet at least 5-7 years of our national needs, to cope with these long periods of droughts. We must act with a sense of urgency.

7.2 *The Weather Time Bomb!*¹²⁴

The Arctic ice is melting rapidly, and scientists are worried. According to Dr. Katey Walter of the University of Alaska, some lakes in Siberia are now 5 times the size that they were only a couple of years ago. The catastrophic consequences could

include the changing of ocean currents which in turn could seriously disrupt the monsoon rains, critical for growth of crops and survival of some 2 billion people. The South Asian region is particularly vulnerable.



7.1 Temperature Rise in the World----Pakistan faces danger. WMO Report: The global climate 2001 – 2010: A decade of climate extremes. Reproduced with thanks from: <http://gpwayne.wordpress.com/2013/07/06/wmo-report-the-global-climate-2001-2010-a-decade-of-climate-extremes/>

The Arctic seems to be much more prone to climate change. The permafrost (frozen soil, water and rock) contains vast quantities of organic carbon, derived from dead plants and animals frozen for over 10,000 years. Its rapid melting can release about 100 billion tons of the buried carbon in the form of carbon dioxide or methane to the atmosphere. Large amounts of methane, trapped as methane hydrates (ice containing trapped methane) under the frozen seas could also be released. Large releases of methane, a far more potent green house gas, could worsen the global warming.

Researchers are trying to discover efficient carbon dioxide eating bacteria that can remove carbon dioxide from the atmosphere and produce organic fuels as a by-product. Artificial chemical dust storms that can absorb the heat are also being considered. However, unless we control the burning of fossil fuels, particularly in the advanced world, it may already be too

late. The weather time bomb is ticking: it may explode sooner than expected, affecting billions.

7.3 *Brown clouds over Himalayas – Our Glaciers are Melting!*¹²⁵

Large quantities of soot-filled brown clouds hovering over a large area of the Himalayas are contributing to the much faster melting of our glaciers. This may lead to the eventual drying up of all the rivers in Pakistan, which are so crucial for agriculture and life. This haze of brown clouds can be up to 3 miles thick and covers an area from the Himalayas to the Indian Ocean, about the size of USA. These clouds of aerosols over India can enhance global warming by 50 percent. They are the direct result of soot-emitting industries in India where environmental controls are virtually non-existent. The particles of soot produced by burning coal and other organic materials absorb the sun's energy, thereby contributing to the atmospheric warming, which in turn leads to the faster melting of glaciers. Studies carried out at the Scripps Institution of Oceanography at the University of California and by NASA have confirmed the existence of this huge polluting "brown cloud".

It is urgent for Pakistan to raise this matter at UNO and other international levels so that countries in the region, particularly India, which are primarily responsible for these "brown clouds" over our sub-continent can install soot-removal devices in their factories. Otherwise, we may face mass famines due to the much faster melting of glaciers resulting in the eventual drying up of all our rivers, turning vast areas of Pakistan into uninhabitable deserts.

7.4 *Coastal Cities in Danger!*¹²⁶

Scientists are worried that we are heading towards an impending catastrophe due to global warming. The sea level rose by 17 cm in the 20th century and the rate at which it is rising is increasing



7.2 Climate Time Bomb. Melting Arctic ice called 'economic time bomb'. Reproduced with thanks from: <http://www.cbc.ca/news/business/melting-arctic-ice-called-economic-time-bomb-1.1372524>



7.4 Beach Cities on the Danger. Climate Change Threatens Cities. Reproduced with thanks from: http://bayridgejournal.blogspot.com/2013/11/climate-change-threatens-cities_2.html

rapidly. The sea level is likely to rise by as much as 1 to 2 meters, possibly more, in the next 90 years, causing huge devastation. The rise in sea levels is due to two reasons---melting of glaciers and thermal expansion of ocean water with increasing atmospheric temperatures. About 60 million people live in the coastal areas, and this number is expected to grow to 130 million by the end of this century. Most housing estates built near the sea will need to be abandoned. Parts of Karachi and coastal areas of Baluchistan will be submerged and become uninhabitable. Coastal areas in Dubai will also disappear under the sea. Maldives will be completely submerged, as will be much of Bangladesh. Five European countries will be badly affected, with Netherlands suffering the most. Devastating hurricanes and accompanying massive flooding, that presently occur once every 100 years, will start occurring much more frequently, probably every 4 years, making it necessary to abandon coastal cities rather than rebuild them. Scientists believe that it is already too late to reverse this situation---even if we stop pumping green house gases to the atmosphere today.

7.5 Fighting Global Warming---with Roof Gardens!¹²⁷

A recent study carried out by Kristin Getter and colleagues in Michigan, USA, has shown that an excellent way to fight global warming as well as save air-conditioning costs is to have a roof garden. In a two-year study on measurements of carbon levels in plants and soil samples, they concluded that in a city inhabiting about 1 million people, if every house had a roof garden, some 55,000 tons of carbon could be captured in a year. This is equivalent to removing the carbon emission effects of 10,000 trucks from the roads.

Roof space is usually wasted. The construction of roof gardens would not only contribute to tackling the growing menace of global warming but also lead to putting empty, usually ugly, space to good use for leisure and for cooling the houses/buildings.

In Pakistan, an excellent roof garden has been built on the roof of the environmentally friendly COMSTECH building opposite

the Prime Minister's Secretariat on main Constitution Avenue, a model that others should emulate.

7.6 Global Warming by Beef Burgers!¹²⁸

Have you ever considered that the food you eat may contribute to global warming! The meat on your table has several global warming components in it, starting from the cows or goats themselves. The animals emit large amounts of methane from their rear ends as a result of the digestion process, and researchers are trying to develop new types of fodder that would lead to a significant reduction of this potent green house gas from the animals. Cows produce 3 to 4 ounces of methane for every pound of meat, equivalent to about 5-6 pounds of carbon dioxide (since methane is 23 times worse than carbon dioxide for global warming).

It has been estimated that the production of meat alone contributes to about 20% of the 36 billion tons of "carbon dioxide equivalent" green house gases produced annually. Pound for pound, producing beef contributes 13 times as much to global warming as producing chicken, or 57 times as much as producing potatoes. It has been estimated in USA that the average annual beef consumption of a person can contribute as much greenhouse gas as driving a car for 1800 miles! So watch out when you eat a beef burger next time ---- you will be contributing to the process of global warming!

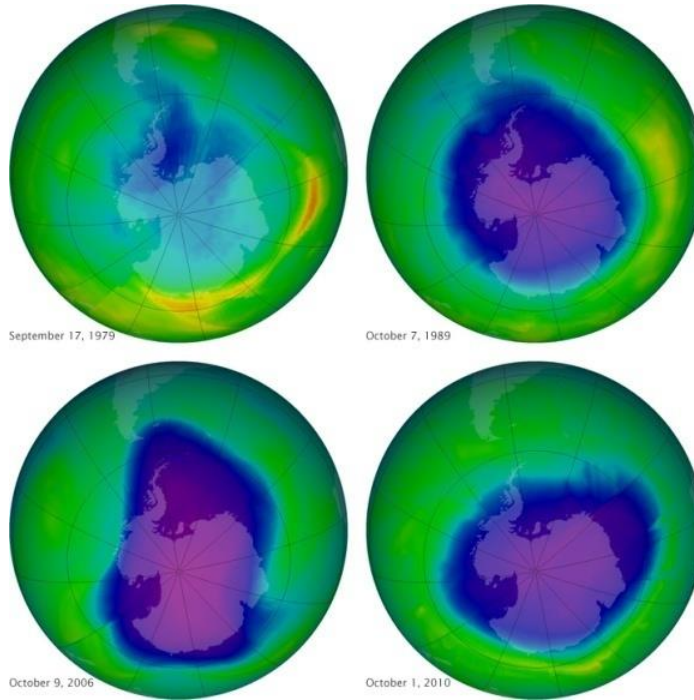
7.7 The Ozone Hole!¹²⁹

In 1974, Sherwood Rowland and Mario Molina, working at the University of California, Irvine warned that certain chemicals used as refrigerants (chlorofluorocarbons, CFCs) could break down in the stratosphere releasing chlorine which could destroy atmospheric ozone. Ozone protects the earth's surface from the damaging effects of ultraviolet radiation. It was not until 1985 that the world was put on high alert when a team of scientists from the British Antarctic Survey discovered the ozone hole above the

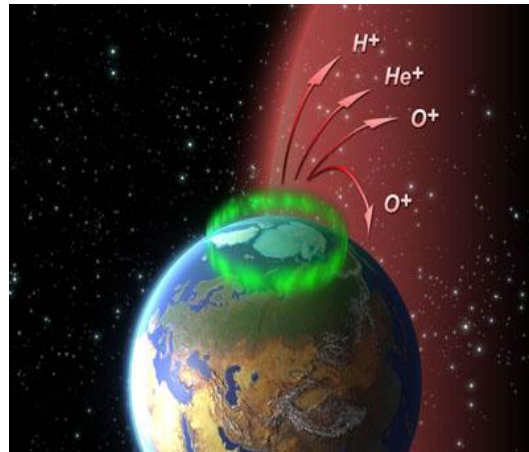
Antarctica. In 1987, under the Montreal Protocol, countries agreed to phase out the production of CFCs as well as the bromine containing compounds used in fire extinguishers. For the first time in human history, the world acted in unison to tackle a major environmental problem. Rowland and Molina shared the 1995 Nobel Prize with Paul Crutzen of Germany for unraveling the ozone chemistry involved. After peaking in the late 1990s, the concentration of ozone destroying compounds is declining in the stratosphere, and the holes in the ozone layer are gradually closing. Why are the holes above the poles? Outside the polar regions, only a few hundred molecules of ozone are catalytically destroyed by each chlorine atom. In the polar stratosphere, however, the ice particles present in the stratospheric clouds provide the surface on which the chlorine atoms rapidly attack tens of thousands of ozone molecules, and the loss rate can reach up to 3% per day in the center of the ozone hole in Antarctica. It has been calculated that if no action had been taken in 1987, two-third of the atmospheric ozone would have been destroyed by 2065, resulting in a dramatic rise in skin cancer.

7.8 Planet Earth--- We are Losing Our Atmosphere!¹³⁰

Outer space is an almost perfect vacuum, exerting a huge suction force on our atmosphere. Fortunately, the gravitational pull exerted by our planet prevents it from escaping --- the loss is very small. The gravitational force is weak in small objects --- an apple too exerts a very small gravitational pull but it is too small to be discernable. However, when objects are of the size of our moon or our earth, the gravitational pull is considerable---fortunately for us. In order for atmospheric molecules to escape into space from the gravitational pull of the earth, they need to achieve a certain escape velocity. Our earth is losing hydrogen at about 3 kg of hydrogen and 50 grams of helium, the two lightest gases, each second. This can be significant in geological time scales. For instance, Mars is red because all of its water vapour was broken down into hydrogen and oxygen, the hydrogen escaped from the planet, and the remaining oxygen reacted with rocks to form



7.7 Hole in Ozone. Reproduced with thanks from: <http://news.softpedia.com/newsimage/The-Evolution-of-the-Ozone-Hole-2.jpg/>



7.8 Earth---We are Depriving of our Atmosphere. Electrically charged oxygen, hydrogen and helium atoms (ions) leaking into space from the Earth. Reproduced with thanks from: <http://www.astronomy.com/news-observing/news/2008/08/earths%20leaky%20atmosphere>

reddish oxidized materials. The escape of atmospheric molecules can occur by heating of the atmosphere by the sun, by the gas particles becoming ionised, and then escaping due to repulsion by electrical fields or magnetized “solar winds” or by bombardment of our planet by asteroids which can throw huge amounts of rocks and atmosphere into outer space.

As the sun gets hotter with time, the escape of hydrogen and other gases will increase. In about 2 billion years, the earth would have lost all atmospheric gases, leaving a barren piece of smoldering hot lifeless rocks. Hopefully, our children would have discovered another habitable planet by then.

7.9 Giant Ice Chunks from Clear Skies!¹³¹

In February 2007, 20 pound chunks of ice fell from clear blue skies in Madrid, Spain and crashed through the roof of an industrial warehouse. More than 50 such events have been reported in different parts of the world in the last 7 years, according to the astrobiologist, Jesus Martinez-Frias at the Center for Astrobiology in Madrid. Climate experts have been predicting extreme weather events such as powerful hurricanes or droughts but no one ever thought that huge chunks of ice could appear suddenly from clear skies, shattering wind shields and destroying roofs of houses and buildings. Such monster ice chunks, called “megacryometeors”, can weigh up to 200 pounds. They are believed to be formed in the lower atmosphere (troposphere) due to atmospheric turbulence. This results in repeated coating of the ice crystals as they are thrown about in the turbulence and progressively grow to monstrous sizes. This is thought to be the direct result of climate change which has resulted in increased humidity and turbulence in the troposphere.

7.10 Can Bacteria Cause Rain?¹³²

Swedish scientists have proposed that certain surfactants released by bacteria may influence the formation of clouds and

lead to rain. Barbara Naziere at the University of Stockholm has shown that certain powerful surfactants secreted by some bacteria have been found to stimulate water droplet formation. A study of clouds above Brazil, Sweden and Finland has shown that they contain tiny amounts of substances resembling the structures of the known surfactants secreted by bacteria.

7.11 Auroras – What causes them?¹³³

Do you know that the sun is responsible for the spectacular bright lights in the night sky seen near the two poles of the earth? The sun throws a magnetic hurricane, comprising a hot gas of charged particles, with associated magnetic fields and electric currents, in the direction of the earth. This hurricane blows over the earth at a terrific one million miles per hour. However we hardly feel it because it is largely deflected by the earth's magnetic field ("magnetosphere"). However, it does cause distortions in our magnetosphere causing a shower of high energy particles which light up the night sky. When there is a high intensity storm, the sky lights up brightly with many colours, the green and red light being produced by the collision of the cosmic particles with oxygen, while blue light appears due to the interaction of the cosmic particles with nitrogen. Fortunately for us, the magnetosphere acts as a protective shield, protecting us from the cancer-causing cosmic rays.

7.12 Venice Flooding Caused by Sun Spots!¹³⁴

David Barriopedro and co-workers working at the University of Portugal have found a direct relationship between the periods in which the sun spots are at a maximum with floods in Venice. Venice experiences frequent flooding each year, which occurs commonly between October and December. The scientists compared hourly sea levels during a 61 year period from 1948 to 2008, and found that such floods remarkably occurred when the sun spots were most abundant. The extreme tides followed the same 11 year cycle as the solar cycle of sun spots, showing

peak flooding when the sun spots were at a maximum (*Journal of Geophysical Research Atmospheres*, DOI: 10.1029/2009JD013114). So the next time you are planning a trip to Venice, check the abundance of sun spots first!

7.13 For Flood Affected Populations: Purifying Water - with Sunlight!¹³⁵

There are some 4 billion cases of diarrhea each year and about 2 million deaths, mainly of children under the age of 5, according to WHO. The problem is particularly serious after floods, such as in Pakistan, where the break-out of diarrhea has been reported from several regions. Science can now offer a cheap and easy way to make the dirty water available safe for drinking. The technology known as "SODIS" (Solar Water Disinfection) requires only one liter transparent plastic (PET) bottles and sunlight. These commonly found plastic bottles allow the UV light to pass through, killing the germs and making the water drinkable. If the water is muddy, it should be filtered through a piece of cloth in order to remove the dirt particles. One liter bottles work best, but 2 liter bottles may also be used. The bottle is placed for a minimum of 6 hours in sunlight and the water can then be drunk directly from it. The bottles must not be old or heavily scratched and any labels should be removed in order to allow the light to pass through unobstructed.

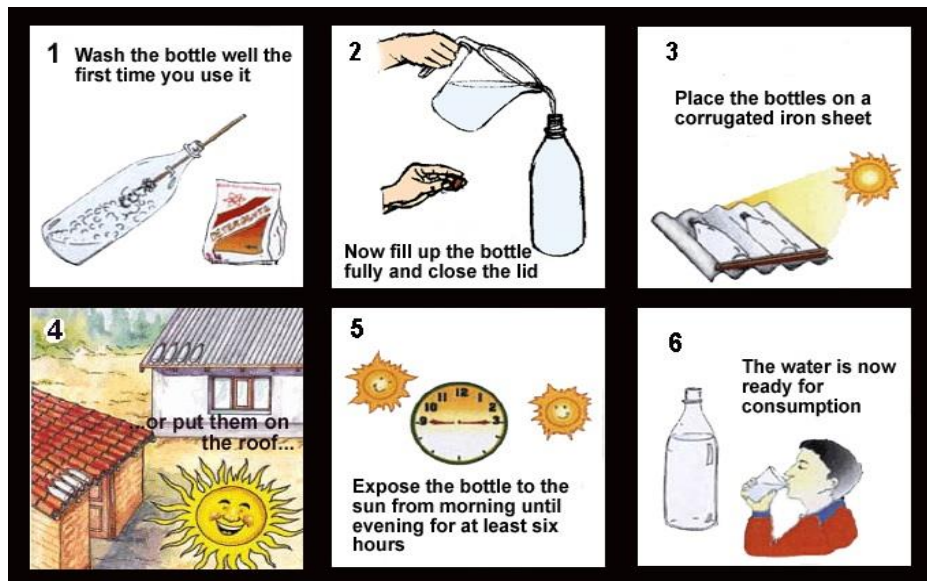
This easy way of purifying water was discovered by Prof. Atfim Acra at the American University of Beirut in the 1980s. The Swiss Federal Institute of Aquatic Science and Technology (Eawag) in collaboration with the Department of Water and Sanitation in Developing Countries (Sandec), has already implemented projects in 33 countries. The clinical control trials demonstrating the efficacy of the process were carried out by Professor Ronan Conroy of the Royal College of Surgeons in Ireland, in collaboration with Michael Elmore-Meegan before it was recommended by WHO as a safe method for water treatment.

The disinfection process involves three different mechanisms. Firstly, the solar radiation (UV-A) attacks the bacteria directly,



7.12a Floods in Venice due to Sun Spots. Reproduced with thanks from: http://www.dailygalaxy.com/my_weblog/2010/09/sunspots-vanishing.html

7.12b Floods in Venice due to Sun Spots. Reproduced with thanks from: <http://www.theprovince.com/travel/Venice+flooding+leaves+tourists+wading/7501210/story.html>



7.13 Solar Water Disinfection in Flood Affected Areas. Reproduced with thanks from: <http://www.medmissionaries.org/id49.html>

killing them by interfering with their metabolic processes. Secondly, the UV-A radiation reacts with the oxygen dissolved in water, producing highly reactive oxygen species and peroxides that kill bacteria. Thirdly, the infra-red light heats up the water,

and if the temperature rises above 50 degrees centigrade, there is a three-fold increase in the rate of disinfection. For further background reading see http://en.wikipedia.org/wiki/Solar_water_disinfection and references therein.

The agencies working under Government of Pakistan and NGOs involved in aid distribution should distribute clean PET bottles along with instruction pamphlets so that the flood affected persons could save themselves from diarrheal diseases.

(I am grateful to Prof. Naeem Jafari, Advisor Academic Affairs, Ziauddin University, Karachi for bringing this technology to my attention).

7.14 Controlling World Climate/Agriculture - with HAARP?¹³⁶

The European Union expressed its concern officially over a secret US program, jointly funded by the US Air Force, the US Navy, the Defence Advanced Research Projects Agency (DARPA) and the University of Alaska. HAARP (High Frequency Active Auroral Research Program) is a highly controversial US programme which aims at manipulating the ionosphere. This is a layer of the earth's atmosphere which extends from about 70 kilometers to about 300 kilometers above the earth's surface, a region where the atmosphere is very thin so that UV and X-rays can penetrate it easily. However, there are still many gas molecules around to react with these rays so that ions are readily generated ---- hence the name "ionosphere". It has been alleged that the programme aims to control the weather by manipulating the ions in the ionosphere, and thereby control the world ---- for food is dependent on weather. It may also affect the tectonic plates causing earthquakes, cause floods through torrential rains and trigger tsunamis. The experiments involve using electromagnetic frequencies to fire powerful pulsed energy beams to excite a certain region of the ionosphere. Energy directed by powerful lasers can heat up the ionosphere and may control weather, making it a potentially devastating war weapon.

The European Union resolution was a serious blow to the attempts of US agencies to portray HAARP as a harmless research project. It proved that there was a real world threat being felt even by European countries, and that HAARP was not just an imaginary figment of empty conspiracy theories. The EU resolution No. 24 of Jan 28, 1999 stated “ *It Considers HAARP by virtue of its far-reaching impact on the environment to be a global concern and calls for its legal, ecological and ethical implications to be examined by an international independent body before any further research and testing; regrets the repeated refusal of the United States Administration to send anyone in person to give evidence to the public hearing*”: http://www.europarl.europa.eu/pv2/pv2?PRG=DOCPV&APP=PV2&DATE=280199&DATEF=990128&TPV=DEF&TYPEF=A4&POS=1&SDOCTA=8&TXTLST=1&Type_Doc=RESOL&PrqPrev=TYPEF@A4|PRG@QUERY|APP@PV2|FILE@BIBLIO99|NUMERO@5|YEAR@99|PLAGE@1&LANGUE=EN

The main Instrument used by HAARP is known as the “Ionospheric Research Instrument” (IRI) which is a powerful high frequency radio-transmitter comprising 180 antennas over a rectangular area of 33 acres at a US Air Force site in Gaskona, Alaska. The project aims at sending pulsed or continuous 3.6 MW signals to the ionosphere. The main goal of HAARP is stated to be scientific research on the ionosphere. It is difficult to study the ionosphere by conventional means since air is too thin for weather balloons to reach it. Satellites are also unable to operate there because the air is too thick.

Prof. Michel Chossudovsky, Professor at University of Ottawa in an article entitled “**Washington’s New World Order Weapons have the Ability to Trigger Climate Change**” writes “Recent scientific evidence suggests that HAARP is fully operational and has the ability of potentially triggering floods, droughts, hurricanes and earthquakes. From a military standpoint, HAARP is a weapon of mass destruction. Potentially, it constitutes an instrument of conquest capable of selectively destabilising agricultural and ecological systems of entire regions” <http://www.globalresearch.ca/articles/CHO201A.html>.

Scientist Dr. Nicholas Begich describes HAARP as: “A super-powerful radiowave-beaming technology that lifts areas of the

ionosphere (upper layer of the atmosphere) by focusing a beam and heating those areas. Electromagnetic waves then bounce back onto earth and penetrate everything-living and dead." (Nicholas Begich and Jeane Manning, The Military's Pandora's Box, Earthpulse Press) <http://www.xyz.net/~nohaarp/earthlight.html>.

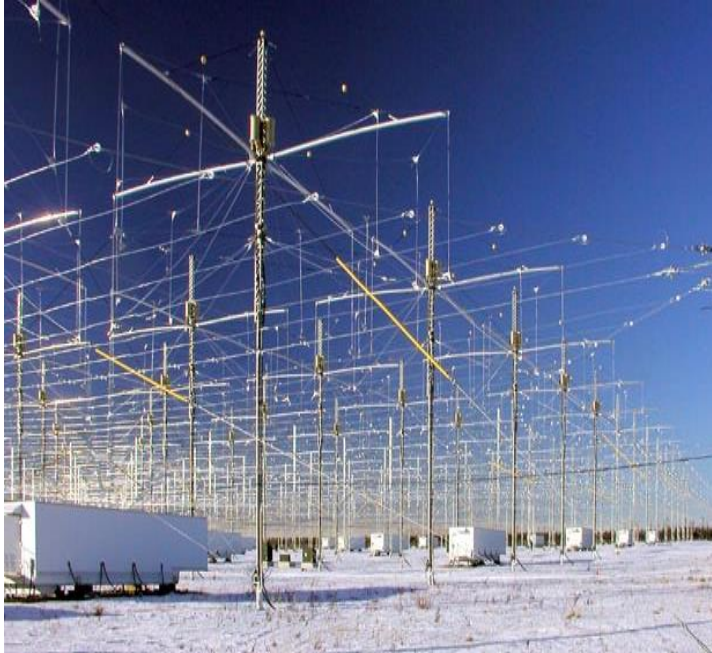
Eminent scientist Dr. Rosalie Bertell confirms that "US military scientists are working on weather systems as a potential weapon. The methods include the enhancing of storms and the diverting of vapor rivers in the Earth's atmosphere to produce targeted droughts or floods"(The Times, London, 23 November 2000, http://www.bariumblues.com/bertell_reveals_many_new_weapons.htm. The History Channel has also produced a 45 minute documentary on HAARP" : <http://video.google.com/videoplay?docid=4515534125267138757#>

The mass flooding in Pakistan has confounded scientists. In his video report entitled "**Turbo-Charged Monsoon Confounds Forecasters**" Tom Clarke, Britain's Channel 4 science correspondent, states:| "Normally the jet stream is a giant loop of high speed winds that whip round the upper atmosphere. ---- But what's happening over Pakistan is even stranger. The southern arm of the Jet stream has looped down so far it has crossed over the Himalayas into north western Pakistan. Experts at the Met Office tell me this is very unusual. And the result is that the fast moving jets stream winds high up has helped suck the warm, wet, monsoon air even faster and higher into the atmosphere – and that has caused rains like no-one can remember. It has turbo charged the monsoon if you like. They're not sure that's ever happened:

http://www.channel4.com/news/articles/world/asia_pacific/pakistan+floods+struggle+to+reach+victims/3738877.

The Venezuelan leader Hugo Chavez accused the United States of causing the catastrophic earthquake in Haiti by using HAARP. He asserted that US was "playing God" by testing devices capable of creating catastrophes <http://www.abovetopsecret.com/forum/thread537877/pg1>.

Is HAARP a harmless research tool ---- or a weapon of mass destruction far more lethal than nuclear weapons? We may never know.



7.14 HAARP to Control World Weather or Agricultural. HAARP is a program focused on the study of upper atmospheric and solar-terrestrial physics and Radio Science. Reproduced with thanks from: <http://www.tatoott1009.com/2012/07/19/weather-control-and-mind-control-as-a-global-weapon-high-frequency-active-auroral-research-program-and-chain-russe/>

7.15 Too Hot to Survive!¹³⁷

As global warming heats up world temperatures due to the burning of fossil fuels, our very survival may be at stake. Our body is designed to function within certain temperature limits. The normal core body temperature is about 37°C, but if it rises above 42°C, we die. Our skin has pores from which sweating can lead to a cooling effect through evaporation, but if the humidity rises, the evaporation (and the corresponding cooling effect) is reduced, resulting in stress on our body. Our skin temperature should not increase above 35°C for more than a few hours. In dry hot weather, we can tolerate atmospheric temperatures of up to 50°C or even above for short periods, because of the cooling effect from our skin.

However, when it is humid, survival at such temperatures becomes difficult. In France alone, about 13,800 persons died of heat stroke in 2003 and worldwide, the annual death numbers due to hot weather are in tens of thousands. Children and the elderly are most vulnerable. The 'wet-bulb' temperature (the temperature recorded by a mercury thermometer wrapped in a wet cloth) is, therefore, considered more relevant when considering stress on human bodies. Even healthy persons will not survive sustained wet-bulb temperatures of above 35°C for more than a few hours. The maximum wet bulb temperatures presently almost never exceed 31°C but as global temperatures rise, the level of humidity will also increase due to increased evaporation from the oceans, and the wet bulb temperatures will also rise.

Steven Sherwood at the University of New South Wales in Sydney, Australia and collaborator Matthew Huber of Purdue University conclude that many parts of our planet will become uninhabitable within a century due to the increased heat and humidity. According to the Intergovernmental panel on climate change (IPCC), the doubling of world carbon dioxide levels is likely to increase the average global temperatures by 3°C. With increasing humidity levels, if we carry on burning fossil fuels as we are doing presently, many parts of our planet will become uninhabitable within the next 10 decades.

7.16 Buildings --- that Clean the Environment!¹³⁸

The Museum of Modern Art (MoMA) is in the process of setting up an outdoor architectural project at Queens in New York that will pluck pollutants from the air while providing shade, shelter and water. The technology has been developed by the US architectural firm HWKN. The project, known as Wendy, employs a fascinating architecture with spikes protruding at different angles with an external fabric skin treated with nano-particles of titanium dioxide that capture and neutralise pollutants. It has been claimed that each such installation would be equivalent to removing the pollution caused by 260 cars on the roads. Such "environmentally friendly shelters" installed along the roads may be tomorrow's answers to reducing road pollution.



7.16 The Buildings which will Clean the Environment. The Wendy Project. Reproduced with thanks from: <http://architectsandartisans.com/index.php/2012/06/hwkns-architectural-storm-at-ps1/>



7.17 Flood Devastation in Sindh. Reproduced with thanks from: <http://www.theguardian.com/world/picture/2010/aug/15/pakistan-natural-disasters>

7.17 Sind Floods --- Is it Worse to Come?¹³⁹

There has been a significant increase in natural disasters on our planet in the last few decades, and the trend is truly alarming. This applies to earthquakes, hurricanes, tornadoes, volcanic eruptions, heat waves and other natural disasters. Natural disasters have caused millions of human deaths and tremendous financial losses throughout the human history. According to Swiss Reinsurance Company Ltd, generally known as Swiss Re, economic damage from natural disasters amounted to US\$ 222 billion during 2010 alone. The Katrina Hurricane of 2008 caused a loss of \$ 80 billion while the Pakistan earthquake caused a loss of 80,000 lives and of billions of US dollars. The floods in Sind last year caused a loss of an estimated \$43 billion while the losses this year may be of similar magnitude. The Japanese earthquake earlier this year caused a staggering loss of \$ 200-240 billion.

Scientists are alarmed at these developments, particularly the increasing incidence since 1998. At the Geocataclysm 2011 world congress held in Istanbul recently, that was co-Chaired by me, leading world authorities gathered to present their findings. The trends, the underlying causes and preventive measures to minimize the losses were discussed in detail. The evidence presented, showing the alarming increase in such disasters with year-wise graphs for the last hundred years, was convincing. Something very worrying is going on.

Both terrestrial and extra-terrestrial factors are involved. The increase in frequency and intensity in weather related disasters is attributed, at least in part, due to global warming that has occurred in the last few decades. This is connected with human activities involving massive burning of fossil fuels and depletion of forest cover. Another major factor seems to be our sun. The solar flares, sunspot cycles, incoming solar luminosity and ultra-violet radiation all affect our climate. Variations in the sun's magnetic field can create huge storms that result in billions of tons of particles being ejected from the sun ("Coronal Mass Ejections", CMEs). These can have a profound effect on our planet. In 1989, a huge CME slammed into our atmosphere, dumping about 1,500 Gigawatts of electricity on the northern hemisphere. This burnt out the

Canadian grid system and six million people suffered from long power failures. Our climate is also affected by the geometry and orbital variability of our solar system, by the wobbling (precession) in the axis of rotation of the earth as well as by the changes (eccentricity) of its orbit around the sun. The rise in the average temperatures of the ocean of about half a degree Centigrade is also having a significant effect as are the ocean tide cycles and ocean currents.

Another factor could be the reversal of the earth's magnetic field that occurs periodically. It last happened 780,000 years ago and it seems to be happening again as there has been a reduction of about 8% in the earth's magnetic field in the last 150 years. The methane burp, release of methane gas from under the oceans where it exists as liquid state in the form of methane hydrates, may further aggravate the global warming. The Sind floods and the earthquake in Northern Pakistan appear to be just the beginning of a rough ride ahead for all of us.

8. GENETICS

8.1 Can We Slow the Ageing Process?¹⁴⁰

How do we age? Can we slow the ageing process and prolong life spans? These are the questions that have attracted the attention of many medicinal chemists and biochemists. In adults, about 50 to 70 billion cells die each day, by a process of programmed cell death built into the structure of each cell (“apoptosis”). In children between the ages of 8 to 14, some 20 to 30 billion cells die every day and even more are replaced by new cells. Over a year, this amounts to about the complete body weight of the child----- amazing! Scientists are learning more about the signaling processes that tell a cell that it is time to stop proliferating and to die. By interfering with these processes, the cells may be induced to live longer, resulting in longer life spans. New drugs will be developed to interfere with the ageing process, allowing us to live longer healthier lives.

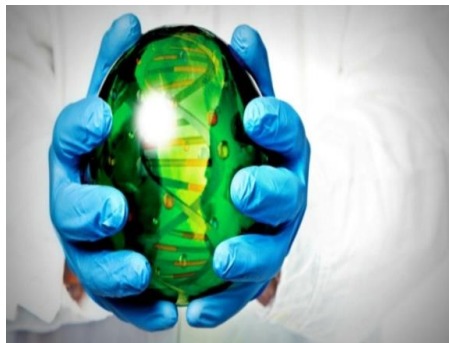
One cause attributed to ageing and death is the damage caused by UV light or other forms of radiation to our DNA. This results in structural defects in the DNA molecules. Fortunately, the damaged areas in DNA are repaired by certain enzymes. However as we grow older, the repair mechanisms become less effective, resulting in the accumulation of damaged DNA which can finally result in ageing and death. Oxygen, so vital for our survival, in its reactive form (oxygen radicals) is intriguingly also responsible for the ageing process by causing damage to our DNA molecules. That is why anti-oxidants, such as vitamin C or certain compounds present in red grapes and certain vegetables, are thought to be good for us. Science has already led to increase in life spans over the last hundred years due to better medical care in most parts of the world. However, the ageing populations in many countries in Europe, China, Korea etc. and the low birth rates resulting in diminishing younger populations are a major cause of concern due to lack of creative workers and the heavy financial burden on health care systems.



8.1 Can We Stop Ageing? Eternal life is still fantasy, but advances in medical science could turn back the clock on your physical age sooner than you think. Reproduced with thanks from: <http://www.openthemagazine.com/article/living/end-of-ageing>

8.2 Synthetic Biology --- An Exciting New Frontier!¹⁴¹

Can life be created synthetically in the laboratory from scratch? Can new living organisms be engineered with attributes not known in natural organisms? Can existing organisms be synthetically modified so that they develop new characteristics not known in nature? These are some of the questions that are being actively addressed in the fascinating field of “synthetic biology”.



8.2 Artificial Biology---Beyond Borders. Synthetic biology has arrived. At a stroke, gene technologists have become the world’s most significant designers. Reproduced with thanks from: <http://earthsky.org/human-world/gene-technologists-todays-ingenuous-controversial-designers>

This rapidly developing subject is already finding many promising applications. In medicine, existing drugs may be produced more cheaply and efficiently by modifying the genetic structure of plants or organisms. For instance, an anti-malarial drug “artemisinin” produced by the sweet wormwood plant (*Artemisia annua*) which grows in the mangrove swamps in Southeast Asia is in considerable demand but its production is limited. Scientists have however succeeded in inserting genes from 3 different organisms into *E.coli* bacteria to produce a precursor substance which can be converted into artemisinin at less than half the price of the material obtained directly from the plants. The molecular machinery of various organisms is similarly being engineered to produce drugs against HIV, to manufacture hydrogen as a source of energy, to remove heavy metals and other pollutants from contaminated soils or to manufacture biological “micro-submarines” that can swim through blood vessels and attack cancer cells at tumour sites.

In 2007, Craig Venter and his team for the first time prepared a synthetic chromosome from chemicals. Last year, the Nobel Prize winner Hamilton Smith succeeded in building the entire DNA assembly of a common bacterium from simpler building blocks in the laboratory, an important step towards creating synthetic life. The researches raise many ethical questions, and are not without their associated dangers.

The word “creation” must be used with caution. Man cannot really create something from nothing, or indeed destroy something to nothing. This may sound strange but it is a fascinating truth, which few of us realize. Take a piece of paper and burn it. You will think that you have succeeded in totally destroying it. Actually you have done nothing of the sort. If you weigh the ashes and the gases produced, they will weigh exactly the same as the original piece of paper! All you have succeeded in doing is simply change its form.

All the Nobel Laureates in the world, assembled and tasked together, cannot actually “create” even the wing of a dead fly!

8.3 Humans and Monkeys --- 99% Identical!¹⁴²

Genetically humans and monkeys are almost identical. Out of the three billion "letters" that constitute the human genome, 2.985 billion are identical---the difference lies in only 1% of the genome. This is surprising since monkeys appear to be significantly different from us---in their physical appearance, intelligence, inability to speak, dexterity of hands etc. Most genetic changes are of a trivial nature, but some sequences are important. One set of changes is responsible for the development of a larger brain (cerebral cortex). Other DNA sequences have given us the ability to form words, digest starch and employ our hands and fingers to use complex tools.

Some genes have made us aggressive ---indeed no other animal kills its own species so ruthlessly as humans do ---- the wars in our history are proof of that. With the unraveling of the human genome and an understanding of the parts of the genome that impart aggression, it may be possible to "turn off" the aggression genes, making humans more "humane".

8.4 Talking Mice and Monkeys?¹⁴³

Why is it that humans can talk whereas mice and monkeys cannot? What is it that gives us humans this unique human trait? If it is our genetics, then what exact part of our genome is involved, and if we make similar genetic changes in animals, will they be able to communicate through speech one day? A clue was provided when a team of British scientists discovered in 1990 that about half the family members of a British family (known as the KE family), suffered from severe speech and language disorders that prevented them from speaking properly (*Dev. Med. Child Neurol.* 32: 352-5.

PMID 2332125). As a result of efforts by scientists in Oxford, it was established that the defect was caused by a damaged gene (FOXP2 gene), now commonly known as "the language gene".

A team led by Wolfgang Enard at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany has recently bred transgenic mice that have the ability to make the human

version of the gene ---- the result is dramatic! The mice are able to make radically different sounds and the learning pathways in their brains appear to be enhanced (Cell. DOI: 10.1016/j.cell.2009.03.041). It is thought that the gene may be responsible for establishing the necessary capabilities in the brain that can lead to coordination between the tongue, lips, larynx and lungs required for speech. If it can also enhance brain functions that are needed to produce ideas, which are later convertible to speech, then before long we may have transgenic talking cats, dogs, mice and monkeys!

8.5 Taming the Wild - Genetically!¹⁴⁴

Some persons are much more aggressive than others. Extreme cases of such tendencies are visible in criminals who indulge in violent crimes. One is also familiar with animals that have not been domesticated because of their in-built wild traits. These include the wolf, fox, ape, zebra, cheetah, rhinoceros, African buffalo and others.

An interesting experiment was conducted at the Institute of Cytology and Genetics in Novosibirsk, Russia in 1970. Rats were repeatedly separated from one generation to the next into two different lines and bred separately for aggressive and tame tendencies. After 30 years of such repeated selection, the two groups showed amazing differences in their behaviour. The "tame" group showed extreme tame tendencies while those bred for aggressiveness were very wild and ferocious. Clearly, there are certain genes responsible for these traits, both in animals and humans. A similar experiment was conducted on silver foxes and within eight generations a new type of domestic silver fox had been produced which had lost most of its aggressive tendencies, had flopping ears, and wagged its tail like a happy relaxed dog. Similarly in just a few generations, tamed otters and minks have been developed by selective breeding.

The answer to eliminating violent crime in humans may lie in genetics. Identifying the genes that are responsible for these wild tendencies and tackling them by gene therapy may be one approach. Another may be simply preventing such criminals by

surgical intervention from having children as a state punishment. This would gradually eliminate such trends from society.



8.4 Talking Rats and Monkeys. Reproduced with thanks from: <http://www.crouchvalevets.co.uk/year/july/>

8.6 Synthetic Life Produced!¹⁴⁵

On 20th May 2010, a new era began in science when Craig Venter and colleagues announced the birth of the first self-replicating synthetic bacterial cell, raising fundamental questions about the nature of life. This exciting advance heralds the advent of a new era in science, perhaps even more important than the industrial revolution and the information technology revolution. Having made the first synthetic cell, controlled by a fully synthetic genome, scientists now hope to use this procedure to engineer bacterial cells so that they could produce biofuels, pharmaceuticals, and other useful chemicals. What exactly did the scientist do? No natural DNA was used. The structure of DNA to be synthesised was designed using a computer. The basic building blocks were successively joined together to afford a loop which comprised a million units (nucleic acids) in length. Once inserted into an empty cell of a bacterium, the synthetic genome took control of the bacterial cell, and over a billion copies of the cell were produced through a replication process. The ability to reproduce is a critical criterion of a living organism.

We need to understand that we cannot “create” something from nothing, nor can we totally “annihilate” something to nothing. We can only change forms. Thus if we burn a piece of paper, the ash, carbon dioxide, water vapour and other gases produced will together weigh exactly what the paper weighed before it was “destroyed”. All that we have succeeded in doing is changing its form from paper to soot and gases. Similarly, the manufacture of the paper was just a change in form, from wood pulp and other added constituents --- it was not “creation” of the paper from nothing.

The work has raised serious ethical questions. Are scientists trying to play God? Where will this work take us in terms of the development of new plant and animal species? Will we be creating monsters that may ultimately destroy us or is humanity about to embark on a new era of artificial organisms designed to benefit humanity in new exciting ways? The developments in synthetic biology will surely impact our lives in a myriad ways in the years to come. http://www.wired.com/science/discoveries/news/2008/01/synthetic_genome

8.7 Synthetic Cornea Holds Out Hope¹⁴⁶

For hundreds of thousands, corneal donations have been the only option for preventing blindness, but corneal donations are rare, and many people go blind each year because their cornea are damaged and donated cornea are not available. Some 40,000 cornea are needed in Europe alone. Dr. Joachim Storsberg of the Fraunhofer Institute for Applied Polymer Research in Germany has now developed an artificial cornea made from a polymer which binds well with surrounding tissue cells, and allows the eyelids to slide over it without friction. It won him the Joseph von Fraunhofer Prize for 2010 after undergoing successful trials since 2009.

In a related development, scientists at the Harvard Medical School have developed a procedure involving shining light on skin wounds to heal them. It may replace the use of sutures, staples and glues presently employed in skin wounds. The process known as “Photochemical Tissue Bonding” involves the

application of a dye to the wound which is followed by shining green light on the wound. The dye absorbs the light, and then facilitates the binding of proteins on the tissue surfaces by formation of “nanosutures” leading to complete sealing of the wounds. The procedure has also been applied to reconnect the cornea. Similarly stem cells have also been employed for corneal repair.



8.7 Artificial Cornea- A ray of hope. Reproduced with thanks from: <http://www.fraunhofer.de/en/press/research-news/2012/october/artificial-cornea-gives-the-gift-of-vision.html>

8.8 Genetically Engineered Crops --- A Boon or a Curse?¹⁴⁷

With the growing world population, expected to reach 9 billion by 2050, and with the limited cultivable area on our planet, there is increasing probability of droughts and mass famines in countries such as Pakistan which will be most affected by global warming. To feed our masses, the spectacular advances in genomics in the last few decades offer hope through the development of genetically engineered crops that will give increased yields, offer greater nutrition and be resistant to disease. Recent exciting advances include the development of insect-resistant cowpeas, fungus-resistant bananas, virus-resistant sweet potatoes, high-yielding pearl millet and drought tolerant cassava. A new variety of genetically engineered rice, known as Golden Rice, will be cultivated in the Philippines which will contain provitamin A, and hence save thousands of lives of children suffering from the deficiency of vitamin A. In Hawaii, the papaya tree was virtually

wiped out by attack of papaya ringspot virus, but the papaya industry has been saved by the use of a virus resistant breed.

There is much propaganda against the use of genetically engineered crops, but as long as safety regulations are carefully applied, we have nothing to fear, and we should develop our own research base to develop new genetically engineered varieties of food crops before we are engulfed by the challenges of famine and drought that surely lie ahead. Science must come to the rescue in such high times.

8.9 High Speed Gene Sequencing - Within Minutes!¹⁴⁸

All our hereditary information is contained in our genes. Think of a tiny microscopic necklace (DNA) with some 3 billion beads in 4 colours (actually 4 different types of molecules known as nucleic acids). It is the sequence in which these beads (nucleic acids) are arranged that determines everything about us--- our height, colour of our hair and eyes, structure of our heart or brain etc. The order in which these beads are arranged is known as the genetic code. The first such code in humans to be unraveled was that of Prof. Jim Watson in 2007. It cost about a million dollars and took 2 years to accomplish. With the faster sequencing machines now available, this can be done today within a couple of months at a cost of about \$ 40,000.

A remarkable breakthrough has now been made by scientists at Imperial College, London. They have developed a microchip which has a tiny (only 50 nanometer wide) hole bored through it. As the molecular necklace (DNA) passes through this hole, the individual nucleic acids (beads of the necklace) are recognized by characteristic changes in the electrical current. The process is carried out at an amazing speed, such that the entire genome of 3.16 billion nucleic acids can be read and deciphered within minutes! The device is being scaled up so that it can read the sequence of molecules at a speed of 10 million molecules per second (as compared to the present machines which read the sequence at 10 molecules per second), says Joshua Edel, one of the co-authors of a recent research paper (Nano Letters 2007 DOI: 10.1021/nl071855d).

Top 10 genetically modified foods



Corn



Soy



Cottonseed



Papaya



Rice



Rapeseed
(Canola)



Potatoes



Tomatoes



Dairy products



Peas

www.HealingPowerHour.com

8.8 Genetically Modified Crops-Progress or Problem. Reproduced with thanks from: <http://fishcalledsanda.blogspot.com/p/healthshare.html>



8.9 Genome organization within Minutes. Reproduced with thanks from: <http://blogs.nature.com/spoonful/2013/01/gene-sequencing-yields-breakthrough-for-children-with-rare-parkinsons-like-disorder.html>

8.10 Crime Gene in Violent Criminals!¹⁴⁹

David Goldman at the US National Institute on Alcohol Abuse and Alcoholism in Bethesda, Maryland and his colleagues have discovered a gene (named *HTR2B*) which is partly responsible for the impulsive uncontrolled violent behavior in criminals. The gene was discovered when the genetic profile of 228 prisoners who were imprisoned for violent crimes in Finland was examined. An unusually large number of persons in this group who had been convicted for violent crimes including murder, arson, battery and assault were found to be carrying this “impulsivity gene”.

The presence of the gene restricts the formation of serotonin B2 receptor, and thereby affects that part of the brain which is responsible for restraint and foresight of the consequences of one’s actions. The presence of the gene increases the predisposition to violence but all persons carrying the gene are not necessarily violent. Other psychological causes may also be responsible for violent behavior.

8.11 Cloning Extinct Ancient Animals!¹⁵⁰

The technology of cloning has been evolving rapidly, and the cloning of extinct animals is fast becoming a reality. A major breakthrough occurred in 2008 when Dr. Teruhiko Wakayama at the RIKEN Center for Developmental Biology in Kobe, Japan successfully managed to clone a mouse from tissue that had been deep-frozen for sixteen years using a completely new technique. The same group is now working to clone a mammoth, an animal resembling a large elephant but with shaggy hair. Mammoths have been extinct for the last 4,500 years but their remains, some 150 million, can be found frozen in Siberia. The Japanese group has now succeeded in extracting mammoth egg cell nuclei. Once they have successfully cloned a mammoth embryo, it is intended to plant it in the womb of a surrogate female elephant for 22 months for the baby mammoth to be born.

Who knows, if this works, we may have the dinosaurs roaming over our planet once again.



8.11 Extinct Animals Cloning. Reproduced with thanks from: <http://www.spiegel.de/international/world/scientists-hope-interspecies-cloning-will-save-endangered-animals-a-865932.html>

8.12 Ageing Genes Identified¹⁵¹

Researchers at Kings College London have identified certain genes that are responsible for the ageing process in human beings. They found that these genes are switched off and on by certain external factors such as diet and environment, and may hold the keys for living a longer healthier life. The discovery was made after they examined the similarities and differences in the genetic make-up of several hundred twins of varying age groups. The study was conducted by Professor Tim Spector and Dr. Jordana Bell who found that the four key genes that affected the rate of healthy ageing and potential longevity were related to cholesterol, lung function and maternal longevity. It provides a deeper insight into the ageing process and opens the door to new anti-ageing therapies.

8.13 Black Death Genome Sequenced¹⁵²

About a quarter of the human population on our planet was wiped out by plague --- fearfully known as the “Black Death” ---- during 1330 to 1347. It is believed to have originated in the northern part of Asia in 1330s and reached Europe in the 1340s, killing about 75 million people worldwide. The entire genome of the bacteria that caused the plague (*Yersinia pestis*) has now been sequenced by scientists at McMaster University in Canada and the University of Tübingen in Germany. The remnants of the bacteria were extracted from the plague pits in London where the persons who died of plague were buried.

About 2,000 people still die each year from this disease caused by descendants of the same plague virus that caused mass deaths in the fourteenth century. An understanding of the genetic structure of the original plague virus can help to develop a cure for this scourge. By comparing the genetic structure of the original disease causing bacteria with modern variants, scientists are trying to get a better understanding how such organisms have evolved over the centuries.

The rapid advances in genome sequencing technologies are opening up a whole new era of medicine. The understanding of the genetic structures of microorganisms is helping in gaining a greater understanding of the organisms that can be useful in drug design. Similarly, the rapid sequencing of the human genome is leading to a greater understanding of the genetic causes of many human diseases. A whole new area of “Personalized Medicine” is also under rapid development that will allow drugs to be tailored according to individual genetic make-up of different groups of populations.

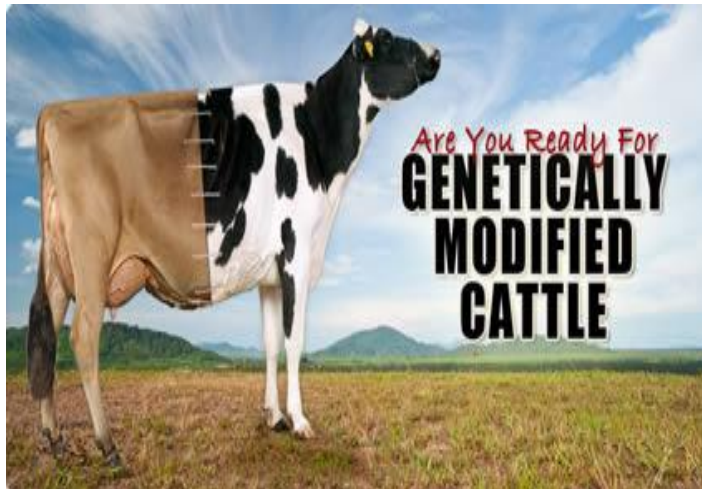
8.14 Genetically Modified Mosquitoes¹⁵³

Over 200 million people are afflicted with malaria each year and some 800,000 deaths are recorded annually due to malaria. Over 90% of these deaths occur in sub-Saharan Africa, mostly of children. The disease is caused by the bite of the female mosquito *Aedes aegypti*. Dengue and yellow fever are also spread by the

bites of such mosquitoes. Resistance has developed to treatment of malaria with anti-malarial drugs such as chloroquine. A drug “qinghaosu” derived from a Chinese medicinal plant *Artemisia annua*, has long been used in Chinese traditional medicine for the treatment of malaria, and it has proved to be the source of a compound artemisinin that is effective against resistant forms of malaria. A number of new anti-malarial drugs have been developed based on artemisinin, but the limited supply of the medicinal plant has posed problems for largescale manufacture.



8.14 Genetically Modified Mosquitoes. Disease-Fighting Secrets of Genetically Modified Mosquitoes. Reproduced with thanks from: <http://www.wired.com/2012/02/gm-mosquitoes/>



8.15 Human Milk from Cow. Reproduced with thanks from: <http://www.thebullvine.com/the-bullvine/genetically-modified-cattle/>

An exciting alternative approach is to develop genetically modified mosquitoes that can bring down the population of the harmful female variety (*Aedes aegypti*). Anthony James, working at University of California Irvine, has now developed a genetically modified variety of these mosquitoes that affects the female mosquitoes only. The genetic deformation prevents them from flying. The larvae hatch on water, but the females cannot fly and therefore die. The males, carrying the mutation, mate with other females thereby propagating the defect by passing the genetic modification to the subsequent generations. This approach of “genetic genocide” may ultimately help to reduce the populations of malaria-causing mosquitoes and save millions of lives.

8.15 Human Breast Milk ---- from Cows!¹⁵⁴

Breastfeeding of babies has been generally accepted to have many advantages. The amino acids (from which proteins are built up) as well as sugars and fats present in breast milk of women are far more balanced for the baby than those in cow or buffalo milk. The enzymes, vitamins and minerals present in the milk of mothers are also much more suited for the intestines of the babies, facilitating the digestive process. Another important component present in mother’s milk is the infection fighting antibodies that protect the baby from chronic and acute infections, particularly in the first few months.

Many mothers are however unable to produce sufficient milk to breastfeed their babies, thereby making it necessary to resort to powdered milk formula feeds. Chinese scientists led by Bin Yang of the State Key Laboratory for Agrobiotechnology at China's Agricultural University in Beijing have now come forward with an exciting solution ---- they have produced genetically modified cows that produce milk resembling human milk in its characteristics. This was done by inserting human milk genes into cloned cow embryos. These embryos were then implanted into surrogate cows, and the resulting calves born by this process were later able to produce “human milk”! The milk was found to have similar infection fighting properties as human milk,

and was more nutritious and sweeter than normal cow milk. It is expected that this milk will be available for sale in super markets within 3 years and meet a significant requirement.

8.16 Longevity Gene Discovered!¹⁵⁵

The “Elixir of Youth” has long been a subject that authors have written about in novels since centuries. Science is now in the process of making this a reality. With the rapid advances in biochemistry, medicinal chemistry and genomics, we are beginning to understand the mechanisms by which the biological clock responsible for the aging process is ticking within us. This understanding is coming from researches on bacteria, spiders, insects, mice and other animals. This is because of the similarity of processes by which cells live, grow older and finally die.

Researchers from the Salk Institute for Biological Studies and the University of California, Los Angeles found that modifying a gene (dPGC-1) that occurs in the intestinal stem cells of the fruitfly can prolong the life of its intestines. More exciting was the discovery that it also prolonged the average lifespan of the fruitfly itself by 50%! Thus the genetic modifications that keep just one organ young and healthy can extend the lifespan of the entire insect (*Cell Metabolism*, Volume 14, Issue 5, 623-634, 2 November 2011). This gene is also found in humans. Swedish scientists had earlier this year identified the enzyme responsible for the fact that eating less leads to longer lives (*Molecular Cell*, Volume 43, Issue 5, 823-833, 2 September 2011).

Within our cells, we have certain “power plants” (mitochondria) that convert the sugars and fat from the food that we eat into the energy needed by the cells to thrive. The number of these power plants increases if calorie-restricted diets are used, resulting in extension of life spans. So, one way to live longer is to eat less. This increase in the number of these cellular power plants (mitochondria) can be achieved by the tweaking of the gene dPGC-1 that is forced to work in the overdrive mode, resulting in longer lives.

It seems to be true that the Good Lord has fixed a life-long quota of food for each one of us --- use it up in a binge over 30 years or make it last for 120 years! That is up to us.

8.17 Spider Silk and Fireflies: Gene Therapy!¹⁵⁶

Spiders are truly amazing creatures. There are some 40,000 different species of spiders known to man. The spider web that they produce, weight for weight, rivals steel in strength. The glue that holds the spider web together contains two interesting proteins that have evolved over millions of years and appear to be responsible for its strength. Fireflies represent another amazing insect. Have you seen fireflies glow at night? This is due to a special protein in them, luciferase, which reacts chemically with another substance (luciferin) to produce energy in the form of light. Prof. David Kaplan and colleagues at Tufts University have now modified spider silk proteins and combined them with firefly proteins in order to develop an exciting new gene therapy against breast cancer.

Gene therapy involves the treatment of certain diseases by correcting defective genes (through insertion of functional genes into the genome or by modifying the defective genes). The scientists modified the genetic structure of spider silk by inserting a gene into it that results in attaching itself to diseased cells and in the production of the same protein that causes fireflies to glow at night. The genetically modified spider silk proteins attached themselves selectively to cancer cells in breast cancer patients, and the resulting glow that was produced allowed the ready identification of the diseased areas (for details, see <http://pubs.acs.org/doi/abs/10.1021/bc200170u>).

8.18 Manipulating Plant “Clock Genes” --- for All Season Crops!¹⁵⁷

Plants and animals have certain genes that regulate their biochemical, physiological and behavioural functions during day and night. Known as “circadian rhythms” in humans, they usually operate in a 24 hour cycle. In plants, the photosynthetic

processes are controlled in this manner, and the plants know through this mechanism when will be the best time to flower so that insects can be attracted for propagation. It has been known that this mechanism in plants occurs through the sequential activation and deactivation of “morning genes” and “evening genes” during day and night respectively. Now Xing Wang Deng, the Daniel C. Eaton Professor of Molecular, Cellular, and Developmental Biology at Yale and his colleagues have found the precise gene (named DET1) responsible for regulating these functions in plants. This has opened up possibilities of controlling the biological clocks in plants, and thereby obtaining crops throughout the year, instead of in a particular season.

9. HEALTH

9.1 *The Science of Losing Weight!*¹⁵⁸

Obesity affects a large number of people on our planet. According to WHO, about 2 billion people are over-weight or obese in the world, about one third of the world's population. A number of causes have been identified, including a genetic cause due to the involvement of an "obesity gene" known as FTO which is found in about 16% of all Europeans (*Science*, Online April 12, 2007., DOI: 10.1126/science.1141634).

One of the reasons for obesity is the lack of sleep. One would imagine that since one burns more calories when awake than when sleeping, the lack of sleep should help you reduce weight. The truth is just the opposite. The Centers for Disease Control and Prevention in USA, in a study involving 87,000 Americans, found that 33% of those who slept for less than 6 hours were obese, compared to only 22% of those who slept between 6 to 9 hours each night. Earlier studies have shown that some appetite regulating hormones (ghrelin and leptin) are disturbed by sleep deprivation, causing increased appetite, and a craving for salty and sweet foods.

A number of environmental factors have also been identified, one of which BPA (bisphenol A) is thought to be particularly widespread, occurring widely in plastic wrappers, toys, tooth brushes and water bottles. It is thought to mimic the activity of a natural hormone estrogen, and disrupt the normal mechanism for regulating fat cells. So watch out when drinking mineral water!

The search for a "fat pill" goes on as it could be a multi-billion dollar business. There are two anti-obesity medications approved for long term use. One is "sibutramine", an appetite suppressant, but both have side effects and cause only marginal weight losses.

Artificial sweeteners may also be having exactly the opposite effect. Terry Davidson at Purdue University, USA has found that mice fed with artificial sweeteners gained weight rapidly, and interfered with the natural calorie counting mechanisms that exist in our bodies.

Ear infections in childhood have also been linked with obesity in later life. The sense of taste may be damaged by chronic ear infections that could lead to tendencies to take in more calories and sweeter foods.

Brown fat, which contains a protein "thermogenin" that burns up calories fast, is present in many of us when we are young but becomes less as we grow older and may disappear above the age of 40. Researchers are trying to develop ways to restore it from normal fat.

Food Consumption Factors



9.1 Science of Losing Weight. Reproduced with thanks from:
<http://www.resourcesforlife.com/docs/item6739>

9.2 Eat Less ---- Live Longer!¹⁵⁹

It has been known that restricting the diet of worms, flies and mice results in a significant prolongation of their lifespans. Now, Richard Weindruch and co-workers at the University of Wisconsin-Madison in USA have shown that when monkeys were fed a low calorie diet (30% percent less calories than the

control group) and their life spans monitored, they tended to live significantly longer than those fed with normal diets. The experiment was performed on 76 monkeys (rhesus macaques) monitored over a twenty year period. Thirty seven percent of those served with the low calorie diet were alive at the end of the monitoring period while only thirteen percent of the monkeys fed with normal diet were alive at the end of this period. The results, the first with primates, were published in the journal *Science* (DOI:10.1073/pnas.0900152106). This is the strongest evidence so far that eating less can significantly prolong human life. The secret to a longer healthier life is simple ---- eat less!

9.3 Brown Fat – for Losing Weight!¹⁶⁰

The key to losing the extra fat on your body may, strangely, be another special kind of fat ----brown fat! Brown fat is responsible for burning up calories, by converting the food directly into heat. It was earlier thought that this type of fatty tissues exists only in certain animals, but new evidence suggests that it is also present, at least in some individuals. The presence of just 50 grams of brown fat can burn up to 500 calories a day, without the need of any exercise. This may explain why some of us are lean and others obese. The reason that the brown fat is able to burn energy while normal fat cannot is that the brown fat cells have a special protein (“thermogenin”).

9.4 Eat Fiber --- Get Slim!¹⁶¹

When considering the calories absorbed by the body from different foods, one needs to also consider the energy consumed by the body in digesting the food. This can substantially reduce the *net* calorie intake. If two different foods with same calorie levels, one fibrous and the other non-fibrous, are considered, then the fibrous food will provide less net calories since a certain amount of energy will be taken up by the body in digesting the fiber. Furthermore, certain microbes present in the gut will consume the fiber to survive.

Similarly, hard foods are less easily digested. For example, bread made from coarse-ground wheat flour, is excreted undigested in up to 30% greater quantities than breads made of finely milled flour. Murakami and coworkers at the University of Tokyo recently surveyed 450 women and found that those who ate harder food (which was more difficult to chew) had slimmer waistlines than women who ate softer foods (*American Journal of Clinical Nutrition*, vol.86, p 206).



9.4 Eat Fiber Food- Lose weight. Reproduced with thanks from: <http://www.girlishh.com/top-5-tips-for-natural-weight-loss/>

9.5 Stunning Weight Losses with New Drug!¹⁶²

A new drug to promote weight loss is presently undergoing clinical trials in USA, and initial results are stunning. The drug code named ZGN 433 has been developed by a new company Zafgen in Massachusetts, USA and it caused average weight losses of 1kg per week for a month without any changes in normal diet or special exercises. The sharp loss of weight is unprecedented. The breakdown of fat is sharply increased by the drug, which probably acts by blocking an enzyme (called MetAP2) which is involved in the overproduction of fat.

Diet pills have so far proved to be largely useless and often dangerous for health. Now a genuine diet pill seems to be on the horizon.

9.6 Secret to Longevity!¹⁶³

Since ancient times, man has sought to learn the secret to eternal youth and longevity. The answer to a healthier longer life may lie in mole rats!

Ageing is believed to occur mainly due to oxidation reactions triggered by a reactive form of oxygen --- oxygen radicals that damage our DNA and important proteins. Certain “search and repair” mechanisms exist in our biological systems, to detect the damaged regions and remove or repair them, but as we grow older, these repair mechanisms get weaker, allowing the oxidized materials to escape undetected. The wear and tear caused to our biological system builds up over time, and is visible in the form of the ageing process.

Prof. Buffenstein and colleagues at the University of Texas Health Science Center in San Antonio have been investigating why mole rats live about 30 years longer than other rodents. For example, mice have average ages of only 3.5 years while mole rats have ten times that average age. For humans, this would be equivalent to having an age of 700 years! They discovered that the level of oxidative damage caused to proteins in mole rats was much less, and that the search and repair mechanisms were much more active.

We may one day be grateful to mole rats for providing us with crucial clues about youth and longevity.

9.7 Diet and Ageing!¹⁶⁴

In a recent study carried out at the Mount Sinai School of Medicine in New York, Charles Mobbs and coworkers have established the linkage between reduction in food intake and living longer. Lifespans are reduced due to “oxidative stress” on living systems caused by the metabolism of glucose. This in turn

leads to tissue damage, cancer and ageing. If glucose metabolism is blocked by drugs or by reduction in food intake, it can lead to the regulation of cellular function by controlling the activity of certain genes, thereby prolonging lives. A high calorie diet, in contrast, accelerates the ageing process due to the greater oxidative stress and may even cause diabetes. The activity of the gene involved is controlled by a certain protein (a “transcription factor”, CREB binding protein, CBP). Interestingly, starvation (drastic reduction in food intake) does not increase lifespans---only partial reduction does. So eat less but do not starve yourself!

9.8 Slow down Ageing—Stop Those Wrinkles!¹⁶⁵

From time immemorial, mankind has sought the secret of eternal youth. Now, science may have found the answer—or at least part of it. It has been known for a long time that eating less leads to longer lifespans in certain animals such as nematode worms, fruitflies and mice. Mice were shown to live up to 50 percent longer if their calorie intake was reduced by 30-50 percent. In mammals, the incidence of age-related diseases such as heart disease, cancer, Alzheimer’s disease and type-2 diabetes was also reduced. A 20-year study on a certain species of monkeys (rhesus macques) is underway and the results obtained so far indicate that restricting calorie intake could indeed prolong age (Science vol 325, p 201). This was in animals—what about humans? A society called ‘Calorie Restriction Society International’ now has 3,000 members, known as CRONies, who are following a calorie restricted diet (10-30 percent lower than the normal recommended calories) which is largely vegetable based and balanced. The health benefits are already becoming visible.

According to a study being carried out by Prof. Luigi Fontana at the Washington University, and head of the Division of Nutrition and Ageing at the Italian National Institute of Health, the Society members have hearts that appear to be 15 years younger than those of other Americans of their age. It appears that an insulin growth factor (IGF-1) is involved as a promoter of ageing in some animals. Another molecule (TOR) is also thought to be

involved in the ageing process, and blocking it has resulted in prolonging lives in several animal studies (*Aging Cell*, vol 9, p 105). There is also evidence that with a specially designed diet lower in amino acids, one need not even restrict the calories to enhance lifespans (*Nature*, vol 462, p 105).

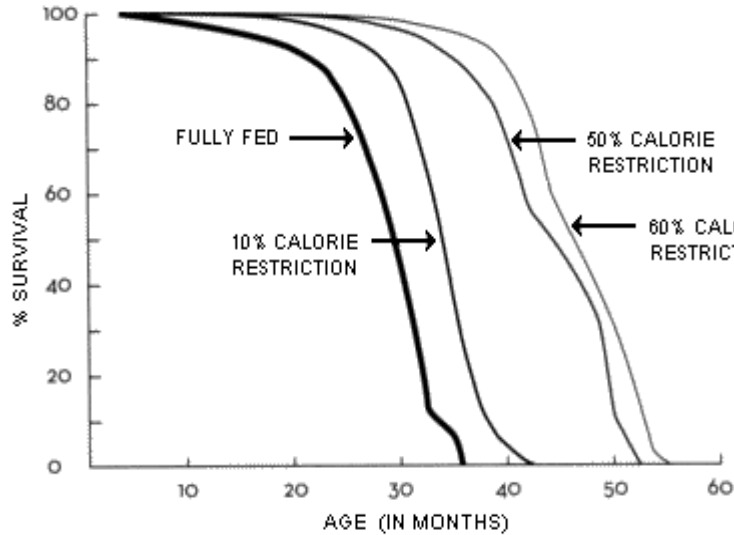
For the present, till an exciting new drug comes on the market, the best way to have a longer, healthier life is to reduce your calorie intake, eat mainly vegetables and exercise regularly.

9.9 An Exciting Breakthrough in Ageing Research!¹⁶⁶

There is a huge demand of anti-ageing products, with annual sales of \$50 billion in USA alone. These products range from anti-wrinkle skin creams, hormone replacements, vitamins, herbal preparations and nutritional items. However, most of these have not been fully tested for their beneficial effects. Medical experts and medical associations have generally been critical of their use, considering their marketing as unscrupulous profiteering by companies. Recent advances in stem cell research for tissue rejuvenation, organ replacement and therapeutic gene therapy hold out hope for the future.

The “clock of ageing” in the human body is believed to be a region of repetitive DNA at the end of the chromosome. This is called a “telomere”. As the cells divide repetitively during our life, the telomere gets shortened, and so do the number of remaining years for us to live. It has been shown that cells that do not experience the shortening of telomeres on cell division continue to divide indefinitely. If somehow science could find a way to protect the telomere from degradation, one could slow down or even reverse the ageing process. Now researchers at Sierra Sciences in collaboration with TA Sciences, Geron Corporation, PhysioAge, and the Spanish National Cancer Research Center (CNIO) claim to have done just that! They have discovered a natural compound, code named TA-65, which has the remarkable property of activating the enzyme telomerase in the human body, thereby extending the length of the telomeres. This represents the first telomerase activating substance safe for human consumption reported so far and it may lead to the extension of human

lifespans to 125 years or beyond. The work was published in the journal *Rejuvenation Research* on 7th September 2010 (<http://www.liebertonline.com/doi/abs/10.1089/rej.2010.1085>).



9.8a Slowing Down Ageing. Reproduced with thanks from:
<http://www.scientificpsychic.com/health/crondiet.html>



9.8b Slowing Down Ageing. Reproduced with thanks from:
<http://www.drdaivesbest.com/products/ta-65-telomerase-activator.html>

9.10 Erasing Memories --- Selectively!¹⁶⁷

Selective erasure of memories may soon no longer just be a subject of science fiction movies. New and old memories have been selectively erased in mice by Prof. Tsien and coworkers at the Brain & Behavior Discovery Institute at the Medical College of Georgia School of Medicine in USA. They have discovered that they could do this by a neat scientific trick involving the formation

(“overexpression”) of a protein (called α CaMKII) involved in brain cell communication at the same time when the particular memory was being recalled. The procedure does not damage normal brain cells and may provide the necessary tools to selectively remove traumatic war memories or unwanted fears. (*Neuron*, Volume 60, Issue 2, 23 October 2008, Pages 353-366).

9.11 Stop Those Wrinkles ---- With Ancient Bacteria!¹⁶⁸

Certain blue-green algae, “cyanobacteria”, have existed on our planet for 3.4 billion years. They derive their energy from sunlight by the process of photosynthesis. However, this exposes them to the damaging effects of UV radiation. Over millions of years, they have developed a mechanism to protect themselves against sun’s UV radiation that involves the synthesis of small molecules called mycosporines. Emily Balskus and Christopher Walsh at the Harvard Medical School in Boston have now identified the genes responsible for making these effective sun-screening substances in the ancient bacteria and transferred them into another organism *E.coli*, which then started to manufacture the same sun-protecting molecules. A company in Switzerland “Mibelle Biochemistry” is producing suncreams by direct extraction of the active ingredients from the ancient bacteria.

9.12 Making the Blind See—with Stem Cells!¹⁶⁹

There are two main types of stem cells. Embryonic stem cells obtained from the embryos of animals (inner cell mass of blastocysts) and adult stem cells found in adult tissues of various organs. Stem cells can now be transformed into various types of cells (nerve, kidney, heart cells etc.), thereby offering opportunities to repair or cure damaged or diseased organs. Indeed, stem cell research promises to change the way medicine will be practised in the future. An exciting recent development is the restoration of (the) eyesight of persons who were blinded by heat burns or by chemicals. Out of 107 such people, who were treated with stem cells, the eyesight of 82

persons was restored to almost-normal at the University of Modena, Italy (The New England Journal of Medicine (DOI: 10.1056/nejmoa0905955)). Since the majority of patients had burns in only one eye, the stem cells were therefore obtained from the other good eye. The treatment resulted in the return to transparency of the damaged, opaque cornea.

9.13 A Matter of the Heart!¹⁷⁰

When a heart is weakened, its ability to deliver oxygen containing blood may be compromised. An exciting approach that is being investigated to tackle such conditions is to somehow induce the blood to deliver a greater amount of the oxygen that it is carrying. The Nobel Laureate Prof. Jean-Marie Lehn at the University of Strasbourg, France took mice with damaged hearts and by using a particular chemical compound (myo-inositol trispyrophosphate, ITPP) the blood in these mice was induced to release more oxygen (Proceedings of the National Academy of Sciences, DOI: 10.1073/pnas.0812381106). Normally haemoglobin can release only about 25% of the oxygen that it carries, but after binding to ITPP, it was found to release much more oxygen, resulting in dramatic improvements in the physical performance of the mice. If the compound was taken dissolved in water, the exercise levels in mice were boosted by 35% while if given by injection, there was a 60 % rise. The substance holds promise for its eventual use in medicine. Prof. Lehn is one of the several Nobel Laureates who have visited H.E.J. Research Institute of Chemistry at Karachi University, the leading chemistry research center in Pakistan, to deliver lectures at international chemistry conferences.

9.14 Preventing Brain Damage in Stroke or Heart Attack!¹⁷¹

The brain damage that can result from a stroke or heart attack can leave a patient permanently disabled. Scientists have been grappling with the problem of preventing such brain damage through timely administration of drugs or surgical interventions. Interestingly, it has been discovered that slowly cooling the brain

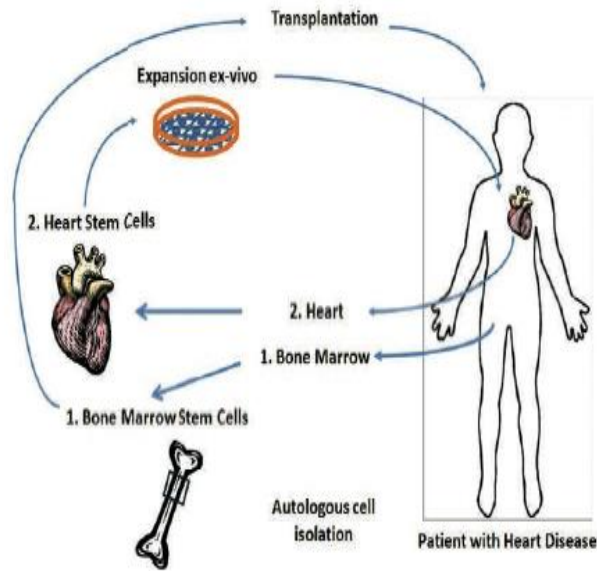
temperature by 2-4 degrees centigrade (at a rate of up to 1 degree per hour) can slow down or possibly prevent the process of brain damage. This is achieved by flow of cold air, use of a cold helmet or administration of a cold spray of perfluorocarbon droplets through the nose (British Journal of Anaesthesia, DOI:10.1093/bja/aem405). This procedure appears to be better than trying to cool the whole body as that can lead to infections and pneumonia.

9.15 Mending a Broken Heart!¹⁷²

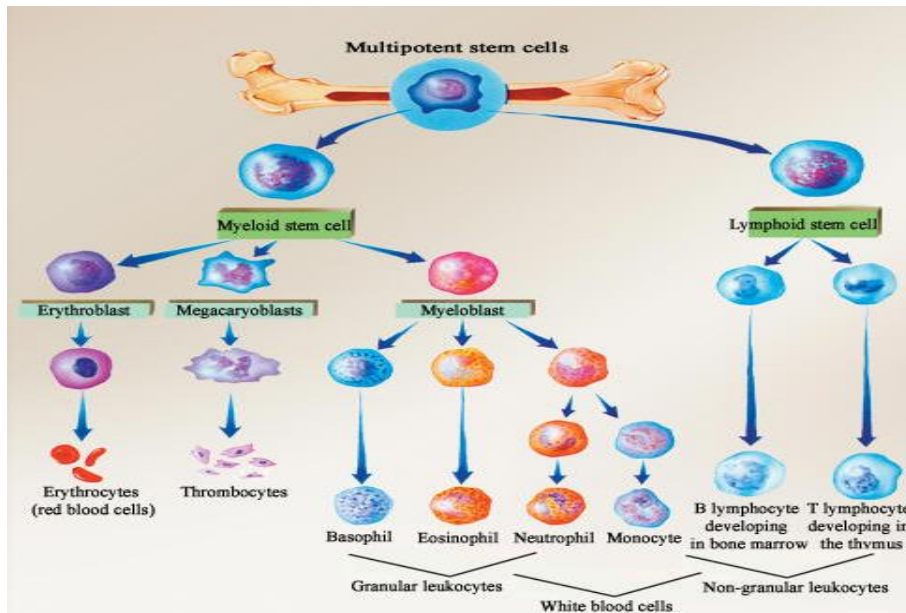
Heart disease remains the single biggest killer today. Rapid advances in stem cell research in recent years offer new hope for heart patients as they have the potential of generating different types of heart tissues. A number of heart cell-therapy trials are being conducted in USA, Germany, UK, Korea and Brazil with stem cells, usually derived from the bone marrow of the patient themselves. Chien and coworkers at Massachusetts General Hospital in Boston have found evidence regarding how stem cells may be converted into different types of heart tissues from a pool of multipotent cells. This was reported in a recent article in *Nature* (July 2009 issue). Stem cells may thus offer a way to treat failing hearts in the future.

9.16 Manufacturing Blood---from Stem Cells!¹⁷³

There have been exciting developments in recent years in the field of stem cells which promise to revolutionize the field of medicine. Stem cells can be converted into heart, kidney and other types of cells, thereby holding out the promise of repairing damaged organs. Initially, they could be produced from only embryonic cells, making the field controversial, but it is now possible to produce them from many different parts of the body such as bone marrow, skin cells, etc. Certain cells have also been developed which resemble stem cells (induced pluripotent stem cells) and which can be converted in the presence of certain other stimulating factors into various types of other cells.



9.15 Generating Heart from Stem Cells. Reproduced with thanks from: <http://www.amepc.org/apm/article/view/575/571>



9.16 Producing Blood form Stem Cells. Reproduced with thanks from: http://cheryl.tessari.com/webpages/blood_cells.html

Embryonic stem cells have now been used to produce red blood cells in large enough quantities to be employed for blood transfusions. The process has been developed by Advanced Cell Technology. Before long, red blood manufacturing automated machines could be developed, which could supply unlimited quantities of universally transfusable blood.

We are at the beginning of an enormous revolution in medicine.

9.17 Making Blood from Skin!¹⁷⁴

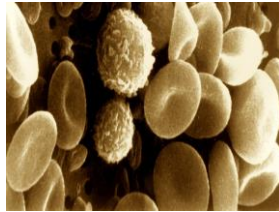
Scientists at McMaster University in Canada have made an important and exciting discovery. They have found a way to convert skin cells directly into blood! Mick Bhatia, scientific director of McMaster's Stem Cell and Cancer Research Institute at the Michael G. DeGroot School of Medicine and his collaborators have repeated the work over the last two years and finally published this exciting breakthrough in a leading scientific journal, *Nature*, in its issue of November 7, 2010.

This opens the way for the large scale production of a patient's blood from his/her own skin cells (<http://www.medicalnewstoday.com/articles/207003.php>).

9.18 Stem cells: A cure for Diabetes?¹⁷⁵

Scientists in Brazil may have finally discovered a way to treat diabetes by using stem cells. A team led by Dr. Julio Voltarelli isolated stem cells from the blood of 15 patients suffering from Type-1 diabetes. The weak immune system of these 15 patients was initially deliberately destroyed by administration of drugs to remove the harmful cells that attack pancreatic islet cells. The stem cells were then injected into the patients who quickly developed a new more robust system. The patients were able to live without injections of insulin or at much reduced doses of insulin. This work was done in 2007 and was initially considered to be controversial but has now been re-confirmed (*Journal of American Medical Association*, Vol. 301, page-1573). A treatment of diabetes may therefore finally be on the horizon. In Pakistan, at

least two laboratories are involved in cutting edge research in stem cells – the Center of Excellence in Molecular Biology in Punjab University, Lahore and the Dr. Panjwani Center for Molecular Medicine and Drug Research (International Center for Chemical and Biological Sciences) at University of Karachi in Karachi.



9.17 Producing Blood from Skin. Reproduced with thanks from: <http://www.stemcellsfreak.com/2013/07/ipscs-are-powerful-new-tool-for.html>



9.20 Stem cells--- New Boundaries in the Field of Medicine. Reproduced with thanks from: http://en.visithainan.gov.cn/en/lynewsview_2538.htm

9.19 Stem Cells: Missiles to Fight Cancer¹⁷⁶

Exciting advances in stem cell research are opening up new horizons in the treatment of heart, kidney and other diseases. Stem cells are now being used as guided missiles to target cancers. A team of scientists at the Beckmann Research Institute in Duarte California injected genetically modified stem cells into the brains of mice suffering from brain cancer, and the mice were then administered an anti-cancer drug (5-fluorouracil). It was found that mice which had been pre-treated with stem cells experienced a 70% reduction in tumour mass as compared to mice not treated with stem cells.

Stem cells tend to accumulate near cancer cells. It is expected that the combined use of stem cell therapy and anti-cancer drugs will allow not only the main tumour to be attacked but secondary growths and even single cancer cells could also be targeted in this manner. Clinical trials on human patients using this approach are expected to commence soon.

9.20 Stem Cells --- the New Exciting Horizon of Medicine!¹⁷⁷

An exciting new rapidly developing field in medicine is that involving the use of stem cells to repair damaged organs. Stem cells found in human beings are of two broad types --- embryonic stem cells and adult stem cells. Stem cells along with certain other cells act to repair damaged tissues in the body since they can be transformed ("differentiated") into other types of cells in the body. They can also be grown by cell culture and then transformed into various types of cells such as nerve, skin or intestinal cells.

In an important recent development, it has been found possible to induce the selective release of various types of stem cells from the bone marrow by the use of certain drugs. Thus instead of providing patients with stem cells from different donors, (in which case there may be problems associated with rejection), the patient's own stem cells can be selectively released from the bone marrow. These can then help in the repair and regeneration of specific tissues, depending on which type of

stem cell is released. This ability to selectively stimulate the release of a patient's own stem cells represents a major breakthrough in this rapidly developing field.

The work carried out by Prof. Sara Rankin of Imperial College London and coworkers could lead to the development of new treatments for the repair of damaged heart tissue, and accelerate the repair of broken bones and ligaments.

9.21 Dissolving Heart Stents!¹⁷⁸

Millions of people have a tiny metal mesh tube inserted into their coronary arteries each year to prop them open so that there is uninterrupted blood flow to the cardiac tissues. However, the blood vessel can harden over this metal tube in a few months, and cause problems. The metal blocks X-rays and MRI scans, and it can also, in rare cases, lead to clot formation. Abbott has now developed a stent made of a biodegradable material (polylactic acid) which dissolves away in a couple of years, while the blood vessel retains its shape. Patients will before long have a choice--- have permanent metal stents or biodegradable stents which dissolve with time.

9.22 Fighting Cancer Stem Cells!¹⁷⁹

Certain cancer "stem" cells are thought to be responsible for the resistance of some tumours to anti-cancer drugs. Cancer can recur in such tumours after other "normal" cancer cells had been destroyed by chemotherapy. Scientists at M.I.T. have genetically engineered similar cells from normal human cells which have properties resembling the cancer "stem" cells, and investigated their susceptibility to drugs. After testing thousands of compounds, they discovered that a compound, salinomycin, could effectively kill these resistant cells without much damage to normal cells. This showed that cancer "stem" cells are not invincible, and it may lead to the development of new lines of treatment (*Cell*, DOI:10.1016/j.cell.2009.06.034).

9.23 Open the Blood Vessels --- Attack Cancers!¹⁸⁰

Scientists at the University of Oxford have found that cancer cells are more susceptible to attack by anti-cancer drugs if the blood supply to the cancerous tumours is increased. Cancerous tissues often have poor blood supplies, which results in the prevention of anti-cancer drugs reaching the diseased areas. The Oxford team, led by Gillies McKenna and coworkers, has found four drugs which enhance the blood supply, thereby facilitating chemotherapy.

Normally, the opposite approach is used----- the blood supply to tumours is blocked to prevent their rapid growth. The two approaches are not contradictory but complementary. Initially, the tumours can be softened by administration of blood flow enhancing drugs. The tumors are then subjected to chemotherapy to kill the cancerous cells, and finally treated with blood vessel blocking drugs to starve the diseased areas of oxygen (*Cancer Research*, DOI:10.1158/0008-5472.can-09-0657).

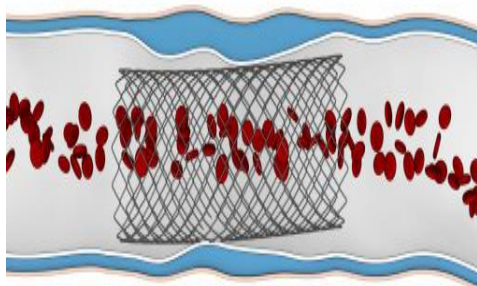
9.24 New Cancer Therapy--- with Rivers of Light (“Plasmons”)¹⁸¹

An exciting new treatment for cancer is under development ---- using light waves travelling across pre-determined paths. The generation of the oscillations, or “plasmons”, can be compared to the dropping of a stone into a silent pond of water, resulting in ripples spreading across the surface. Similarly, if light particles (photons) strike a metal surface, the surface oscillations of the electrons spread across the surface, picking up more light and carrying it with them---- rivers of light are thus generated (*Science*, **275**,1102-1106,2008). Plasmons are finding applications in a number of fields such as cancer treatment, biochemical sensing, solar cells and optical computing, making this one of the hottest areas in this ranch of physics.

Naomi Halas at Rice University in Houston injected mice with gold nanoparticles bound to certain antibodies which attack cancer cells. Once the nanoparticle-antibody units became attached to the tumors, the tumor was exposed to weak infrared

laser light, thereby heating the nanoparticles, resulting in the destruction of the tumour (*Proc. Natl.Acad.Sci. USA* **100**,13549-13554, 2003). The cancer therapy, which worked very well in mice, is presently being further investigated through clinical trials in humans (*Nature*, **461**, p720-722, 2009).

The cure for many cancers may lie in exposing them to “rivers of light” carried by waves of electrons!



9.21 Dissolving Stents in Blood Capillaries. Reproduced with thanks from: <http://www.rsc.org/chemistryworld/2013/08/biodegradable-vascular-stent-atherosclerosis>



9.23 Attacking Cancer-using Open Vessels. Reproduced with thanks from: <http://www.medindia.net/news/blood-vessel-plaques-exactly-identified-by-nanoparticle-131488-1.htm>

9.25 A New Treatment for Enlarged Prostates --- Plasma Therapy!¹⁸²

Enlarged prostates (or Benign Prostatic Hyperplasia, BPH) is a common condition, affecting about a third of men over 50 years old, and about half those who are over 70 years old. It can cause

difficulties in urination, and if not treated it can lead to urinary tract infections and even kidney failure. The normal surgical treatment involves removal of a part of the prostate. This works well in most cases but in some cases it can be accompanied by excessive bleeding which can be life-threatening, particularly in heart patients.

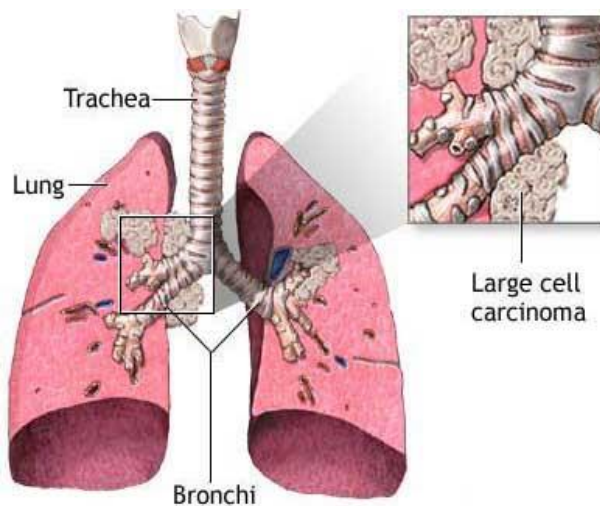
Now a new procedure has been developed by Olympus --- the PlasmaButton Vaporisation Electrode. This allows the tissue of the prostate to be vaporized directly using a small button-shaped electrode, without the need of it coming into contact with the tissue. The electrode is allowed to hover above the tissue to be removed, vaporizing it, and coagulating the surrounding tissue so that there is minimal bleeding. Since the procedure is almost bloodless, and allows the surgeon to implement it with good visualization while it is being carried out, clinical studies have shown that the hospital times, as well as the time for complete recovery are considerably shortened as compared to conventional surgical procedures.

9.26 Early Cancer Detection--- Dramatic Development!¹⁸³

About 8 million people die of cancer each year. A major problem associated with this disease is that it is often detected after it is already considerably advanced. In lung cancer, the tumour can reach the size of a cricket ball before it is detected. Ninety percent of lung cancer patients therefore die within 5 years of its detection. Routine screening methods also fail to show up early cancers, making treatment after their late detection far more challenging.

Now, a simple blood test has been developed after 15 years of research by scientists and clinicians in Nottingham (UK) and Kansas (USA) that is being considered as a major breakthrough in early cancer diagnosis. The new technology involves detection of the first molecular signs of cancer. When cancer starts developing, small amounts of certain proteins ("antigens") are produced which prompt the immune system of the body to react by forming antibodies. The blood test developed tracks this activity, and allows scientists to accurately identify the antigens,

the corresponding antibodies and correlate them with the type of cancerous tumour that is being formed. This can be done with only 10 ml of the blood of a patient in a routine testing procedure that will allow the cancer to be detected at a very early stage when it is usually treatable. The test will be introduced in USA in June 2010 and in United Kingdom by early next year. The test is already leading to dramatic improvements in the management of cancers in lung cancer patients and in 90% of other solid cancers in pilot trials.



9.26 Rapid advances in Early Detection of Cancer. Reproduced with thanks from: <http://www.health.am/cr/more/early-diagnosis-of-lung-cancer1/>

9.27 Cancer --- Predicting its Spread!¹⁸⁴

About 13% of all human deaths each year (some 8 million people) are due to cancer. This rate is rising as the average age increases and the population of the elderly grows. With new drug development, some cancers are now curable, particularly if they have been detected at early stages. Many tumors tend to form secondary growths (metastases), which can eventually prove to be fatal. There has therefore been a search for methods to predict the tendency for such growths, before they occur.

An exciting recent breakthrough in this field has been made by Peng Loh and colleagues working at the National Institute of Child Health and Human Development at Bethesda, Maryland in USA. They found that a particular protein (modified form of carboxypeptidase E) develops in the tumors before the secondary growths occur. This protein activates a gene responsible for the secondary growths of tumors. Early detection of such tendencies will go a long way in providing another powerful tool to physicians for treating cancer.

9.28 Making Tumours Glow!¹⁸⁵

A problem commonly faced by surgeons operating on cancer patients is to try to ensure that the cancerous tumour is completely removed. This has a direct bearing on survival rates of patients after surgery. Dr. Roger Tsien and colleagues at the University of California , San Diego have now succeeded in attaching certain proteins to cancer cells which glow when illuminated with certain techniques (magnetic resonance or fluorescence imaging), thereby allowing the detection of cancer cells that may not be visible otherwise. By using these “markers”, it was found that 90% more residual cells could be detected and removed, thereby dramatically increasing the survival rates of mice. It is expected that the technology will soon be available for human use (doi: 10.1073/pnas0910261107 (2010).

9.29 Gene Therapy --- for Colour Blindness!¹⁸⁶

The unraveling of the structure of the human genome has opened up opportunities for addressing genetic defects. About 1 in 12 men and 1 in 230 women suffer from some form of colour blindness or related defects. These are usually caused by mutations in genes which result in inactivation of the light absorbing pigments present in the eye retina. If the red photopigment is absent, it results in red and green objects

appearing as different shades of grey. This defect is also found in some types of monkeys. Jay and Maureen Neitz, a husband and wife research team at the Eye Institute of the University of Washington, have discovered that it is possible to cure this defect employing gene therapy. A virus containing the defect-free gene was injected into adult color blind monkeys. The monkeys were trained to identify coloured spots on computer screens, being rewarded by squirts of fruit juice each time they touched the screen at the correct place. Initially, the colour blind monkeys could only identify yellow and blue spots, but could not recognize red and green spots properly. Five months after the gene therapy, the monkeys suddenly became capable of identifying the red and green spots (*Nature*, p 695, vol.461, 8 Oct.2009).

Before long, the treatment is likely to become available for humans.

9.30 Gene Therapy --- for Alzheimer's Disease!¹⁸⁷

Certain diseases are caused by defective genes. Gene therapy involves insertion of genes, or alteration/ replacement of genes in a person's cells and biological tissues to cure the disease. It is still in its infancy and limited successes have been achieved employing it.

Now scientists at the Feinstein Institute for Medical Research in Manhasset, New York have found that it is possible to improve the condition of patients suffering from Parkinson's disease by using gene therapy. Parkinson's disease is a neurodegenerative disorder that causes tremors, rigidity of muscles, sluggish movements and impairment of balance. The condition is caused due to the lack of a chemical substance in the brain (GABA). The scientists introduced a virus into the brains of such patients that contained a gene that was able to increase the levels of GABA. This led to a marked improvement in the condition of such patients in clinical trials.

Scientists at Imperial College, London's Department of Gene Therapy, led by Gene Therapy Professor Nicholas Mazarakis

have also been making significant progress in using gene therapy to treat various motor neurone disorders. This is an exciting horizon in medicine.

9.31 Design Your Babies!¹⁸⁸

On March 3 last year, the front page story in *New York Daily News* related to a service being offered by an organization, Fertility Institutes, which would allow parents to choose the colour of their baby's hair, eyes and skin. Fear of negative public reaction forced the institute to cancel the project, but this may be only temporary as the technology is here. It involves testing the embryos prior to fertilization in the womb, and is known as preimplantation genetic diagnosis (PGD). It has already allowed thousands of parents to prevent genetic diseases being passed on to their children.

A menu of traits can now be offered after examining the genetic structure of embryos and the horrible prospect of breeding humans with special features, such as height, fighting characteristics or intelligence may be around the corner. Indeed in certain defense establishments in advanced countries, this may even be happening today secretly.

9.32 Battle against HIV --- Winning at last?¹⁸⁹

AIDS continues to be a big killer, particularly in Africa. In 2007, about 2 million people died and another 2.7 million people were infected by this devastating virus. However, a cure may be around the corner and there is renewed hope for AIDS patients - --- using gene therapy! A man in Germany suffering both from leukemia and AIDS was cured after being given a bone marrow transplant which replaced the patient's immune cells. The spectacular discovery made by Gero Hutter was published in *The New England Journal of Medicine* (vol.360, p 692). However, bone marrow transplant is not an option because bone marrow donors are rare and the treatment would be

cumbersome and expensive. A US company Sangamo Biosciences is however developing a gene therapy based cure which would emulate the effect of the bone marrow transplant. If successful, just one shot of gene therapy could completely eradicate this deadly virus. Presently, the best approach used against HIV is the use of antiretroviral therapy (ART). However, these drugs have to be used all one's life, and they are expensive.



9.32 Success is Near in War against HIV. Cure of HIV After Bone Marrow Transplants. Reproduced with thanks from: <http://www.newser.com/story/150905/2-cured-of-hiv-after-bone-marrow-transplants.html>

9.33 Is a Flu Pandemic Coming?¹⁹⁰

There is a growing concern among many scientists that a major flu epidemic which can take millions of lives may be inevitable. Scientists are worried that history may repeat itself. In the 1918 Spanish flu pandemic, about a billion people were infected, and some 50 to 100 million people died--- an astonishingly high figure. More than 200,000 people died in USA in just one month. The swine flu virus which originated in Mexico has spread rapidly across the world. The Mexican flu virus is very different in its structure as compared to the existing flu viruses, which means that humans have not developed any natural immunity to

it. If it evolves into a more deadly variety, tens of millions could die again.

Pharmaceutical companies are unwilling to risk producing large quantities of vaccines with no guarantee of efficacy if the virus continues to mutate, or of sales if the pandemic does not materialise. If the flu turns into a nasty killer, most countries will be left at its mercy due to non-availability of vaccines. The 1918 flu epidemic started in a mild form in spring but had mutated to a lethal killer by that autumn. It could be even more devastating now due to far greater number of travelers across the globe. What is alarming is that the world is not prepared.

9.34 Exciting Advances against Flu!¹⁹¹

Influenza (flu) attacks several million people each year, causing 250,000 to 500,000 deaths annually. In pandemic years, the death toll can rise to millions. Flu is caused by certain types of RNA viruses that attack mammals and birds. In advanced countries, it is quite common for the elderly to get themselves vaccinated against it, so that they are completely or partially protected.

However, the virus is quite a scam artist, since it uses 'smoke and mirrors' to deceive the attacking antibody or vaccine. It evolves by rapidly changing the structure of the protein coat that it wears on its surface so that vaccines effective against it in one year lose their efficacy in a subsequent year as it has changed its coat (surface protein) by which it was being recognised. The problem is complicated by the fact that there are sixteen different types of coats (surface proteins, proteins Hemagglutinin (HA)) that it can wear, so that any vaccine effective against one of these viruses will be ineffective against another.

There has, therefore, been a search by researchers to discover a region of that surface protein coat which does not change. The protein is shaped like a mushroom and at the stalk of this mushroom-shaped protein such a region has now been discovered. Scientists at Scripps Research Institute in La Jolla, California, collaborated with Peter Palese and colleagues at Mount Sinai Medical School in New York to develop a vaccine which was

effective against all flu viruses that attack human beings. Experiments carried out on mice infected with these viruses showed that the vaccines developed reduced the severity of the flu attack against all the virus types, thereby holding out hope that an effective vaccine against all types of flu viruses may soon become available. An Israeli firm, Biondvax, and the American firm, Dynavax, are in the process of developing the vaccines commercially (Proceedings of the National Academy of Sciences, DOI: 10.1073/pnas.1013387107).



9.33 (190), Spain, flu, 1918. Reproduced with thanks from, http://www.flu.gov/pandemic/history/1918/the_pandemic

9.35 Detecting Swine Flu!¹⁹²

A major pandemic which could kill tens of millions may be imminent, and some airports are preparing themselves to detect incoming flu patients, using the latest technologies. CAPSCA (the Cooperative Arrangement for the Prevention of Communicable diseases by Air travel) is involved in helping airports in this respect. Infra-red cameras have already been installed at some airports to detect passengers with fever. The first swine flu patient in Turkey was detected with this technique. However, the procedure is imperfect since swine flu is infectious

even a day before the patient develops a fever. Such patients can escape undetected through these surveillance devices. A cough detector has also been developed which can distinguish the difference between the cough of a person simply clearing his throat from that of a sick person. Such devices could be built into phones so that health authorities are alerted when a sick person is making a call. Recently, the Japanese government has initiated a GPS based 2,000 person trial which will alert the cell phone users if their GPS history shows that they may have been exposed to infection.

9.36 Swine Flu is Coming!¹⁹³

Next winter may pose a huge challenge for mankind---swine flu is intensifying and the pandemic becomes more serious with each passing day. It is also replacing the normal strains of seasonal flu, thereby creating new risks. The Spanish pandemic flu in 1918 was the most devastating in human history, leading to some 50 million deaths. The Asian avian influenza, which originated in China from ducks in 1956, caused over 2 million deaths. The Hong Kong flu in 1968 killed about a million people world-wide and affected some 500,000 people in Hong Kong alone.

In the US, more than 98% of flu cases in June this year were due to swine flu. In Victoria (Australia), 99% of the reported flu cases were also due to H1N1 swine flu. Similarly in Chile and Argentina, more than 98% of flu cases are due to H1N1 swine flu. There are ominous signs that the virus may be beginning to mutate to a more lethal and resistant form. Some cases of swine flu resistant to the anti-viral drug Tamiflu have also been reported. In Pakistan, an increasing number of cases of swine flu have been reported, and a number of deaths attributed to it. It is important to have access to vaccines --- these are not available in Pakistan presently, specially for the susceptible populations.

9.37 Nanoparticles for Detecting Tuberculosis!¹⁹⁴

The identification of tuberculosis, which involves growing large colonies of the bacteria, can take a couple of weeks. Now a test has been developed using magnetic nanoparticles which can

identify the disease causing bacteria within 30 minutes! The nanoparticles are coated with antibodies that can bind to the TB-causing bacteria and detected by a magnetic scanner. The work was recently reported by scientists at the Harvard Medical School and is expected to greatly facilitate early detection of this disease (*Angewandte Chemie*, DOI:10.1002/anie.200901791).

9.38 Diabetes: Bacteria to the Rescue!¹⁹⁵

John March and colleagues at Cornell University have engineered a strain of gut microbes (non-pathogenic *E.coli*) which secrete a protein (GLP-1) that triggers the release of insulin by human intestinal cells in the lab in response to glucose. When the bacteria were administered to diabetic mice, the sugar levels of such mice were restored to normal levels. It is hoped that the approach can be used to develop a yoghurt drink containing such engineered bacteria for treating diabetic patients. An advantage of the approach would be that since the bacteria would secrete just the required amount of the protein in the patient, the right amount of insulin will be produced and the constant need of self-monitoring of sugar levels would be eliminated.

9.39 Curing Infections---with Magnetism!¹⁹⁶

An exciting new development on the horizon uses iron oxide beads coated with antibodies to seek out and trap bacteria or fungi causing infections. The beads are very fine, having the thickness one-hundredth of that of a human hair, and they are injected into the blood stream of patients. A dialysis-like machine employs an electromagnet to pull out the beads, along with the disease causing bacteria or fungi stuck to the antibodies on the beads, from the blood into a saline solution. About 80% of the disease-causing agents are thus removed, making it much easier to tackle the rest with drugs. The treatment is thought to be particularly useful when wounds become septic, and organ failures can take place before the drugs have a chance to act. A

large number of sepsis related deaths occur each year. Animal trials taking place currently under the supervision of Prof. Don Ingber at the Harvard Medical School and Children's Hospital will be followed by human trials. The technique has also the potential of removing cancer cells or harvesting stem cells.

9.40 Healing Wounds --- by Printing!¹⁹⁷

Inkjet printers are commonly used for printing documents. An astounding breakthrough has recently been made by doctors at the Wake Forest Institute of Regenerative Medicine in USA in which they have used a device that resembles an ink jet printer but it can be used for spraying new skin cells onto burn wounds, thereby dramatically shortening the healing time. This method results in rapid healing and it could eventually replace the need of having skin grafts.

The device resembles a colour inkjet printer, comprising a tank that contains skin cells, stem cells and nutrients. These are sprayed by a computer controlled nozzle directly on the burnt area. In animal experiments, flesh wounds in mice were fully healed within 2 weeks as compared to 5 weeks taken by skin graft procedure, and showed less scarring and better hair regeneration. The technology will initially be employed by the US army to "print-shut" bullet wounds and blast damage.

9.41 Malaria—A Vaccine at last!¹⁹⁸

Each year, some 300-350 million cases of malaria are reported, and about 3 million persons die, mostly children in sub-Saharan Africa. Now there is hope. A vaccine has been developed by GlaxoSmithKline that reduced infection by 65% in children during small scale clinical trials in Kenya and Tanzania. Now, large scale trials are being carried out on 16,000 patients in 11 hospitals in Kenya, Burkina-Faso, Malawi and Tanzania. If the trials are successful, the vaccine should be submitted for regulatory approval next year.

9.42 Anti-viral Drugs ---- for Future Viral Diseases!¹⁹⁹

A major challenge for scientists is to cope with viruses that may suddenly emerge, as happened with HIV, SARS, Ebola and H1N1 which were unknown in human history. As we do not know which viruses may evolve in the years ahead, development and large scale manufacture of vaccines to cope with such a pandemic pose a huge problem. Michael Godblatt, who was leading the biodefense programme at **Defense Advanced Research Projects Agency** "DARPA" (a research arm of the Pentagon) began to work on a new generation of anti-viral drugs, which he hoped would not only be effective against all presently known viruses but also be effective against any viruses that may evolve in the future. This seemed to be too good to be true. However, after moving to a biotech company, Functional Genetics, in Gaithersburgh, Maryland, his team has developed some drugs which have shown promise in clinical trials. His work relies on the fact that viruses are utterly helpless without the hosts. It is by deceiving the host cells to make multiple copies that viruses multiply. What if one could identify and block the proteins in the host which are essential for the multiplication process? This would prevent the killing of healthy cells as well as prevent virus multiplication. They targeted a particular protein (TSG 101) in the host which the viruses need to break-out from the host cells. One drug (FGI-104) was found to be active against a large number of viruses (HIV, hepatitis C, Ebola) and may represent a new chapter in anti-viral drug development (*American Journal of Translational Research*, vol. 1, p 87). A number of other groups have developed similar approaches (*Nature Medicine*, vol. 14, p. 1357).

It remains to be seen if viruses can evolve in a manner that can circumvent this new threat against them. The battle goes on!

9.43 Killing Viruses --- with Ceramics!²⁰⁰

A novel ceramic coating has been developed by a UK based company, Intrinsic Materials in the UK, based on the researches of John Oxford and colleagues at Queen Mary, University of London.

It was found that nanoparticles made from silica and metal carbide ceramics could kill 99.9% of viruses within an hour. Applications for which this material could be used are facemasks, air filters, cash machines, trolley handles in super markets and even bank notes which may be infected due to public handling.

9.44 Relieving Allergies ---- with Parasitic Worms!²⁰¹

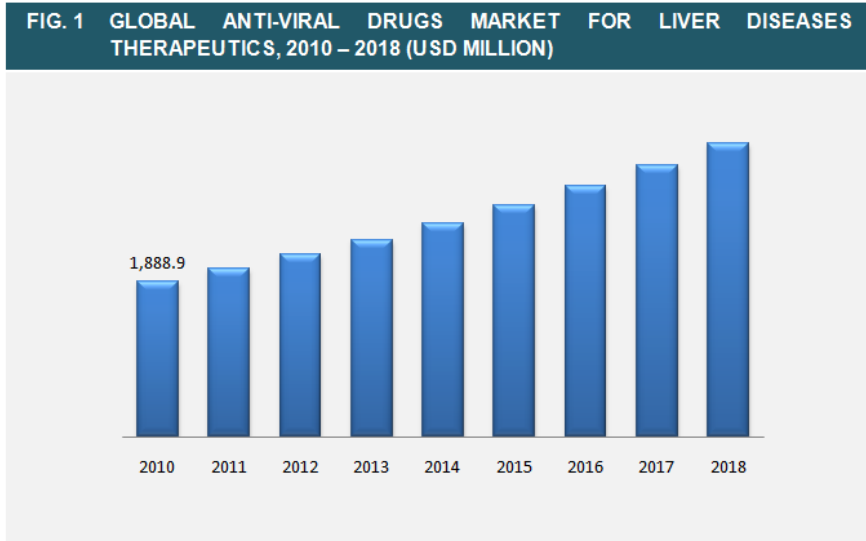
There is growing evidence that infections with certain parasitic worms can have beneficial effects for patients suffering from certain types of allergies. It has been shown in Ethiopia that the severity of asthma can be reduced if patients are exposed to hookworms. In Brazil, patients suffering from asthma could get relief if they were infected with a flatworm responsible for the tropical disease schistosomiasis (*Lancet*, vol 358, p1493). In Taiwan, it was shown that patients infected with a pinworm were much less likely to suffer from hay fever (*Clinical Experimental Allergy*, vol.32, p1029). These and other results indicate that the immune system is triggering positive responses to infection by different types of worms. Scientists at Imperial College London have also recently found protective effects of parasitic worms against pneumonia caused by influenza.

Such helminthic therapies may reveal exciting underlying factors in the future.

9.45 Electronic Pills!²⁰²

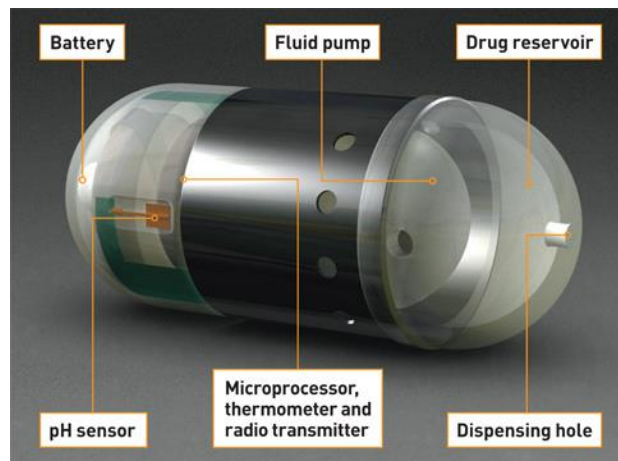
Almost all drugs have some side effects, and tend to affect other organs besides the ones that are being targeted. This limits the dosage of the drugs being administered. Clearly if there was some way to control their release so that they would affect mainly the diseased organ, it would be very useful.

A new approach being developed is that of an electronically controlled pill ("iPill") that will reach the site of the infection, release the drug directly on the infected area, and then pass out of the body without causing harm. The approach is particularly



Source: Company Annual Reports, KOL Opinions, Transparency Market Research

9.42 Antiviral drugs for antiviral diseases. Reproduced with thanks from, <http://www.transparencymarketresearch.com/liver-diseases-therapeutics.html>



9.45 i-pill. Reproduced with thanks from, <https://mgitecotech.wordpress.com/2011/11/02/>

suitable in diseases of the gastro-intestinal track such as colitis, inflammation and colon cancer. The pill is controlled by a microprocessor with which the doctors can monitor its exact location, pH and the time of its release. A small radio transmitter

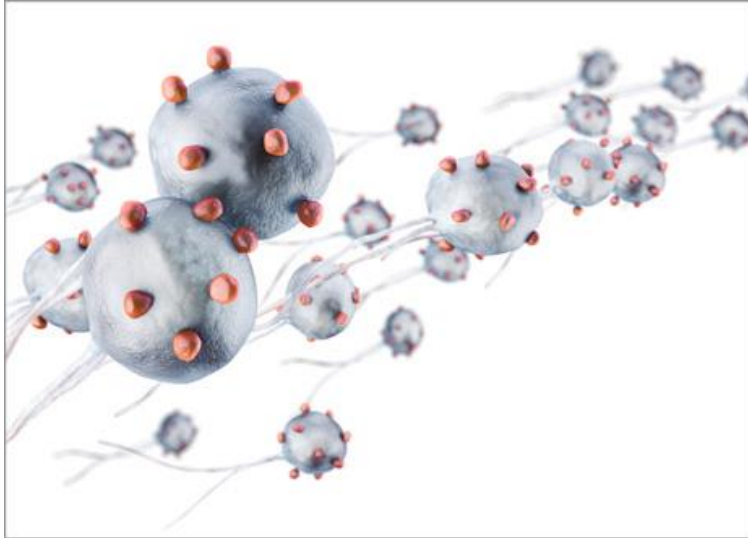
embedded in the pill relays the data to an external computer with the doctor, allowing the monitoring of the position of the pill and release of the drug at the desired site. The pill contains a tiny motor that drives a piston to dispense the drug through small holes in the pill. The iPill, which has been developed by Philips, is likely to become available commercially soon.

9.46 Robo Nurses!²⁰³

She is tall, caring with gentle sensitive fingers and a soft affectionate voice watching over you day and night ---- but she is not human but a robot! Her fingers can delicately grip a drinking straw but her arms are strong enough to lift you up like a small child and carry you as if you were a baby. Developed by researchers at Waseda University in Tokyo, Japan, and known as “TwendyOne”, the robo nurse can be particularly useful for elderly patients requiring constant care. It can readily accept commands such as to get medicine, refreshments or otherwise help the patient.

9.47 Converting Bacteria to Robots!²⁰⁴

Can you command bacteria to perform specific tasks, just like robots? Now you can! Prof. Sylvain Martel and colleagues at the NanoRobotics Laboratory of Ecole Polytechnique de Montreal, Canada have used a magnetic device to control and command bacteria to build a small pyramid! Certain bacteria (magnetotactic bacteria) have built-in natural compasses (“magnetosomes”) that force them to follow the pull of a magnetic field. These bacteria were induced by scientists using external magnetic fields to form a giant computer-controlled swarm of about 5,000 bacteria which was then “persuaded” to build a small pyramid from tiny epoxy bricks within 15 minutes. In another experiment, the bacterial swarm was forced to travel through certain blood vessels. The scientists are now planning to



9.47 (204), Magnetotactic bacteria. Reproduced with thanks from, <http://spectrum.ieee.org/robotics/medical-robots/magnetic-microbots-to-fight-cancer>

use these tiny workhorses to act as engines that will propel larger nanorobots carrying specific drugs to the site of infections. Bacteria could also be used for detecting other disease causing microbes, as well as to operate micro-factories for performing genetic and pharmacological tests. With “synthetic life” having been developed recently by Craig Venter and colleagues in USA (http://www.asm.org/index.php?option=com_content&view=article&id=91483),



9.48 (205) phage therapy. Reproduced with thanks from, <http://kightleys.photoshelter.com/image/I0000gLVrscLaL0>

computer designed DNA can now be inserted into bacteria which can reproduce themselves with the new genetic information to meet specific human needs for drugs, pesticides, fuel and energy. No unions, no protests, no hassle--- millions of tiny workers at work using tiny magnetic fields as the drivers.

9.48 Bacteria-eating viruses!²⁰⁵

Bacteria are constantly outsmarting our efforts to kill them with various antibiotics by developing new mechanisms of resistance. There is therefore a continuing struggle by pharmaceutical companies to develop new antibiotics that can kill such resistant bacteria, and treatment of many common diseases such as pneumonia, salmonella, and tuberculosis is affected by the emergence of new resistant bacterial strains.

One disease which can be hard to treat is ear infection caused by *Pseudomonas Aeruginosa*. These disease causing bacteria coat themselves with a protective biofilm which makes it a thousand times more difficult to kill them with antibiotics.

Now Andrew Wright and coworkers at University College London have come up with an interesting approach to attack such bacteria- the use of viruses capable of gobbling them up!. The treatment involves using certain viruses called bacteriophages which can break down the protective biofilm and kill the disease causing bacteria without causing any harm to the other useful bacteria present in the body.

While such methods have been used in the past, particularly in Eastern Europe, this is the first time that the effectiveness of this approach has been demonstrated through a proper clinical trial. Viruses may soon be used side by side with antibiotics in the physicians armour against disease.

The approach is fascinating use of biology for self-defence: if bacteria resist, feed them to viruses!

9.49 Are Viruses Responsible for Obesity?²⁰⁶

Are we genetically prone to getting fat? Or is it that we eat too much? Or could there be a third factor --- a virus ---- that is

responsible for us being overweight? About 20 years ago, Dr. N. Dhurandar, a medical doctor in Bombay, India, found that a chicken virus had the surprising property of making other birds obese when they were infected. The virus was identified as belonging to a special group of viruses (“adenoviruses”). Could such viruses be responsible for obesity in humans? 30% of obese persons have antibodies to this type of virus, indicating that they had been infected with it during their lives. In lean persons, the prevalence of this virus was only 4% (New Scientist, p26, 5 August 2000). Eight other viruses have been linked to obesity in animals, and the viral theory of obesity is gaining ground.

A number of diseases that were previously thought to have genetic or other origins are now known to be due to infections. Stomach ulcers that were thought to be caused by stress are known to be due to an infection caused by a bacterium, *Helicobacter pylori* and are readily cured by appropriate antibiotics. Similarly, mouse mammary tumour virus (MMTV) has been found to cause breast cancer in mice, and it has been shown that the virus could infect breast cells in humans (*Retrovirology*, DOI: 10.1186/1742-4690, vol.4, p 73).

Could the same be true for obesity? If so, a treatment with a suitable anti-viral drug may hold the answer to obesity. It has been found that human stem cells, when grown in the lab in the presence of the virus (Ad-36), were transformed to fat cells, implicating viruses. A cure for obesity may not be that far away.

9.50 Plastic Antibodies---A New Approach to Fight Disease!²⁰⁷

Antibodies are certain natural proteins that are employed by our immune system to fight against disease-causing bacteria and viruses. The tips of the antibodies have millions of variable structures, allowing them to bind to a very large number of different targets (antigens). Using nanotechnology, scientists at the University of California, Irvine, have now succeeded in making antibodies completely of plastic which are effective against bee venom. The process used involves molecular imprinting with polymers around bee venom molecules. The bee

venom was then dissolved away, leaving plastic antibodies ---- nano-particles that had cavities with the exact shape of the bee venom molecules, and therefore the potential of trapping them.

Mice were then injected first with the bee venom, and then 20 seconds later, with the plastic antibodies. The majority of mice injected with the plastic antibodies survived, whereas those in which the venom alone had been injected all died. This established that the plastic material was trapping the bee venom molecules, making them harmless.

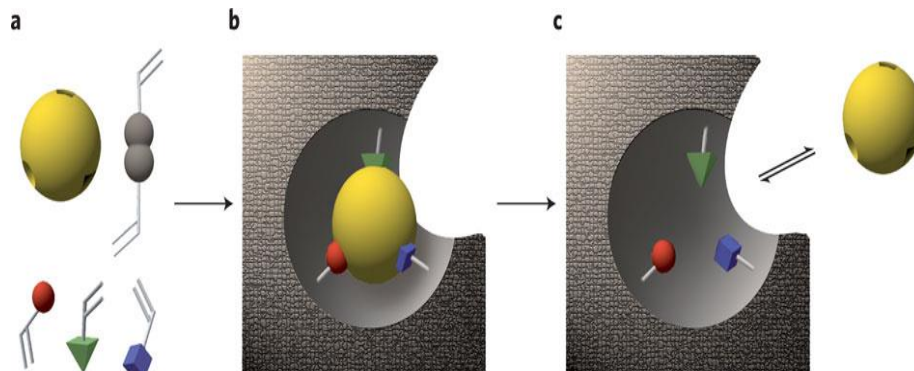
This opens up a new way of fighting infections or poisons. It could also allow new plastic antidotes to be developed to lethal nerve gases and other poisons (*Journal of the American Chemical Society*, DOI: 10.1021/ja102148f).

9.51 Tackling Stroke --- by Vacuum!²⁰⁸

Stroke is the second largest cause of death world-wide, after heart disease. About 10% of deaths are caused by stroke, resulting from the loss of blood supply to the brain caused by blockage from clot formation, or haemorrhage due to bursting of blood vessel. About 80% of strokes are “ischemic strokes” involving formation of clots in the brain. Currently, the treatment involves the use of a drug t-PA which has to be administered within 3 hours of the clot formation. A recent development to treat such patients is to use a vacuum-based technique (Penumbra System of Continuous Aspiration Thrombectomy) to suck out the clot from the blood vessel. It needs to be applied within a few hours of the stroke in order to restore the blood supply and prevent permanent damage to the brain. The technology has been developed by a company Penumbra, and it involves entering through the patient’s groin and threading a small catheter into a blood vessel. The catheter is taken up to the neck. Then an even smaller catheter emerges from it and is taken to the affected region of the brain before vacuum is applied and the clot is sucked out. The procedure has helped to save the lives of 27 patients and restore their normal functions at the Seaman MR Research Centre at the University of Calgary in Canada. It works well only in massive strokes, and requires proper training to be successfully applied.



9.49 (206) Viral theory of obesity. Reproduced with thanks from, <http://www.healthhabits.ca/2009/01/26/1-in-3-people-infected-by-the-obesity-virus/>



9.50 (207) Plastic antibodies. Reproduced with thanks from, <http://www.nature.com/nmat/journal/v9/n8/full/nmat2818.html>

9.52 *Monitoring Heartbeat—from a Distance!*²⁰⁹

In order to monitor heartbeats for long periods, heart patients need to be constantly hooked up to monitoring equipment with sensors taped on to them. This is uncomfortable and restricts the freedom of movement of the patients while they are trying to sleep or relax.

Now a team of scientists at the Department of Engineering and Design at the University of Sussex, UK, have developed

noncontact sensors that can be about a metre away from the body of the patient, but are still able to record the profiles of the heartbeat accurately. These 'Electric Potential Sensors' are so sensitive that they can even detect eye movements or brain/nerve fibre signals. The scientists are now working with a company called "Passive Systems" to develop a flexible home monitoring system that will detect any changes in heart patterns of elderly patients from the homes, and alert doctors of emergencies in cases of changes in heartbeat patterns.

9.53 Nanoparticle Vaccines—Hope for Diabetes Patients!²¹⁰

About one in every 400 children suffers from diabetes type 1, also known as juvenile diabetes. It occurs when white blood cells go astray and start attacking the insulin-producing beta cells in the pancreas. The result is increased levels of glucose in the blood and urine of such children, a condition that can prove fatal unless treated with insulin. The patients have to regularly inject themselves with insulin, since there is no known cure. Now there is hope at last due to the work of a research group at the Julia McFarlane Diabetes Research Centre at the University of Calgary, Alberta, Canada. Using nanoparticle vaccines, mice suffering from type 1 diabetes have been cured. This was done by means of a vaccine using particles which were thousands of times smaller than a cell.

These particles were coated with certain protein fragments (peptides) which were specific to type-1 diabetes. An advantage of this approach is that it reverses the tendency of the immune system to attack the insulin-producing cells in the pancreas, but does not suppress the other beneficial effects of the vitally-important immune system, necessary for fighting off disease-causing bacteria and viruses. A b i o t e c h n o l o g y company, Parvus Therapeutics Inc., is now in the process of further developing this new technology for commercialisation.

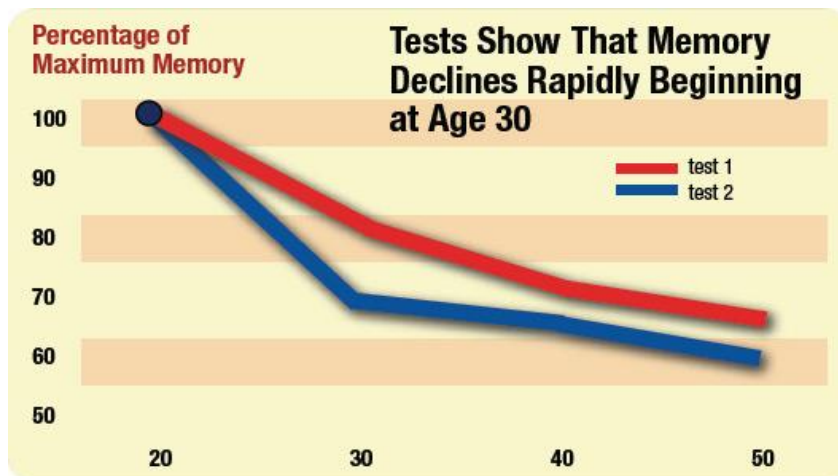
9.54 Next generation smart bandages!²¹¹

Next-generation bandages are being developed that will transmit information about the condition of a wound and even secrete

medicine onto it as and when required! These smart bandages will reduce healing times and facilitate treatment. The information from the bandage is transmitted to the medical personnel by means of electronic sensors that are embedded in the bandages. These bandages can be extremely useful in the case of sudden emergencies in which many people are wounded and they have to await treatment. The use of such bandages, that can sense the status of the wound and start delivering medication to it even before the arrival of medical personnel, can help save lives. This next generation 'SmartAid' bandage is a development from the Battelle Industrial Group.



9.54 (211) Smart bandages. Reproduced with thanks from, <http://www.topnews.in/health/smart-bandage-speed-wound-healing-212323>



9.56 (213) Age and memory. Reproduced with thanks from, <http://memplex.com/>

9.55 Reducing Brain Damage in Strokes—with Antibodies!²¹²

A very serious problem in stroke patients is the timely administration of a clot dissolving drug called rtPA. The drug only works well if it is administered within a few hours after the stroke, otherwise the risks outweigh the benefits. These risks include a sudden increase in blood pressure caused on the dissolving of the clot by the drug which can, in turn, lead to rupture of the blood vessels and further bleeding. Moreover, the administration of the drug can only be done after a time-consuming scan has been taken of the patient's brain, to determine the nature of the stroke. Patients who have suffered from a stroke due to haemorrhage caused by the bursting of a blood vessel should not be administered this drug as it can cause further bleeding. For this reason, only five to 10 percent of patients can be administered the drug in a timely fashion.

Now, an antibody has been developed by scientists at the University of Caen Basse-Normandie, France that binds to certain brain receptors, thereby reducing the side effects of the drug and giving more time for the treatment. The brain damage in mice was found to be reduced by 70 percent if the drug was administered in combination with the antibody, both when the antibody was given immediately after the stroke or six hours later. The recovery of the antibody-treated mice was also much better. It is hoped that the antibody may be administered to the patients even before they reach hospital, making the administration of the clot-dissolving drug safer and improving the state of recovery of the patient.

9.56 Memory Loss with Age—Exciting Advances!²¹³

As we grow old, our ability to retain and recall memories, particularly the recent ones, diminishes. This can become a source of frustration and embarrassment, particularly if you meet and try to introduce a person whom you know well but cannot recall his name, in spite of your best efforts. Now, a cure for this condition may be on its way.

Dr. Jonathon Seckl of the University of Edinburgh, UK has found that by blocking a particular brain enzyme (11 beta-hydroxysteroid dehydrogenase type 1 (HSD1)), it is possible to reverse the memory impairment and restore the memory of ageing mice so that it becomes comparable with that of young mice (Journal of Neuroscience, DOI: 10.1523/jneurosci.2783-10.2010). The new inhibitor will now be subjected to trials on human patients.

For those with the failing memories, there is hope, at last.

***9.57 Improving Brain Functions - with Electrical Shocks!*²¹⁴**

Dr. R.C. Cadosh and colleagues at the University of Oxford have developed a method which enhances mathematical skills. This involves giving electric shocks (transcranial direct electrical stimulation, TDCS) to the right side of the brain (right parietal cortex) while applying the opposite current to the left side of the brain. The process enhances the functioning of the neurons by making them fire more readily, thereby improving mathematical capabilities (Current Biology, DOI: 10.1016/j.cub.2010.10.007).

***9.58 Dieting - By Fooling the Brain!*²¹⁵**

Most people find dieting a tiresome experience. They need to resist the attraction of tasty high fat foods by trying to divert their thoughts away, often unsuccessfully. Now, scientists have come forward with a very interesting way to dieting which is quite opposite of how it is normally done. Instead of trying to divert your thoughts away from the food, you deliberately focus your thoughts on the food and imagine that you have been eating it to your fullest. By fooling your brain in this manner, it has been found that one can actually reduce the pangs of hunger which can result in consuming lesser amounts of the food.

The researches were carried out by Joachim Vosgerau and coworkers at Carnegie Mellon University in Pittsburgh, Pennsylvania, USA. The researches involved dividing volunteers into groups and allowing them to eat specific foods after the

individuals were allowed to actually imagine for a few minutes that they had been eating the same food for some time before they started eating. The amount of food consumed was measured against the control a group that had not been asked to use their imagination in this manner. It was found that the group that was asked to deliberately fool the brain in this manner ate significantly less than the control group (*Thought for Food: Imagined Consumption reduces Actual Consumption*, **Science** 330 (December 10), 2010; 1530-1533). A good way to eat less is therefore to firstly imagine that you are eating your second chapatti when you are actually eating the first, and to focus on each mouthful while you eat. The hunger pangs are thus significantly reduced.

9.59 Facilitating Learning --- by Brain Stimulation!²¹⁶

Scientists at Germany's Ruhr University Bochum have shown that it is possible to make rats smarter by stimulating their brains magnetically. The technique can selectively activate suitable neurons in the brain. The rats that were exposed to such stimulation were found to learn more easily. The technique known as "transcranial magnetic stimulation" (TMS) allows different regions of the brain to be turned on or off as desired. This has facilitated the study of the different interconnections of the brain non-intrusively and painlessly. The use of repetitive TMS is being used to study brain disorders such as depression and schizophrenia.

Brain stimulation in this manner not only results in smarter rats but may one day also lead to smarter kids!

9.60 Magnetic Resonance Imaging --- Exploring the Brain!²¹⁷

The human brain has a hundred billion neurons. Each neuron is connected with others through some 7,000 synapses, thereby presenting an amazing system of intelligence and communications. Scientists have been struggling to understand how it functions for decades.

A modern technique for mapping the brain is that of Magnetic Resonance Imaging (MRI). This relies on observing the concentrations of hydrogen atoms in water molecules within the brain. A technique known as “diffusion MRI” allows the long distance connections to be mapped by observing the water molecules as they diffuse lengthwise through the “axons” (the long projections of the nerve cells that connect distant areas of the brain). The method is being used by scientists at Oxford University to study the effects of a stroke on brain tissues. It has been found that development of certain skills such as mathematics results in the thickening of some clusters of neurons.



9.60 (217) MRI scna of Brain. Reproduced with thanks from, <http://www.sciencedaily.com/releases/2013/05/130509104354.htm>

Another related technique being employed also (functional connectivity MRI) allows the effects of workload on different parts of the human brain to be observed. The US National Institute of Health is spending US \$30 million to map the brains of 1,200 persons in order to understand how the 100 billion neurons connect to one another at short and long distances. It took 14 years to develop the wiring diagram of the brain of a one millimeter long worm that had only 309 neurons --- the resulting research publication occupied 446 pages (*Philosophical*

Transactions of the Royal Society, B, vol 314, p 1). The mapping of the human brain with a hundred billion neurons is a daunting task. It will take several decades of arduous research, costing tens of billions of dollars, before we even begin to have a proper understanding of this marvelous piece of machinery designed by nature with meticulous care and precision --- the human brain.

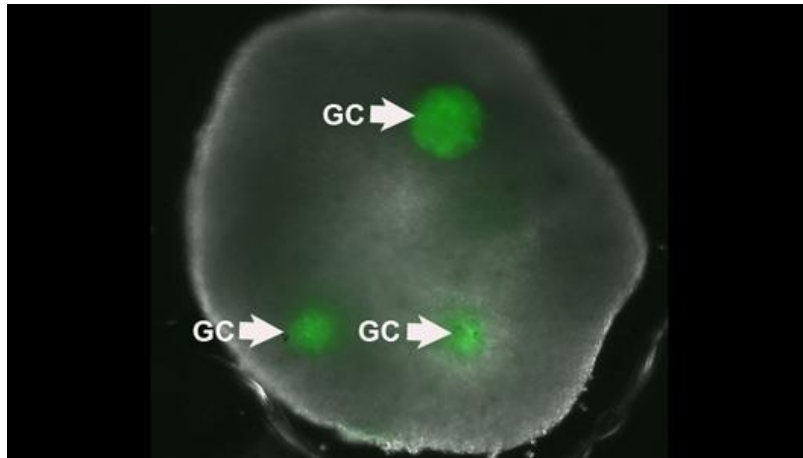
9.61 Exciting Progress in Tackling Alzheimer's Disease!²¹⁸

With ageing populations, particularly in advanced countries, the number of persons suffering from Alzheimer's disease, the most common form of dementia, is expected to increase from the present 25 million to over 100 million by the year 2050. A certain protein (amyloid beta) is produced in unusually large quantities in the brains of these patients leading to plaque formation and ultimately killing the neurons, causing dementia. The drugs available today do not work well. The development of a new imaging technique combined with a greater understanding of what may be responsible for this disease is finally holding out hope that a breakthrough may be around the corner. A team led by William Klunk and Chester Mathis working at the University of Pittsburgh, Pennsylvania, USA, has developed a new brain marker (PiB) which allows the affected areas of the brain to be lighted up and seen in live patients in PET (positron emission tomography) brain scans (*The Lancet Neurology*, vol 9, p 363). Previously, the damaged areas could only be detected by autopsies after death. This should greatly facilitate early diagnosis and new drug development as the disease can be monitored more effectively in patients.

There is growing evidence that the plaques may not be the root cause of the disease but only its symptoms. Certain tangles made of a different protein (called "tau") were found within the neurons. Recent researches indicate that it is a shortened version of the tau protein (oligomers) that may be responsible (*Annals of Neurology*, DOI: 10.1002/ana.22052) and new drug development is targeting these smaller molecules. A cure may still be some years away, but we are finally beginning to understand the causes of the disease.

9.62 DNA Testing --- in Hours!²¹⁹

The advent of DNA testing proved to be a revolutionary new development for the identification of criminals, after the introduction of finger printing in the first half of the last century. The time consumed for samples to be taken from the crime scene to the lab, testing and final results can however take up to 2 weeks, although most genetic tests take 24-72 hours. By the time the test results come, the suspects have often been released. There was clearly a need for a rapid DNA test. Scientists at the University of Kansas in Arizona in collaboration with The Forensic Science Service in the UK have now come up with a new chip which is capable of providing the results within 4 hours, and improvements in this technology are expected to reduce it to 2 hours. A portable device in police cars will allow on-site testing by taking a DNA sample from the suspect's mouth. This technology is expected to be commercialised soon, thereby resulting in a major new advance in forensic science.



9.63 (220) Artificial ovary. **SUCCESS:** The artificial human ovary surrounds and supports fluorescent human granulosa cell spheres (GC), which are one of the three types of ovary cells, after several days in culture. Reproduced with thanks from, <http://www.mnn.com/health/fitness-well-being/stories/first-artificial-ovary-matures-human-eggs>. Sandra Carson, *et Al.*, In vitro maturation of oocytes via the pre-fabricated self-assembled artificial human ovary, *J Assist Reprod Genet.* Dec 2010; 27(12): 743-750.

9.63 Artificial Ovaries!²²⁰

Researchers at Brown University and Women and Infants Hospital, USA, have succeeded in creating artificial ovaries made of 'theca' cells donated by women of reproductive age. The cells were grown into a honeycomb structure and then human egg cells (known as 'oocytes') were inserted into the holes of the honeycomb structure which behaved like an artificial ovary and allowed the egg cells to grow into mature human eggs in the laboratory.

This opens the way for salvaged eggs of women suffering from cancer to be recovered and allowed to mature outside such patients in this artificial laboratory. The researches were led by Sandra Carson, professor of obstetrics and gynecology at the Warren Alpert Medical School of Brown University and director of the Division of Reproductive Endocrinology and Infertility at Women and Infants Hospital.

9.64 Ageing Process Reversed!²²¹

The elixir of eternal youth has been the subject of many fancy tales but science may now be beginning to get us there. The advances in genetics, particularly during the last six decades, have given us new understandings of some of the underlying causes of ageing, thereby opening up possibilities of reversing it. As each cell divides, the DNA is split into half with the formation of two new cells. However, with the passage of time a small amount of information is lost with each cell division. The chromosome can be considered in a simplified manner as an X shaped unit made up of DNA molecules, and it is protected at its end by a cap, a buffer zone, known as a 'telomere'. This cap protects the end of the chromosome from being degraded during cell division, but is itself eroded in the process. With the passage of time, this cap erodes completely and the protection afforded by it to the chromosome is lost, with the corresponding deterioration of our organs.

A team of scientists at Harvard led by Ronald DePinho have now found a way to stop and even reverse this process in mice. This is done by activating an enzyme (telomerase) that repairs the

damage done to the telomere—i.e. it restores the protective cap at the end of the chromosome. They found that the mice appeared to become younger with many of the aged organs undergoing self-repair. The downside of such an approach may be increased risk of cancer.

9.65 Baldness --- Is a Cure Round the Corner?²²²

Baldness begins in 25% of men after they are 20 years old. Beyond the age of 60, about 70% of men suffer from this condition. The baldness gene androgen receptor (AR) is thought to be responsible for baldness, and gene therapy has been successfully tried on mice.

An interesting recent discovery by George Cotsarelis and colleagues at the University of Pennsylvania, School of Medicine, Philadelphia, is that while similar number of stem cells is present in skin with normal hair as compared to skin of bald patches, the stem cells on bald skin become dormant. These “sleeping” stem cells need to be somehow awakened so that they can be transformed into “progenitor cells”, and eventually into hair. This may be done by isolating these stem cells, multiplying them into progenitor cells, and then returning them to the balding patches so that hair can grow back. Another strategy is to find a way to awaken the sleeping stem cells by using a chemical signal. A suitable cream rubbed on the balding patch may then be sufficient to do the job.

With these exciting recent developments, a cure for baldness may be around the corner.

9.66 Homeopathy --- Is it Science or Nonsense?²²³

Before discussing the issue of homeopathy, one needs to understand the “placebo effect”. If a patient takes an inert pill or coloured water, believing that it will cure him, it does actually have a beneficial effect. This is known as the “placebo effect” and it needs to be carefully considered when randomised clinical trials are being carried out to determine the efficacy of

medicines. The reason that the placebo appears to work in some persons is that if you really believe that a particular medicine will work for you, then your body chemistry reacts accordingly and in some cases it actually does!

Homeopathy is widely practiced in many parts of the world, including Europe. But does it really work beyond the placebo effect? Extensive randomized clinical trials under strictly controlled conditions have proved over and over again that it has no more benefit than that which can be attributed to the placebo effect. Some clinical trials that initially indicated some positive effects were later shown to be faulty.

The National Center for Complementary and Alternative Medicine of the National Institutes of Health, USA, has reported: "*its key concepts are not consistent with established laws of science (particularly chemistry and physics).*" Health organisations in many advanced countries such as the UK's National Health Service, the American Medical Association (*AMA Council on Scientific Affairs (1997). "Alternative Medicine: Report 12 of the Council on Scientific Affairs (A-97)", American Medical Association*), and the Federation of American Societies on Experimental Biology (FASEB) (*FASEB J 20 (11): 1755-8, doi:10.1096/fj.06-0901ufm, PMID 16940145*) have also issued definitive statements that there is no convincing scientific evidence to support the use of homeopathic treatments in medicine.

It is clear that any benefits of homeopathy are due to two main reasons: (a) the placebo effect, and (b) the natural tendency of the body to heal itself over time. Beware also of a third dangerous factor: addition of corticosteroids to such medicines by charlatans. These may give you immediate relief but are injurious to health.

However, in spite of lack of scientific proof of its efficacy, homeopathy continues to be widely practiced in many countries.

9.67 Does the Brain Control Obesity?²²⁴

The World Health Organisation has estimated that there are about 2 billion obese people world-wide. This would constitute

about a third of all persons above the age of 15 on our planet. About 20 million children below the age of 6 also suffer from obesity.

Obesity has been known to be a condition that is inherited and there has been a constant search for genes that are responsible for this condition. Now, there is growing evidence that genes control appetite, and the brain plays a key role in obesity. Dr. Andrew Hattersley of Peninsula Medical School in Exeter, UK and coworkers discovered a gene variant in 2007 that may help to regulate the amount of fat in the body. The gene known as FTO was discovered in a study involving 2,000 diabetics. Since then an array of genes have been identified that play a role in obesity, and 64 gene variants have been discovered in various studies. It is not clear how these genes work, but it is thought that they may be involved in encoding certain brain proteins associated with the feeling of hunger. In time, we will be able to develop drugs that target the genetic pathways involved, but for the present we must resign ourselves to burning more than we eat by exercise and diet control.

9.68 Down Syndrome --- Hope for Patients!²²⁵

Down syndrome is a genetic defect caused by the presence of an extra copy of the genetic information on the 21st chromosome. It leads to impairment of physical features and learning abilities. Such disabilities are considered to be permanent, although special training can help children suffering from this condition. About half the children suffering from this condition also have congenital heart disease and many suffer from leukemia.

In order to look for cures for this disease, scientists have been experimenting on genetically modified mice in which a condition is produced that is similar to that is encountered in the Down syndrome. Catherine Spong and colleagues at the National Institutes of Health in Bethesda, Maryland, USA have found that if the mothers of such mice were injected with two proteins (called NAP and SAP), then such development problems could be prevented. Moreover, when mice with this condition were

orally fed with these proteins, the learning abilities of them significantly improved. The discovery offers new hope for children suffering from this debilitating condition.

9.69 The Germs are Winning!²²⁶

The microorganisms that are responsible for disease have built in mechanisms to survive by undergoing genetic changes (mutations) and by other means. This has allowed antibiotic resistant strains to survive and develop. There is therefore a constant race between scientists working to develop more powerful antibiotics to replace the ones which have lost their efficacy, and microorganisms which are evolving and developing resistance against existing antibiotics. Indeed, infections by resistant strains of microorganisms represent a major threat in most hospital wards, and many deaths occur during hospital treatment.

The problem has been severely aggravated by the huge costs associated with new drug development. These can exceed a billion US dollars, and the investment is often a complete loss since Food and Drug Administration (FDA) often rejects those drugs which show side effects before they can be commercialised. Most pharmaceutical companies have therefore abandoned their research programmes directed to develop new antibiotics against resistant strains, as it is no longer economically feasible. As a result, we are now losing the race against disease causing germs, and there is a growing risk of multiplication of disease resistant strains. This could lead to millions of deaths because of non-availability of effective antibiotics.

An exciting initiative to look at plant derived natural extracts for their antibiotic activity against resistant strains has been undertaken at the Premier Research Institute of Pakistan --- International Centre of Chemical and Biological Sciences (ICCBS) at Karachi University. Both H.E.J. Research Institute of Chemistry and Dr. Panjwani Centre of Molecular Medicine and Drug Research, are the prestigious institutions that are integral

parts of ICCBS. Over a dozen promising compounds have been discovered as a result of these efforts.

We may therefore go back to what nature has provided: the survival of mankind on this planet may lie in the biodiversity, and associated chemical diversity, that nature has blessed us with in the form of the plant kingdom.

9.70 A Sonar Device: for Strokes!²²⁷

Sound propagation through water (sonar) is a standard technique used by submarines to detect and avoid other vessels. Passive sonar involves listening to the sounds made by other vessels. Active sonar involves emitting pulses of sounds and listening to the echoes that bounce back after colliding with objects.

Now, sonar has been adapted to detect strokes in human brains. A device is worn on the head, and the pressure waves that are generated by the blood passing through blood vessels are detected by highly sensitive sensors on the device. Any abnormalities in such blood flow caused by clots in blood vessels or rupture of blood vessels can be readily detected by analysis of the resulting patterns. Strokes represent a major cause of death the world over, and early diagnosis of the problem is critical for recovery. The sonar device promises to add another tool in the hands of the physician to detect the nature of the stroke and the medication required to address the problem.

9.71 Healing Cartilage Wounds --- with Nanofiber Spheres!²²⁸

Cartilage wounds are often difficult to treat. They can be allowed to heal by themselves but the healing process may not proceed well as the new cartilage formed may not have the same form or provide the same functionality. The patient's own cells are often injected into the wound to promote the healing process, but as

the cells are not injected uniformly across the wound, the procedure is often unsatisfactory.

Now, scientists at the University of Michigan, USA, have developed tiny nanospheres made of a special fiber that can trap the patient's cells and carry them uniformly to the site of the wound by injection. The nanospheres can also carry trapped nutrients, thereby promoting the healing process. As these tiny spheres are made of a substance that degrades naturally (biodegradable), the spheres dissolve away in time without causing any side effects.

Nanotechnology is finding myriad applications in almost every field of human activity.

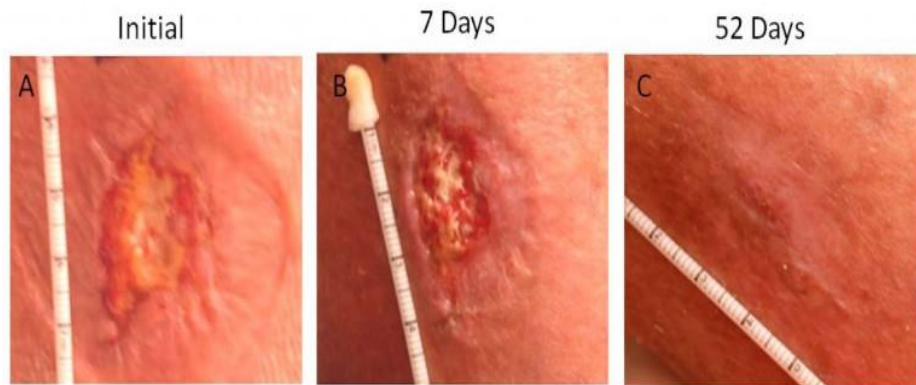
9.72 Cotton Candy-Like Glass --- for Difficult Wounds!²²⁹

Some wounds in diabetic patients are difficult to treat --- and it can take years before the healing occurs. In severe conditions, even amputation of the limbs may be necessary. The normal wound healing process relies on the formation of a fibrous structure (fibrin) which traps the blood platelets and offers the scaffolding on which the covering over the wound is formed. Now, scientists at the Mo-Sci Corporation in Rolla, Missouri, USA have developed a new glass nanofibrous material that resembles cotton candy floss that children enjoy eating. It copies the natural process and traps blood clots, thereby facilitating healing. The material is made from borate glass and is cheap to manufacture. It is eventually absorbed into body, so that no removal of sutures or bandages is necessary. The product is undergoing clinical trials and is expected to be marketed under the name of DermaFuse in the near future.

9.73 High Speed Biopsies!²³⁰

Fast analysis of the nature of tissues, whether they are cancerous or harmless, can make the difference between life and death during surgery. A histologist needs to analyse the sample and advise the surgeon which can take about an hour,

thereby delaying a critical surgical process. Now, NMR and mass spectroscopic techniques are being employed to provide instantaneous identification.



9.72 (229) Cotton candy for wound healing. Reproduced with thanks from, <http://globalwarming-arclein.blogspot.com/2011/05/cotton-candy-for-difficult-wounds.html>

The tissue is subjected to strong magnetic fields and radio-frequency waves in an NMR spectrometer. The tissue molecules undergo a special dance (“precession”) in the strong magnetic field. It is the manner in which they dance and absorb energy under the influence of radio-frequency waves that reveals whether they are cancerous or benign. The first such NMR spectrometer to be used for immediate analysis of cancerous tissue was installed at St. Mary’s Hospital in London.

In another related development, a pin-head size of tissue is burnt during the surgical process using electrodes (electrosurgery) and the vapor of the burnt tissue is guided into a mass spectrometer. Here, the different types of molecules are accelerated through vacuum and separated according to their weights. This allows rapid identification of cancerous materials. This technique is being applied by a German research group from the University of Glessen in a hospital in Debrecen, Hungary.

One of the best facilities for NMR and mass spectroscopy in the Afro-Asian region is located at the Husein Ebrahim Jamal Research Institute of Chemistry (International Centre for

Chemical and Biological Sciences), University of Karachi. There are twelve superconducting NMR spectrometers installed in this institute which work at -269°C , (just four degrees above the absolute zero!). This world class institution is the only institution in the Islamic world to have won the Islamic Development Bank (IDB) Prize (for being the best science institute of the Islamic world) twice in the last six years. Its contributions led to the University of Karachi being ranked at a prestigious 223 in world rankings in natural sciences last year.

9.74 Detecting Asthma Attacks --- A Day Before!²³¹

Asthma attacks can be very painful, and it will be a huge relief if patients could know in advance when they are going to occur, so that they can take medicines to preempt them. Now, Siemens has developed a handheld breath sensor that can give a warning of an impending asthma attack 24 hours before it occurs, allowing a person to take preventive medication. It has been found that there is a telltale increase in the levels of nitrogen oxide in the body up to 24 hours before an asthma attack, corresponding to the beginnings of inflammation in the lung prior to the asthma attack. The sensor detects the levels of nitric oxide at extremely low concentrations (one part per billion). The greater the inflammation, the higher will be the concentrations of the nitric oxide, thereby indicating the severity of the attack that is to occur. The doctors can prescribe medications accordingly.

9.75 Hope for the Paralysed!²³²

A man paralysed from the waist down after an accident for the last four years is now able to walk because of a historic development. Scientists working at UCLA, Caltech and the University of Louisville have been successful in implanting an electrode array into the body of the paralysed person. This device sends electrical signals that stimulate the lower part of the spinal cord that controls the movements of toes, ankles, knees and hips. The device therefore copies the signals of the human brain that cause

movement. The device used does not bypass the nervous system, and it does not directly stimulate the leg muscles. Instead, it stimulates the nerves in the spinal cords which in turn send the required commands to the lower limbs and feet.

The discovery holds out hopes for persons paralysed by spinal injuries.

9.76 Scars after Surgery? Not any more!²³³

When surgical sutures are removed after the wound has largely healed, the skin on the sides of the wound starts to pull apart, since the support by the sutures is no longer there. This results in the formation of scars around the wound due to formation of scar tissue. This may be disfiguring and aesthetically unacceptable. Researchers at Stanford University have now developed a new type of dressing that prevents the wound from experiencing the mechanical stress that is responsible for the formation of scars. The new dressing is made of a thin layer of elastic silicone which is pressed over the wound after the sutures have been removed. The plastic layer starts to contract evenly with time, pressing the edges of the wound together, instead of allowing them to pull apart. This results in healing with almost no scarring.

9.77 Exciting Military Applications—through University Researches!²³⁴

About half of the US\$400 billion spent in USA annually for research comes from defense agencies such as NASA, Office of Naval Research, US Air Force, etc. Much of this work is outsourced to universities and research institutes such as MIT, Stanford, Caltech and Stevens Institute of Technology.

One recent example of universities and research institutes playing a key role in the development of new devices that can help soldiers in the battle field was reported recently by biomedical engineering students working at New Jersey's Stevens Institute of Technology. They addressed the problem of

soldiers dying in the battle field due to loss of blood. This results in a condition known as “hypothermia”, a lowering of body temperature due to the blood loss, resulting in death.

The Stevens team set themselves the task of developing a device that could prevent or delay the occurrence of hypothermia by artificially heating the blood till medical aid could arrive and blood transfusions given. Presently, the techniques used for raising body temperature after blood loss are to use warm blankets and intravenous drips. These can take up to 16 hours to raise the temperature to a level where the patient becomes stable, a critical time period.

Using the device developed by the Stevens students, this could be achieved in a much shorter period of only four hours. The device works by passing warm humid air directly into the lungs of the patient. As the blood supply passes through the lungs, the body temperature rises to safe levels.

In Pakistan, very little work is outsourced to our universities. Moreover, not even one percent of the defense budget is spent on indigenous R & D. We buy expensive “toys” from wherever they are available, often at exorbitant costs, sold to us only if politically expedient. These soon become outdated and we then go out looking for more.

The recent Osama capture reflected our failure in technology as we were not able to detect “stealth” helicopters by our radars, making all our installations, including nuclear storage units, very vulnerable to such attacks. It should become mandatory for the military establishments to spend at least 10 percent of the defense budget on indigenous R & D in our universities so that we can develop capabilities in such areas as drone technologies, stealth weapons and robotics. Otherwise, we will always remain sitting ducks.

9.78 Lower IQ Linked to Childhood Infections!²³⁵

The world’s poorest countries may be paying a higher price than imagined for their state of affairs—decreased IQ of their young. This may be leading to a vicious circle of under development and disease. Recent studies at the University of New Mexico

have shown that the increased prevalence of infectious diseases in children in the developing world may have a negative impact on the IQ levels of children. Christopher Eppig and colleagues mapped the IQ levels of healthy persons in developed countries (with a lower burden of infectious diseases) and compared them with the IQ levels of those of developing countries with the heaviest burden of infectious diseases. It has been shown in the past that IQ levels correlate with GDP, nutrition levels and education. However of all these, infectious disease was found to be the most important factor suggesting that brain function and development may be permanently impaired as a result of some infectious diseases.

9.79 Mending a broken heart!²³⁶

After a heart attack, some of the tissues of the affected area of the heart may die. The damaged tissue normally cannot be repaired, though efforts are underway to use stem cells or other techniques to repair the damage. Now, engineers at Brown University, working closely with scientists at the Indian Institute of Technology at Kanpur, have succeeded in developing a patch made from carbon nanofibres and an approved polymer to repair the damage. The patch has a network construction which gives it flexibility so that it can expand and contract with the heart. When placed over the damaged tissue, it allows electrical signals to be transmitted through it as it is an excellent conductor of electricity. The patch is seeded with heart cells (cardiomyocytes) which grow rapidly on the patch, accompanied with the growth of neurons. Before long, surgeons may have a new tool in their hands to repair broken hearts!

9.80 A Cure for Baldness?²³⁷

As we grow older, our hairs thin out and the hairline recedes, revealing a shining “nut” underneath. This is cosmetically unacceptable to some, which is where wigs, laser hair insertions

and a number of crack pots offering magical cures come in. Scientists have been investigating various ways to trigger hair growth. Now, Valerie Horsley, assistant professor of molecular, cellular and developmental biology and colleagues at Yale have found the underlying cause why hairs do not re-grow. The stem cells needed for hair development are present but they require certain growth factors (Platelet Derived Growth Factors, PDGF) to be activated. Scientists are now beginning to understand how these stem cells may be triggered to spur hair growth. A cure for baldness may be around the corner!

9.81 A New Approach to Treating Cancer²³⁸

About 13% of all deaths in the world are due to some cause of cancer. Intensive efforts have been going on for decades to treat various cancers, some with remarkable success. One approach has been to develop methods for direct delivery of anti-cancer drugs to the cancer cells in such a manner that the drug is released only when it is near the cancer cells. This is in order to minimize the side effects of these toxic drugs on normal cells. A new approach developed by Marc Ostermeier (a Johns Hopkins chemical and biomolecular engineering professor in the Whiting School of Engineering) and James R. Eshleman (a professor of pathology and oncology in the Johns Hopkins School of Medicine) involves developing the ability in cancer cells to produce their own cancer medication! This results in the cancer cells self-destructing without affecting normal cells.

The approach involves incorporating a “protein switch” that is made by fusing two different proteins. One of these proteins detects the cancer cells while the second protein transforms an inactive prodrug into a cancer-killing material. The first step therefore is to introduce the “switch” into cancer cells. The patient is administered the inactive prodrug. When the prodrug comes near the cancer cells, the protein switch detects the cancer cell and converts the inactive prodrug into the active drug, thereby killing it.

9.82 A Single Drug Against Many Viruses?²³⁹

There are millions of different viruses, of which some 5,000 have been described in detail. They are responsible for many diseases in plants and animals. Scientists have been in search of a broad spectrum anti-viral drug, just as penicillin provided a powerful weapon against many bacteria in 1928. There are a few drugs available effective against specific viruses, but these soon develop resistance and lose their efficacy. Now, MIT scientists led by Todd Rider in Lincoln Laboratory's Chemical, Biological, and Nanoscale Technologies Group may have found the answer. They have been able to design a drug that seems to be highly effective against a large number of different viruses. The drug attacks only the cells that are infected with different viruses, and then kills them. It latches on to the infected cells by recognizing a typical feature of such cells (presence of long strings of double-stranded RNA) and simultaneously sends a signal that causes the cells to commit suicide.

The new class of drugs, called DRACO, was found to be effective against all the 15 viruses tested, including the H1N1 influenza virus (for details, see <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0022572>).

9.83 A Vaccine against Cancer --- At last!²⁴⁰

About 13 million new cases of cancer are diagnosed each year and about 8 million people die of this disease annually, accounting for about 13% of all the deaths worldwide. Cancer may be caused by exposure to cancer causing chemicals, physical inactivity and obesity, infectious diseases, exposure to radiation and rarely by inherited genetic defects. A number of cancer causing viruses ("oncoviruses") have also been identified. However, attempts at developing vaccines have so far not been successful. This was because the earlier vaccines employed just one gene to stimulate the body's immune system to destroy the cancer, to which the cancer cells soon adapted. A

multi-gene approach was not used because of the associated risk of stimulating an out-of-control response of the immune system which the body could not handle.

Now, Professor Alan Melcher and colleagues at the Leeds Institute of Molecular Medicine have made an exciting advance. They have used a 'library' of gene fragments to trigger the immune responses, but extracted the genes from the same type of tissues. This resulted in the formation of many different "soldiers" (antigens) to fight the cancer but it did not over stimulate the immune system. DNA was taken from a healthy prostate, and the fragments inserted into a virus. The resulting vaccine was used to treat prostate cancer in mice. The result was a complete cure! The technique is now to be applied to humans --- it is hoped that gene therapy may lead to a cure for certain cancers in humans.

***9.84 Artificial Spinal Disc for Back Pain!*²⁴¹**

In our spine are certain natural shock absorbers. Known as intervertebral discs, they prevent our vertebrae from grinding against one another. These natural cushions may erode with aging or they may be damaged by injury, leading to severe back pain problems. Indeed about \$100 billion are spent annually on back pain treatment in US alone. One approach is to have spinal fusion operations but they lead to decrease in the flexibility of the spine. Another approach is to replace the damaged discs. Now, engineering professors Anton Bowden, Larry Howell and former student Peter Halverson, at Brigham Young University (BYU) have developed a new artificial disc that promises to help millions of people that suffer from chronic back pain. The new artificial disc is elastic and durable, allowing spinal movement while withstanding the extreme pressures that it is exposed to between the spine vertebra. The technology has been licensed to Crocker Spinal Technologies, a company based in Utah, USA and the product is expected to be marketed later this year. Back pain sufferers may now look ahead with greater hope to the end of their long sufferings.

9.85 Basis of Human Memory!²⁴²

As far as we know the human brain is the most complex object in the universe. The human brain has an astounding 100 billion neurons, each connected to other neurons by some 7,000 synaptic connections. The process of thinking is therefore through this amazing connectivity. When I say the word “mother” a certain image is formed in your brain. How exactly are such images formed, and information stored/recalled? This has been one of the most perplexing and challenging areas in science. One would think that thought is abstract --- not true. Each thought has a concrete molecular basis. Indeed thoughts can be manipulated by various known chemicals. For instance, anti-depressants can fight against depressive moods.

About 11 years ago, we had proposed that certain glycoproteins present in the neurons in the brain (hypothalamus) may be responsible for memory storage through formation of protein-protein complexes. This binding can occur through a special “natural glue” --- hydrogen bonds. This novel theory was published in a top US journal, and was based in the clustering of these proteins in defined patterns through the formation of hydrogen bonds. (Atta-ur-Rahman *et al.*, *Pure Appl. Chem.*, **73**(3), 555-560 (2001). Each pattern would be unique, depending on the memory. In a recent publication by Jack Tuszynski from the University of Alberta in collaboration with University of Arizona’s Prof. Stuart Hameroff, the scientists have now provided evidence in support of formation of such protein-protein complexes in the process of memory formation and storage. They report that a certain protein (calcium-calmodulin dependent kinase complex II, or CaMKII) may be interacting with certain other proteins (microtubulin proteins) to form complexes. The process of information storage could therefore occur through such protein-protein interactions in the human brain.

The computers of the future could be biological computers designed by man according to his needs.

9.86 Biochips for Diabetics!²⁴³

The measurement of sugar levels in blood by diabetics can be a painful experience involving pricking the fingers with a needle once or several times a day. Now, a new technology is being developed by scientists at Rhode Island's Brown University that could well rid the diabetics forever from finger pricking devices. This involves the use of very sensitive biosensors. The scientists have succeeded in determining glucose levels in water at extremely low concentrations. The methodology could also be used for determining sugar levels in saliva that could be correlated with blood sugar levels.

9.87 Camera Pills – Inside your Body!²⁴⁴

A Japanese company RF System Lab had developed a camera-equipped pill that allowed pictures to be obtained from inside your body in 2004. Subsequently, Olympus announced a similar device with improved features in 2010. Now, a Norwegian company has made further improvements to this technology in a joint project named “Melody” between Oslo University Hospital, the University of Oslo, the Norwegian University of Science and Technology, the Norwegian Defense Research Establishment, and other partners. The capsule will comprise a tiny video camera, light source, radio transmitter, battery, and a microprocessor that will transmit HD videos of the various internal organs to which/where the capsule can travel.

9.88 Cancer Detection: Within an Hour!²⁴⁵

A team of doctors and scientists at the Massachusetts General Hospital USA, have developed the world's smallest cancer diagnosing machine that detects cancer accurately within an hour. The hand held device uses the phenomenon of magnetic resonance for detection purposes. Conventional magnetic resonance imaging (MRI) devices involve the body being placed inside a circular magnet followed by excitations of the hydrogen

atoms within the water molecules present in the body. As cancerous regions have dense tissue with less water molecules, they can be readily distinguished by MRI scans. However, to determine if the tumour is malignant or benign requires further tests that can take 2-3 weeks. This delay in starting proper treatment can mean the difference between life and death. The diagnostic magnetic resonance (DMR) device can accurately determine the presence of cancer in less than an hour, and it may thus save thousands of lives.

Led by Prof. Ralph Weissleder, the team employed magnetic nano-particles that could be attached to specific antibodies targeted for certain cellular cancer markers. When such tagged nano-particles were mixed with the biological material drawn by a biopsy from a patient, they stuck to the cancerous materials, and the resulting magnetic resonance signals established the presence of cancer. The range of accuracy was a remarkable 96% as compared to 84% accuracy with the conventional tests. The procedure using magnetic resonance can also be applied to detect other diseases.

9.89 Cheap Pharmaceuticals ---from Crab Shells!²⁴⁶

One of the main components of the exoskeletons of crabs and lobsters is a material called chitin. It has found wide use in self-healing car paints, biologically compatible transistors and for making flu virus filters. Now, scientists at the Vienna University of Technology have found another important use of it --- as a cheap replacement for a material used in the manufacture of anti-viral drugs.

The currently used anti-viral drugs are manufactured from N-acetylneuraminic acid (NANA). This material costs about \$ 2,700 per gram, and is about 50 times more expensive than gold. The conversion of crab shells into NANA is achieved using a bioengineered fungus (*Trichoderma*). Besides crabs and lobsters, chitin can also be obtained from insect exoskeletons, snail shells, squids and some fungi.

9.90 Dentists Rejoice --- A Painless Plasma Brush!²⁴⁷

Going to the dentist can be a nervous experience for some, fearful of those jarring mechanical devices and the pain from the needles in your gums. Now, all that may soon be over, with the development of an exciting new gadget --- the plasma brush. The plasma brush has been developed by Engineers at the University of Missouri (MU) in conjunction with Nanova, Inc. who found that it can painlessly clear cavities without any mechanical abrasion before the cavity is filled. The plasma brush also prepares the tooth surface in such a manner that the filling binds to the tooth more firmly. It is claimed that the fillings are 60% stronger if the tooth cavity has been prepared using a plasma brush. The process is fast and painless, taking only half a minute to prepare a cavity for filling.

About \$50 billion are spent in USA alone in some 200 million dental restorations annually. A tooth can normally tolerate 2 or 3 restorations before it has to be pulled out, so the stronger fillings using a plasma brush should save billions of dollars due to fewer visits to the dentist. The plasma brush is expected to be commercialized within 18 months.

9.91 Destroy Bacteria -- with a Torch!²⁴⁸

A group of collaborating scientists from Huazhong University of Science and Technology, CSIRO Materials Science and Engineering, the University of Sydney and the City University of Hong Kong, have developed a novel plasma flashlight that destroys bacteria instantly. Powered by a small 12 volt battery, it releases a plume of plasma at 23 degrees Celsius that is perfectly safe on our skin but destroys bacteria. The exact mechanism by which the flashlight works is not known. It does release weak UV light that may be responsible for the activity or its bactericidal effect may be the reaction of the plasma with the surrounding air. The flash light is expected to cost under \$100, and be useful to surgeons and physicians wanting to clean a certain body area.

9.92 Diagnosing Disease by Breath Analysis!²⁴⁹

The medical doctors of tomorrow will have a small device looking like a thermometer that will be able to analyse your breath and tell what illness you are suffering from. It is already possible to determine how intoxicated a person is with alcohol by analyzing his/her breath. The technology is now being extended to identify diseases such as cancer, diabetes and infectious diseases. This is achieved utilizing the facts that persons suffering from different illnesses have characteristically different metabolic patterns. Thus if a person suffering from a specific disease is fed or injected with a certain compound such as sugar having an enriched form of a particular isotope of carbon -13, then by analyzing the level of this isotope in the carbon dioxide exhaled in the breath, it is possible to detect tell-tale signs of a disease. Researchers at the University of Wisconsin-Madison have been working on developing the technology that will allow a hand-held “metabolic breathalyzer” to become a useful tool for medical practitioners.

9.93 Dogs Sniff Out Cancer!²⁵⁰

We are all aware how sensitive the noses of dogs are. They are widely employed all over the world to sniff out explosives that may be hidden away and not easy to detect. Now, scientists at Schillerhoehe Hospital Germany have found that dogs are excellent in detecting lung cancer by detecting the characteristic volatile organic compounds that are present in the breath of such patients when the disease is still at its early stages!

About 340,000 persons die in Europe each year due to lung cancer. Such patients may be saved, if the disease can be detected and treated in its early stages. Clearly, there are certain characteristic “markers”, typical of lung cancer patients, present in their breath that are detected by dogs. Scientists are now working to identify these specific compounds that dogs can detect, so that an early detection method using scientific instruments can be developed.

9.94 Drug Testing from Finger Prints!²⁵¹

Finger prints are normally used for determining the identity of persons. However, scientists at the University of East Anglia, UK, have now developed a device that detects illicit drugs in a person from the perspiration on the finger prints. A spin-off company, "Intelligent Fingerprinting", affiliated with the University of East Anglia, plans to market the device next year. Drugs taken by a person may be detected directly, or they may be broken down in the body to characteristic metabolites that can be recognized by the device. The equipment can be used not just for detection of illicit drugs but also as a health tool to monitor the level of medicines in the body. In a related development, scientists at Imperial College, London have been carrying out research to identify the race, diet or sex of a person purely from the chemicals present in the perspiration on the fingers detected during the finger printing process.

9.95 Eat Less, Live Longer!²⁵²

It has been known for many years that restriction of diet without reducing the intake of vitamins and minerals results in a slowing down of the ageing process and lengthens life spans. This was shown to be true for monkeys, rats, fish and even for microorganisms such as fungi. Scientists have been puzzled by this fact and have been investigating the scientific reasons behind the evidence.

Professor Mikael Molin of the University of Gothenburg's Department of Cell and Molecular Biology and colleagues seem to have at last found the answer (Molecular Cell, Volume 43, Issue 5, 823-833, 2 September 2011). There is harmful hydrogen peroxide in the cells of our body that is removed by an enzyme (peroxiredoxin 1), (Prx1). This enzyme degrades during the ageing process, making it less effective in removing the damaging effects of peroxide. The impaired function of this enzyme therefore leads to cancer and some genetic defects. There is however another "doctor in the house"--- a repair enzyme present (Srx1) that repairs the degraded enzyme Prx1.

It was found that restriction of diet increases the concentration of this repair enzyme Srx1, thereby leading to increased life spans. An interesting related finding was that if the level of this repair enzyme Srx1 is increased, then the ageing process can be slowed without restricting the diet. The diet restriction can potentially result in reduction of age-related diseases, including Alzheimer's and Parkinson's, leading to healthier longer lives.

9.96 Eat More but Still Lose Weight!²⁵³

Scientists from UC Irvine (UCI), Yale and Marche Polytechnic University in Ancona, Italy, have recently made a startling discovery. By altering forebrain neurons in mice, they produced less of a substance known as 2-arachidonoylglycerol (2-AG), and the mice could eat rich fat diets without gaining weight. They could burn fat calories far more efficiently than normal mice. Scientists are now looking at ways they could block the production of 2-AG in the brain so that the problem of obesity could be permanently solved on our planet!

9.97 Fight against Alzheimer's Disease!²⁵⁴

Alzheimer's disease is the most common form of dementia that afflicts about 30 million people worldwide. People above the age of 65 are often affected. In the early stages, it leads to difficulties in remembering recent events, but as the disease advances, it leads to confusion, difficulty in expressing oneself, irritability, aggression, long term memory loss and finally loss of body functions leading to death. The precise cause of the disease is not known, although it is clear that the plaques and tangles in the brain are affected. There is no cure for it, although a large number of clinical trials are being conducted presently.

An anticancer drug bexarotene has shown promise in reversing the physiological, cognitive, and memory deficits characteristic of Alzheimer's disease, in mice. Researchers led by Professor of Neurosciences Gary Landreth at Case Western University found that more than half of the "amyloid beta plaques" in brain cells of

mice associated with Alzheimer's disease were cleared from the brain within a few hours. Remarkably, within 72 hours the mice started to behave normally. Scientists at the Salk Institute for Biological Studies have developed another exciting lead compound, named J147 that appears to work in mice. The fight against Alzheimer's disease goes on and an effective drug may become available soon.

9.98 Fight against Malaria: Genetically Engineered Mosquitoes!²⁵⁵

Last year Prof. Anthony James, a molecular biologist working at the University of California, Irvine, had genetically modified mosquitoes so that the females were born without wings. This prevented them from flying around and attacking humans in their thirst for blood. The genetically modified non-biting males are born with wings. When they mate with normal (unmodified) females, they can spread these genes to the offspring. This can drastically reduce the population of female mosquitoes that are responsible for spreading malaria.

Now, the same group has carried out further genetic engineering so that the immune system of the mosquitoes has been altered (*Proceedings of the National Academy of Sciences*, June 11, 2012, doi: 10.1073/pnas.1207738109). Parasites picked up by the mosquitoes are then attacked by the mosquitoes' immune system so that malaria cannot be caused. It is hoped that these genetically modified mosquitoes will eventually be released and will multiply in large numbers so that they can replace the normal mosquito populations, thereby eradicating malaria from our planet.

9.99 Fighting Anthrax --- with Silk!²⁵⁶

Anthrax is a disease caused by a bacterium *Bacillus anthracis* that normally affects goats, cows, sheep and horses. Anthrax has also been used in bioterrorism that drew a lot of international attention. It can cause ugly sores on the skin, and if ingested it

can lead to internal infections that can cause death. If inhaled, it can migrate to lymph glands in the chest where it can proliferate and cause death. In the dormant form, anthrax spores can form a tough outer coating that protects them from antibiotics, radiation and heat. In one case, it was reported that such spores survived for 250 million years.

Scientists working at the Air Force Research Laboratory at Wright-Patterson Air Force Base in Ohio, USA have discovered a novel way to kill such resistant spores --- by using a chlorinated form of common silk! They found that when silk cloth was dipped in diluted bleach and dried, the resulting fabric was highly toxic to *E. coli* bacteria, killing all within 10 minutes. Similar activity was observed when bacteria closely related to Anthrax were exposed to the silk. It has been proposed that chlorinated silk could be used as a defense against terrorist attacks in the form of protective clothing or protecting areas of buildings with such silk materials (*ACS Appl. Mater. Interfaces*, Article ASAP, DOI: 10.1021/am2018496).

9.100 Fighting Asthma --- with Bacteria!²⁵⁷

The increasing prevalence of asthma worldwide, specially in industrialised countries, has led to growing investigations regarding the underlying causes. One explanation given is that the lack of infection in the childhood days leads to the body's natural immune system becoming weak and susceptible to asthmatic attacks in later life. Scientists at the University of Zurich and the University Medical Center of the Johannes Gutenberg University Mainz have now found that this is indeed the case. They attributed the increase in asthma in western societies to the disappearance of a gastric bacterium, *Helicobacter pylori* (*H.pylori*).

This bacterium infects about half the world's population and has been implicated in gastric and duodenal ulcers, gastritis, and in some cases it causes stomach cancer. About 80% of patients infected with this bacterium do not show any symptoms. Experiments on mice carried out by the Swiss and German

scientists showed that if young mice, which were a few days old, were infected with this bacterium, they developed a strong immune system. This protected them against attack by asthma-causing allergens at an older age. Mice not infected in this manner at their young age were very susceptible to asthmatic attacks by asthma-causing allergens.

This exciting discovery provides a deeper insight into asthma, and is likely to lead to new approaches to preventing such attacks.

9.101 Fighting Fat with Fat!²⁵⁸

The key to losing weight may lie in the amount of brown fat that is present in your body. It is actually brown in colour and burns calories rapidly ---nature's furnace that exists within each of us. It was earlier thought that brown fat was only present in rodents that could not shiver, and used the brown fat within them to burn calories and keep themselves warm. It is also present in human infants for the same reason but it is less needed in adults as they can shiver to keep warm. Later, it was found that it is also present in certain parts of the body in adults. A recent study by Canadian scientists led by Dr. André Carpentier at the University of Sherbrooke in Quebec has shown that when the body gets cold, the brown fat present sucks away normal white fat and burns it to keep warm. On average, it was found that the brown fat burned about 250 calories over a 3 hour period. It is thought that the key regulator of the conversion of white fat to brown fat is a special protein (named PRDM 16). The researchers hope to discover safe new drugs that can regulate the production of brown fat, thereby allowing persons to burn far more calories with this "calorie-burning good brown fat". Bruce Spiegelman, professor of cell biology and medicine at the Dana-Farber Cancer Institute has reported that in mice exercise can turn ordinary white fat into brown fat.

The days are not far when you will be able to feed on chocolates and fatty foods as you will be armed with large energy-burning brown fat ---fighting fat with fat!

9.102 Fighting Obesity in Novel Ways!²⁵⁹

Obesity can have adverse effects on health, leading to reduced life expectancy. It increases the likelihood of heart disease, type-2 diabetes, certain types of cancer and osteoarthritis. The life expectancy, on average, is reduced by six to seven years due to obesity and is believed to cause over a million deaths annually in Europe alone. About 64% of cases of diabetes in men and 77% of those in women are attributed to excess body fat.

Now, a compound found in peanuts and grapes has been found by scientists at Purdue University to block immature fat cells from growing into mature fat cells. The compound "piceatannol" alters the functions of the genes involved in this process of fat cell formation ("adipogenesis"). It was found that the compound binds to insulin receptors of immature fat cells in the early stage of fat cell formation. By this binding action, the compound is able to block insulin's ability to activate genes that carry out fat cell formation.

9.103 Get a Health Check ---- While Driving!²⁶⁰

Researchers from Germany's Technische Universitaet Muenchen, in collaboration with BMW have developed a special steering wheel fitted with sensors that detect the status of health of the driver. Two types of sensors on it detect high blood pressure and determine if the driver is experiencing severe stress. The information is then conveyed via a microcontroller onto an information display in the vehicle. One set of sensors measures the electrical conductance on contact of the fingers with the sensors on the steering wheel. An infra-red light shines on the fingers, and a second set of sensors measures the heart rate and oxygen saturation levels from the reflected light.

The idea is to alert the driver when the conductance levels on the skin indicate high stress levels. This could lead to sound level of the radio to be automatically reduced and the use of phone blocked. In severe cases, the speed of the car can automatically reduce, an emergency signal turns on and in extreme cases automated emergency brakes can be applied.

http://www.gizmag.com/smart-steering-wheel/20467/?utm_source=Gizmag+Subscribers&utm_campaign=0493b67ff1-UA-2235360-4&utm_medium=email

9.104 Gold Nanostars to Fight Cancer!²⁶¹

Materials exhibit special properties when their size is reduced to the nanometer range. It is the extraordinary properties exhibited by such materials that have resulted in the field of "nanotechnology" --- a very hot area in science and engineering today. One nanometer is a billionth of a meter (or a millionth of a millimeter), and nanotechnology involves substances that have a size between 1 to 100 nanometers (nm). To give an idea of the scales involved, the DNA double helix has a diameter of 2 nm while the smallest cellular life form, bacteria of genus *Mycoplasma*, have a length of about 200 nm.

A problem associated with the treatment of cancer by chemotherapy is that the drugs used also attack normal healthy cells and cause serious side effects. Scientists have therefore been searching for ways that will allow the cancer cells to be selectively targeted rather than using the "shotgun" approach that attacks cancer cells and normal healthy cells indiscriminately. Such a targeted approach would result in a significant reduction of the drug that is used because of the much smaller mass of the cancer cells, and cause correspondingly lower side effects. Scientists at Northwestern University have now developed gold nanostars that deliver drugs precisely to a cancer cell's nucleus. The drug to be used against the cancer cells is attached to the star shaped gold nano-particles. These nanostars carrying the anti-cancer drug are attracted to a protein on the cancer cell's surface. This protein acts like a tiny shuttle service, carrying the nanostars to the nucleus where the drug is released, killing the cancer cells selectively.

9.105 Hope for the Bald!²⁶²

Professor Takashi Tsuji and coworkers from the Tokyo University of Science have found a way to induce hair growth in

hairless mice --- by using stem cells. They successfully induced natural hair growth by implanting bioengineered hair follicles that were formed from adult-tissue derived stem cells. This brings new hope for the balding and also opens up new possibilities of bioengineering of organs for regenerative therapies.

9.106 Hope for the Blind!²⁶³

Neuroscientists at the Wisconsin-based Wicab, Inc. have developed a device "BrainPort" that helps users see without their eyes. According to the late co-founder of the company, the neuroscientist Paul Bach-y-Rita, we see with our brains and not with our eyes, so that it should be possible to develop devices that allow the blind to see. The device involves collecting visual data using a small digital camera that the blind person wears on sunglasses. The digital optical signals are then converted by a central processing unit (CPU) about the size of a cell phone that the blind person carries in his/her pocket into electrical signals, simulating and replacing the function of the retina. (Normal human beings use about two million optic nerves to transmit the optical images from the retina in the form of electrical signals to the brain). The CPU then sends the signals to an electrode array on the surface of a lollipop-like device that the blind person carries in the mouth. The bunch of nerves on the tongue receive these signals and transmit them to the brain, thereby creating the images of the object being viewed. With a little learning, the user can distinguish between a knife and a fork on the dining table or distinguish between the lift buttons, read letters and numbers, etc. The device originally announced in 2009 has been extensively tested at the University of Pittsburgh Medical Center's UPMC Eye Center.

In another related development, a team of scientists led by Prof. Michael Beauchamp at the University of Texas is exploring the possibility of electrically stimulating the visual cortex of the brain by means of electrical implants. He too believes that we see not with our eyes but with our brains and if electrical images generated from the visual objects could be transferred to the correct region of the brain, vision could be restored. About 10%

of the blind experience vivid hallucinations. This is attributed to the hyperactivity of the visual cortex of the brain, and the images seen can be in exquisite detail. It is envisaged that a webcam fitted on the glasses of the blind person could be connected to an implant in the brain to restore vision. The work was recently published in a leading science journal, (*Nature Neuroscience* (2012) doi:10.1038/nn.3131).

9.107 Inhaling Chocolates!²⁶⁴

If you are a “chocoholic” like me, it is a constant struggle to avoid them, while watching the calories. Now, Professor David A. Edwards, Professor of the Practice of Biomedical Engineering Division of Engineering and Applied Sciences at Harvard University has found an innovative way to satisfy that urge, without consuming many calories. He and his colleagues have invented a chocolate inhaler that allows one to consume a whiff of chocolate powder from a small lipstick-shaped inhaler. This allows you to get a mouthful of chocolate powder with only a very tiny amount of calories. The chocolate powder remains in the mouth and is not inhaled into the lungs as the particles of chocolate are 10 microns or larger in size. The chocolate inhaler is marketed under an appropriate name ---“Le Whif”. The sale of this novel chocolate dispenser started in April this year in Paris. A pack of six is available for about \$13 and it is offered in four different flavours (plain chocolate, mint chocolate, raspberry chocolate and mango chocolate).

So next time you have the urge, whiff it rather than eat it!

9.108 Insulin Substitute for Diabetes Treatment²⁶⁵

About 6% of the world population, some 285 million people, suffer from diabetes. A large number of these diabetic patients have to take daily injections of insulin. Pricking needles into oneself each day, week after week, month after month, is an uncomfortable experience, and scientists have therefore been looking for ways to avoid this and to have patients take a pill

instead. This has proved difficult as insulin happens to be a protein which is broken down in the gut if taken orally, losing its activity.

Now, scientists at Curtin University in Australia appear to have finally found the answer to this problem. Professor Erik Helmerhorst and his colleagues have found an insulin substitute after carefully examining a three-dimensional map of insulin, and identifying the region responsible for its activity. They then went through some 3 million smaller molecules and discovered one compound that could act as a substitute to insulin. The lead molecule is presently being optimized, and clinical trials will begin in a few years.



9.108 Substitute for insulin. Reproduced with thanks from, In an effort to find a compound that emulates the molecular map of insulin, Professor Erik Helmerhorst and his colleagues at Curtin University in research undertaken with Australian pharmaceutical company Epichem searched the structures of three million compounds. Unlike insulin, the small drug molecule isn't broken down in the stomach so can be taken orally as a tablet. As well as appealing to people who aren't fond of needles, Prof. Helmerhorst says a tablet would also be cheaper to produce and easier to store than insulin. This would make it easier to distribute in developing countries where the rates of diabetes are on the rise. <http://www.gizmag.com/oral-insulin-substitute/20433/>

9.109 Light Therapy ---through the Ear!²⁶⁶

Seasonal Affective Disorder (appropriately known as SAD) refers to a condition that causes a depressive condition in individuals with the onset of certain seasons. The symptoms include sleeping too much, lacking energy, and depression. The conditions may manifest themselves year after year in winter or summer, spring or autumn. There are several treatments available that include anti-depressant medications and light therapy involving exposure to bright light. In Nordic countries, winter depression is quite common as the environment is cold and dark with very little sunshine. Light therapy normally involves sitting about 30 to 60 centimeters away from a bright light source for 30 to 60 minutes.

Scientists at the University of Oulu, Finland, have now invented an amazing device that shines light not onto your face but into your ears. The Valkee device resembles a music player, except that light comes out of the ear plugs, instead of music. The scientists claim that there are 18 regions of the brain in which the photoreceptor (OPN3) proteins are located. One can affect these receptors by shining light at them through the ears. In clinical trials carried out, it was found that 92% of the patients could be cured in this manner. One needs to place these glowing fibres into the ears for about 10 minutes a day only, to get rid of the symptoms of depression. The device is available at the Valkee website at a cost of \$294.

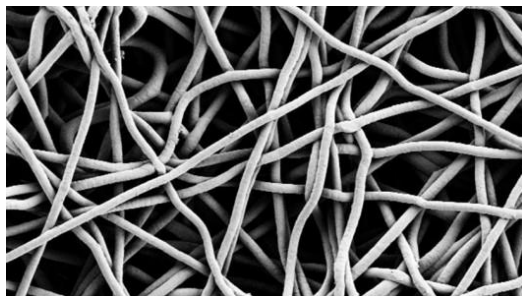
9.110 Medicines Release over Months!²⁶⁷

Slow sustained release of active principles from pills, tablets or capsules can be achieved by coating the active drug with a substance that does not dissolve immediately after intake, a process known as microencapsulation. This can also be done by embedding the drug in a matrix of an insoluble material (acrylics, chitin etc). The drug is then released slowly as it finds its way through the small holes in the matrix. This is in contrast to most tablets and capsules that lead to immediate release of drugs in the body. The slow release capsules can be very beneficial in

controlling chronic pain or in cases of cancer where sustained release of drugs can prevent the re-growth of cancerous tissues. Usually, such sustained release materials can have their effect last for a few days or even a week.



9.109 Treatment with light. Reproduced with thanks from, With its MP3-player resembling devices, Valkee offers on-demand, in-ear bright light therapy. This exists because, apparently, people are increasingly suffering from reduced exposure to daytime light, for a variety of reasons (shift work, long-distance travel and whatnot). Reproduced with thanks from, <http://tech.eu/features/215/valkee-conundrum-ive-shining-bright-light-brain-weeks-now-dont-know/>



9. 110 Microen capsulation. Scientists have developed a new material that can slowly release medication over a period of several months. It's hoped that the "superhydrophobic material" may one day lead to implants that would assist in the treatment of chronic pain, and in the prevention of recurring cancer tumors by gradually releasing medication over a period of months. The team of scientists is now planning *in vivo* experiments to gauge the effectiveness of the material in living organisms. Reproduced with thanks from, <http://www.gizmag.com/hydrophobic-material-drug-release/21314/>

Now, Professor Mark Grinstaff, Dr. Yolanda Colson and colleagues at Brigham and Women's Hospital in USA have succeeded in developing an exciting new material implant that will release the active drug over months and not days. The water-resistant material has a fibrous 3D structure with air trapped within it. However, some water can gradually penetrate through its pores, allowing the air in it along with the drug, to be slowly displaced and released. Medications trapped in this material can be released over months. When an anti-cancer drug was embedded in the material, the implant was found to be effective in fighting cancer cells for months.

9.111 Micro-Rockets --- in your Stomach!²⁶⁸

Micro-rockets powered internally by hydrogen, shooting through your stomach at super fast speeds of 100 body lengths per second, carrying with them urgently needed drugs, and releasing them at the diseased sites --- it sounds like a fairy tale but it is true. Scientists at the University of California, San Diego, have developed hydrogen bubble-powered micro-rockets that can be steered to the targeted sites and release their payloads. These micro-rockets are tiny 10 micrometer long polyaniline tubes with a diameter of a few micrometers. The tubes are lined internally with zinc that reacts with acid in the stomach to generate hydrogen bubbles. These bubbles propel the tubes forward at high speeds reaching 380 mph, depending on the pH of the stomach. The tubes can be coated on the outside with magnetic materials, thereby allowing them to be guided magnetically to a targeted site. (*J. Am. Chem. Soc.*, **2012**, *134* (2), pp 897-900; (DOI: 10.1021/ja210874s)).

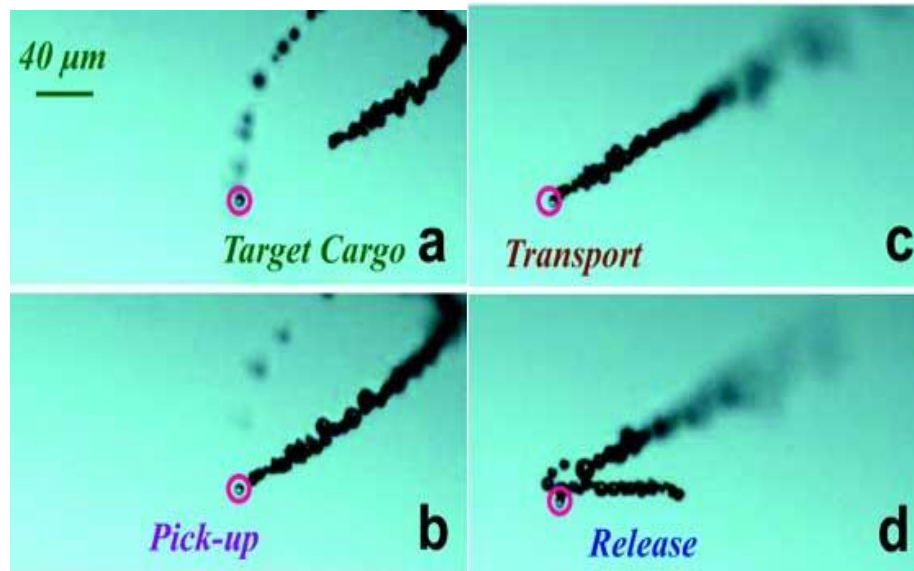
9.112 Minimising Brain Injuries²⁶⁹

Researchers at North Carolina's Wake Forest Baptist Medical Center have found a new way to minimise brain damage after injury. When the head receives a severe injury, it leads to irreversible death of some brain cells at the point of impact.

Toxic substances are then released at the injured area which cause the brain to swell, thereby decreasing the blood flow to that region. This leads to lower oxygen levels that in turn cause more brain cells to die. These brain cell deaths often lead to permanent impairment of body functions.

The US researchers found that if a bioengineered material matrix is placed directly on the injured area of the brain, and then computer controlled vacuum suction applied, it could draw out the excess liquid causing the swelling, and considerably reduce secondary cell deaths. The process, known as mechanical tissue resuscitation (MTR), was found to be effective in reducing the brain damage by about 50% and the rats recovered much more quickly from the brain injuries.

The technique will soon be subjected to clinical trials for applications on human patients.



9.111 micro-rocket. Time-lapse images of a microrocket (5 μm diameter) approaching (a), capturing (b), transporting (c), and releasing (d) the 5 μm target sphere. Reproduced with thanks from, *Journal of the American Chemical Society* 2012 134 (2), 897-900. Copyright 2012 American Chemical Society. <http://www.physicscentral.com/explore/action/rockets.cfm>

9.113 Neuronal Cells -- from Skin Cells!²⁷⁰

There have been exciting developments in the field of stem cells. Such cells were originally obtained from embryonic cells but they can now be extracted from bone marrow and other parts of the body. They can then be appropriately stimulated so that they are converted into other types of cells --- heart, kidney, pancreas, etc. This is an exciting fast evolving area of regenerative medicine, opening up futuristic possibilities of repairing damaged hearts, kidneys and other body parts.

Now, researchers at the Max Planck Institute for Molecular Biomedicine in Münster, Germany, have succeeded in reprogramming skin cells from mice so that they are converted into neurons. A growth factor was used to guide the development of skin cells so that they could be converted into neuronal somatic stem cells. The German scientists now plan to extend the work to human cells.

9.114 Playing Back Brain Images!²⁷¹

The ability to record brain activity while seeing an image, and then play it back to reconstruct the image has been a matter of pure science fiction --- until now. Scientists working at the University of California, Berkeley, have succeeded in reconstructing visual images after recording the brain activity of human subjects watching movie trailers ---- they were able to see what the people's brains were seeing! They used a functional Magnetic Resonance Imaging (fMRI) scanner to record the flow of blood in certain parts of the brain. Using powerful computing techniques, it was possible to correlate the visual images with the corresponding brain activities. This allowed the images to be reconstructed. The researchers hope to eventually “read the thoughts” of patients in coma or suffering from paralysis after a stroke. Researchers have now also succeeded in reconstructing words spoken to persons by detecting the corresponding brain activity.

9.115 Repairing a “Broken” Heart!²⁷²

Some tissues of the heart die after a heart attack. Scientists have been looking at ways to mend such a “broken” heart by growing fresh tissue on the heart itself. The common experimental techniques used involve the laying of a micro-scaffolding on the damaged section of the heart on which the new cells grow. This scaffolding could be made of gold nano-wires or carbon nano-fibres that need to be applied to the heart after a surgical intervention. An exciting new development has been the invention of a hydrogel that could be injected using a catheter so that no surgery would be needed. The invention is the result of efforts by researchers from the University of California, San Diego, led by Karen Christman, a professor in UCSD's Department of Bioengineering. The gel, prepared from cardiac connective tissue, has worked well in animal trials. A new start-up company Ventrix has been formed that will commence clinical trials on humans next year.

9.116 Robots --- for Brain Surgery!²⁷³

Keyhole neurosurgery is a very delicate affair. It involves making a small “burr” hole into the skull and performing the complicated brain surgery through this tiny hole. The slightest error, with the knife of the neurosurgeon deviating a fraction of a millimeter from its path, can lead to permanent brain damage. The procedure is useful for biopsies, to investigative endoscopy, tissue removal and deep brain stimulation and for obtaining samples of blood or fluid in the brain. It can also be used for removing brain tumours or for treating conditions such as epilepsy, Parkinson's disease, etc.

Computers are now being developed to perform such delicate tasks in close association with the neurosurgeon. The “ROBOCAST” system, being developed as a European Union project, involves the use of two computer systems, large and small, working together with the neurosurgeon. The large computer first positions itself near the area where the hole is to be made in the skull of the patient. Then the small computer

comes into action and the neurosurgeon uses it to follow a predetermined path on which the surgery is to be performed with the scalpel. There is an autonomous trajectory planner which guides the smaller robot on how to use the scalpel, and to make adjustments in case an unforeseen emergency arises. Another related project, named "ACTIVE" will allow patients to remain awake while robots carry out neurosurgery.

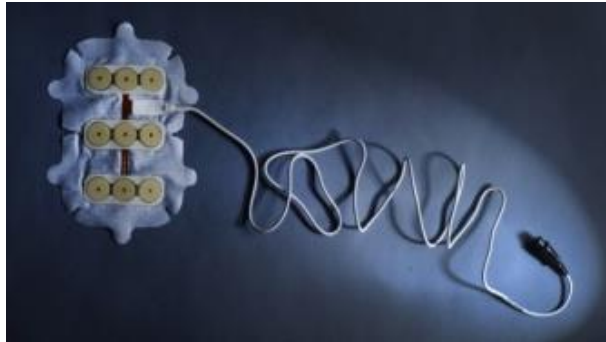
9.117 Stem Cell Bandages²⁷⁴

Stem cell therapy is heralding the advent of a revolution in medicine to repair damaged kidney and heart cells or to treat diabetes and other such diseases. Stem cells are the cells found in human beings and other animals and organisms that can multiply to produce more stem cells, and they can differentiate into different types of specialized cells (heart, kidney, pancreas etc). Adult stem cell therapies have been used for a long time to treat leukemias and other cancers by bone marrow transplants. Now, a special bandage, seeded with stem cells, has been developed by scientists at the Bristol University in the UK for repairing cartilage tears that sometimes occur and are difficult to heal. The bone marrow is extracted from the hip of the patient with a needle. Stem cells are obtained from it and multiplied separately before being embedded into a special membrane/bandage which is inserted into the torn cartilage. The stem cells present on the membrane are expected to help the healing process. The procedure is still in the research stage, and it could help in addressing a common problem of damaged cartilages (meniscal tears), particularly common in athletes.

9.118 Treating Brain Tumors --with Electrical Fields²⁷⁵

Patients with recurrent brain tumors (recurrent glioblastoma or GBM) can now be treated with electrical fields that can slow down or even reverse tumor growth. This new treatment has been recently approved by FDA. The patient wears a portable device weighing 3 kg that he can carry throughout the day and perform

his daily duties without any difficulty. This treatment has many advantages as it avoids the debilitating effects of chemotherapy that has to be performed on patients suffering from recurrent brain tumors. The new non-invasive treatment by Novocure uses "Tumor Treating Fields" (NovoTTF) and it involves placing pads onto the patient's skin. An alternating low intensity electric field is then applied to the tumor. This results in cancer cell death prior to division and does not harm healthy cells.



9.118 Electric field and treatment of brain tumor. The Novo TTF treatment involves placing pads onto the patient's skin that creates a low intensity and alternating electric field within the tumor. Reproduced with thanks from, <http://www.gizmag.com/treatment-of-brain-tumors-with-electrical-fields/21433/>



9.119 Nasal spray. Nasal spray vaccine currently being trialed in Australia could prevent the development of type 1 diabetes. Previous research showed that the nasal vaccine was successful in preventing the disease in mice, and now the results of a study involving 52 adults with early type 1 diabetes has provided encouraging evidence that it could also be effective in preventing the disease humans. Reproduced with thanks from, <http://www.gizmag.com/nasal-vaccine-for-type-1-diabetes/18918/>

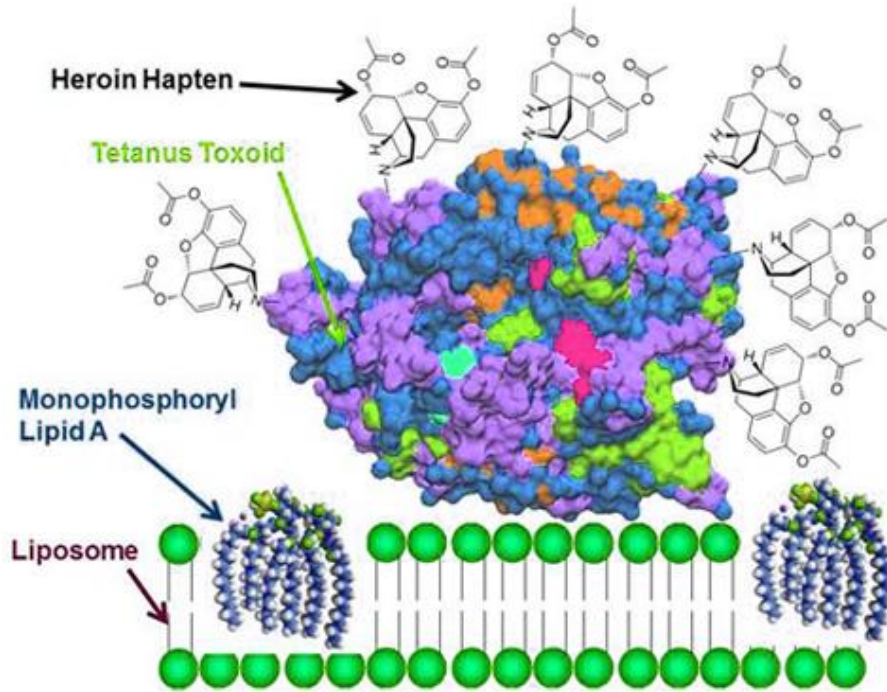
9.119 Treating Diabetes --- with a Nasal Vaccine Spray!²⁷⁶

Type-1 diabetes is caused by the loss of insulin producing beta cells from the pancreas due to the attack by the body's own immune system. It results in increased levels of glucose in the blood and urine. If left untreated, it can lead to heart disease, kidney failure, stroke and blindness. The usual treatment involves indefinite administration of insulin. The causes include genetic and environmental factors as well as diet. Viruses may also be responsible, with the body's autoimmune system attacking the virus infected cells, but simultaneously damaging the beta cells in the pancreas that produce insulin.

An exciting breakthrough has been recently reported by researchers at the Walter and Eliza Hall Institute and the Royal Melbourne Hospital in Australia. A clinical trial carried out on 52 patients who had early type-1 diabetes (at a stage in which injections of insulin were not yet needed) with a nasal vaccine has shown very promising results. The vaccine was administered to the patients for 12 months, and it was found to stimulate the immune system in such a manner that the white blood cells no longer attacked the beta cells of the pancreas. The researchers hope that a commercial nasal vaccine will be available within two years. The work was published recently in the April 2011 issue of the journal "*Diabetes*".

9.120 Vaccine against Heroin!²⁷⁷

Scientists working at the Scripps Research Institute in California have developed a vaccine that prevents the advent of the "high" after taking heroin. This can prove to be useful for those who are trying to break away from addiction to heroin. It acts by producing certain antibodies which prevent heroin or its metabolites from reaching the brain. The researchers are now collaborating with researchers at Walter Reed Army Institute of Research on the development of a related dual purpose vaccine that will be effective against HIV as well as heroin in a single dose.



9.120a Vaccine against Heroin. Reproduced with thanks from:
<http://www.nih.gov/news/health/jul2012/nida-25.htm>



9.120b Vaccine against Heroin. Reproduced with thanks from:
<http://12steps.sbnvideo.tv/heroin-vaccine-blocks-relapse-in-preclinical-study/>.

10. MATERIALS SCIENCE

10.1 The Incredible World of Smart Materials!²⁷⁸

Imagine you are driving a car and the car meets an accident--- the car is dented. You get out of the car and start smiling. The car is made of a memory alloy, so the dented material repairs itself, as if by magic, and the dent disappears as the material restores itself to its original shape. What about the paint job necessary? No worries! The car has been painted with a self healing paint which when scratched can heal itself. Science fiction? No, such materials are already here.

Rapid advances in nanotechnology, information technology and synthetic chemistry are opening up new worlds of exciting intelligent materials. The new smart materials can heal themselves if damaged since the original shape is “remembered” by them, change their shape (“morph”) in response to electric currents or magnetic fields, and serve as powerful bullet proof “living” exoskeletons which can be worn by Robo-Cop type soldiers during combat. These suits, when connected to the neural systems of the soldier, can react instantly to commands. The program is spear-headed by the Defense Advanced Research Projects Agency (DAPRA) of the Department of Defense in USA and is being implemented by the US Army Research Office (ARO), Office of Naval Research (ONR), NASA Langley Research Center and the Space Operations Vehicle Technology Office at Wright Patterson Air Force Base. The new alloys being used in aircraft can change their shapes in response to electrical signals triggered by stress, and return to their original shape when the stress is removed. The Smart Memory Alloys are effectively “noise cloaked”, useful in the development of silent stealth helicopters and ground vehicles. These “living” materials mimic the biological systems, but instead of living cells, they have nano-machines incorporated into their structures. Under the CHAP (Compact Hybrid Actuator Program) initiative, carbon nano-tubes that are 600 times stronger than steel by weight, and ultra-thin films made from composite materials are being employed to produce surface skins of spacecraft. These provide enormous strength, reduce aircraft body weights and self-

repair if damaged. Some surfaces can even store hydrogen that serves as a shield against the lethal damaging effects of cosmic radiation. Objects fabricated with new “metamaterials” can indeed be invisible.

The insect-sized drones used by foreign intelligence agencies are built with special materials having stealth properties that can evade detection. Controlled remotely, they can be maneuvered so that they can be strategically positioned on the walls and tables of the Prime Minister, President or heads of strategic organizations, recording all that goes on, and transmitting the sound and video intelligence data to receiving stations located miles away.

We live in this strange and wondrous world of science where innovation determines progress, and truth is stranger than fiction.

10.2 Science of the Invisible!²⁷⁹

Scientists have developed some special “metamaterials” which can make objects invisible to everything that travels as a wave. Both light and sound are waves and, at the sub-atomic level, even matter has wave character. These metamaterials derive their amazing characteristics of being able to bend waves away from an object because of their size and shape. When tiny concentric rings of the metamaterial are placed around an object, the material bends the light waves without any reflection or absorption. The waves of light thus go around the object, like a stream of water going around a rock, and then meet again behind it, making the object completely invisible.

The first such cloaking materials were developed by John Pendry at Imperial College London and David Smith at Duke University who worked only with microwaves but Xiang Zhang and colleagues at University of California at Berkeley later succeeded in bending visible light waves backwards. A design to cloak a submarine from sonar waves has been prepared and it has been shown that atomic waves can also be bent, since sub-atomic particles travel as waves. These researches have obvious defense applications. Indeed about 50% of all research in USA is funded by US defense agencies (NASA, ONR, US Air Force etc.).

It is high time that our armed forces start diverting major funds (at least 5% of their respective budgets) to universities, leading centers of excellence and research organizations so that Pakistan can attain leadership in such areas as metallurgy, nanotechnology, industrial microelectronics, robotics, biotechnology and computer sciences. The real strength of our country comes not from imported weapons but from having a strong knowledge of economy which rids us from the paralytic dependence on others for all our technological needs --- civilian or defense. Will our Chief of Army Staff make this happen?

10.3 Transparent Aluminum --- Seeing Through Solid Matter!²⁸⁰

Prof. Justin Wark and colleagues at the Department of Physics in Oxford University have made an interesting discovery. When aluminum was bombarded briefly with powerful soft X-ray lasers, a core electron in every atom of its crystalline structure seemed to be displaced, and it became completely transparent. Transparent aluminum was conceived in the film *Star Trek IV*, but fiction now seems to have become a reality. The discovery will throw light on what is happening during the creation of "miniature stars" by high powered laser implosions and increase our understanding about harnessing the power from nuclear fusion.

In another related development, scientists working at Imperial College London and University of Neuchatel (Switzerland) have shown that it is possible to have lasers pass through solid objects. They prepared some nanocrystals and when lasers were passed through them the nanocrystals became transparent. The discovery may lead to our ability to see through solid objects, such as people buried below a collapsed building, and do away with the need of X-rays in medicine.

10.4 Making Objects Invisible!²⁸¹

Magicians have been practising the art of making objects disappear for centuries. Now, however science can really make objects invisible!

In 2006, Prof. John Pendry and colleagues proposed the design of a cloak that could steer light around an object, thereby making it invisible. Soon thereafter, Dr. David Smith at Duke University succeeded in making such a cloaking device using certain exotic “metamaterials” having unusual electromagnetic properties. This first cloak however could only hide two-dimensional objects, and only if they were viewed at one particular frequency, not at the complete range of frequencies found in visible light.



10.3 Transparent aluminum. Reproduced with thanks from, <http://dornob.com/transparent-aluminum-glass-like-see-through-metal/#axzz2vj4dbtcF>



10.4 Metamaterials. Reproduced with thanks from, <https://lifeboat.com/ex/10.futuristic.materials>

That was four years ago. Optical cloaking devices made of silicon have now been independently built by physicists at the

University of California, Berkley (<http://arxiv.org/abs/0904.3602>) and Cornell University in Ithaca, New York (<http://arxiv.org/abs/0904.3508>). When these “carpet cloaks” are placed over an object, the object becomes invisible when viewed from one angle and the carpet appears flat. The limitation of the need to view an object from one particular angle for it to be invisible has recently been largely overcome by Tolga Ergin of the Karlsruhe Institute of Technology, who have used new technologies so that the object appears invisible from a wider range of angles, bringing 3D invisibility a step closer (<http://www.sciencemag.org/cgi/content/abstract/328/5976/337>). The technology being developed has applications in defence, as it may allow soldiers, weapons, warships and planes to appear invisible.

Harry Potter’s cloak of invisibility is fast becoming a reality!

10.5 Invisibility Cloaks --- Made from Invisible Threads!²⁸²

Metamaterials are materials that can bend light and make objects invisible if cloaked by them (<http://news.duke.edu/2009/01/invis09.html>, <http://discovermagazine.com/2009/jan/007>).

Now invisible threads are being designed and synthesized which are made of components smaller than the wavelength of light. This allows them to bend light waves and imparts optical properties not present in normal substances. Computer models indicate that such threads should not be thicker than 1 micrometer, and efforts are now under way to fabricate such threads by Alessandro Tuniz at the Institute of Photonics and Optical Science in Sydney, Australia. What does the future hold? ---invisible armies, ships, planes and submarines cloaked by metamaterials!

10.6 Intelligent Materials and Self-Healing Paints²⁸³

Spectacular progress is being made in the development of intelligent materials that can change their shapes when electrical

currents, magnetic fields or heat is applied. New alloys have been developed that have a built-in memory that allows them to remember their original shapes and which can repair themselves if cut or damaged. The US government is funding researches for development of new types of aircraft that have smart wings with the ability to flex their wings like insects and convert from bombers to fast and agile fighter aircraft in mid-flight. Nickel free titanium alloys (“NiTiNoI”) can remember shapes and, triggered by magnetic fields, adopt those shapes when required. Iron-palladium alloys have also been found to have remarkable shape-changing abilities due to the built-in molecular nano-machines. Carbon nano-tubes have been found to have 600 times the strength of steel. Space craft and aeroplanes may be built with such materials in the future. Self-healing materials made of long chain molecules (“ionomers”) can even heal themselves after a bullet has passed through.

Paints which have the ability to self-repair scratches use chitosan, derived from chitin, present in the shells of crustaceans (crabs, shrimps, lobsters etc.). Alternatively, the paints can have tiny liquid-filled capsules which release fresh paint when damaged.

In the future, you may well be riding in cars which when dented in an accident, heal themselves because they are made of such memory alloys, coated with self-healing paint.

10.7 Paper Stronger than Iron!²⁸⁴

Can paper be stronger than iron? Yes, it can be! Researchers at the Royal Institute of Technology in Stockholm have prepared a special “nano-paper” which is so strong that it is bullet-proof! The paper is made of tightly woven nano size (one millionth of a millimeter in thickness) cellulose fibres. Cellulose is the main constituent of cotton (about 90%) and wood. The bullet proof paper was prepared by digesting wood pulp with enzymes, finely chopping the fibers with a blender and then making sheets of the special nano-paper in which the cellulosic fibers were tightly intertwined in a strong network. The material was even stronger than Kevlar, a synthetic material which was initially used as a replacement for steel in racing tires.

10.8 Tougher Spider Silk!²⁸⁵

Spider silk is one of the toughest fibres known. Indeed, weight for weight, it is stronger than steel. Scientists have now developed a way to make it tougher, learning from how nature toughens insect parts. There are a number of creatures which have metals in their claws, jaws and stingers which are responsible for their strength. The mandibles of certain ants contain toughening zinc metal while the jaws of certain marine worms are strengthened by the presence of copper. Lee and Knez at the Max Planck Institute of Microstructure Physics in Halle, Germany have succeeded in impregnating spider silk with titanium, making it ten-fold stronger (*Science*, DOI:10.1126/science.1168162). By mimicking this process in artificial fibres, the scientists hope to produce super-tough textiles.

10.9 Nanotechnology for Cancer Treatment!²⁸⁶

When materials are reduced to the size of one millionth of a centimeter, they exhibit special properties which are being used in the development of new medicines, cosmetics, water purification techniques, construction and fabrication materials, and a host of other applications. Scientists working at the City University of New York have now developed nanofibres, which can take drugs to the exact diseased areas that need to be attacked. This avoids the side effects caused by these drugs on other normal parts of the body. Anti-cancer drugs attached to molecular nanofibres can be detached, in response to enzymes released by tumours so that they only attack cancerous sites.

10.10 Artificial Cartilages Bring Hope!²⁸⁷

Pain in knee joints is a common problem in elderly people. It is often due to the wear and tear of the joints. Natural cartilages, which reduce the friction between the bones, can wear out and may eventually need replacement. Efforts to develop artificial materials that can replace natural cartilages have had limited

success, because the high friction exerted between the joints can result in stiffening of the synthetic materials, so that they can lose their function after a certain number of years.

Jacob Klein at the Weizmann Institute of Science in Israel has developed low friction joints made of a polymer with surface molecular brushes. These brushes attract water molecules which act as a lubricating sheath as they slide past each other, thereby lowering the friction dramatically. The material has properties comparable to natural cartilages.



10.10 Artificial cartilages. Articular cartilage is the tissue on the ends of bones where they meet at joints in the body – including in the knees, shoulders and hips. It can erode over time or be damaged by injury or overuse, causing pain and lack of mobility. While replacing the tissue could bring relief to millions, replicating the properties of native cartilage -- which is strong and load-bearing, yet smooth and cushiony - - has proven a challenge. Reproduced with thanks from, <http://www.pratt.duke.edu/news/duke-engineers-make-strides-toward-artificial-cartilage>

10.11 Fireproof Houses!²⁸⁸

Entire neighbourhoods can be destroyed by raging fires that spread rapidly if there is wind blowing, causing large scale losses of life and property each year. Houses located in congested localities or near forests are particularly vulnerable as burning embers can travel a long way and engulf them, even before the actual fire reaches them. Fires killed 173 persons last year in Australia when they were trying to save their houses and a large number of shops and buildings were recently gutted in Karachi when miscreants set fire to them.

A technology has been developed that can make houses and buildings completely fireproof. It involves covering the entire house with a completely fire-proof tent located on the roof which

rolls out and inflates (just as a car air bag does) at the push of a button and covers the entire house within minutes. Two large fans come into action, pumping air into the flexible tubes of the tent that form its exoskeleton. As the tent inflates, the fabric cover unfolds and envelopes the roof and sides of the house quickly with the fireproof fabric. A similar tent was earlier used by the US army for protecting military vehicles from chemical attacks and has been adapted for civilian use.

10.12 Self-Cleaning Glass Windows!²⁸⁹

Deriving inspiration from the manner that lotus leaves are able to keep themselves clean, some scientists at Tel Aviv University, while trying to develop a cure for Alzheimer's disease, have accidentally developed a new type of surface nano-material. The material has a surface with tiny hairs of small protein molecules (peptides) about one-millionth of a millimeter in size which are resistant to water and heat. Coatings made from this material can seal glass surfaces and keep them clean by repelling particles of dust or moisture. The material can be useful in keeping glass windows of sky scrapers clean that otherwise require a lot manual window washing. They have also been found to be useful in keeping solar panels clean from dust and dirt, increasing their efficiencies by up to 30%.

10.13 Nanotechnology: Fast Charging Hybrid Car Batteries!²⁹⁰

"Hybrid cars" working both on petrol as well as fuel cells (which use hydrogen as a store of power) or batteries (which can be electrically recharged) have been known for some years. One problem associated with such rechargeable batteries is that it takes hours to charge them. Kang and Ceder at MIT have now developed an experimental battery that charges 100 times more quickly. The battery contains "nanoballs" of lithium iron phosphate which can be charged in minutes instead of hours. Cell phones containing batteries made of such nano-materials may be charged

in seconds! The day may not be far when petrol filling stations may be replaced by “battery charging stations”.

10.14 Lightest Solid in the World Invented!²⁹¹

Scientists working at the University of Central Florida have succeeded in preparing the lightest solid in the world. It is so light that one cubic centimeter of it weighs only 4 milligrams! It has been nicknamed “frozen smoke” since it is a translucent aerogel made of fine carbon tubes (nanotubes). Aerogels are 99.8% air, and they are a thousand times lighter than glass. They are 39 times better insulators than carbon fiber materials. The material is springy, with the ability to be stretched thousands of times. If an ounce of the material is stretched out and the pieces placed side by side and end to end, it would cover a space equal to three football fields! It is an excellent conductor of electricity and may find a host of applications as sensors in electronics. Since it is made of fine nanostructures, membranes made from it offer exciting possibilities of use as catalysts in fuel cells and for storage of energy.

10.15 Intelligent Plastic Film!²⁹²

Prof. Andrew Mills and coworkers at Strathclyde University in Scotland have developed an intelligent plastic film that tells you when the food that is wrapped within it starts to go bad. The manner in which the plastic works is being kept a closely guarded secret. The film undergoes a change of colour as the food starts to go bad, alerting you about its status.

A related discovery by Researchers from Germany’s Fraunhofer Institute for Process Engineering and Packaging is the development of a special food packaging film that kills bacteria and keeps food fresh longer. The film is coated with a lacquer that contains an edible antibiotic substance. As the film touches the food, the antibiotic is released slowly, thereby killing any harmful bacteria that are generated. As a result, various foods such as meat, cheese and fish can be kept fresh longer.

10.16 Glass Stronger than Steel!²⁹³

Scientists at the Berkeley Lab and the California Institute of Technology (Caltech) have developed a special glass which is stronger than steel. The glass bends rather than cracks because it possesses an enormous amount of plasticity, a property incorporated into it by the presence of a small amount of palladium. The resistance to cracking in this glass is far higher than found in some of the toughest materials that have been developed previously. The glass is expected to find wide applications in defense as well as in industrial products.

10.17 Self-Healing Materials!²⁹⁴

Imagine that you are wearing a shirt and accidentally tear it. Then something remarkable happens. The shirt senses that a part of it has been damaged, and starts repairing itself. In a few moments, it has glued itself back at the tear and is again as good as new! Intelligent materials have been invented that remember their structure and shape and have the capability of repairing themselves if damaged.

Such self-healing materials usually incorporate microcapsules within their structures. These microcapsules get ruptured when a section is damaged, thereby releasing a liquid that acts as a sealant. Such technologies have been employed in plastics as well as in a self-healing concrete, in which the cracks that appear automatically heal themselves.

More recently, biopolymers have been prepared from vegetable oils and they return to their original shape when heated. Intensive researches in this exciting field are being carried out by Dr. Michael Kessler of Iowa State University and a number of research groups in USA, Europe and Japan.

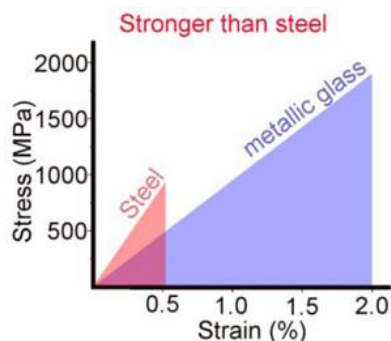
10.18 Touch Screens - from Carbon Nanotubes!²⁹⁵

There has been growing demand for touchscreens for mobile phones and other devices. The most popular touchscreens need

to have high transparency in thin screens and excellent conductivity. These “capacitive screens” are made from an element, indium, which is in short supply on our planet. There has therefore been a search for alternatives. Researchers at the Fraunhofer institute in Germany have now developed low cost touchscreens made from carbon nanotubes and low cost polymers.



10.14 solid lighter than air. Reproduced with thanks from, <https://www.acs.org/content/acs/en/pressroom/presspacs/2011/acs-presspac-january-12-2011/one-ounce-of-new-frozen-smoke-could-carpet-three-football-fields.html>



10.16 Glass harder than steel. Reproduced with thanks from, <http://today.ttu.edu/2013/02/texas-tech-researcher-shatters-metallic-glasses-mystery/>

Carbon nanotubes (different from carbon fibers) are extraordinarily strong, although about 50,000 times thinner than a human hair and can have a length of up to 18 centimeters. They are cylindrical carbon molecules with a length to diameter ratio greater than of any other material (about 132 million to 1). They were developed after the serendipitous discovery of “buckyballs” --- football-shaped carbon molecules that were discovered by two independent groups led by Prof. Harry Kroto at Sussex University and Prof. Richard Smalley and Robert Curl at Rice University. They were exploring how certain compounds (polycyanoacetylenes) were formed in the stars and ended up heating graphite to high temperatures, resulting in the accidental discovery of football shaped pure carbon molecules. They shared the chemistry Nobel Prize in 1996 for this discovery. Carbon nanotubes have found applications in many fields including electronics, optics and material sciences.

10.19 Illusion Cloaks!²⁹⁶

Magicians have been practicing a trick for centuries --- making pretty girls disappear before our very eyes. Now, science can do the same by actually bending light around objects through the use of “metamaterials”. Moreover, it may also be possible to replace the real objects by others, so that you see something else instead!

The researches have been carried out by Wei Xiang Jiang and Tie Jun Cui's team at Southeast University in Nanjing, China. Cui and coworkers had earlier developed the “electromagnetic black hole” for light in 2009. Now, they have created a new type of metamaterial that changes the manner in which radio waves interact with copper, making it appear as if it was made of another substance. This discovery can find applications in defense, by cloaking aircraft or submarines, and making them appear as objects with another shape and not made of metal--- flying birds in the sky instead of attacking planes or sharks under water instead of submarines, for instance.

10.20 Next Computer Revolution --- from Graphene?²⁹⁷

We have all heard of graphite. It comprises layers of carbon stacked together and arranged in a honeycomb pattern. If one peels off layers from it which are a few atoms thick, one obtains the material “graphene” that possesses remarkable properties. The 2010 Nobel Prize for Physics was awarded to Andre Geim and Konstantin Novoselov for their groundbreaking work on the two-dimensional structure of graphene. The material shows remarkable electron mobility, with the electrons being able to zip across the surface at dazzling speed. James Tour at Rice University in Houston, Texas and coworkers have now developed a way of etching these sheets of atoms, so that portions of the material with a single layer can be formed that behaves like a metal to perform the functions of a wire. If a portion of graphene is etched differently, a double layer is formed, which behaves as a semiconductor that can be transformed into a transistor.

Precise control in the manner the etching is carried out can thus lead to the development of super-fast computers of tomorrow.

10.21 Plastics --- from Bananas, Pineapples and Coconuts!²⁹⁸

Most plastics are normally made through polymerization reactions of certain chemicals that come from petroleum or natural gas. A group of researchers at Sao Paulo University in Brazil have now found that they can manufacture excellent plastic materials starting from pineapple leaves and stems, banana plants and coconut fibers. A special type of material, nano-cellulose, is prepared from these sources, a pound of which can be used to prepare a hundred pounds of reinforced plastic. The resulting material is expected to be used in manufacture of plastics used in the automobile industry.

Driving a car while sitting on a car seat made of bananas and pineapples? Why not? --- After all this is the wondrous world of science!

10.22 Building Materials from Green House Gas!²⁹⁹

The carbon dioxide emitted from burning of fossil fuels, particularly in industrial plants, is adding to the increasing threat of global warming. The use of scrubbers in such plants can remove the carbon dioxide but the resulting liquid must then be processed to remove the carbon dioxide from it, which is then compressed and stored. However, the process is expensive and industries are reluctant to bear this additional expenditure. Now, students at Michigan Technological University in USA have developed a process that captures the carbon dioxide from chimney stacks and converts it into a solid that can be used as a building material. This will allow industrialists to have a value-added by-product which they can sell and recover the investment made in the process.

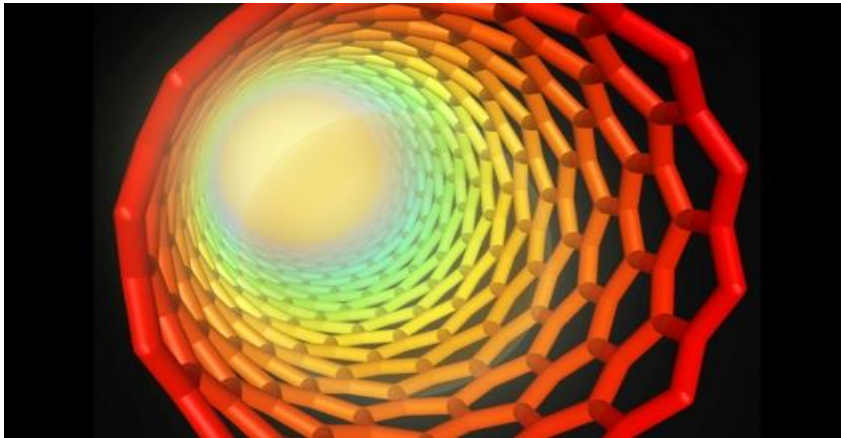
10.23 Colour Changing Smart Materials!³⁰⁰

Certain fishes, reptiles, amphibians and squids have the remarkable property of changing their colours. They can make the colours of their skin light or dark, or completely change their colour according to their environment. Pulsating bands of colour can also often run across their skins, creating a fascinating picture. This is achieved by them through contraction of muscles in unison that in turn affect certain special cells ("chromatophores"). These cells contain granules of pigments. When the cells contract, these pigment-containing cells expand, and the colour that they contain becomes the dominant visible colour. In the case of zebra fish, a different mechanism is employed. They have similar cells that contain reservoirs of liquid colour. When they contract their muscles, this liquid colour runs across underneath the skin, spreading like coloured ink. Now, scientists at the University of Bristol in UK are designing smart materials that can change colour just like these fishes and reptiles. They have used soft stretchable electrically activated polymers ("dielectric elastomers") to achieve the same effects. On application of an electric current, the elastomeric materials can expand, and create effects of changing colours, just like the

expansion of the pigment-containing sacs in reptiles and fishes. By controlling the pigments and electrical currents, various shades of fabrics made from these materials can be created. So in tomorrow's parties, you may be able to change the colour of your shirt by pressing a button!

10.24 Electricity Generating Carbon Sheets!³⁰¹

Graphene comprises one-atom thick sheets of carbon atoms in which the atoms are arranged in hexagonal honeycomb patterns. It is the thinnest and strongest material known with excellent heat and electricity conducting properties. Andre Geim and Konstantin Novoselov at the University of Manchester were awarded the Nobel Prize in Physics for 2010 for their groundbreaking experiments on graphene. It has already found wide applications ranging from corrosion coatings to transistors and super-capacitors.



10.24 power generation from carbon sheets. Scientists have discovered that a moving pulse of heat traveling along the miniscule wires known as carbon nanotubes can cause powerful waves of energy. These "thermopower waves" can drive electrons along like a collection of flotsam propelled along the surface of ocean waves, creating an electrical current. The previously unknown phenomenon opens up a new area of energy research and could lead to a new way of producing electricity. Reproduced with thanks from, <http://www.gizmag.com/carbon-nanotubes-thermopower-waves-electricity/14442/>

Now Reed and Mitchell Ong working at Stanford University have shown that graphene can actually generate electricity if it is subjected to mechanical stress. It can also change shape when an electric current is passed through it (i.e. it can behave as a “piezoelectric” material). This property was incorporated by introducing atoms of different elements such as hydrogen, lithium, potassium and fluorine on one the flat carbon sheets. This opens up a host of new applications in the field of acoustics, photonics, electronics and energy harvesting devices.

10.25 Exciting Advances in Wonder Material Manufacture: Graphene!³⁰²

Have you seen a bee hive --- how it is made of hexagons fused together, with little compartments, inside which bees store food and live. Now, think of an ultra-thin flat sheet having a similar shape of fused six-membered rings made of carbon. An exciting new material developed in recent years, “graphene”, comprises such a honeycomb structure of single carbon atoms. Graphene was discovered in 2004 by Andre Geim and Konstantin Novoselov who were awarded the Nobel Prize in Physics for 2010 for this work. The material is beginning to find wide applications in transistors, capacitors, batteries and computer chips. The layers of graphene are so thin that if 3 million sheets are stacked one on top of the other, they would have a thickness of only one millimeter! Graphene is usually prepared by vapor deposition but in order to make the best performing material, a challenge is to obtain uniform thickness. Now a team of scientists led by Ivan Vlassiouk at the U.S. Department of Energy's Oak Ridge National Laboratory, and Sergei Smirnov at New Mexico State University have developed a new approach involving the use of hydrogen gas in the vapor deposition process. The result was the formation of sheets of graphene of uniform thickness which could be used for production of high quality electronic components.

The discoverers of graphene at the University of Manchester, Madrid and Moscow reported in July 2011 that electron-electron interactions with graphene, can considerably enhance the

velocities of the electrons (*Nature Physics*, 2011; doi:10.1038/nphys2049). This opens up a whole new world of electronics and can lead to the development of ultra-fast transistors and super detectors.

10.26 Gold Coated Fibres – for Gold Fabrics!³⁰³

A Swiss company has developed a plasma coating machine that can put a fine layer of gold on silk thread. A piece of gold is bombarded with a stream of fast moving ions of argon. This results in atoms of gold being dislodged from the metal and these are then coated on a thread of silk passing slowly nearby in the machine. This gold coated silk can then be used to weave beautiful silk ties. The plasma coating process of the silk thread is such that the gold does not come off during subsequent washing. There is however one snag--- the cost of the fabric made from it. Each tie will carry 8 grams of gold and will be marketed at a price of about \$8,500!

10.27 New Mosquito Resistant Clothing!³⁰⁴

According to WHO, some 200 million people suffer from malaria each year. It caused about 655,000 deaths in 2010, though the actual number may be much higher as many deaths are often unrecorded. Children below the age of five are the most vulnerable. Most of the cases of severe disease are caused by the mosquito *Plasmodium falciparum*, though four other mosquito species are also known to cause milder forms of malaria. The disease is widespread in sub-Saharan Africa, Asia and the Americas, particularly in the tropical and subtropical regions near the equator where high humidity, warm temperatures, constant rainfall and stagnant waters provide ideal breeding grounds for mosquito larvae. The development of resistance to most drugs has further aggravated the problem. A number of sprays and lotions have been developed that repel mosquitoes and mosquito repellent bed nets are commonly used.

Now, a company in Portugal, "Nanolabel", has invented a new treatment for clothing that it claims to be much superior to existing repellents. The process involves the use of nanotechnology. Clothes are impregnated with amorphous silica (sand) nanoparticles that have a chemical repellent embedded within their core. The exact nature of this repellent is being kept a closely guarded secret. The work was carried out at the Institute of Hygiene and Tropical Medicine in Lisbon.

10.28 Next Generation Robotic Suits!³⁰⁵

US soldiers now have access to special suits that give them super-human strength and speed. This is the result of a decade long effort by a US Defense agency, DARPA, that funded a \$ 50 million project about a decade ago. The project, entitled "Exoskeletons for Human Performance Augmentation" was designed to develop various types of exoskeletons that could be worn by soldiers in order to give them strength and speed as well as allow them to carry large quantities of arms and ammunitions and other heavy objects for long periods of time without tiring. The Wearable Energetically Autonomous Robot (WEAR) from SARCOS Research Corporation was one of the successful products resulting from this research. The suits will now be powered using fuel cells that will add to their utility.

Another interesting development has been the Springtail Exoskeleton Flying Vehicle, built by Trek Aerospace. This has a range of 125 miles, a cruising speed of 70 knots and the ability to hover dead still at altitudes of up to 8000 meters. These flying suits, that can be worn individually by soldiers and allow them to fly to battle, are under development by Trek Aerospace with funding from the US defense agency, DARPA.

10.29 No More Flat Tires!³⁰⁶

At the Tokyo Motor Show in Japan held recently, Bridgestone displayed novel tires that are solid and consequently cannot



10.27 Mosquito repellent dress. Reproduced with thanks from, <http://www.mosquitoreviews.com/mosquito-clothes.html>



10.28 Exoskeleton for human performance augmentation. Reproduced with thanks from, http://www.signomotus.it/en/research/body_ext_en.php

develop a puncture. The 9 inch wheels have no air in them but have thermoplastic-resin spokes that extend from the rim to the tread. The material from which the tires are made can be recycled. Earlier in 2006, the French company had developed its “Tweel” technology that was used to make airless tires. Later, Resilient Technologies LLC based in Wisconsin was funded under a Department of Defense (USA) contract to develop tires that could not be punctured. The US army was interested because its heavy military vehicles, such as Humvees, could be immobilized in the battlefield by explosive devices. The company developed a tire with a honeycomb internal structure that could not be punctured. Now Bridgestone too has entered the fray!

10.30 Reusable Sticking Tape --- learning from Lizards!³⁰⁷

Have you seen how insects and lizards can climb up walls as well as slither on the roof of your room upside down without falling off? What gives them this remarkable ability? They have thousands of tiny hairs (“setae”) on their feet and legs. As these large numbers of hairs simultaneously touch the surface of the wall or the roof, the additive effect of the weak attractive forces (Van der Waal’s attractions) creates a significant sticking force that allows these insects and lizards to climb up vertical walls or travel upside down on the bottom of a roof with ease.

Now, scientists at the Zoological Institute at the University of Kiel in Germany have developed a new type of adhesive learning from these gravity defying lizards and insects. The new silicone tape invented by them has a large number of tiny hairs on its surface, just as on the legs and feet of insects and lizards. The new tape does not use any kind of sticking glue, but it sticks far more strongly than standard adhesives. It can be reused thousands of times, and it also sticks strongly when used under water.

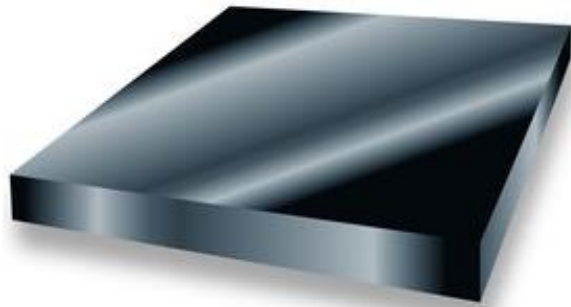
10.31 Smart Fabrics!³⁰⁸

Could mobile telephones or other electronic devices be made of paper or fabrics? A new recent discovery has made this

possible. Scientists at the North Carolina University in USA have found that it is possible to deposit conductive nanocoatings on paper or textiles. Such materials can then be used in all sorts of electronic devices. The coatings are thousands of times thinner than a human hair, and are made up of the same inorganic materials that are used in electronic sensors, solar cells and microelectronics. They can be coated on paper, woven cotton or on non-woven polypropylene materials that are commonly used for making grocery bags.



10.29 Airless tires. Reproduced with thanks from, http://en.wikipedia.org/wiki/Airless_tire



10.32 Harder carbon. Reproduced with thanks from, <http://www.2spi.com/catalog/mounts/vitreous.php>

This is opening up new possibilities to manufacture “communication clothing” and smart fabrics are being developed. Thus researchers at Iowa State University have used photovoltaic textiles to develop a tie made of solar cells that will charge a mobile phone. Similarly, Bluetooth iJackets have been developed by a company, Zegna Sport. It will allow the wearer of the jacket to listen to an iPod and use a cell phone simultaneously through a controller embedded in the sleeve. Such intelligent clothing is strong, water proof and smart.

10.32 Super Hard Form of Carbon Discovered⁶⁰⁹

We are all familiar with carbon. Coal is a common form, as is graphite. Ladies often swoon over diamonds which are crystalline and the hardest form of carbon known. Another exciting form of carbon, graphene, was discovered in 2004. Its two dimensional layer of carbons is revolutionising the electronics industry, and is beginning to find use in flexible touch displays, lighter aircraft, cheaper batteries and small and fast electronic devices. Scientists have now been able to make a new super hard form of carbon that can stand extreme stresses. This was previously possible only with diamonds, (as is evident from the glass cutting pens that have a diamond tip, and can easily cut glass without being affected themselves). Diamonds also find many industrial uses because of their hardness and other properties.

The new form of super hard carbon was prepared by scientists at Stanford University and the Carnegie Institute of Science. They took “glassy carbon” and exposed it to very high pressures. Glassy carbon has been known for the last 60 years ---- it combined the properties of glass with ceramics and graphite (high temperature resistance, hardness, low density etc.). The new form of super hard carbon is amorphous (in contrast to diamonds that are crystalline). The strength of diamonds depends on the direction in which the crystals grow. The new form of hard carbon may therefore have significant advantages over diamonds as it will have strength in all directions. The super hard nature of the new material is likely to lead to a host of new materials with applications in industry.

10.33 *Thermoelectric Fabrics*^{β10}

A new thermoelectric material, named "Power Felt" was created by a team of researchers at North Carolina's Wake Forest University. The material has the amazing property to utilise the temperature difference between the inner side of the fabric and its outer surface. The inner surface is warmer because it is heated by body heat, while its exterior surface is cooled by the wind. This temperature difference is utilised to produce electricity. The novel fabric can be used for a number of devices that need power to operate. A mobile phone cover could keep the phone on permanently being provided with power without connecting it into an electrical socket. It could also be used to have housings made of it that can power flashlights. It could even be used to power electrical devices in your car if your warm butt is covered with it! Efforts are under way to make a thinner fabric using carbon nanotube technology.



10.35a Beyond meat. Reproduced with thanks from, <http://www.yumsugar.com/Vegetarian-Chicken-Substitute-30502838>

10.34 Undetectable to Eyes --- Now to Ears!^{β11}

An exciting new branch of science, “metamaterials”, has evolved rapidly in the last few years. These materials have the remarkable ability to bend light around them, so that objects coated with them are invisible to the naked eye as well as to infrared and other viewing devices. The persons looking at such objects can therefore see only what lies behind such objects. Scientists at Germany's Karlsruhe Institute of Technology have now succeeded in using the same principles for developing regions from which sounds cannot be detected --- cones of silence.

The “invisibility cloaks” being developed will help in providing camouflage to tanks, airplanes and submarines. Research in this area is therefore being intensively funded by US and other defense agencies.

There have been exciting developments in the field of new materials. Intelligent materials have been developed that remember their shapes and revert to them when distorted. Nano-cellulose has been found to be bullet proof, and may be employed in making bullet proof jackets.

10.35 Vegetable Products that Taste Like Meat!^{β12}

Ethan Brown, a US entrepreneur, along with Fu-hung Hsieh and Harold Huff at the University of Missouri has developed plant based proteins that look, feel and taste like chicken meat. The product known as "Beyond Meat" is manufactured using different plant ingredients such as soy, peas, carrots and gluten-free flour. The heating and cooling processes employed finally lead to the finished product that looks and tastes like strips of chicken meat.

About 18% of greenhouse gases are caused by animal food products, and about 50 billion land animals are slaughtered each year to end up on our dinner plates. The vegetable substitutes to meat would therefore address this environmental concern.



10.35b Vegetable Products that Taste Like Meat. Reproduced with thanks from: <http://www.kpcb.com/news/beyond-meat-completes-largest-financing-round-to-date>



10.35c Vegetable Products that Taste Like Meat. Reproduced with thanks from: <https://foodadventureswithlana.wordpress.com/2013/01/>

11. PHYSICS

11.1 Search for the “God Particle”¹³

Physicists are carrying out a fascinating experiment in a tunnel near Geneva to detect a predicted (but not yet discovered) particle. A huge ring shaped particle accelerator, the Large Hadron Collider (LHC), has been built by the European Organization for Nuclear Research (CERN). The accelerator lies between 170 ft to 600 ft below ground, has a circumference of 17 miles, and has 9,300 superconducting magnets cooled with liquid helium to a temperature of -271.3°C , just about 2°C above the absolute zero. This array of magnets accelerates the two streams of protons in opposite directions to a speed very close to the speed of light (99.999996% of the speed of light!). This is the most expensive single machine ever built by man, costing US\$ 8 billion contributed by 26 countries. Some 5000 scientists and engineers from many countries have been involved in its construction and operation.

When the two streams of protons collide at these huge speeds, the new particles formed will be detected. It is hoped that conditions that existed at the birth of the universe – a fraction of a second after the Big Bang – will thus be recreated. One of the most sought after particles in this experiment is the Higgs Boson, also known as the “God particle” because it is thought to be the godfather of all other particles, responsible for endowing them with weight, or mass. Only 4% of the universe is visible. The rest is contributed by the mysterious forces of dark matter (22% of its mass) and dark energy (about 74% of its mass-energy). The results of the LHC experiments, hopefully, should shed light on some of the basic building blocks of matter.

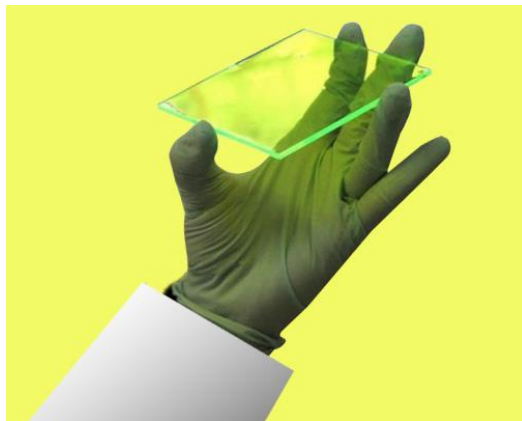
The results of the first collisions should be obtained later this year, and the hitherto elusive “unification theory” --- a theory that explains all the fundamental interactions in our universe-- may finally materialize. A new era in physics may be about to begin.

11.2 Are We All Made up of Tiny Strings?³¹⁴

Arguably the two greatest breakthroughs in physics were quantum mechanics and Einstein's theory of general relativity. Quantum mechanics tells us about the fuzziness of nature on the atomic scale while Einstein's theory of general relativity addresses the physics involved at the macro level (such as planetary motions, gravitation etc). However while quantum



11.4a Turning Glass Windows into Solar Panels. Reproduced with thanks from: <http://www.extremetech.com/extreme/188667-a-fully-transparent-solar-cell-that-could-make-every-window-and-screen-a-power-source>



11.4b Turning Glass Windows into Solar Panels. Reproduced with thanks from: <http://inhabitat.com/colored-solar-panels-dont-need-direct-sunlight/>

mechanics works well at the atomic level, it cannot be applied at the macro level. Similarly, Einstein's theory of general relativity cannot be applied at the atomic level, clearly emphasizing the need to have a unifying theory – a “theory of everything”. To unify these two great frontiers of physics, Ed Whitten from USA proposed that the smallest building blocks of matter may not be atoms but much smaller loops or strings which vibrate in a space with 10 or 11 dimensions. We may therefore be made up of tiny dancing strings ---- difficult, if not impossible, to prove!

11.3 Faster than Light?³¹⁵

Swiss physicists have carried out a fascinating experiment that may open up exotic possibilities of teleportation (have you seen Star Trek?). A pair of photons was sent on fiber-optic cables to two villages on two opposite sides of Geneva, one to each village. When one photon was measured on its arrival, the other was instantaneously affected, although they were 11 miles apart. This spooky phenomenon of “quantum entanglement” has never been observed before at such large distances, though it has been recognized for a long time. If one assumes that one photon sent an ultra-fast signal to its partner, then that signal would have had to travel at 10,000 times the speed of light, impossible according to modern concepts of physics. The physics behind these “ghostly” interactions at long distances is not well understood.

11.4 Turning Glass Windows into Solar Panels!³¹⁶

A Norwegian company Ensol, in collaboration with the Department of Physics and Astronomy at the University of Leicester in the UK, has developed an exciting new thin film solar cell technology that allows the solar cells to be sprayed onto glass or other surfaces. Glass windows and even walls or roof tiles are then transformed into electricity generators, and provide the power required in the building. As the material sprayed is transparent, the glass windows only develop a slight tint after spraying. The film comprises metal nanoparticles embedded in a transparent composite matrix. It is

expected that the material will develop the same level of efficiency (about 20%) as of standard solar cells but will be much cheaper to produce and more convenient to use.

Another competing technology recently developed by Kyosemi Corporation involves the use of Sphelar solar cells that can also be used in windows. These were demonstrated at the PV Expo 2010 conference in Tokyo earlier this year. They comprise solidified silicon drops that are embedded into glass and can collect light from any direction as well as from both sides of the glass, thereby making them highly efficient for energy production. These Sphelar cells can also be embedded into flexible materials, thus allowing dome shaped surfaces to be produced.

12. SCIENCE POLICY

12.1 Ushering a 'Silent Revolution' Making Great Strides³¹⁷

Pakistan has made remarkable progress during the period 2002-2013 in higher education which has directly impacted scientific research. The increase in scientific research output is nothing short of spectacular—600 per cent increase in scientific publications in international journals (Fig.1 below) and a similar increase in citations (the number of times the work of Pakistani scientists is cited by others in their references) in the same period (Fig.2 below).

There is no other country in the world that can boast of such rapid changes in such a short period of five years. Indeed, Pakistan has won four prestigious international awards in recognition of the rapid transformation in the higher education sector. Not a single Pakistani university could be ranked among the top 600 of the world during the 57-year period from 1947 to 2003. Today, five of our universities are ranked among the top 600. National University of Science and Technology, NUST is ranked at 350 in the overall world university rankings (Times UK Higher Education rankings, November 2009). In the disciplinary rankings, University of Karachi is ranked at 223 in the world, NUST at 260 and Quaid-e-Azam University at 270 in the field of Natural Sciences. This is no ordinary achievement after decades of stagnation.

The major landmarks achieved have been:

- a) Establishment of a Digital Library in Pakistan which is regarded as one of the best digital libraries anywhere in the world: Every student in every public sector university today has access to 45,000 textbooks and research monographs from 220 international publishers as well as to 25,000 international research journals completely free of charge. The books are keyword searchable and downloadable.
- b) The Pakistan Educational Research Network (PERN) provides high speed internet access to all universities. It is being upgraded to PERN-2 that provides 1GB

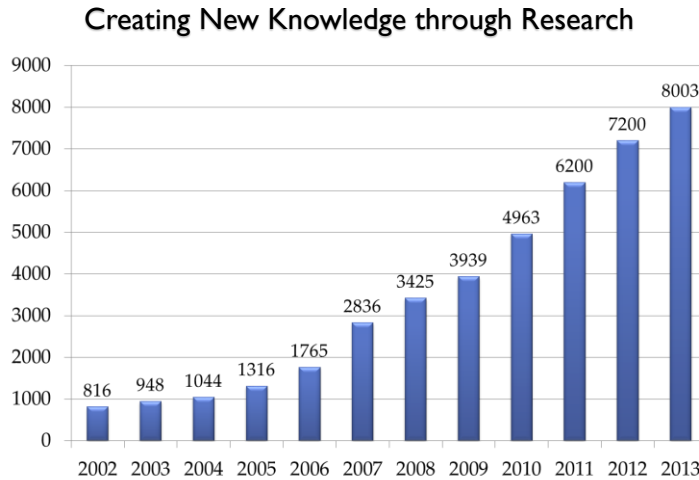


Fig.1 : The graph shows the phenomenal increase in internationally abstracted research publications in Pakistan during last 6 years. The data is taken from Institute of Scientific Information, Philadelphia, USA

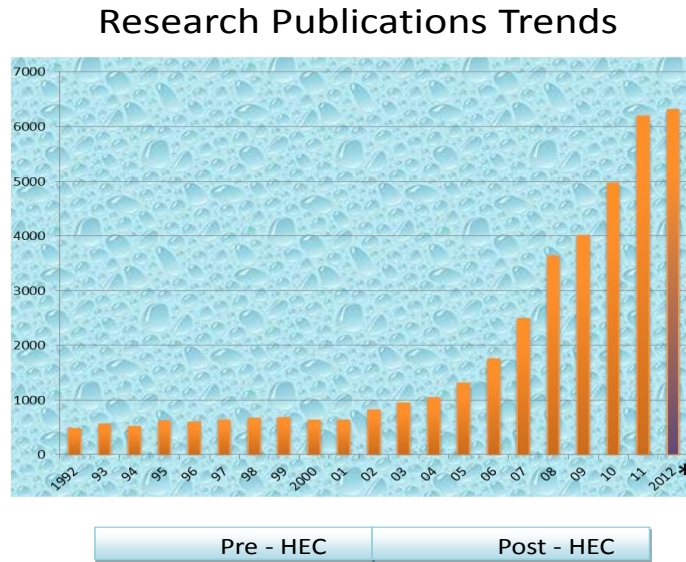


Fig.2 : The graph shows the rapid increase in international citations of publications of Pakistani researchers during the last 6 years. The data shown is for 3 year periods for each year, so that a meaningful comparison can be made. The data for 2008 is estimated for the third year (2010) based on the trend.

connectivity to each university and 10GB connectivity to loops around major cities. This became possible because there was an explosive growth of internet in Pakistan during 2001-2002—internet spread from only 29 cities to over 1,000 cities and towns during this short period.

- c) University enrolment has tripled—it had reached to only 135,000 during the 56-year period from 1947 to 2003 but in the subsequent five-year period from 2004 to 2008, it increased to about 400,000.
- d) There were only 59 universities and degree awarding institutes in the year 2001 in Pakistan. These grew to 127 such institutions by 2008. Eighteen new campuses of existing universities were also established in remote localities to provide opportunities for higher education to deprived areas.
- e) About 5,000 PhD level scholarships were awarded for study in technologically advanced countries (largest programme ever in the developing world) with about 10 million rupees being spent on each student. Some 3,000 indigenous PhD scholarships were also awarded.
- f) The world's largest Fulbright Scholarship programme (US\$150 million) was launched with joint funding (HEC/USAID) to send 640 students to Ivy League universities in the US.
- g) Pakistan's first educational satellite (PakSat-1) was placed in space in 2001. The educational channels of the Virtual University and most of Pakistan's commercial channels operate on it. The distance learning programmes utilising it have resulted in increase in enrolment from only 89,000 in 2001 to 560,000 by 2008.
- h) Four-year undergraduate programme (18 years for M.A/M.Sc.) was introduced so that our degrees could be

internationally recognised, whereas previously there was only a two-year undergraduate programme.

- i) A number of steps were taken to enforce quality and improve governance. For the first time in the history of Pakistan, plagiarism that had been rampant in universities was checked by the introduction of software that could detect cheating if the research publications or thesis had been copied from any other published source.
- j) Powers were taken away from the President of Pakistan and the Governors to appoint Vice Chancellors arbitrarily. Vice-chancellors can now be appointed by them only from one of three persons nominated by a Committee of eminent scholars.
- k) The quality of PhD degrees being awarded in Pakistan was strengthened by making it mandatory that they be evaluated by at least two foreign experts from technologically advanced countries.
- l) The promotion criteria for the faculty were toughened to ensure that only the best could be promoted to higher positions.
- m) A new tenure track system was introduced that raised the salaries of Professors in universities to an amount Rs325,000 per month and the tax rate reduced from 35 percent to only five per cent so that the salary levels rose to an amount equivalent to Rs450,000 per month after considering the tax concessions. The appointments at this higher salary level were linked to positive international evaluations, first after three years and then after six years by an international panel of experts, with the result that only about six percent of the 17,000 faculty members could cross this tough barrier.
- n) Quality Assurance cells were set up in the university so that universities could have their own peer review of the

processes, and regular external peer reviews were also initiated.

- o) A strict monitoring system of all university projects was introduced to ensure that the funds were properly spent. All accounts of HEC were audited by international auditors in addition to government auditors.

International praise

The tremendous growth that occurred in the research output from Pakistan and the uplifting of our universities was recognised and applauded at international levels. Pakistan's programme is now regarded as a model to be followed by developing countries. Indeed, these phenomenal developments have been described as a 'Silent Revolution' by the World Bank in a comprehensive report. A number of editorials and articles have appeared in the world's leading science journal, *Nature* about this transformation. In its Editorial of 27th November 2007 entitled "The Paradox of Pakistan" (*Nature* 450, 585 (29 November 2007) | doi: 10.1038/450585a) it commented about the two contrasting faces of the country—on the one hand, it was a military dictatorship with its associated problems and on the other hand, it had implemented such a dynamic programme in the higher education sector.

An independent senior US educational expert Prof. Fred Hayward after careful analysis of this sector on behalf of USAID wrote: (*Number 54, winter 2009, Source: International Higher Education Quarterly*):

"Since 2002, a number of extraordinary changes have taken place. The Higher Education Commission instituted major upgrades for laboratories and information and communications technology, rehabilitation of facilities, expansion of research support, and development of one of the best digital libraries in the region. Its successes have been remarkable---. Quality had increased significantly, and several institutions were on their way to becoming world-class institutions." (http://www.bc.edu/bc_org/avp/soe/ci/hel/newsletter/Number54/p19_Hayward.htm)

Another educational expert, Prof. Wolfgang Voelter of Tübingen University, who has earlier been conferred two Civil Awards from

the government of Pakistan for his contributions to the development of science in this country, paid glowing tributes to the reforms undertaken by the Higher Education Commission in an article in Dawn on November 28, 2008 under the heading *The Golden Period*. He states:

“A miracle happened. The scenario of education, science and technology in Pakistan changed dramatically as never before in the history of Pakistan. The chairperson of the Senate Standing Committee on Education recently announced it as “Pakistan's golden period in higher education.” Unquote. (http://epaper.dawn.com/artMailDisp.aspx?article=23_11_20_08_123_003&typ=0)

Prof. Michael Rode, Former Chairman of the United Nations Commission on Science, Technology and Development and presently heading a Network of European and Asian Universities (ASIA-UNINET) wrote: ***“The progress made was breath-taking and has put Pakistan ahead of comparable countries in numerous aspects.---The United Nations Commission on Science and Technology has closely monitored the development in Pakistan in the past years, coming to the unanimous conclusion that (the) policy and programme is a ‘best-practice’ example for developing countries aiming at building their human resources and establishing an innovative, technology-based economy.”*** Unquote. (<http://dildilpakistan.wordpress.com/tag/dr-atta-ur-rehman/>)

Conclusion:

Pakistan has won four prestigious international awards for the revolutionary changes in the higher education sector brought about by the Higher Education Commission. These include the TWAS (Academy of Sciences for the Developing World, Italy) Award for Institutional Development at the 11th General Conference of TWAS in Durban, South Africa in October 2009, the Austrian high civil award *Grosse Goldene Ehrenzeischen am Bande* (2007), the Fellowship of Royal Society (London) (2006) and Honorary Life Fellowship of Kings College, Cambridge

University (2007) conferred on former Chairman Higher Education Commission. This progress became possible because the government of Pakistan was persuaded to make a 2400 percent increase in the development grant for universities, following an earlier 6,000 percent increase in the development grant of the Ministry of Science and Technology.

Our universities still have a long way to go before they can be ranked among the top 100 in the world, but they have made rapid progress and this needs to be sustained and magnified. In this knowledge driven world, only those nations are able to progress that invest in high quality education, science, technology and innovation.

12.2 The Science of Socio-economic Development --- the Four Pillars³¹⁸

We live in a world in which knowledge has become the key driver for socio-economic development. Natural resources such as oil, gas, minerals, etc. have diminishing importance. The four pillars needed for progress today are knowledge, technology, innovation and, perhaps most important of all, an honest, visionary and technologically competent leadership that recognises the key role of high technology exports in alleviating poverty and rapidly transforming a nation.

The first pillar, knowledge, can be subdivided into four critical sub-components that must all come together to make a coherent whole. These are compulsory primary education for all, and high quality secondary, technical and university education compatible with the best international standards. To make this happen, the emphasis must be to attract the brightest and highly qualified professionals into the teaching profession. This will need to be coupled with a central single world class examination system.

The second pillar is technology. After 20 years, will we be world leaders in building ships, or manufacturing of pharmaceuticals, or designing and manufacturing of computer chips? What are the niche opportunities in which we should focus our efforts? A “technology foresight” process involving

intensive consultations with technical experts in various disciplines, industry leaders, and economists allows the identification of key projects that can change the fate of a country. Finland, with a population less than a quarter of that of Karachi, identified telecommunications and agro-forestry through such an exercise about 20 years ago. Today, just one company, Nokia, from this tiny country has exports of about \$40 billion, more than double the total exports of Pakistan! A similar exercise has already been conducted in Pakistan under my leadership during 2004-2006 and the roadmap approved by the Cabinet on 1st August 2007. However, it remains unimplemented. The document entitled "*Technology-Based Industrial Vision and Strategy for Pakistan's Socio-Economic Development*" is available at www.comstech.org. The human resource development efforts in our universities and colleges are tailored to such a roadmap so that Pakistan can begin to manufacture and export high technology (and hence high value added) products. We need to further strengthen our centres of excellence in selected disciplines to provide the needed research inputs for new technology development. High quality technical colleges with internationally recognised degrees and diplomas are urgently required to produce professional workers with the requisite skills needed by our industry. To produce industrial products conforming to world standards, there must be training programs and implementation systems so that our products are all manufactured to certain minimum quality standards. This system, known as MSTQ (Metrology, Standards, Testing and Quality) is vitally important for our exports to be internationally accepted.

The third pillar is innovation. It is only when entrepreneurship can thrive that a nation can move forward rapidly. This requires a number of measures to be taken: (1) a strong Intellectual Property Rights regime to protect the discoveries made by our scientists and engineers, (2) establishment of a network of Technology Parks where new ideas can be developed into products and processes. Good examples to emulate are the Ishfahan Technology Town in Ishfahan, Iran and the Middle East University Technology Park in Ankara,

Turkey.(3) access to a major Venture Capital Fund which can be used to develop good ideas into products, (4) incentivisation mechanisms to promote private sector R&D so that most national R&D is carried out largely in private industrial companies so that it has commercial orientation and focus, (5) establishment of industrial clusters in electronics, engineering goods, pharmaceuticals, sports goods, textiles etc., with all relevant facilities such as built-up space and uninterrupted services so that an industrialist can start manufacture within 48 hours, (6) ease of starting new businesses so that a new company can be registered within 2 hours rather than several weeks.

The fourth and most important pillar is that of an honest, educated, enlightened and technologically competent leadership that understands what it takes to transition to a knowledge economy. In China, many cabinet members are eminent scientists and engineers. In Korea, it is the same with the Minister of Education, Science & Technology having the status of a Deputy Prime Minister.

Pakistan is blessed with a vast young population----about 90 million out of a population of 170 million are below the age of 19. We need to educate them properly in the right fields and Pakistan can prosper. If we don't, darkness lies ahead. This requires political will -- the nation must decide that henceforth we will starve, if necessary, but divert all resources, at least 10% of our GDP, to education. Malaysia has been spending 25% of its budget for the last 30 years on education, and as a result its exports are \$155 billion annually as compared to ours being only \$19 billion---why can't we?

12.3 Race for Science & Technology Domination!³¹⁹

We live in a strange and wondrous world of science --- a world in which the total quantum of knowledge that man has acquired since he has been on planet earth will double itself over the next eight years! It is a world in which 90% of scientists who have ever lived on planet earth are alive today!

These are mind boggling statistics, and reflect the explosive growth in knowledge during the last 5-10 decades.

There is a definite shift of capabilities of new knowledge generation from the West to the East, particularly to China and India. Huge young populations in these two countries are being trained in hundreds of thousands and their impact has already been felt in the process of socio-economic development, with sustained GDP growth rates of between 7-10% annually. China's student population was only 5 million nine years ago but it has been rapidly expanded to 25 million. Out of 1700 higher education institutions, about 100 have been given an elite status under "Project 211", and they produce 80% of China's PhD students, 70% of its graduate students and a third of its undergraduate students. Just one of its universities, Tsinghua, produces a thousand high quality PhDs annually, about double the PhD output of all Pakistan's 130 public and private sector universities taken together! The research output of China increased from 20,000 research papers in 1998 to 120,000 by 2009, second only to USA.

Pakistan succeeded in achieving stunning progress in its higher education sector during 2002-2009 under the newly established and autonomous Higher Education Commission that reported directly to the Prime Minister. Its programmes resulted in spectacular progress ---- tripling of enrolment in universities (from 135,000 in 2002 to about 400,000 in 2009), more than doubling of the number of its universities (59 to 127 in same period) a 600% increase in research publications in international journals and a 1000% increase in citations! Five universities of Pakistan are now ranked among the top 600 of the world (Higher Education Times UK rankings, November 2009). In Natural Sciences, Karachi University is ranked among the top 223 in the world, mainly due to the remarkable research output of its International Centre of Chemical and Biological Sciences which won the Prize of Islamic Development Bank, Jeddah for the best science institution in the Islamic World, and became the first institution to have ever won this prestigious Prize twice. The National University of Science & Technology, Islamabad is ranked at No. 260 in the world in natural sciences while Quaid-e-Azam University

Islamabad is ranked at No. 270 in the world in natural sciences. It is no mean accomplishment to reach these highly respectable international rankings after decades of stagnation. A number of neutral international authorities have showered Pakistan with praises of what it was able to accomplish in a short period of 6-7 years (Prof. Wolfgang Voelter, Tubingen, Germany

(http://epaper.dawn.com/artMailDisp.aspx?article=23_11_2008_123_003&typ=0), Prof. Michael Rode, former Chairman of United Nations Commission on Science and Technology (<http://dildipakistan.wordpress.com/2008/10/29/letter-from-chairman-european-coordinator-of-asea-uninet-published-in-dawn-today/>), and an independent US expert Prof. Fred Hayward,

(<http://educationdev.net/educationdev/fe/Article.aspx?Aid=84>)

Following a presentation made to the Prime Minister of India by India's leading scientist and Adviser to the Indian Prime Minister, Prof. C.N.R. Rao, about the rapid advances that Pakistan was making under the newly established Higher Education Commission (see article published in Hindustan Times entitled "Pak Threat to Indian Science" dated 23rd July 2006 by Neha Mehta), India decided to undertake sweeping reforms of its higher education system. It is establishing eight new IITs, thereby more than doubling the number of these world class institutions from the present seven to fifteen. It will also establish five new Indian Institutes of Science, Education and Research, seven new Indian Institutes of Management and 20 new Indian Institutes of Indian Institutes of Information Technology, thereby doubling the number of its top-tier institutions. Following Pakistan's footsteps, hefty salary increases have been given, tripling the salaries of many professors. Pakistan on the other hand has had a major setback after its "golden period" in higher education, with the new government giving a very low priority to education, and spending only 1.6% of its GNP on this vitally important sector. Pakistan was sending about a thousand of its top students for PhD to leading foreign universities each year but has succeeded in sending only a few dozen in the current financial year, indicating the growing crisis in this sector. All the good

work done in the last few years will be undone if the Higher Education Commission is not fully supported.

Will our new highly educated Finance Minister honour the commitment made by his Prime Minister Mr. Gilani in the Parliament to allocate at least 4% of our GNP to education?

12.4 Invest in Science---or Accept Slavery!³²⁰

Natural resources such as oil, minerals and gold have lost their importance and knowledge has become the key driver for socio-economic development. Nations which have realized that their real wealth lies in their children and have had the foresight to invest massively in quality education are progressing rapidly, leaving others behind. Just one world class institution can make a huge difference. From just one educational institution, the Massachusetts Institute of Technology in USA have sprung over 4000 new start-up companies with annual sales of over US\$ 230 billion ---- Pakistan, a country with a population of 170 million, has annual exports of only about US\$18 billion!

Pakistan embarked on a visionary program to uplift its higher education sector in 2002, and this has led to a tripling of university enrolment from only 135,000 in 2002 to about 400,000 presently in a short span of 6 years. The number of universities and degree awarding institutes grew from only 57 in the year 2000 to 127 in 2009. Five Pakistani universities were ranked in October 2009 among the top 600 of the world in the Times UK Higher Education rankings with the National University of Science & Technology (Islamabad) ranked at 350 overall and Karachi University ranked at 223 in the world in Natural Sciences. A 600% increase in research publications and a 1000 percent increase in citations have occurred in Pakistan. This led to three independent international agencies (World Bank, USAID and British Council) coming forward with detailed reviews praising the higher education reforms undertaken by Pakistan and the world's top international journal Nature writing several articles and editorials about the need to sustain and magnify them. An independent US educational consultant has written authoritatively about this

“silent revolution” in Pakistan--- readers should enjoy reading about something good happening in this country: (http://www.bc.edu/bc_org/avp/soe/cihe/newsletter/Number54/p19_Hayward.htm)

Something wonderful has begun to happen in Pakistan in an otherwise grim political and economic scenario. We must continue on this path of knowledge.

Malaysia has been spending 25% of its budget on education for the last 30 years --- Pakistan is spending only 1.4% of its GNP on education---when will the promise of allocation of 4% of GNP to education made by the Prime Minister a year ago materialize?

12.5 India Takes Giant Leaps in Science---Pakistan Slumbers!³²¹

Jawaharlal Nehru made science and higher education the central pillars of India’s development. Subsequent governments continued his visionary policies. The establishment of seven Indian Institutes of Technology (IITs) and Indian Institute of Science and massive funding of the science & technology programs have led to a huge GDP growth rate of India. There are some 400,000 engineering graduates being produced by India annually as compared to about 10,000 produced by Pakistan. The quality of engineering education in the IITs is superb. India has decided to set up eight additional IITs and six additional Indian Institutes of Science some of which have already started functioning. In January this year, an Indian spacecraft Chanrayaan-1 flew above the lunar surface, in preparation of a landing a man on the moon. The first manned space flight is expected to occur within 5 years, followed by a manned mission to the moon a few years later. The technologies that are being developed have far reaching implications both in industry and defense. India is already manufacturing an under US\$ 2,000 car (world’s cheapest automobile) and Tata has acquired the rights to manufacture a car which will run on air pressure. It has also

bought over Jaguar with all the accompanying sophisticated technologies.

In Pakistan a visionary program was initiated to establish world class engineering universities in partnership with China, Germany, Sweden and Austria. It would have brought together consortia of the top 30 European and Chinese engineering universities to provide high quality engineering education with degrees being given by leading foreign universities at affordable prices. Top European companies had agreed to establish Research and Development Centers in the Technology Parks located within each university and eventually over 60 such R & D Centers would have been established. Pakistan has not been able to establish a single international R & D Center since 1947. Alas! This program was suspended in 2008 and still remains frozen, in spite of being formally approved by ECNEC in February 2008 and by the present Prime Minister in May 2008. Wake up Pakistan!

12.6 US Appoints Science “Dream Team”!³²²

Convinced that economic revival lies in science, technology and innovation, President Obama has appointed top scientists in the country to lead the national science & technology programs and allocated huge funds for science and technology. This contrasts with the relatively low priority accorded to science by the previous US regime. The Nobel Laureate in Physics Stephen Chu has been appointed at the key executive position of Secretary of Energy with a US \$ 24 billion departmental budget. Obama has announced that out of the US \$ 787 billion stimulus package for the US economy, a huge amount of US \$ 120 billion will go to research and technology ventures.

12.7 Pakistan Floods ---- Can We Sue the West?³²³

There is growing scientific evidence that the devastating floods that Pakistan experienced were largely the effect of global

warming caused by the burning of fossil fuels, mainly by industrialized nations. Can we legally claim compensation for the huge devastation of properties and the crippling economic set back? Considering that about 20 million persons are affected, a claim of \$ 2,500 per person means a liability arising of the order of \$50 billion. A target for a lawsuit could be the oil companies that contribute to global warming through the oil that they produce. It is believed that higher sea-surface temperatures and large quantities of moist air above the Indian ocean were responsible for floods in Pakistan (as well as the heat wave in Russia), and it is now possible to estimate the extent of this contribution using modern computing and analysis techniques.

Precedence exists for such legal action. The victims of hurricane Katrina filed a lawsuit in 2005 against a group of oil companies, in which it was claimed that the oil companies contributed to the environmental conditions that led to strengthening of Katrina in the Gulf of Mexico. The case was dismissed in 2007 but then the decision was reversed on 18th November 2009 by Judge Stanwood Duval and compensation was awarded for \$700,000 to four persons who had filed the lawsuit. This paved the way for billions of dollars of lawsuits from other Katrina victims. In June this year, the Court of Appeals again dismissed the case because of insufficient judges needed for a quorum. So the fight goes on. UN has potentially hundreds of billions of dollars available in fund for assisting developing countries adapt to climate change. Pakistan can claim support from this fund.

Can developing countries such as Pakistan that have been devastated by floods have the tenacity and lobbying power to fight out a legal case against oil companies or claim compensation from the United Nations? To win a lawsuit, science must provide a convincing answer to the extent that global warming contributed to the floods in Pakistan. In a meeting held in Colorado recently, organized by US National Oceanic and Atmospheric Administration, UK Foreign and Commonwealth Office and UK Met Office's Hadley Centre the view was that it may now be scientifically possible to assign if a certain weather event (such as the flooding in Pakistan) was

due to climate changes triggered by global warming. The work of Allen Myles at the University of Oxford indicates that the science of climatology has evolved enough to make it possible. If that is so, then a lawsuit for compensation against damages can be filed.



12.7 Pakistan Floods ---- Can We Sue the West? Reproduced with thanks from: http://www.chapatimystery.com/archives/homistan/donate_for_pakistan_flood_2010.html

13. SPACE SCIENCE

13.1 *The Greatest Miracle of All!*³²⁴

What is the greatest miracle of all? We are! I am not referring just to the process of evolution, the creation of life and the billions of factors involved that must come together in mind-boggling precision and coordination for life to exist. I refer to an even more amazing process that most of us are unaware of ---- exploding stars and their intimate connection to us.

About 65% of our body is made up of oxygen and about 18% of carbon. The rest is nitrogen, and a large number of other elements in smaller quantities such as, phosphorus, iron, magnesium, calcium, etc. Where do all these atoms come from and how do they end up within us?

The process through which these atoms are created involves nuclear fusion---- the fusing of smaller atoms to give larger atoms. These fusion reactions occur in the centers of hot burning stars where the temperatures are millions of degrees centigrade, and there are huge gravitational forces that crunch atoms together to create conditions so that fusion can occur. These are nature's kilns---- super hot furnaces--- where the atoms are cooked together till they fuse into each other, creating the heavier elements.

The process of fusion leads to huge bursts of heat and light---- the thousands of stars that we can see lighting up our skies are due to the light emitted from them by fusion reactions. This is how our sun lights up our days and warms the earth, thereby sustaining life on it. Fusion of hydrogen atoms leads to helium and all other elements are the result of subsequent fusion reactions. The temperature of our sun at its core is about 15 million degrees Centigrade and it produces mainly helium from the fusion process. However, when stars are about 8 times the size of our sun, then the much higher gravitational forces with correspondingly greater "crunch power" result in the formation of some of the heavier elements such as carbon, nitrogen and other elements up to iron. To produce even heavier elements such as nickel, gold, uranium requires fusion to occur at much higher energies. This happens when stars collapse (implode) and then finally explode in a huge burst of light and energy, with the emission of radiation---the supernova.

The light produced from each supernova is sufficient to temporarily illuminate an entire galaxy and it then fades away over a period of a few weeks. The luminosity in this intense explosion is greater than what our sun will produce throughout the billions of years of its existence! Such supernovae are quite common, occurring once every 50 years in a galaxy of our size. All the matter that has been synthesized in the bosoms of the stars is ejected into outer space. The stellar dust produced from the super nova explosions can later collapse to give rise to planets---such as our earth. Indeed, every single element on planet earth was once in the center of a burning inferno--- in the bosom of a star!

Now comes the exciting part. We are what we eat. A baby grows into a man or a woman by converting what he or she eats into the various components of his/her body. All the fruits, vegetables and other edible materials are derived from the atoms and molecules present on earth and end up in our bodies in the form of our flesh, bones and various organs. Our food items, in turn, have all arisen from the exploding star from which the earth and the planets of our solar system were formed. This leads to an absolutely stunning conclusion: every single atom in your body was once in the center of a burning star! All the atoms present in your fingers, skin, eyes, hair etc. were, a long long time ago in, the core of a certain star at temperatures of tens of millions of degrees centigrade! This is fact--not a theory or fiction. From burning atoms in exploding stars, we have been miraculously transformed to living, feeling human beings---the greatest miracle of all!

As Allah subhanahu wa ta'ala says in the Quran:

Then which of the favours Of your Lord will ye deny?

“Fabe Ayye aalaae rabbekuma tukazzeban”?

An attempt is being made to try to reproduce the process of nuclear fusion in the world's largest scientific experiment, the ITER reactor in the south of France. Superconducting magnets will be used to squeeze plasma of heavy hydrogen isotopes to temperatures of 150 million degrees centigrade. The construction of the machine should be completed by 2019, and full scale experiments begin in 2026. If the experiment works, it would

produce ten times more energy than consumed by it, and we would have learned to replicate the chemistry of suns and stars to meet our energy needs from isotopes of hydrogen.

13.2 The Miracle of Life!³²⁵

Our galaxy, the Milky Way, contains about 200 billion stars, and it could contain thousands of other worlds similar to ours. In order for life to evolve and survive, the planet has to be located in a “habitable zone” at a certain distance from a star. If the planet is too far, water will exist as ice, thereby making it difficult for the chemical reactions required to form the building blocks of life (amino acids, proteins and nucleic acids) to occur. If the planet is too close, then water, if present, will exist as steam, again making it difficult for life to evolve.

In 1976, the spacecraft Viking 1 landed on Mars in search of life. At that time, Mars appeared to be the only likely place where life could be present. That perception has changed dramatically since then. During the last 33 years, the deployment of new more powerful telescopes and satellite space missions has allowed us to identify many new worlds where life can potentially exist. Since mid 1990s, some 340 earth-like planets have been discovered revolving around their respective suns, about 20 of which have been called “super-earths” as they resemble our world in size and temperature. In the 1990s, Jupiter’s moon “Europa” was shown to have an ocean of liquid water below the frozen surface, as revealed by the Galileo space probe, thus adding to the growing list of localities where life could evolve. In November last year, the spacecraft “Cassini” found geysers of water gushing out from the surface of Saturn’s small (300 mile wide) icy satellite, Enceladus --- and the search goes on.

The supernova explosions of stars can lower the chances of life in nearby planets because of the damaging effects of the resulting high energy radiations (gamma rays, X-rays and ultra-violet light). Such explosions however are also crucial for the development of life as they shower the space around them with various elements such as carbon, nitrogen, silicon, phosphorus, calcium and the heavy metals such as iron, necessary for life. These elements are synthesized in the fiery bosoms of the hot stars through fusion

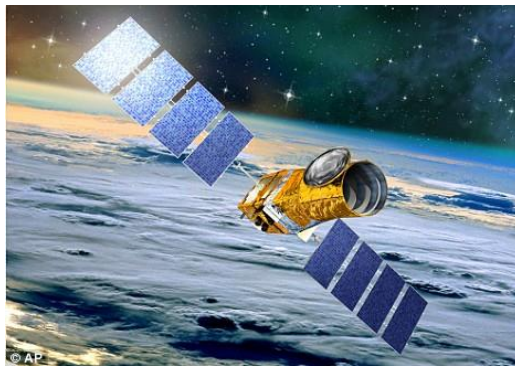
reactions. This illustrates the fine equilibrium that must be reached between opposing forces for life to exist and evolve.

From the fiery bosoms of hot stars where elements are born by fusion reactions, to supernova explosions by which they are dispersed in space---and onto the synthesis of the building blocks of life---the amino acids, proteins, self-replicating nucleic acids--- and then to the simplest living creatures---amoeba, and then onward again to the complex biodiversity of plants and animals, lies a fascinating journey of life and its evolution. This journey commenced in the stars billions of years ago and has finally led to the development of intelligence and man.

The amazing mind-boggling truth about the miracle of life therefore is that *every single atom in our body was once billions of years ago in the center of a burning star---yes, these very atoms that make up your skin or lips or eyes!* So when you look at yourself in the mirror next time, remember that you are looking at star-dust!

13.3 Are there other planets with life?³²⁶

Does life exist on other planets? This question has puzzled scientists for centuries. Such “alien earths” need to be at the right distance from the sun so that water can stay in a liquid form - if they are too near then water will exist as steam, while if they



13.3 The spacecraft, An illustration of the Corot satellite in space. A team found the sound from three nearby stars picked up by the telescope had regular repeating patterns. Reproduced with thanks from, <http://www.dailymail.co.uk/sciencetech/article-1080240/The-sound-space-Scientists-reveal-music-stars.html>

are too far then it will be frozen. The Kepler space telescope launched by NASA in March this year in an orbit around our sun may provide some answers. It is now about 11 million kilometers from earth and proceeding on its planned course. The Kepler space telescope will be monitoring the existence of planets by the decrease in brightness of some 100,000 stars as planets pass in front of them. Meanwhile, the European satellite “Corot” has discovered an earth-like planet about 390 light years away from us which has a diameter twice that of earth. However, its surface temperature is over 1000 °C which is too hot for life to survive.

13.4 A Planet that May Support Life!³²⁷

There is excitement among scientists who have been scanning the skies for a planet that may be able to support life. If planets are too far from a star, they are too dark and cold for life to evolve, whereas if they are too close, they are too hot for water to exist in a liquid form. There are a few hundred billion stars in our galaxy, and even if a small percentage of them have habitable planets associated with them, then one could potentially have billions of such planets many of which may have water and be able to sustain life. There is, therefore, a ‘habitable zone’ which is just at the right distance for water to exist in a liquid state and astronomers have been searching for such habitable planets for decades. Now, they have found one at last. The discovery was made by Steven Vogt of the University of California, Santa Cruz, and Paul Butler of the Carnegie Institution of Washington, DC, who used a 10-metre Keck I telescope in Hawaii to measure the wobbles of a star and discovered the planets around it by the way it was wobbling. It lies some 20 light years away from us. It has a rocky surface, just like the earth, and is about four times its size. Known as the ‘Goldilocks’ planet (or Gliese 581 g), it takes about 37 days to orbit its sun. Its star is not as bright or warm as our sun, producing only about one percent of the life that our sun does, so the habitable zone of that solar system lies much closer to that star.



13.4 keck telescope. Reproduced with thanks from, <http://astronomy.swin.edu.au/coma/the-survey-Keck.htm>

13.5 Evolution: Is the Moon partly responsible?³²⁸

Planetary scientists believe that in the first hundred million formative years of the solar system, a large Mars sized object smashed into the earth, knocking off a portion of it as debris which later gelled together to form the moon. Our moon is therefore relatively much larger as compared to the size of its associated planet, Earth, than the moons of the other planets in our solar system. Such an unusually large moon that we have has a remarkable hidden benefit. Its gravitational pull on our planet has a steadying effect on the natural tendency of the earth to wobble vigorously while spinning on its axis. Had this wobble not been controlled, it would have resulted in dramatic changes in the climatic conditions of our planet and made it more difficult for life to begin and evolution to take its present course. So next time you look at the moon be grateful - for the gentle grasp it has on you!

13.6 The Vast Universe.³²⁹

Suppose that we could travel at the speed of light i.e. at a speed that will take around the earth at the equator about 7 times within a second! Even at these dazzling (and impossible) speeds, it would take years to travel from one star to another as the

average distances between them are 30 million million kilometers. In our own galaxy, there are a huge number of stars--estimates range from one hundred billion to four hundred billion stars. And there are about 140 billion galaxies, some bigger than ours. So, we are a speck of dust in a tiny solar system within a galaxy which has over a hundred billion stars---our sun being only one of them. And with 140 billion galaxies we shrink to the almost invisible. The mind just cannot readily comprehend the huge dimensions that we are considering here. If there was a civilization existing somewhere on the outer fringes of our galaxy, and the aliens could peer at what was happening on earth, since the light from our earth would take thousands of years to reach them, they would only be able to observe what was happening on earth during the time of Abraham, or of Moses, or of Prophet Mohammed (pbuh) --- depending upon how far they are----not what is going on now. For this they will have to wait for another dozen centuries. The universe is believed to be about 90 billion light years in its expanse. Thus if you could travel at the speed of light (i.e. at a speed that allows you to travel seven times round the earth at the equator within a second) it would still take you 90 billion years to traverse the width of the universe.

13.7 Our Huge and Expanding Universe!³³⁰

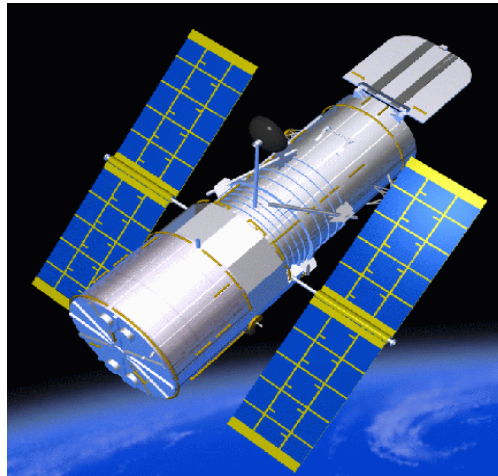
Einstein had wrongly conceived a static universe. He later admitted that this was “the greatest blunder of my life”. Our universe is not fixed in size but is expanding rapidly. Hubble discovered in 1929 that galaxies were racing away from one another, and the farther they were, the greater the velocity at which they were receding. Interestingly, they were not racing away through space, but the space in which they existed was itself expanding, so that they were receding away with_space! Cosmologists think that the rate of expansion has been accelerating for the last 5 billion years, but it was decelerating before that.

The expansion is attributed to a strange mysterious force which is pushing the galaxies away from one another and which makes

up about 71.3% of our universe--dark energy! Recent results from Arfan Shafieloo at the University of Oxford suggest that the rate at which the universe is expanding may be slowing down. If that is the case this implies that dark energy may also change with time, opening up a new Pandora's Box in physics, raising a question: does dark energy exist at all ?

Our universe is thought to be about 13.7 billion years old with a diameter (of the observable universe) of at least 93 billion light years. One light year is the distance travelled by light in one year and it is equal to about 5879 billion miles! When we consider that the time taken by moonlight (actually reflected sunlight) to travel from the moon to the earth is only about 1.3 seconds, imagine the distance light will cover in 93 billion years---this is how big the visible universe is.

This raises a problem. If the universe is only 13 billion years old, how can two galaxies lying on the opposite sides of the universe be some 93 billion light years away from one another, if matter cannot travel at speeds faster than the speed of light? The reason is that this limitation does not apply to the expansion of space itself which can occur without any speed limits. This allows galaxies to travel away from one another at speeds much faster than the speed of light because of the expansion of space itself.



13.7 Hubble telescope. Reproduced with thanks from, <http://imagine-hawaii.com/hubble.html>

13.8 Dark Matter ---- The Invisible Cosmic Glue!³³¹

Our universe is filled with a strange and mysterious substance which is about five times as abundant as the “normal” matter that we see in the planets and stars. It is called “dark matter”. It is invisible ---- it does not emit or reflect light and cannot be observed directly through telescopes. However, the enormous pulling and twisting effects exerted by it on galaxies can be indirectly seen. Many of the smaller galaxies (“dwarf galaxies”) should have been torn to shreds by the very strong gravitational forces of the giant galaxies near them, but this powerful invisible glue ---- dark matter ---- seems to be holding these smaller galaxies together by opposing the gravitational pulls of the giant galaxies.

The nature of this force has remained a huge unsolved mystery for the last seventy five years. The astronomer Fritz Zwicky was the first to propose the existence of dark matter when he observed some very fast moving galaxies in 1933 which should have been torn apart but some invisible force seemed to be holding them together. Many scientists have been searching for the elusive particles of dark matter on earth --- others question if it even exists. Possible candidates for this mysterious force are WIMPSs (Weakly Interacting Massive Particles). WIMP detectors have been installed deep in abandoned mines in Minnesota and Ontario. The first blips of what may be dark matter have been picked up in Italy (DAMA/LIBRA experiment) recently but the results have yet to be verified.

The fascinating world of science holds many mysterious secrets --- - the exploration of the various frontiers takes us on journeys where we are constantly dazzled by the beauty of the multi-faceted architecture of nature ---- this is the truly thrilling and wondrous world of science!

13.9 The Invisible Universe!³³²

Do you know that we can see only about 4% of the universe. About 74% of it is accounted for by a mysterious force called “dark energy” while another 22% is composed of an invisible matter, termed “dark matter”. Determining what this missing mass is

composed of is among the biggest puzzles in cosmology and particle physics. In 2005, astronomers at Cardiff University have discovered a galaxy some 50 million light years away which appears to be made up entirely of the invisible dark matter.

About 96% of our universe is therefore not composed of “normal” visible matter but of invisible dark matter and dark energy. We know very little about these strange and mysterious forces around us! This is therefore a huge unsolved mystery.

13.10 Granular Space?³³³

Space and time can be combined into a single continuum----spacetime. Matter can distort this continuum. Take a piece of fabric, hold it tightly at all 4 corners and place a heavy ball on it. The fabric bends downwards at the place where the ball rests. It is thought that spacetime itself is bent in a similar manner by planets and stars, the curvature representing gravity. What is gravity composed of, and how does it relate to the other fundamental forces of nature? Is it possible to develop a “theory of everything”-- - a theory that will blend all the forces in nature, including gravity, into a single theory? Is outer space silky smooth, as envisaged by Einstein, or is it rough and granular? How do planets attract each other? These are questions that have perplexed many scientists over the decades, be it Einstein or our own late Abdus Salam.

On 30th June 2005, in Canarie Islands, Spain, a powerful telescope known as MAGIC (“Major Atmospheric Gamma-ray Imaging Cherenkov telescope”), while scanning the skies for high energy light particles (photons), detected something truly extraordinary. Light is believed to travel at a uniform speed in a specific medium----the speed of light being about 300,000 km per second (actually 299,792,458 meters per second). The MAGIC telescope however found that the low energy particles of light reaching the telescope from another galaxy some 500 million light years away arrived 4 minutes faster than their higher energy brethren. This may be important evidence towards the granular foamy nature of space. Results obtained by NASA’s Fermi Gamma-ray Space Telescope recently from a source 12 billion light years away have found a similar 20 minute difference

between the speed of the faster low energy light particles and the slower higher energy ones. These observations have raised expectations that we may finally be on the verge of understanding the fundamental nature of space-time and gravity.

13.11 Is Our Universe Granular?³³⁴

Near Hannover in Germany a fascinating experiment is being conducted – it is known as the GE 600 experiment since the detector in it is 600 meters in length. This detector is trying to detect ripples in space-time (gravitational waves) which could have come from some super heavy space objects such as black holes or neutron stars. While it has not yet detected these, it may have inadvertently stumbled upon the most important discovery of the last 50 years – the limits of space-time i.e. where space-time is no longer a smooth continuum as envisaged by Einstein but becomes granular. It had indeed been predicted that when looked at space-time at a huge magnification - the space-time would appear to be convulsing wildly, causing graininess to appear. If it is so, then the whole field of theoretical physics itself may be about to face major convulsions!

13.12 Our Solar System---Swinging Every 62 Million Years!³³⁵

On our planet we witness another strange phenomenon---the extinction of a huge number of plant and animal species every 62 million years. This has been attributed to the bobbing up and down motion of our sun as it travels through the Milky Way. The Milky Way has a flat disc-like shape, and the sun rises above the plane of this disc and then falls below it. When the sun rises above the “north” side of the disc once every 62 million years (the side pointing towards the Virgo cluster of galaxies), the biodiversity drops sharply due to the damaging cosmic radiations referred to above, resulting in mass extinction of species. Did you know that all of us, our planet earth and our solar system are presently

hurtling across space along with our galaxy towards the enormous Virgo cluster of galaxies at some 120 miles per second?

13.13 The Fate of Our Solar System³³⁶

Our sun has another 6 billion years or so before it dies. It will gradually get brighter and hotter. Within 2 billion years, all life on our planet will disappear because of the enormous heat from the sun which will slowly expand to about a million times its present size, becoming a red giant that will swallow up Mercury, Venus and probably our earth too. The inner hot furnace of the sun will finally consume the last remnants of hydrogen fuelling it, and it will start shrinking and become a tiny white dwarf.

As far as human civilization is concerned, Sir Martin Rees, President of Royal Society (London) feels that this may well be our last century, as we seem to be in a self-destruct mode, causing havoc to our environment through global warming caused by reckless burning of fossil fuels, developing weapons of mass destruction, emergence and spread of new diseases and carrying out dangerous experiments that can create black holes that may gobble up the planet.

13.14 Our Sun—Is Something Wrong?³³⁷

Sun spots, dark patches on the surface of the sun caused by variations in the surface temperatures, appear and disappear at intervals. Their number increases and then starts decreasing again fairly regularly—in 11-year life cycles. However, they have been largely missing for the past two years, and something strange is going on. Such a long period of “quiet” has not been experienced for the last 100 years. Is this the quiet before a devastating storm that will affect lives on earth in a number of traumatic ways?

Sun spots appear when huge loops of magnesium spring up from the interior of the sun, onto the surface, lowering its temperature wherever they appear. The temperature on the ‘normal’ surface of the sun is about 5780 K but the temperature at the darker sun spot

regions is in the range of 3,000- 4500 K (4940-7640 degrees Fahrenheit). Colossal sun storms with energies billions of times higher than an atomic explosion can disrupt life severely on our planet. The solar flares emit huge amounts of ultra-violet light which is absorbed by our stratosphere when it reaches our planet. This causes the stratosphere to heat up resulting in increased wind speeds and strong jet streams that ultimately affect our weather patterns.

So, what is going on? Are we about to experience a massive number of sun spots before long that will heat up the earth—or is the opposite happening i.e. the sun is shrinking and slowly losing its ability to form sun spots? Whatever is going on, it could have profound effects on life on our planet.

13.15 A Monster --- in our Galaxy!³³⁸

There is a monstrous supermassive black hole lurking in the center of our galaxy, about 30,000 light years from us, hungrily gobbling up matter. Evidence for its existence has been published by Shep Doeleman from MIT (*Nature*, vol455, p78). The black hole, named “Sagittarius A”, has about 4.5 million times the mass of our sun although it is estimated to have a diameter of only 27 kilometers, and exerts a huge gravitational pull, so powerful that it does not even allow light to escape from it. A number of microwave telescopes across our planet would be networked together so that they can operate as one giant instrument in order to see the silhouette of the black hole more clearly.

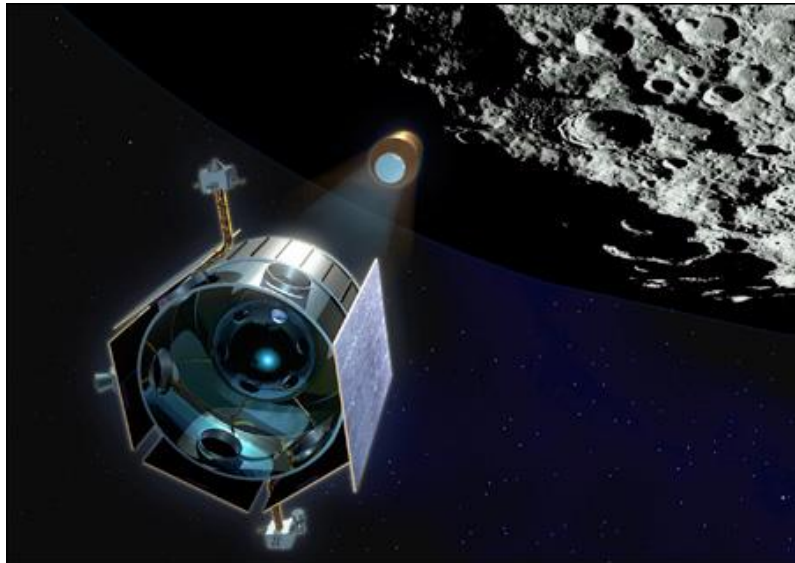
13.16 Galaxy Collisions!³³⁹

Our galaxy may have smashed into another huge galaxy about 2 billion years ago. As a result, some stars near our solar system are travelling with much greater velocities than others in our galaxy. This conclusion was reached by Minchev and coworkers at the University of Strasbourg in France after studying computer simulations of the velocities of billions of stars. The huge shock waves caused by the clashing of the galaxies caused pulsations of energy in the form of a pattern of ripples to appear, due to the

merging of two galaxies. Minchev's work explains how streams of fast moving stars exist along with slow moving ones in our galaxy.

13.17 Water on the Moon!³⁴⁰

Water has been recently discovered on the moon. The credit for this spectacular discovery goes to the collaborative effort between NASA and India Space Research Organisation. The data from NASA space missions and that from the Indian space mission Chandrayaan 1 (India's first mission to lunar orbit) had indicated the presence of water---not water as in streams, rivers, lakes and oceans but water bound to the rocks and dust on the lunar pole, which could be extracted. The exhausted upper stage of the launch vehicle of the Lunar CRater Observing and Sensing Satellite (LCROSS) and a few minutes later the LCROSS itself were hurled at a crater that had been hidden from sunlight for billions of years, creating a huge plume. This was examined spectroscopically by LCROSS, which was travelling at 1.5 miles per second, till the time of its impact. The results confirmed the presence of water molecules --- a historic discovery!



13.17 Sign of water on moon. Reproduced with thanks from, <http://www.minnpost.com/christian-science-monitor/2009/10/nasa-moon-bombing-successful-did-we-find-water>

13.18 Silver and Water on Moon!³⁴¹

In October last year, NASA crashed a rocket on the moon and the ejected material was analysed by spectroscopic methods. One of the great surprises was that there was a large amount of water ejected as a result of the crash. About 5.6 percent of the debris ejected comprised water, indicating that about a billion gallons of water may exist within 10 kilometres of the point of impact. Much of this water may exist as ice under the surface in the form of a layer of permafrost. Another surprise was that there was a significant amount of silver ejected also.

So, when you next listen to the 1909 hit song, "*By the Light of the Silvery Moon*", remember that our moon is indeed silvery.

13.19 Moon Craters --- When Did They Arise?³⁴²

The moon is about 4.5 billion years old and is believed to have been formed as a result of a giant collision between the earth and another planetary body, which resulted in rocky debris being knocked off the surface of the earth. Some of it went in orbit around the earth and aggregated in the form of the moon. In support of this hypothesis is the fact that the moon lacks an iron core. The iron in our planet is believed to have melted and sunk into the centre of the earth to form its core by the time the impact with the other planetary body occurred. Hence the debris knocked off from the earth, from which the moon was formed, has very little iron. Studies of lunar rocks indicate that the moon initially had a molten surface and its "magma ocean" solidified over a period of about 900 million years. It also experienced intense volcanic activity in these earlier years of its formation.

The Lunar Reconnaissance Orbiter, a robotic spacecraft, has been sending back 3D images of the moon's surface. This is triggering a debate as to what caused these craters and when they were formed. It is believed that about 3.9 billion years ago there was a sudden increase in bombardment of the moon by large rocks that created the craters but the level of bombardment declined over time. A special mission to the moon, "MoonRise", is now being planned to collect samples from the largest crater on

the moon which is over 2,500 kilometers wide to understand how and when the bombardment of the moon's surface occurred.



13.18 Silver and water on moon. Reproduced with thanks from, <http://news.nationalgeographic.com/news/2010/10/101021-science-space-moon-crash-water-silver-mercury-nasa-icross/>



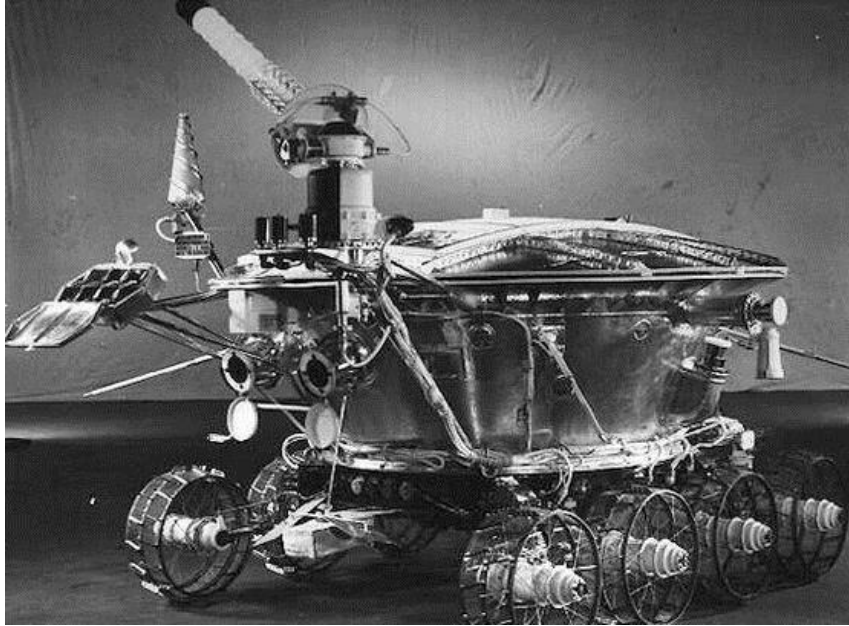
13.19 Volcanoes on the surface of moon. Reproduced with thanks from, http://roc.sese.asu.edu/EPO/Trivia/moon_volcanoes.php

13.20 Self-sustaining Robots on the Moon!³⁴³

Japan has launched a \$ 2.2 billion project through its space agency JAXA to place intelligent robots on the moon by 2015. Japan also plans to have a fully operative unmanned lunar base by 2020. The robots (“behemoths”), weighing 660 pounds each, will be equipped with tank-like treads in order to travel freely on the lunar surface. With humanoid-arms, they will collect rock samples which will be returned to earth on rockets. The various scientific instruments installed in them will include high definition cameras to collect data. These highly intelligent robots will make their own decisions and largely operate with complete autonomy to perform tasks assigned to them, including self-repair if damaged. These self-sustaining multi-tasking intelligent robots reflect things to come in the future ---- robots replacing human beings in many space missions and explorations.

In a related development Japan is planning to place a solar panel-equipped satellite in space that will wirelessly beam gigawatt levels of power wirelessly down to earth, in order to supply electricity to some 300 homes. The satellite will have a huge surface area of some 4 kilometers. The power will be transmitted by microwaves to a base station on earth. There are several advantages of putting solar panels in space rather than on earth, which include the absence of hindering clouds, and suitable cold temperatures. The project will cost about \$21 billion, and is to be implemented by Mitsubishi along with another designer company, IHI.

Japan is arguably the world leader in robotics and machine intelligence. It has highly automated manufacturing plants of automobiles and house appliances, and is rapidly developing robots to serve as nurses in the hospitals or to take care of patients at home. However, with the growing advances in machine intelligence, we will find intelligent robots capable of making independent decisions within the limits assigned to them. The spectre of run-away robotic systems which one day, due to faulty design, may start replicating themselves and take decisions in their own self-interests rather than of us “weaklings” is never far away.



13.20 Robot on moon. Reproduced with thanks from, http://science.nasa.gov/science-news/science-at-nasa/2010/03jun_oldrover/

13.21 Mathematics helping in Planet Discovery!³⁴⁴

Scientists working at the Herzberg Institute of Astrophysics have applied new mathematical tools to study the data obtained ten years ago from the Hubble Space Telescope. The procedure involved digitally creating a reference image of stars without planets. When this reference image was subtracted from the image obtained of a certain region of our galaxy, three planets magically appeared. Each of these planets is about 10 times the mass of Jupiter. One day, an earth-like “blue” planet could also be discovered in this manner!

13.22 Commercial Supersonic Flights --- in Space!³⁴⁵

Lockheed Martin is developing a “Quiet Supersonic Transport” that will be able to travel from Chicago to Paris in under 4 hours.

More exciting is the project undertaken by the German space agency, DLR. The European Commission has funded this project of a "Spaceliner" which will be capable of traveling at a speed of 14,000 mph and carry 50 passengers ---through space (!) --- from New York to Sydney in less than 90 minutes. This may be regarded as a modified version of a space shuttle which may be powered by rockets operating on liquid hydrogen/oxygen thrusters. The spaceliner would reach a height of 62 miles, which is the lower boundary of space, within 7 minutes of take off. As it would be at such a great height, the sonic boom generated by it will not disturb the populations over which it travels. Traveling at such stupendous speeds will cause the heating of the spaceliner to temperatures up to 5,400°C. To keep the body cool, special porous ceramic tiles are being developed which would "sweat" water, as the human skin does! If you are willing to spend \$ 200,000, commercial space travel is already available. The US Company Virgin Galactic has already made pre-bookings of 200 persons with a total price tag of US \$ 30 million. Their spacecraft will take you along with 5 other passengers to a height of 68 miles and give you the ride of your life for 2.5 hours. A number of other US, European and Kazakhstan based companies are also developing similar space tourism initiatives.

13.23 First Space Taxi Launched!³⁴⁶

The first space taxi, named Falcon 9, was successfully launched on Friday 4th June 2010 from Cape Canaveral, Florida by a private company Space X. A NASA contract has been given to this company to carry cargo to the International Space Station and the company is hoping to win contracts to carry astronauts also to space. The Obama administration is in favour of using such private space carriers in the future for transporting cargo and men to space stations, as it is considered to be much more cost effective. However concerns remain about the safety aspects of using commercial space vehicles, as safety aspects may be compromised. It is planned that Falcon 9 will make two more space trips this year.



13.22 supersonic flight in space. Reproduced with thanks from, <http://www.dailymail.co.uk/sciencetech/article-2543245/Virgin-Galactic-goes-SUPERSONIC-Incredible-video-reveals-SpaceShipTwo-broke-sound-barrier-test-flight.html>



13.23 Space taxi. Reproduced with thanks from, <http://www.space.com/15082-nasa-space-taxis-congress-impatient.html>

13.24 Stairway to Space?³⁴⁷

A proposal has been made by scientists at York University in Toronto, Canada to build a staircase to the edge of space (Acta

Astronautica, DOI: 10.1016/j. actaastro.2009.02.018). Initially, a 15 kilometer tower could be built, made of inflatable materials. Located on the top of a mountain, it would provide a view of upto 600 kilometers on all sides, similar to that from space. Modules of pneumatic materials already used in spacecraft could be assembled together and held erect employing gyroscopes and active stabilization systems. Such a tower could be extended in a subsequent phase to a height of 200 kilometers.

13.25 Detecting Toxic Wastes---from Space!³⁴⁸

Toxic waste disposal is a major environmental challenge that is being turned into big business by criminal firms that buy it off companies and illegally dump it at unauthorised sites. Technologies have now been developed that allow such waste dumps to be detected by ground-penetrating radar (GPR). This is done by bouncing the microwaves off the buried material. The strength of the signals that return provides valuable information of what lies underneath the soil. It has been shown by Italian scientists working at Consorzio Venezia Nuova in Venice that such toxic waste sites can be detected by satellites in space (DOI:10.1080/13658810802112128). Such remote sensing techniques will make it more difficult for criminals to get away with dumping toxic wastes.

13.26 Observing the Sun— from a Space Observatory!³⁴⁹

The sun is just one of 100 billion stars in our galaxy, having a diameter of about 865,000 miles (about 109 earths) and a mass of about 330 earths. It is actually white in colour, appearing yellow only because we are peering at it through our atmosphere (just as the sky is jet black, but appears blue). It is mostly made up of hydrogen and helium and is racing though our solar system, carrying with it the planets in our solar system, including earth. It is orbiting the Milky Way, at a distance of about 24,000-26,000 light years, and completes one full orbit in about 225-250 million years. At its core, it has a temperature of about 15 million degrees Centigrade, and a

pressure of about 340 billion times earth's air pressure. The surface temperature is about 6000 degrees Centigrade.

In February this year, the Solar Dynamics Observatory (SDO) spacecraft was launched by NASA that will observe how the sun's magnetic field and its other features affect us on earth. It has begun to send some stunningly beautiful pictures of the sun, and over the next five years, it will provide a wealth of information that will allow us to better understand its functioning. Of particular importance is to understand the turbulent solar flares, solar winds and the large magnetic storms caused by the sun on our planet.



13.25 Ground penetrating radar. Reproduced with thanks from, http://en.wikipedia.org/wiki/Ground-penetrating_radar



13.26 Observing sun through space. Reproduced with thanks from, http://www.nasa.gov/mission_pages/sdo/multimedia/SDOimg_beautyshot3.html

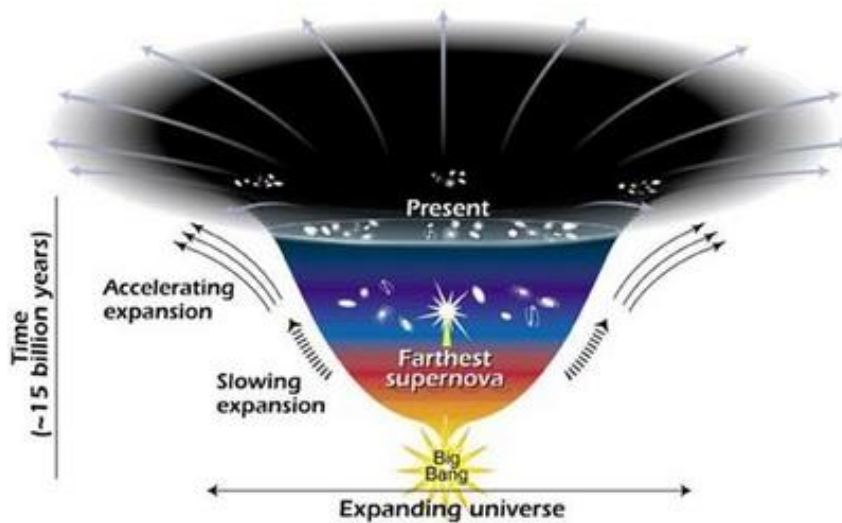
13.27 The Mysterious Universe³⁵⁰

One of the greatest puzzles of our universe is that the total visible matter made up of atoms including planets, solar systems, stars, galaxies etc. accounts for only 4% of the total mass of the universe. The rest is accounted for by a mysterious force known as dark energy (72% of total mass of universe) and dark matter (24% of total mass of universe). Scientists are struggling to understand what these two entities, dark energy and dark matter, really are. Dark matter, though completely invisible, is being studied by the effect of its gravitational pull on other objects. Dark energy however exerts no such effect and is more difficult to explore. It is the force that is pushing the galaxies apart and causing the universe to expand at an accelerating pace.

Scientists are now using a massive cluster of galaxies to serve as a huge magnifying lens to study dark energy. This cluster of galaxies (known as Abell 1689) acts as “cosmic lens” and allows NASA’s Hubble telescope to look at the galaxies lying behind this huge lens. The light coming from these rear galaxies is affected by dark energy, and the scientists can then indirectly measure how this mysterious force is contributing to the acceleration of our universe.

13.28 Solar Powered Spacecraft Launched!³⁵¹

On 21st May 2010, Japan launched the first solar powered spacecraft, known as IKAROS (Inter-planetary Kite-craft Accelerated by Radiation Of the Sun). It uses solar sail technology as the main source of propulsion. The solar sails, which are 14 meters long on each side, comprise a thin polymeric square membrane, resembling a kite, with thin-film solar cells built into the membrane. The sails will be unfurled a few weeks after launch, and the spacecraft powered by sunlight will travel over a 6 month period to the planet Venus, and then travel for another 3 years to the far side of our sun, collecting scientific data. If successful, a new spacecraft will be built with solar sails 50 meters in size to power it.



13.27 Secrets of the Universe. Reproduced with thanks from, <http://themysteriouseverything-sheila.blogspot.com/>

13.29 Force Fields to Protect Space Travellers³⁵²

A major hazard for astronauts undertaking long journeys, such as that to Mars, in space is their exposure to deadly solar winds of high energy particles (plasma) from the sun. Now it has been discovered that a small magnet, about as wide as your thumb, can deflect this stream of charged particles and protect the astronauts from dangerous exposure which can lead to death by radiation sickness. Such force fields can be created around space ships by a modest sized electromagnet on board, making the hitherto science fiction concept of protective force fields around spacecraft a reality. The discovery was made by scientists at the Rutherford Appleton Laboratories in Oxford, UK. The idea of creating such force fields around space craft was first conceived in the 1960s by the rocket pioneer Wernher von Braun who was the creator of the Apollo programme. However, he mistakenly dismissed the concept as he thought that the magnets required for creating such protective fields would be too big to be carried aboard spacecraft. It turns out that only very weak magnetic fields are needed to create such force fields. These can be created by tiny magnets.

13.30 Exploring the Nature of the Universe!³⁵³

Beneath the border between France and Switzerland near Geneva lies one of the scientific wonders of the world—the world's largest and highest energy particle accelerator. It lies about 175 metres below the earth's surface and has a circumference of about 27 kilometres. Built by the European Organisation for Nuclear Research (CERN) at a cost of more than four billion dollars, some 10,000 scientists and engineers from 100 countries have been involved in its construction. It may answer some of the fundamental questions of physics such as the nature of space and time as well as what is gravity made of.

It was installed in September 2008 but developed leakages and had to undergo major repairs before starting again in November 2009. In spite of fears by sceptics who predicted a doomsday scenario through creation of microscopic stable black holes in the machine that could swallow the earth and our solar system, it has functioned safely and smoothly, having already met its target for proton collisions during 2010. Travelling at almost the speed of light (only three metres/second slower!) they take only 90 microseconds to go once around this huge 27 kilometre ring—i.e. they go around this ring 11,000 times within one second! Travelling in opposite directions, they smash into each other. A fireball of more fundamental particles (quarks and gluons) is produced that make up the protons and neutrons. Analysis of the resulting soup of particles produced can shed light on the deepest laws of nature.

In November 2010, this largest man-made machine in human history will migrate to another exciting phase, colliding heavy lead particles after accelerating them to such fantastic speeds.

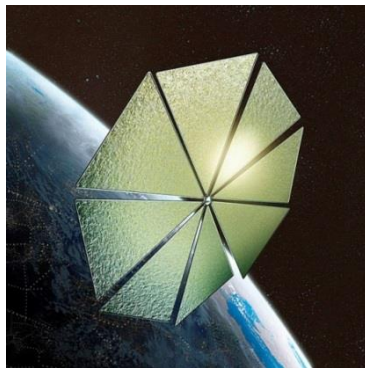
13.31 First Solar Sail - in Space!³⁵⁴

Solar sails, also known as “light sails”, are being developed to propel spacecraft using the pressure of radiation from stars or lasers. These are very large ultra-thin mirrors made of polymeric materials which propel the spacecraft forward due to two different forces: the stronger radiation pressure and the weaker

solar winds. The radiation pressure is due to the fact that photons (light particles) possess a small amount of momentum. The solar wind pressure is three magnitudes smaller. The acceleration produced by these two forces is very small, even in large solar sails, but since the spacecrafts are travelling in a complete vacuum, and there is no resistance except possibly from gravitational forces, the speed of the spacecraft becomes very significant over time.

The first spacecraft to use solar sail technology as the main source of propulsion was IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun), of Japan Aerospace Exploration Agency launched on 21st May 2010. In December 2010, the spacecraft passed the planet Venus, a huge leap forward for the Japanese space programme.

NASA unfurled a 100 square foot solar sail in low earth orbit recently which will gradually descend to earth. It may eventually be employed to bring satellites back to earth before the highly sensitive and secret US technology is “stolen” by other nations.



13.31 Solar sail. Reproduced with thanks from, <http://minerva.union.edu/novinsc/phys123/index.html>

13.32 New Exo-Planets Discovered!³⁵⁵

The Kepler space telescope of NASA, launched in March 2009, has been searching for earth-like exo-planets where life may exist. It has so far looked at 156,000 stars and found 1,235 planets that have the potential to harbor life as they are

in the habitable zone (near enough to their respective suns for light and warmth to reach them but not too close where it would be too hot for life to exist). An exciting recent discovery is the Kepler 11 planetary system which has at least 6 planets around its star. It is the most compact and largest planetary system discovered till now, since very few stars have been found that have more than one planet revolving around them, and none was known previously (besides our own) which had more than three planets.

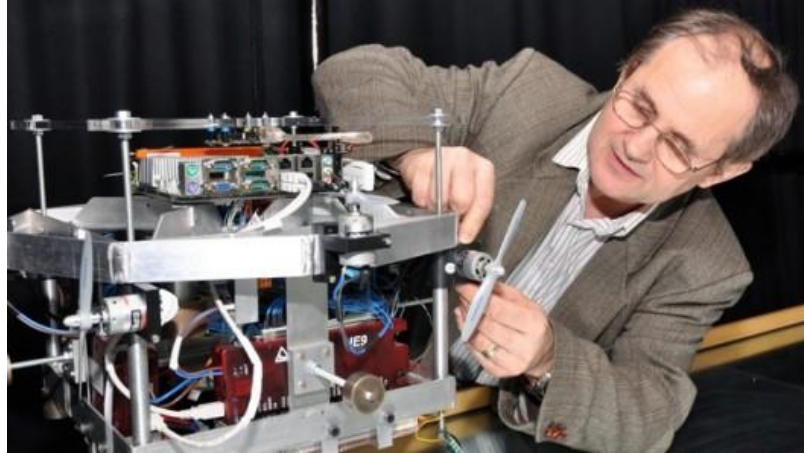
The Kepler telescope has identified 54 planets so far which are in the habitable zone since its launch. As the telescope has been aimed at only a very tiny section of the sky, it is apparent that there must be hundreds of thousands of planets, if not millions, that exist in the universe and on some life may have evolved.

The problem with the Kepler 11 planetary system is that it is about 2,000 light years away from us. So, if you ever want to go there, it would take 2,000 years even if you could travel at the speed of light, which you cannot.

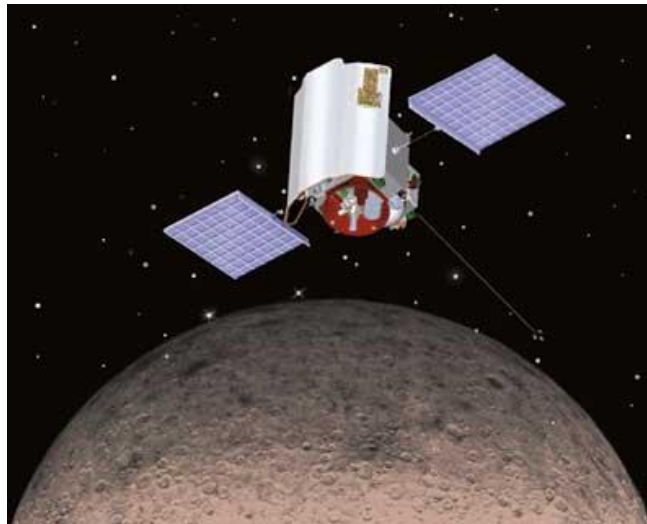
13.33 Brainy Satellites!³⁵⁶

As the amount of junk in space increases, there is a growing risk of damage to satellites by collision with such floating junk. Satellites are expensive, costing hundreds of millions of dollars, and have highly sensitive equipment involved in their manufacture. There is therefore a need for satellites to have some mechanism of jumping away out of danger when they find junk floating right at them on a collision course.

Scientists at the University of Southampton have now developed a brain with a built-in collision avoidance system which can be incorporated into the satellites. Known as “sysbrain”, the software in this system allows the satellites to read instruction manuals in English. Using this, the satellites can carry out various tasks, including moving out of danger if another object approaches them. The satellites can read such instructions directly from the internet and can therefore update themselves remotely.



13.33 Intelligent satellite. Reproduced with thanks from, <http://www.gizmag.com/sysbrain-allows-satellites-to-act-autonomously/17899/>



13.35 Messenger around Mercury. Reproduced with thanks from, <http://spaceflightnow.com/news/n0203/30messenger/>

13.34 Planet — Munching Bloated Stars!³⁵⁷

Some hungry stars have been detected across the galaxy. They are munching away in a feeding frenzy ----- and gobbling up entire planets! The stars have become bloated as a result of this binge and have been named “bloatars” by Loredana Spezzi at

the European Space Agency in Noordwijk, the Netherlands who has been trying to explain their bloated shape. A group of nine such stars were detected by the Hubble telescope about 20 light years away from us in a young cluster of stars. The work will be published in *The Astrophysical Journal* (arxiv.org/1101.4521).

13.35 Around Planet Mercury --- After Six years!³⁵⁸

The US spacecraft *Messenger* has been travelling for the last six and a half years in our solar system. Finally on 17th March 2011, it reached the planet Mercury, and went into an elliptical orbit around it. Mercury is about 96 million miles away from our planet but the spacecraft reached it by a circuitous route, after travelling almost 4.9 billion miles and going thrice past Mercury, twice past Venus, and once past earth. It sent a large number of very informative photographs and scientific data during this long trip. Planet Mercury is relatively unexplored. The last time Mercury was photographed by a spacecraft and data sent back to earth was in 1974-1975 when Mariner 10 sent back photographs of about 45% of the surface of planet Mercury.

Messenger will stay in orbit for about a year and send back colour photographs of about 90% of the planet's surface. The data that it provides will throw light on the birth of the planets in our solar system.

13.36 The Amazing Universe!³⁵⁹

Our universe is believed to be about 13.7 billion years old. The observable universe is believed to have a diameter of about 93 billion light years i.e. it will take about 93 billion years for light to travel from one edge of our universe across to its other edge. There is growing scientific evidence that the universe is expanding, and that the expansion is accelerating because of a mysterious force, dark energy. Most of the matter in the universe is not constituted by what is observable --- the galaxies with their stars, solar systems and planets --- but by another mysterious material which is termed "dark matter".

There are about 100 billion galaxies in our observable universe. Interestingly, this is about the same number as the neurons in our brain, the most complex object of our universe --- the universe within! Each galaxy is on average about 30,000 light years in diameter. Our galaxy, the Milky Way, is somewhat larger than the average size, having a diameter of 100,000 light years. The distance between galaxies is typically about 3 million light years. The galaxy nearest to our galaxy is called the Andromeda galaxy and it is about 2.5 million light years away from ours.

A remarkable fact about the universe is that it has been "fine tuned" ---- life as we know it would not exist if some of the physical constants were different. Stephen Hawking, the famous Cambridge physicist, has noted, "*The laws of science, as we know them at present, contain many fundamental numbers, like the size of the electric charge of the electron and the ratio of the masses of the proton and the electron. ... The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the development of life.*" (Stephen Hawking, 1988. *A Brief History of Time*, Bantam Books, ISBN 0-553-05340-X, p. 125).

13.37 The Amazing Discoveries of Voyager Spacecraft!³⁶⁰

The spacecrafts Voyager 1 and 2 have been hurtling through space for the last 33 years, making fantastic discoveries as they travel across planets and transmit photographs and other information. They are now an incredible 11 billion and eight billion miles away from our planet, having traveled further into deep space than any other manmade object in the past.

Voyager 2 was launched on August 20, 1977, closely followed two weeks later by Voyager 1. The launch dates were carefully selected as the spacecraft would be able to benefit from the rare alignment of four giant gas planets, Jupiter, Saturn, Uranus and Neptune. The twin aircraft reached Jupiter in 1979 and Saturn in 1980, sending back breathtaking photographs of these planets, their moons and of the mysterious rings of Saturn. These rings were found to be made up of large icy particles, some giant sized ones as big as a house. Eight active volcanoes were discovered on one of the moons of Jupiter.

Previously, only Earth had been known to have active volcanoes. The gravity of Jupiter and Saturn propelled Voyager 2 even further, passing Uranus in 1986 and Neptune in 1989. Neptune was found to have the fastest winds sweeping across it in the solar system, speeds of 1,200 miles per hour. A moon (Triton) of Neptune was found to be the coldest in the solar system with temperatures of - 390° F. From its surface huge geysers spewed nitrogen gas into its icy atmosphere. The planet Neptune, like Jupiter, was found to have a Great Dark Spot, caused by a giant storm as big as the Earth itself.

Voyager 1 and 2 hurtle on through space. Voyager 1 is 117 times further from the sun than we are and the sun appears to be very dim from this huge distance, about 10,000 times less bright than it appears to us. The signals from Voyager 1 and Voyager 2 take about 16 hours and 13 hours to reach us.

As the two spacecrafts speed away, they carry with them images of our civilisation, greetings in 50 languages as well as music representative of different cultures and eras. If they were to encounter extraterrestrials, they will have a fascinating story to tell of the wonders that were accomplished by man.

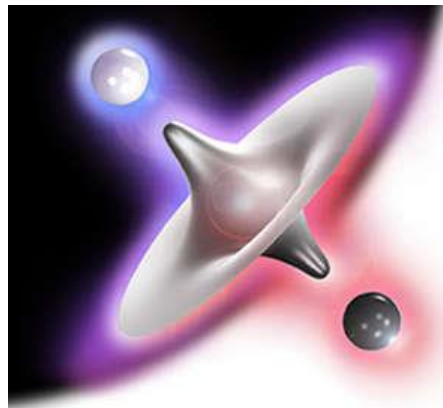
13.38 Antimatter Trapped!³⁶¹

According to our present scientific understanding of the birth of the universe, when the big bang occurred about 13.7 billion years ago, equal amounts of matter and antimatter were produced. However, a big mystery is to unravel where all the antimatter has gone, if originally half of the universe was composed of antimatter, since our present universe is composed of matter. We human beings, our planet, the solar system and much of the visible universe that we see are all made up of matter.

The concept of antimatter is based on the premise that every particle of matter has an associated particle of anti-matter. Carl Anderson in 1932 first identified the antiparticle to an electron, the "positron", having a positive charge instead of a negative



13.37 Voyager 1-2. Reproduced with thanks from, http://en.wikipedia.org/wiki/Titan_III



13.38 Antimatter. Reproduced with thanks from, <http://www.crystalinks.com/antimatter.html>

charge. Subsequently in 1955, scientists at the University of California identified the antineutron and the antiproton. Matter reacts violently with antimatter so that they mutually annihilate

each other, creating a huge amount of energy. Just half a gram of this substance would be sufficient to cause an explosion equal to the atomic bomb that devastated Hiroshima. It is therefore very difficult to study anti-matter. Until recently, scientists had been able to produce antimatter only for a fraction of a second before it destroyed itself by reacting with matter around it.

An exciting recent advance has been the successful production and storage of this exciting elusive material for up to 16 minutes by Canadian scientists working on a project (the ALPHA project) at the European Organisation for Nuclear Research (CERN), located near Geneva. Fujiwara and colleagues created antihydrogen in a tiny steel cylinder which was cooled to a very low temperature of -269°C , just 4° above the absolute zero. At this low temperature, the antihydrogen could survive for upto 16 minutes, a world record, supported by a powerful magnetic field which prevented it from escaping too quickly.

This represents a major breakthrough as it will allow the properties of antimatter to be studied more closely. Can distant galaxies be built up of antisolar systems, antistars and antiplanets? This has been theoretically envisaged but never proved. Now that we have a method of generating and storing antimatter, its study can throw light on the nature of this fascinating material. If scientists discover that it is different from what had been predicted, it will throw the entire field of physics into turmoil and physics books may need to be re-written. An exciting journey lies ahead.

13.39 Astronomers—yes, but Robots!³⁶²

Scouring the skies for unusual blips through powerful telescopes, night after night, year after year—this is what astronomers do. It is a lonely task, demanding patience and perseverance. Now robots have come to the rescue. The arduous task of scanning the skies has now been taken over by robots in some laboratories.

The brightness of some stars fluctuates—a feature that helped scientists to conclude that the universe is not static but is expanding rapidly as the galaxies race away from one another, propelled by that mysterious force, “dark energy”. Such “variable stars” may appear for a while and then disappear—they are therefore called transients. At the Mount Palomar Observatory,

artificial intelligence is being used to detect and analyse them. The software used to analyse images from powerful telescopes removes spurious noise signals to provide cleaner pictures. Similarly, supernovae, that appear temporarily and then disappear, can be detected.

Social networks of computers have been built that work in unison. Through special software, computers in Chile, Hawaii, Australia, South Africa, Texas and the Canary Islands are linked up and communicate with one another. The amount of data collected in one night from a single observatory is huge—impossible to analyse in a life time without the aid of these new companions on earth—computers.

As the robots become smarter and men pour over data provided by them, it becomes fuzzier regarding who is the master and who is the slave.

13.40 A Galactic Collision!³⁶³

The latest data provided by the Hubble telescope indicates that our galaxy, the Milky Way, is on a collision course with the nearest neighbouring Andromeda galaxy. However, you need not worry as there is no immediate danger. The collision will start in about 4 billion years, and will continue for another 3 billion years after which the two galaxies would have merged into a single large elliptically shaped galaxy.

Our earth however faces serious problems much earlier. The sun is now approaching the time when it will transit into a red giant star. This will cause all oceans to evaporate in about a billion years. In another two billion years, all water would have been lost from our planet, and finally the earth will be swallowed by the sun as the red giant star expands far beyond its present size.

13.41 A Planet that Orbits Two Stars!³⁶⁴

While scientists have postulated the existence of planets that orbit two stars instead of one (“circumbinary planets”), such planets had never been discovered. Now, NASA scientists led

by by William Boruckias using the Kepler space telescope have discovered just such a planet, about 200 light years from earth. The two stars around which the planet circles are smaller than our sun, and one orbit of the planet around the stars is completed in about 229 days. The planet, named Kepler 16b, is about the size of our Saturn, and lies outside the “habitable zone” where water, and hence life, could exist. The planet is made largely of gas and rocks.

13.42 An Earth – Like Planet!³⁶⁵

Man has wondered since time immemorial if there is extraterrestrial life out there. Search for aliens, UFOs and living organisms has gone on for decades. A part of this search is to look for signs of water essential to life as we know it, as well as for organic materials. The search has also involved looking for other planets in our galaxy that are in the “habitable zone” --- close enough to their respective suns so that they could benefit from their warmth, and yet not so close that the heat would prevent the formation of life forms. The search has therefore been focused on the habitable “Goldilocks Zone” of our galaxy.

Kepler is a giant space camera with a resolution of 95 megapixels, greater than that of any other space camera yet developed. It measures the brightness of stars by downloading a huge amount of data ---about 100 gigabytes --- each month that is then analysed. If a planet passes across the star, the light from the star dims slightly. It is by how much the light dims and how fast it dims and recovers that provides valuable information about the size of the planet and its orbit. The Kepler spacecraft carrying this camera was launched in March 2009, and the spacecraft was placed in a heliocentric orbit behind the earth. It points at a single spot in the sky where there seems the greatest possibility of finding exo-planets in our galaxy.

Kepler has so far detected about 2,300 planets, of which about 20 resemble the earth as they are in the habitable zone. However the most exciting of these is a planet recently discovered, named Kepler 22b. It is about 600 light years from earth, located between the constellations Cygnus and Lyra. It

has the size about that of our earth, is near a star resembling our sun and is at a distance from its sun that puts it in the habitable zone.

Are there little green men (and women) on it? This is anyone's guess at present.



13.42 Kepler and earth. Reproduced with thanks from, <http://imgarcade.com/1/kepler-22b-compared-to-earth/>

13.43 Asteroid Mining³⁶⁶

Certain asteroids are rich in some precious metals such as gold, platinum, iridium and rhodium. This can be a commercially attractive opportunity if we could reach them and bring back some of these metals in an economical manner. Now a new company, Planetary Resources, has been formed that has joined hands with some other powerful companies with a net worth of \$ 30 billion. The company recently announced its intention to explore the possibility of mining for these precious metals in asteroids found in space. The new company is headed by Chris Lewicki, the former NASA Phoenix Mars Lander mission manager. A recent press release from the company states "the company will overlay two critical sectors – space exploration and natural resources – to add trillions of dollars to the global GDP. This innovative start-up will create a new industry and a new definition of natural resources."

13.44 A Diamond Planet!³⁶⁷

An entire planet made of diamonds? It sounds too good to be true for the diamond lovers! A team of researchers from Australia, Germany, Italy, the U.K. and the U.S., led by Professor Matthew Bailes of the Swinburne University of Technology using several radio telescopes in Australia, UK and USA have discovered this planet in the Sepens constellation in our Milky Way galaxy. There is however one tiny problem ----- it is about 4000 light years away from us. So even if you could travel at the speed of light, it would take you 4000 years to reach it.

The planet has a diameter of about 60 kilometers, about five times that of earth. It was discovered from the strange manner that a nearby pulsar was sending its signals. Pulsars are very small stars with a diameter of only about 15 miles, which send out strong radio waves. These radio waves regularly sweep our planet as the pulsar spins. The manner in which the radio waves were changing regularly led the team of astronomers to conclude that there was a nearby planet responsible for this modulation. An estimation of its density showed that it was much higher than anticipated, largely because it was made up of a crystalline substance---diamonds!

13.45 A Waterworld Discovered!³⁶⁸

The search for planets outside our solar system has led to the discovery of over seven hundred exoplanets in our galaxy, many circling around two suns. Some have massive storms on their surface. Others may be so near their suns that the rocks in them vapourise and then rain from the skies in the form of "rock rain". One example of that is COROT-7b discovered four years ago by the COROT telescope.

A particularly interesting planet is a planet known as GJ 1214b. Located 40 light years away, it was discovered in 2009 as part of the MEarth Project being conducted by the Harvard-Smithsonian Center for Astrophysics (CfA) under the leadership of Dr. David Charbonneau. The planet is about 2.7 times the diameter of our earth and its atmosphere is mostly made up of water. It has a

temperature of 230°C. It has much more water and less rock than earth. The high pressures and temperatures on it would result in the formation of weird materials such as “hot ice”.

13.46 Bombardment by Meteors/Asteroids!³⁶⁹

Each day, many meteoroids enter the Earth's atmosphere weighing about a hundred tons of material. Most of these weigh just a few grams or less each, and are burnt on entering the earth's atmosphere (the "falling stars" that are occasionally observed at night). The larger ones can weigh hundreds of tons and can cause craters. The iron meteor 30-50 meters in diameter that hit the earth 50,000 years ago near Winslow, Arizona caused a crater that is 1200 meters wide and 200 meters deep. There are about 120 craters identified on our planet.

A good example of what happens when a small asteroid hits the Earth is the Barringer Crater near Winslow, Arizona. It was formed about 50,000 years ago by an iron meteor about 30-50 meters in diameter. The crater is 1200 meters in diameter and 200 meters deep. More recently in 1908, a similar impact occurred in Tunguska, Siberia. The impact was so severe that the sound of the explosion was heard in London half way around the world and all trees within a 50 kilometer radius were flattened.

The real danger to our existence comes from the larger asteroids. There are more than 1,000 asteroids with a diameter of more than one kilometer that cross the orbit of our planet and strike earth about once in a million years. One such asteroid (or comet) struck our planet about 65 million years ago, causing a huge crater, 180 kilometers in size in the Yucatan Peninsula in south eastern Mexico. It is considered to be responsible for the extinction of dinosaurs.

13.47 Building Blocks of Life Originated in Space!³⁷⁰

It has been speculated that the building blocks of life originated in space and were seeded on earth in its early history. However, it is only recently that convincing evidence is becoming available. What is this evidence?

Many molecules exist as mirror images of each other. They are called “chiral” molecules, and they are either left handed or right handed. A simple analogy to illustrate the concept of “chirality” is our left and right hands. They are symmetrical mirror images of one another but they are not super imposable. Similarly, certain biologically important molecules, such as amino acids and sugars, exist in only one form that is either left handed or right handed. It has been a major dilemma to explain why evolution on earth led to only one of the two possible mirror image forms and not to the other. For instance, amino acids, that are present in natural proteins, occur only in the left-handed form. Sugars present in DNA of living organisms occur only in the right-handed form. Scientists have therefore speculated that such molecules may have arisen in outer space under conditions in which the formation of one of these two mirror image forms was favoured over the other (for example under the influence of circularly polarized light in the stars).

Two exciting developments during the last one year have provided strong support to this hypothesis that the building blocks of life originated in space. A team of scientists led by Louis d'Hendecourt at the Institut d'astrophysique spatiale (Université Paris-Sud 11 / CNRS), recreating the conditions that may have existed in interstellar conditions in space, succeeded in producing one of the two forms of amino acids in excess of the other. This provides strong support to the idea that chiral molecules on earth originated from extraterrestrial organic material that may have come from outside our solar system, and that contained predominantly one of the two possible chiral forms of amino acids. Circularly polarized infrared light present in massive star formation could have led to this effect (*The Astrophysical Journal*, 2011; 727 (2): L27 DOI: 10.1088/2041-8205/727/2/L27).

A second piece of important evidence comes from the recent discovery by scientists at NASA that certain meteorites from outer space contained two of the four nucleobases that constitute our genetic code, and that the material was not a contaminant from earth (*Science*, 2011; 332 (6035): 1304-1307 DOI: [10.1126/science.1203290](https://doi.org/10.1126/science.1203290)).

All the elements found on earth, including every atom of our body, have been born in the centres of hot stars through fusion reactions. Oxygen, nitrogen, phosphorus, calcium, nickel, silver, gold---- every element found on earth --- has arisen in this manner.

With this new evidence about the origin of chiral molecules in outer space, an important piece of the jigsaw puzzle seems to be finally in place.

13.48 China Takes Another Giant Step in Space Technologies!³⁷¹

On November 2nd 2011, China successfully docked two unmanned spacecraft in orbit about 211 miles above the earth. This represented a giant step forward for China in its plans to become a major space power and build the first Chinese space station by 2020. This maneuver was first achieved by USA in 1965 and it has been subsequently carried out by Russia, Europe and Japan. It is being used to make the first International Space Station. China's rapid progress is based on its huge investments in science & technology.

13.49 Did Ocean Water Come from Outer Space?³⁷²

The origin of sea water on our planet has remained a controversial subject. According to one theory, the water may have come from asteroids that brought the water to our planet. Another theory proposes that ocean water is the result of the bombardment of earth by comets from space. Now some solid evidence has been found to support this hypothesis. An analysis of a comet, Hartley 2, has established that the ice present on this comet has the same composition as sea water on earth! This analysis was carried out by scientists who employed the orbiting telescope on the Herschel Space Observatory to read the characteristic infra-red signals of the organic molecules present. Paul Hartogh of the Max Planck Institute for Solar

System Research in Katlenburg-Lindau, Germany thinks that when the solar system was being formed, there may have existed a large number of such comets that could have rained down on our planet, resulting in the formation of our oceans.

13.50 Expanding Universe Researchers Bag Nobel Prize³⁷³

It has been accepted for over a hundred years that the universe has been expanding since the big bang occurred about 13.7 billion years ago, but it was believed that the rate of expansion is decreasing. Two groups of scientists, while searching for a special type of supernova, found convincing evidence that the universe was expanding at an *increasing* rate. The scientists who were selected for the Nobel Prize in Physics for 2011 for this discovery are Saul Perlmutter of the University of California, Berkeley's Lawrence Berkeley National Laboratory, Brian P. Schmidt of Australian National University, and Adam G. Riess of Johns Hopkins University and Space Telescope Science Institute.

A supernova is caused by the bursting of a "white dwarf". This is a compact star that can be as small as our earth but is as heavy as the sun. The explosion can produce as much light over a few weeks as produced by the entire galaxy. The expansion of the universe is thought to be driven by a strange and mysterious force, dark energy. Scientists are still struggling to understand what this force is that lurks everywhere in our universe.

13.51 Galactic Winds Studied!³⁷⁴

Galactic winds comprise high-speed charged particles that blow out of galaxies at speeds of up to 3000 km/sec. They are produced by starbursts or by super massive black holes that lurk in the center of most galaxies. The material is shot across the stars and some of it reaches our solar system. It is being studied by NASA's Interstellar Boundary Explorer (IBEX) that was launched in October 2008. There are four types of atoms

detected reaching our solar system from other parts of our galaxy. These are hydrogen, helium, oxygen and neon. IBEX has been systematically counting the different neutral atoms that are being carried into our solar system with the galactic wind. An interesting discovery has been that this composition of atoms differs from that already present in the solar system in that it has a lower concentration of oxygen atoms. This indicates that there is more oxygen in any slice of space within our solar system than in the interstellar space outside it.

13.52 Huge Water Source Discovered in Universe!³⁷⁵

Two international teams of astronomers working at the California Institute of Technology have independently discovered a huge source of water in our universe. The amount of water is stunningly huge ---- about 100,000 times the mass of our sun and about 140 trillion times the size of all the oceans of the earth combined! There is one little problem ---it is 12 billion light years away. As its image has taken 12 billion years to reach us, and since the estimated age of our universe is 13.7 billion years, what this really means is that water was also present in huge quantities in the early universe. The images obtained showed that the water was feeding a huge black hole, called a quasar. Quasars are highly luminous objects that feed on surrounding dust and gases and emit huge amounts of energy.

The visible universe as seen from the earth is a sphere with a diameter of about 92 billion light years. Galaxies are relatively much smaller, typically about 30,000 light years in diameter. They are still huge, considering that one light year is the distance that light, travelling at a speed of 300,000 kilometers per second, would travel in one year!

13.53 Mars “Rover” Lab Ready!³⁷⁶

The Mars “rover” lab is ready to go to Mars. It will be attached to the top of a huge Atlas 5 rocket and launched on an eight month 354 million miles long journey to Mars in a few weeks. The

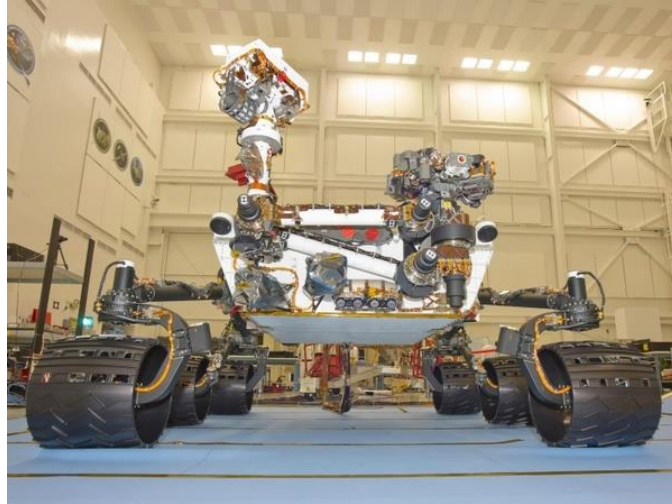
laboratory weighs almost a ton, and it has taken 7 years to develop at a cost of US \$2.5 billion. It will need to collect data under harsh conditions on the red planet – sub zero temperatures of up to -90° Celsius, the lack of any magnetic field to give it a sense of direction, and an atmosphere of almost pure carbon dioxide. The Gale Crater where it will land was known to contain water at one time, and the Curiosity Rover will search for signs of water and organic material that may indicate the presence of life. The Rover is bristling with scientific instruments with which it will analyse the environment that it finds itself in. Signals from the roving laboratory will take about 14 minutes to reach earth. It will be able to cover a distance of about 290 feet per hour, while gather samples, analyse them and send the data back to earth.

13.54 Private Space Missions!³⁷⁷

On 19th May 2012, a new spacecraft will be launched that will open the way for future private space missions. The spacecraft is the result of a collaboration between SpaceX and Bigelow Aerospace (BA) that will allow international customers to experience space travel, specially the near zero gravity experience. The "Dragon" spacecraft will be able to accommodate seven passengers and carry them to orbit around the earth.

13.55 Refueling Stations in Space!³⁷⁸

A problem encountered when planning for sending humans to the moon or to other planets is that sufficient fuel needs to be carried for the return journey. This adds considerable expense to the project because of the need to transport this additional weight. Now, Shackleton Energy Company (SEC) is planning to set up an ice mining unit on the moon that will be used to produce liquid oxygen and liquid hydrogen propellants needed for rockets. This will allow the refueling to be carried out in orbital gas stations in space.



13.53 Rover space vehicle. Reproduced with thanks from, http://wallpaperswa.com/Aircraft/Space/outer_space_robots_mars_nasa_vehicles_lowangle_shot_rover_curiosity_space_vehicle_space_scienc_e_51633



13.54 “Dragon”, spacecraft. Reproduced with thanks from, [http://en.wikipedia.org/wiki/Dragon_\(spacecraft\)](http://en.wikipedia.org/wiki/Dragon_(spacecraft))

The company hopes to have these fueling stations operational by 2020. In this connection, it will send two robotic scouting

machines to the lunar poles in order to locate sufficient quantities of ice. It also plans to place industrial astronauts to the moon for the purpose of establishing the fuel production facilities. The industrial expedition to the moon is expected to cost about \$15 billion. The first fuelling space depot will be located near the International Space Station. Others such depots will be established as and where required.

13.56 Space --- A Huge Mystery!³⁷⁹

The universe, estimated to be about 13.7 billion years old, is constantly expanding. The galaxies are racing away from one another due to some very strange forces that we do not understand. It turns out that space is not one dark empty vacuum. Some strange and powerful forces lurk within it. One mysterious force, "dark energy", accounts for roughly 71% of the mass of our universe while about 25% of it is made up of another powerful invisible glue that we call "dark matter" that appears to be holding the galaxies together. Indeed, it is remarkable that only 4.6% of the mass of the universe is accounted for by the "ordinary" visible matter made up of atoms - --the rest is dark matter and dark energy!

Our galaxy, the Milky Way, contains over 100 billion stars. Twenty "super earths" have been discovered that are at the right distances from their respective suns to have suitable temperatures for life to exist. Besides the right temperature, water must also be present for life, as we know it, to evolve. Water has been found on Jupiter's moon "Europa", Saturn's small (300 mile wide) icy satellite Enceladus, and on our own moon.

After a certain period of time, our earth's magnetic field undergoes a reversal so that north becomes south, and south becomes north. This last occurred 780,000 years ago. The magnetic field is responsible for the "magnetosphere" that protects the earth from the damaging effects of cosmic rays. Life would not have existed in its present form without this protective effect.

Finally, while may think that we are stationary, we are all actually travelling across space at an amazing velocity, 120 miles per second, on the giant spacecraft called "earth" towards the

enormous Virgo cluster of galaxies! Mysteries surround us everywhere!

13.57 Spacecraft Juno to Probe Jupiter³⁸⁰

Our solar system comprises four inner planets, Mercury, Venus, Earth and Mars and the outer giant gas planets, Jupiter, Saturn, Uranus and Neptune. In addition, there are the five dwarf planets, Ceres, Pluto, Haumea, Makemake and Eris. Jupiter is the largest of these planets and it is composed mainly of hydrogen and helium.

On August 5th 2011, the US Space agency NASA launched the spacecraft Juno from the Kennedy Space Centre in Florida on a mission to Jupiter that will cost \$ 1.1 billion. Juno will take about 5 years to reach Jupiter, the largest planet of our solar system. After reaching Jupiter in July 2016, it will spend one year in a polar orbit around Jupiter, sending back information about Jupiter's magnetic and gravitational fields. It will also study the amount of water present on that planet, thereby providing valuable information how the planets formed from a molecular cloud about 4.6 billion years ago and evolved.



13.57 spacecraft, Juno. Reproduced with thanks from, [http://en.wikipedia.org/wiki/Juno_\(spacecraft\)](http://en.wikipedia.org/wiki/Juno_(spacecraft))

13.58 Tiniest Solar System Discovered!³⁸¹

Kepler spacecraft has been searching for planets in a particular region of our galaxy. It does this by monitoring the change in brightness of these stars when planets cross in front of them. In December 2011 Kepler discovered a planet in the “habitable zone” (Kepler-22b) that was 2.4 times the size of our planet, earth. The habitable zone is the zone near a star which is the right distance for life to exist. If it is too close, it will be too hot for water (if present) to exist as a liquid and for life to evolve, while if it is too far, it will be too cold and water will exist as ice, preventing evolution from occurring.

Kepler has now discovered the tiniest solar system known so far. It comprises a single red dwarf and three small planets that are half and three-quarter the size of the earth. The smallest of the three planets has a surface temperature of 400°C and it is about the same size as Mars.

13.59 Transporting Astronauts and Space Cargo Cheaply!³⁸²

The Space Shuttle Atlantis touched down on 21st July 2011, marking the end of an exciting era in space transportation and the beginning of a new one. NASA’s Space Shuttle programme spanned a period of 30 years in which 135 space shuttle missions were undertaken by 5 space shuttles. There were many spin-offs in medicine and engineering of the programme. The artificial heart was developed employing the miniaturized ventricular assist pumps that were based on the fuel pump technology used in space shuttles. Many biodegradable lubricants used today were first employed on the giant crawlers that ferry the space shuttles to the launching pads.

With the ending of the space shuttle era, a new cheaper reusable aircraft, “Dream Chaser”, is being developed to carry astronauts and goods to the International Space Station. The new space plane is capable of vertical take-off and landing and will be able to carry up to seven persons. A contract of US\$ 80

million was awarded earlier this year to Sierra Nevada Corporation (SNC) for developing and testing the space plane. At present USA has to pay \$ 50 million per person carried on the Russian Soyuz aircraft to the International Space Station, and this dependency will be removed once the Dream Chaser starts its operations. The space plane may also be used for space tourism.



13.59 Dream Chaser, spacecraft. Reproduced with thanks from, <http://www.space.com/14446-photos-dream-chaser-space-plane.html>

13.60 Treasures in Space!³⁸³

Floating in space around our planet are about a hundred dead satellites. Such satellites are very expensive to build and launch, and the parts they contain are very valuable, being worth about \$ 300 billion. They also have highly sensitive technologies concealed in them and the Americans are worried that they could eventually fall in the wrong hands. The Chinese and the Indians have been struggling to build sophisticated satellites but with limited success due to the secret technologies involved.

Now, the US agency DARPA (Defence Advanced Projects Research Agency) plans to recover these valuable parts by scrounging them from the dead satellites. DARPA's Phoenix program is aimed at sending an unmanned spacecraft that will recover parts from the dead satellites, and attach the reusable parts such as antennas to new satellites. This would allow lighter satellites to be launched from earth as some parts could be fixed on them after they have been scrounged from dead satellites.

13.61 Voyager 1 at the Edge of Solar System!³⁸⁴

Voyager 1 is a US spacecraft that was launched about 34 years ago. It has been hurtling across space all this time and is now about 11 billion miles away from us. The data that it sends takes almost 17 hours to reach us. It is on the verge of becoming the first man-made object to leave our little section of this universe and enter into inter-stellar space. As it hurtles outwards, it is experiencing a significant increase in the intensity of the cosmic rays that are bombarding it. In this hitherto unexplored region of space, Voyager 1 is likely to come across new experiences as it enters the very edge of the solar system.

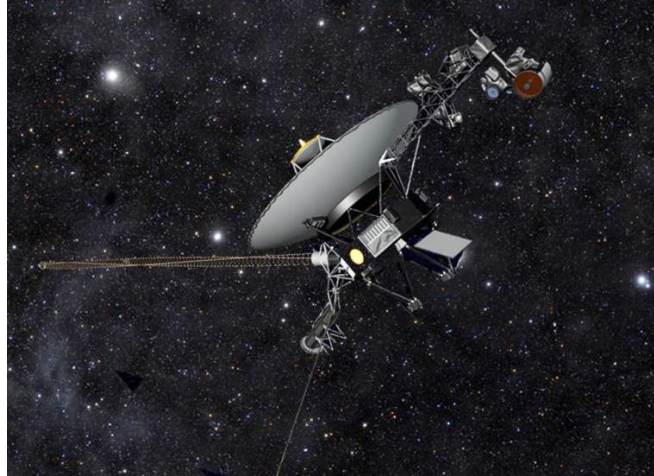
Another spacecraft, Voyager 2, was launched in 1977. It is now about 8.8 billion miles from the sun. The two spacecrafts have been traveling along different trajectories in order to provide information about different sections of our solar system. Voyager 1 is traveling somewhat faster, at a speed of about 38,000 mph, while Voyager 2's velocity is about 35,000 mph.

Will these spacecrafts be able to provide us with information about those mysterious forces that lurk in outer space --- dubbed as "dark matter" and "dark energy" by scientists, because of their ignorance of what they really are. The fact that about 95% of our visible universe is made up of these strange forces illustrates how little we know about ourselves.

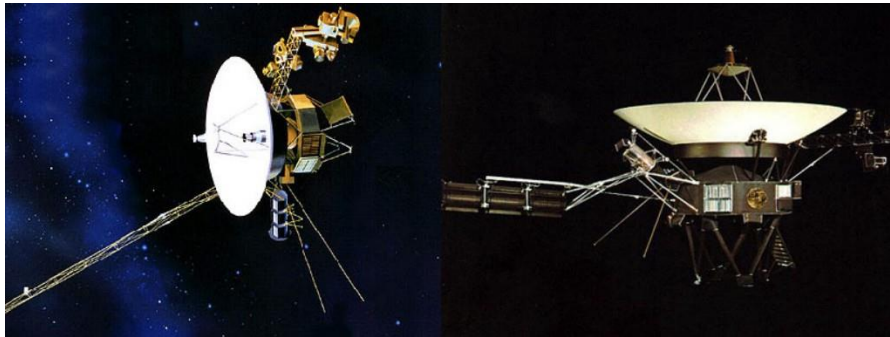
In the meanwhile the elusive "Higgs boson" (often referred to as the "God particle" as it is believed to impart mass to all other particles) is on the verge of discovery at CERN near Geneva. Scientists expect that within the next 3-4 months they should be able to tell with some certainty if the signals that they detected were indeed due to this particle, opening up an exciting new chapter in physics.

13.62 Winds at 20 Million Miles per Hour!³⁸⁵

The Chandra X-ray Observatory, launched in 1999, being one of the four great Observatories of NASA has found that ultra-fast 20 million mph winds are blowing in outer space from a gas disk around the "stellar-mass black hole" IGR J17091-3624.



13.61a Voyager 1 Explores the 'Magnetic Highway'. This still image and set of animations show NASA's Voyager 1 spacecraft exploring a new region in our solar system called the "magnetic highway." In this region, the sun's magnetic field lines are connected to interstellar magnetic field lines, allowing particles from inside the heliosphere to zip away and particles from interstellar space to zoom in. Image credit: NASA/JPL-Caltech. Reproduced with thanks from, http://en.wikipedia.org/wiki/Voyager_1



13.61b The Voyagers, Launch September 5, 1977 (Voyager 1, left), August 20, 1977 (Voyager 2, right)

Astronomers at ESA's Herschel Space Observatory now believe that such incredibly strong winds are preventing the formation of stars. (The other three great Observatories are the Hubble Telescope, Compton Gamma Ray Observatory, and the Spitzer Telescope).

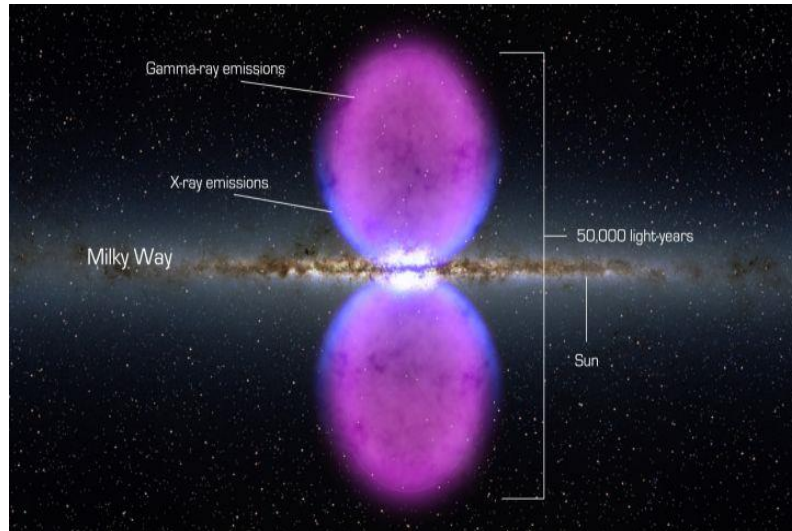
There are two other types of black holes thought to exist that are much more massive than stellar black holes. They are the "intermediate-mass black holes" that occur in the centre of globular clusters and "supermassive black holes" that are found in the centre of the Milky Way and in other active galaxies.

Lurking at the core of all the large galaxies lie black holes that swallow up anything that comes within their grasp. They do not even allow light to escape, and hence they are invisible, being detected by the effects that they exert on stars and solar systems in their vicinity. Stellar mass black holes are formed when a star more than 5 times the mass of our sun (5 solar masses) has burnt out all its energy. The outer layers of such stars are then thrown out in a huge supernova explosion. The core of the star then collapses and becomes so dense that even the atomic nuclei get tightly squeezed together. Once formed, the black hole continues to grow by swallowing up all the other stars in its neighborhood. So, a small black hole can grow over a period of time to a supermassive black hole of millions of solar masses.

It is thought that hiding at the centre of our own galaxy, the Milky Way, lies a supermassive black hole of more than 4 million solar masses.

13.63 World's Most Sensitive Radio Telescope³⁸⁶

The world's largest and most sensitive radio telescope is under construction. Known as the Square Kilometre Array (SKA), it will comprise 3,000 individual ground-based dish antennas that will be linked to act as one large telescope. The individual dishes will be spread over an area of approximately 3,000 kilometers (1,864 miles) and they will transfer one exabyte of astronomical data per day, twice the amount of data that is handled daily by the World Wide Web. IBM is partnering with a Dutch company ASTRON (the Netherlands Institute for Radio Astronomy) to develop computer systems that can process this huge amount of data efficiently.



13.62 From end to end, the newly discovered gamma-ray bubbles extend 50,000 light-years, or roughly half of the Milky Way's diameter, as shown in this illustration. Hints of the bubbles' edges were first observed in X-rays (blue) by ROSAT, a Germany-led mission operating in the 1990s. The gamma rays mapped by Fermi (magenta) extend much farther from the galaxy's plane. Credit: NASA's Goddard Space Flight Center. Reproduced with thanks from, (http://www.nasa.gov/mission_pages/GLAST/news/new-structure.html)



13.63 The Square Kilometer Array telescope will revolutionize our understanding of the universe. This computer-generated image shows how some of its 3,000 dishes would look on site. The Square Kilometer Array (SKA) telescope. Reproduced with thanks from, <http://edition.cnn.com/2012/03/26/tech/innovation/ska-telescope/>

14. TECHNOLOGY

14.1 Bionic Limbs with Sensitive Skin³⁸⁷

While bionic limbs have been known for some years, scientists at NASA and US National Institute of Aerospace have developed a synthetic skin which has fine carbon nanotubes embedded in it—tubes so fine that they are one-hundredth of the thickness of a human hair. These nanotubes impart some special electrical properties to this synthetic skin. This can allow a person fitted with an artificial limb coated with such a skin to acquire a sense of touch through transmissions of these sensations via a microchip connected to the human brain.

Time is not far when bionic parts will out-perform natural human body parts.

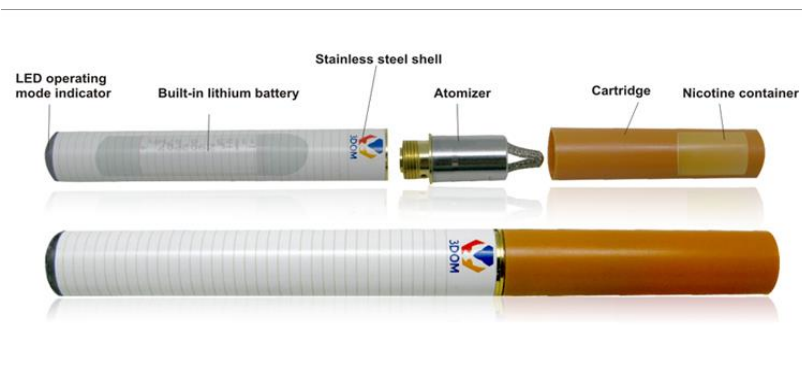
14.2 Ever Heard of “e-Cigarettes”?³⁸⁸

I was sitting on a plane last month on my way back from a conference in Trieste when I noticed a passenger on my left who was smoking a battery powered “cigarette”. The tip glowed red due to a fitted LED light every time he puffed but very little smoke came out of his mouth. The cigarette does not contain tobacco but allows the smoker to inhale a few micrograms of nicotine. Invented by a company in China the device costs about US\$60 while nicotine cartridges cost about US\$1.5 each. Tobacco contains certain cancer-causing nitrosamines which are largely absent in e-cigarettes (except from some minor contamination in the nicotine).

14.3 On Wireless Electricity and Intelligent Walls!³⁸⁹

We may be at the beginning of a new era in which electricity may not require wires and electronic devices may be operated without plugging them into wall sockets. The development has come from the path-breaking work of Prof. Marin Soljacic at MIT and is based

on the principle of transfer of energy between two magnetic coils having the same frequency. The first coil is contained in a box embedded in a wall, and is connected to the home's electricity mains which supplies the power. The second "recipient coil" is attached to the electronic devices such as television, laptop computer etc. The frequency of the two coils is matched which allows the transfer of energy from the first "supplier coil" in the wall to the second one on the device being used. The technology is perfectly safe as it is based on magnetic fields which have no negative effects on the human body. Indeed, the same principle has been employed in Magnetic Resonance Imaging (MRI) body scanning machines for decades in which the resonance frequency of the oscillator coils in the MRI machine is matched with that of the dancing ("precessing") hydrogen atoms inside the human body, thereby allowing these atoms to absorb energy and become visible. A US company "WiTricity", using the work of Prof. Soljacic has now demonstrated that it is possible to transport electricity wirelessly through the air, so that a light bulb can be switched on or a computer operated without any wiring or batteries!



14.2 How E-Cigarette Works: Internal Components Explained.
Reproduced with thanks from, <http://www.e-cigaretteinc.net/>

There are some 40 billion disposable batteries built every year, and millions of miles of wiring required in our homes annually ---- all this huge expenditure may soon be a thing of the past because our homes will have intelligent walls with in-built devices to supply invisible power through the air to various home gadgets!

14.4 Cars Running on Compressed Air!³⁹⁰

A French company (MDI, near Nice) has built a novel car which runs on compressed air in fiber tanks which pushes the pistons to create movement. It has a glued (not welded) tubular chassis, a fiber glass body and is the ultimate in electronic gadgets with voice recognition, internet connectivity, GSM telephone, GPS guidance system and a whole host of entertainment systems. It has a wireless control system with one tiny transmitter controlling lights, indicators etc. The car requires no keys but reads an access card from your pocket! Its cost of running is one-tenth that of a petrol engine, has a top speed of 68 mph and a range of up to 300 km before requiring a fresh charge of compressed air. The car can be refilled at adapted petrol stations within 2-3 minutes with compressed air. It also carries its own air compressor for emergencies or overnight refilling from the mains (takes 3-4 hours). It has zero pollution and requires 1 liter of vegetable oil every 50,000 km for oil change. The temperature of the air expelled from the car is 0 to 15 degrees below zero, which can be used for an internal air conditioning system, without needing any refrigerant gases or power for cooling. It took 10 years for the French company to develop this car and it has been licensed out to Tata Motors in India for mass production. The car will be launched in USA in 2010.

14.5 A Car that Goes 2487 Miles per Gallon!³⁹¹

A prototype car built by students at Laval University in Quebec, Canada won the first prize at the 2010 Shell Eco-Marathon in 1st week of April 2010 by achieving an astonishing 2487 mpg! The car was built with special lightweight materials and had an aerodynamic design with a very special type of combustion engine. The present world record is held by a hydrogen-powered car manufactured by the Swiss institute ETH in Zurich that reached 5385 kilometres with hydrogen equivalent to 1 litre of petrol.

14.6 Electric Cars --- Lean and Mean!³⁹²

Electric vehicles have been in commercial use for a long time. The milk delivery vans in use since the 50s in the UK were battery

powered to avoid the irritating noise of combustion engines early in the morning. One imagines electric powered vehicles to be quiet but slow moving dull vehicles. Not true anymore. A German company, e-Wolf, has been developing mean looking electric sports cars for some years. Its latest model, which looks like a Ferrari or a Maserati, is claimed to accelerate from 0 to 60 mph in less than 4 seconds with a top speed of 155 mph. It has an ultra-light carbon-aluminum chassis and weighs about 900 kg. Each of its 4 wheels is powered by 134 powered electric motors using flat Lithium ion batteries which allow the car to travel 186 miles without recharging.



14.4 MDI AirPod at the 2009 Geneva Motor Show. Reproduced with thanks from, <http://en.wikipedia.org/wiki/AIRPod>



14.6 German electric sports-car manufacturer e-Wolf has unveiled its very special E1. Reproduced with thanks from, http://www.gtspirit.com/2009/10/07/green-power-e-wolf-e1-e2/?switch_theme=mobile&font_size=small

14.7 Electric Vehicle Sets World Record³⁹³

Rapid improvements in battery technologies combined with light weight materials for car construction are making electric-powered cars the vehicles of the future. Now, the US manufacturer of Tesla electric sports cars has set a world record at the Global Green Challenge race in Australia, when the vehicle managed to travel a formidable 501 km on a single battery charge. Its design resembles that of the Lotus Elan. Honda achieved a distance of 360 kilometers on a single charge in the same race, but was more efficient in terms of distance travelled per watt hour of battery power. It achieved an efficiency of 85 watt hours per kilometer, which is claimed to make it the most energy efficient vehicle in the world.

The electric cars are coming!

14.8 A Leaning Vehicle!³⁹⁴

The Japanese car maker Nissan has recently developed a tilting, half-width, two-seater, light weight motor car which works with lithium ion batteries. The ability of the vehicle, known as “Land Glider” to tilt by up to 17 degrees when going round corners provides the exhilarating feeling of riding a motor cycle. The car batteries can be recharged wirelessly at super markets or wherever facilities for charging exist. The car is fitted with a robotic crash avoidance system which detects nearby vehicles and automatically avoids collisions.

14.9 Talking Cars!³⁹⁵

Hundreds of people die each day in car accidents, and the cost of these accidents in US alone is over \$ 230 billion. Now technology is beginning to come to the rescue. New devices installed in the vehicles will allow vehicles to electronically communicate with one another and alert you of another invisible approaching vehicle which is round the corner. The system will even put on your brakes if you do not respond in time. Such

systems will be available on most cars before long and they will constantly track the speed and direction of other approaching vehicles. The communication networks between cars and with the main traffic control systems will considerably reduce the danger of surprise collisions.



14.7 Internode managing director Simon Hackett has driven his Tesla Roadster into the record books, completing 501km on a single electric charge in the 2009 Global Green. Tesla grabs land distance record for electric car. Image source: Teslamotors. Reproduced with thanks from, Challenge <http://www.pcauthority.com.au/News/159181,tesla-breaks-land-record-for-electric-car-on-a-single-charge.aspx>



14.8 The Land Glider is a tilting-body, electric powered, concept car which Nissan revealed at the 2009 Tokyo Motor Show. Reproduced with thanks from, http://www.diseno-art.com/encyclopedia/concept_cars/nissan_land_glider.html

14.10 Cars that drive themselves!³⁹⁶

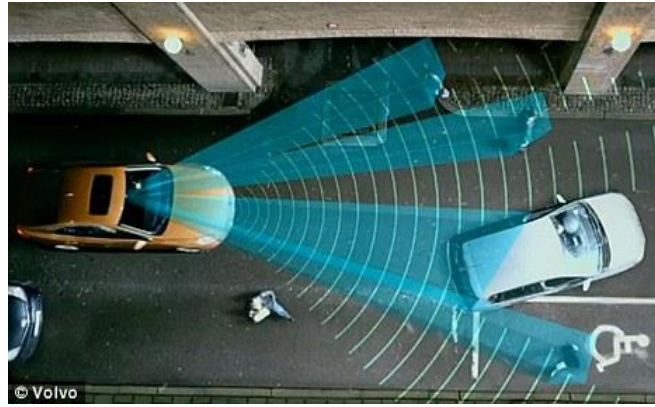
About 100,000 people die in car accidents each year. Can we have cars that will sense an impending accident and come to a screeching halt before the impact occurs? Well, you will be pleased to learn that one such car, Volvo S 60, will be launched next month, and other manufacturers are likely to follow. The car is equipped with camera and radar devices that monitor approaching objects and laser systems that accurately determine distances and transmit these to on-board computers. When all cars on roads are equipped in this manner, we will enter in a new era that will be free of road accidents.

In Japan, a new smart highway system has already been developed that alerts drivers if they get too near a car in front of them, if there are vehicles converging on to the road from a side road, or if the road in front is congested. Known as 'Smartway', the system is expected to dramatically reduce road accidents.

The most exciting of such projects under development is aimed to make the car drivers redundant, at least for most of the journey. Known as SARTRE (Safe Road Trains for the Environment), the system is being developed by seven car manufacturers and some European universities. Cars will travel at high speeds in a convoy of eight cars, only one metre apart, with a lead car controlling the convoy's movements by an onboard computer. This will allow drivers to read, sleep, or play games as long as their car is within such a convoy. The drivers will be able to resume control when they wish to exit the highway. Cars joining the highway will be able to book their place within one of many such convoys travelling on the highway. It is expected that fuel consumption and emissions will also be cut by 40 percent by this system.

14.11 Intelligent Vehicles!³⁹⁷

Have you ever played chess against a computer, and felt dazed at how clever the machine was? Intelligent chess sets have been around for more than two decades. In the meanwhile, machine intelligence has progressed at a phenomenal rate.



14.10a Radar sensors: Volvo has developed a pedestrian detection system that automatically brakes a car to a halt whenever someone steps out in front of it. Reproduced with thanks from, <http://singularityhub.com/2011/02/22/volvos-new-pedestrian-detector-brakes-car-for-you-video/>



14.10b This time last year, the Safe Road Trains for the Environment (SARTRE) program hit a milestone. Using a specially equipped Volvo S60 with a big-rig taking the lead, the EU-funded researchers managed to create the world's first fully-functional road train, allowing the driver in the sedan to sit back and enjoy the ride without touching the controls. Reproduced with thanks from, <http://www.autoblog.com/2012/01/24/sartre-autonomous-road-train-enters-final-phase-with-trio-of-vol/>

This was demonstrated dramatically when a Toyota Prius fitted with an electronic brain developed by Google and with hundreds

of sensors drove itself across highways and busy roads in California without human intervention, deftly dodging approaching vehicles. This heralds a new era of automated driverless vehicles that will carry you wherever you want after a simple voice command informing the robotic vehicle of the destination.

Such automated cars are fitted with video cameras, laser range finders and radar sensors to instantaneously avoid collisions with other moving or stationary objects and to follow the road signals accurately. They use GPS systems for constant guidance. The cars can be programmed to drive in 'aggressive' or 'cautious' modes according to the different personalities that may be travelling in them. The car was conceived by Thrun, director of Stanford Artificial Intelligence Laboratory and a Google engineer.

Cars with built-in artificial intelligence, capable of driving themselves may soon put an end to traffic fatalities.

14.12 Electric Cars—Fast and Furious!³⁹⁸

Electric cars have been generally considered as slow moving, expensive vehicles with little to cheer about. This is not true any longer. At the Paris motor show, a large number of manufacturers exhibited new hybrid and electric cars, but one bound to create much excitement was that displayed by a little known French company Exagon. The car can go from zero to 100 kilometers per hour in 3.5 seconds, has a range of 500 miles, and a top speed of 155 mph. It has two Siemens 168 hp electric motors that generate a total of 336 horsepower. Its range when travelling on electric motors is 400 kilometers (250 miles), and then the petrol engine takes over to double the range.

While electric cars are presently more expensive than those using combustion engines, mass production is likely to bring their cost down.

14.13 Improving Car Performance --- with Batteries!³⁹⁹

Hybrid cars that run on petrol and battery powers are under intensive development. Nickel-metal-hydride batteries are being

used in some hybrid cars, while Mercedes have recently announced the use of lithium-ion batteries on its S400 BlueHybrid which will be connected to a 20-horsepower electric motor to provide additional power to the main 3.5 liter V6 engine, thereby improving its performance to that of a V8 engine, and allowing the car to achieve a fuel economy of 30 miles per gallon. The engine is switched off when the car slows to speeds below 9 mph, and the electric motor restarts the engine at higher speeds. Some other manufacturers such as BMW, Mazda and Porsche are also using this engine “off-on” method to improve fuel economy.



14.11 Google's self-Driving Car. Reproduced with thanks from, <http://www.examiner.com/slideshow/examples-of-self-driving-vehicles#slide=1>



14.13 2010 Mercedes-Benz S400 BlueHybrid. Reproduced with thanks from, <http://www.roadandtrack.com/car-shows/2008-paris-auto-show/photos-2010-mercedes-benz-s400-bluehybrid-1#slide-1>

14.14 The Most Fuel Efficient Car in the World?⁴⁰⁰

A number of car manufacturers are trying hard to develop fuel efficient cars by using a combination of batteries and fuel (hybrids), reducing the weight of the vehicles and making them more aerodynamic. Volkswagen has announced that it will start manufacturing a vehicle by next year powered by a tiny single cylinder engine which will be able to go up to 100km with only one liter of petrol (235 miles per gallon). Fitted with such safety features as air bags, deformable front end etc., the outer body is made of carbon fiber composites while magnesium instead of aluminum has been used in the frame to reduce weight. The result is the most fuel efficient car in the world which weighs only 639 pounds!

14.15 Optical, DNA and Quantum Computers⁴⁰¹

Present day computers use electric current in transistors, with the electrons moving in-and-out of transistors to create binary logic. New types of computers are under development based on optical computing, DNA computing and quantum computing. With optical computers, employing optical transistors, photons in infra-red or visible light beams are employed to carry out the digital computing process resulting in higher processing speed, since photons (light particles) travel much faster than electrons. Another advantage is that unlike the passage of an electric current which produces heat and can damage the hardware, the passage of light does not produce heat.

DNA computers can carry out parallel processing, i.e. multi-tasking, like the human brain, unlike most modern electronic computers which carry out tasks sequentially. This is expected to make DNA computers much faster than conventional machines. Biochips, involving the use of DNA molecules integrated on computer chips, are presently under development. Once developed, it is expected that DNA computers will be incredibly powerful, and able to carry out complex tasks and calculations far more efficiently than today's electronic machines.



14.14 The XL1 is 153.07" long, 65.55" wide and just 45.39" tall. By usual automotive standards these are extreme dimensions. For comparison: a Polo has a similar length (156.3") and width (66.22") but is significantly taller (57.56"). Reproduced with thanks from, http://www.europeancarweb.com/news/epcp_1302_volkswagen_xl1_concept_production/#ixzz2uzQIKJGM

Quantum computers under development will operate at speeds a billion times faster than today's computers and the information transferred will be ultra-dense. As quantum computing is reversible, theoretically there will be no net energy consumption. Japan and US defense agencies are allocating huge research funds in the development of quantum computers because they will be utterly secure, as they rely on the principle of "quantum teleportation" (seen Star Trek ?) of information without any signal path!

14.16 Cool Computers!^{A02}

"Spintronics" is a fast evolving field which relies on the spin of electrons rather than variation in voltages used in modern electronics to store and transport information. A material, bismuth telluride, has been found to possess a highly desirable property---- it offers almost zero resistance to the flow of electrons. It is more attractive than conventional superconducting materials (which require cooling to about -150°C) as it exhibits the near zero resistance at room temperature and no heat is produced, thereby allowing power transmission to occur without losses. Spintronic materials are

likely to find wide applications by improving memory density in hard drives, and speed in Magnetic RAMs.

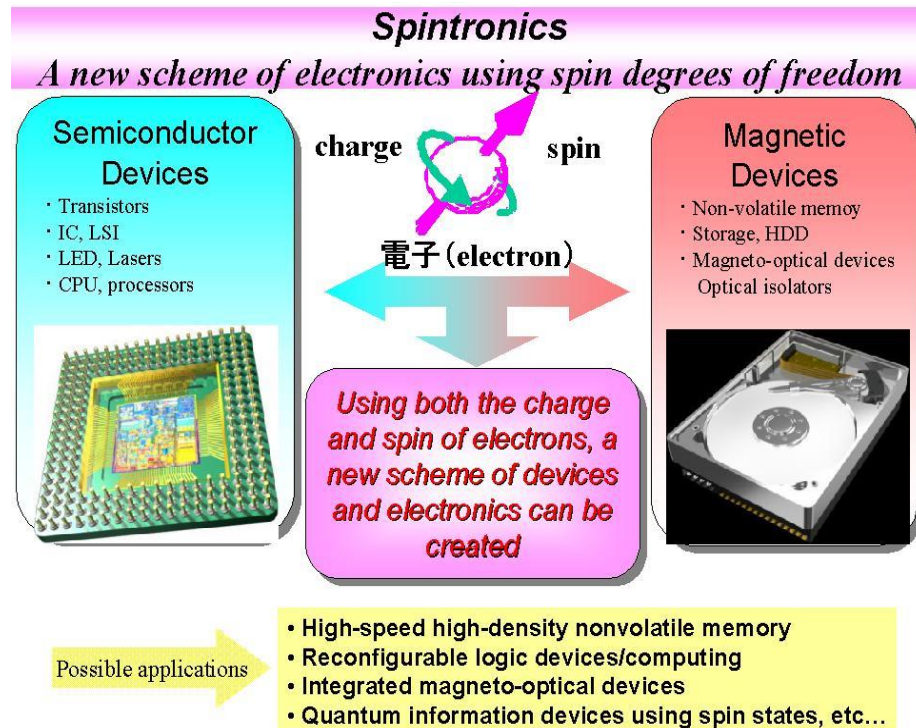
Another interesting development is that of “excitons”. These are electrons bound to a hole in an insulator material. Integrated circuits have been successfully built, operating at -148 °C, based on exciton technology, thereby opening up possibilities of much faster computers.

14.17 Robots: Learning like Children!⁴⁰³

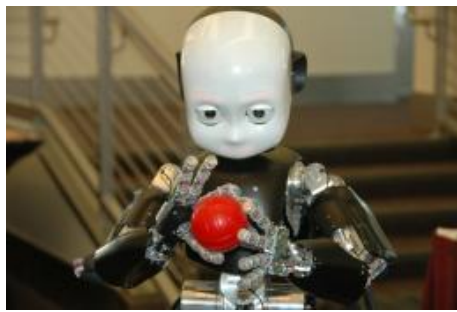
At the Italian Institute of Technology in Genova, robots have been created with the ability to learn from their surroundings, just as children do when they are growing up. The robot has the size of a toddler, and its brain has been designed so that it learns by interacting with its surroundings. Scientists hope to understand from the robot, named “iCub”, how human beings think and learn. iCub can recognize human faces and detect specific objects against a background. It has fingers which can clasp objects and it is learning how to catch a ball in mid-air. In time, it is hoped that iCub will also learn to recognize different sounds and finally learn to speak.

Eleven European Universities and research institutes have joined together in this Robot-Cub project with a US 12 million grant from the European Union. Twenty iCubs are being manufactured of which eight have already been sent to selected laboratories in Europe and Turkey, where they will be subjected to various training programmes. Other robots previously developed are the wheeled robot Khepera, built by a Swiss consortium, and the Japanese humanoid robots HRP-2, PINO and ASIMO which can play music or walk on uneven surfaces. Robots have a huge potential in both industrial and military areas, and countries with the most advanced robotic armies may one day rule the world.

Once robots become super intelligent and learn to replicate themselves, there may no longer be any need for those frail and volatile biological earthlings called “humans”!



14.16 Reproduced with thanks from, <http://www.cryst.t.u-tokyo.ac.jp/~masaaki/content.english.html>



14.17a iCub, the Toddler Robot.
<http://www.robotcub.org/>



14.17b The HRP-2 completes task such as controlling your TV, moving a chair for you or opening your fridge and getting you a beer by just saying a few voice commands. To see a video of this robot in action. <http://hight3ch.com/hrp-2-beer-fetching-bo/>

14.18 World's Fastest Computer to Explore Dark Matter, Dark Energy Mysteries!⁴⁰⁴

The world's fastest computer "Roadrunner" has been developed through collaboration between IBM and the Los Alamos National Laboratory. It is able to perform 1000 trillion operations per second! It is being employed for the US nuclear programme, as well as for exploring the secrets of the universe, genomics and climate change. The machine is a giant---- it occupies 6,000 square feet of space, has 10,000 connections which use 57 km of optical fiber and its 80 terabytes memory weighs 500,000 pounds!

Only 4.6% of the mass of the universe is accounted for by the "ordinary" visible matter made of atoms. About 23% of the matter is "dark matter" that is invisible but its presence can be deduced from the motion of galaxies. The remaining 73% of the universe is an even stranger component, "dark energy". This is a huge unsolved mystery. Although dark matter cannot be seen directly, its presence can be indirectly sensed from the grasp on clusters of galaxies, holding them together. Dark energy also accounts for the manner in which the universe continues to expand at an accelerating pace.

The base unit used for calculations by the "Roadrunner" is a particle with a mass of a billion suns. Such a large unit was necessary as the galaxies being modeled have masses of about a trillion suns. The computer employs some 64 billion or more of these "billion sun" particles to simulate the dimensions of the universe. The scale of the calculations involved is truly mind boggling.

14.19 Artificial Intelligence – the Dark Side!⁴⁰⁵

Will intelligent machines one day threaten our very existence? Self- evolving machines that have the capability of making other machines better than themselves are very much a possibility in the future. You may have been surprised how intelligent an electronic chess player is and how it can foresee your moves,

preempt them, and plan its own strategic approach to defeat you. Robots currently available can only perform mundane tasks



14.17c Asimo dancing. Okay! Don't hurt yourself! (http://robotgossip.blogspot.com/2005_12_01_archive.html)



14.18 Roadrunner – BladeCenter QS22/LS21 Cluster (IBM). Reproduced with thanks from, <http://www.gizmocrazed.com/2011/11/top-10-supercomputers-in-the-world-november-2011/#ixzz2v3wd7zwb>

such as cleaning floors or obeying simple commands. However, more sophisticated systems are being employed to help lifeguards to detect when a person is drowning in a swimming pool or assist drivers to pick the best road to their destination after analyzing traffic flows. Researchers are concerned that the day is not far when an Artificial Intelligence “singularity” will be created, an out-of-control chain reaction in which machines start building other improved machines.

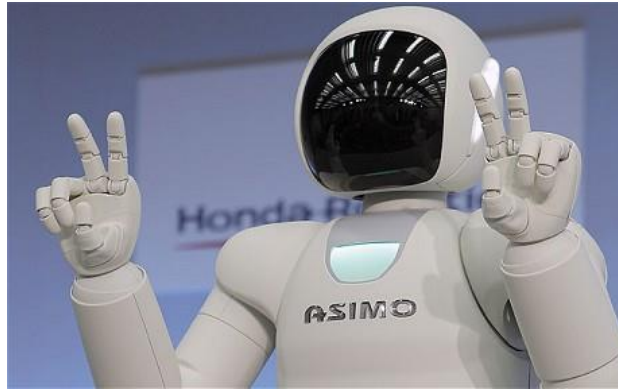
14.20 Controlling Robots---by Thought Alone!^{A06}

Honda has developed a special hat which when worn can control the movements of robots just by thought! The hat is in the form of a skullcap that has highly sensitive electrodes fitted in it which detect the electrical signals from the brain as well as the blood flow. The information is transmitted to a robot, which recognizes the intention of the person wearing the hat and acts accordingly. This mind reading hat uses remote sensing sensors so that no surgical implants are needed.

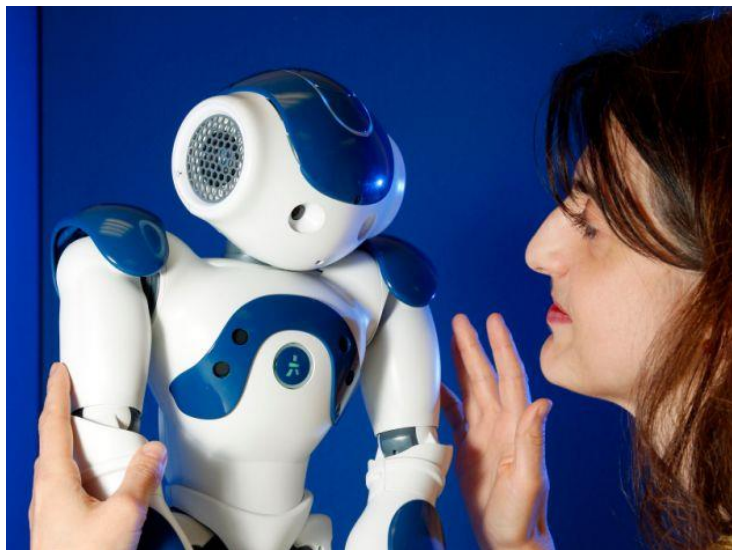
14.21 Robots - that Sense Your Emotions!^{A07}

Prof. Peter Robinson and colleagues at the University of Cambridge have developed a robot that can sense your emotions and make appropriate responses. It reacts with feelings of empathy, joy, anger or frustration, depending on the situation and the mood of the person interacting with it.

While voice recognition software has been around for quite a while, mood recognition software is a new development. The robot is fitted with a camera that detects the changes in the facial movements, body gestures, and pitch of the voice of the person, thereby enabling an assessment to be made of the overall mood of the person. The robot then responds accordingly with its own remarks.



14.19 Artificial intelligence robot which can help round the home is unveiled. Reproduced with thanks from, <http://www.telegraph.co.uk/technology/8878257/Artificial-intelligence-robot-which-can-help-round-the-home-is-unveiled.html>



14.21 Lola Cañamero comforting a sad robot. Reproduced with thanks from, (<http://plus.maths.org/content/making-robots-feel>)

14.22 Robotic Fighter Aircraft - A New Era Begins!⁴⁰⁸

The tremendous advances in machine intelligence are heralding a new era in which machines will be able to assess the situation on ground in a battle environment and work out the best strategy to destroy the enemy. Such robotic soldiers are under intensive

development at a number of defense related establishments, particularly in USA. On Friday 4th February, 2011, a historic step was taken when an unmanned aircraft, being capable of taking off from an aircraft carrier, engaging enemy aircrafts or neutralizing other threats and then returning to base, made its first successful flight test from Edwards Air Base in California.

The aircraft has a high level of machine intelligence incorporated in it and makes its own decisions in various situations. The U.S. Navy X-47B Unmanned Combat Air System Demonstration (UCAS-D) aircraft has been developed by Northrop Grumman and can operate as a completely autonomous system without human intervention.

14.23 Robots - that See Through Walls!⁴⁰⁹

The US army has funded a programme under which a robot has been developed that is so sensitive that it can actually see through walls by detecting reflected radio-waves. The robot contains an extremely sensitive RF scanner that can send wide band signals that can penetrate through concrete walls and reveal the sights and sounds that occur behind. The robot can be controlled remotely and can be used for spying what is going on in hotel rooms or in the office or home of the President or Prime Minister of a country. Even the sound of breathing of a person can be detected by this robot remotely, as it is fitted with a fine beam ultra-wide band multi-Gigahertz radio-frequency sensor arrays. This “sense-through-the-wall” (STTW) technology will expose many politicians and leaders to intruding electronic ears and eyes. Named Cougar 20H, the robot has been developed by TiaLinx.

Meanwhile, the space shuttle Discovery blasted off to space recently with the first humanoid robot (Robonaut 2) on board. It will learn to perform various tasks that are normally performed by astronauts and will eventually replace astronauts for certain chores once it is properly trained. It will also be useful in emergencies to perform repairs and other tasks in space.



14.22 (The Navy's X-47B Unmanned Combat Air System (UCAS) demonstrator aircraft. Results from test flights conducted with the aircraft earlier this year will help the Navy to develop parameters for a next-generation variant of the X-47B for its UCLASS program). http://www.aviationtoday.com/av/unmanned-aircraft-systems/GAO-Reports-Concerns-on-Navys-Unmanned-Aircraft-Program_80313.html#UxbAdM6s_N4



14.23 Cougar20-H surveillance robot that sees through walls and detects breathing, <http://www.gizmag.com/cougar20-h-surveillance-robot/17800/picture/129773/>

14.24 Carnivorous Robots!⁴¹⁰

Ever heard of carnivorous robots? James Auger and Jimmy Loizeau at the Royal College of Art London have designed a number of domestic robots that will lure and then eat up flies and other small moving insects. They will also benefit from the process by deriving energy from the swallowed insects. This is because they are powered by an internal microbial fuel cell installed within the robots which runs by this process. The idea of using vermin as fuel was first proposed by a UK based company, Bristol Robotics Lab, which had developed the first fly-powered robot in 2004, and proposed that similar marine robots could be developed which could “survive” on plankton.

14.25 Moving Wheelchairs --- by Mind Control⁴¹¹

Is it possible to control the movement of wheelchairs by thought? Indeed it is! Paralysed patients can now move around unaided across rooms on battery powered wheelchairs the direction of which can be controlled by focusing thoughts while they concentrate on a screen fitted on the chair which has a 3D map of their surroundings. The 3D map is constantly created and updated by a laser mounted in the front of the chair. The users need to wear a special skull cap which has a number of electrodes fitted around their scalp. The electrodes detect brain activity. If the brain activity lasts longer than a millisecond, which happens when the user is looking at the point on the map to which he wishes to travel, this triggers the movement of the wheelchair in that direction.

The chair has been developed by Javier Minguez and his colleagues at the University of Zaragoza in Spain. The invention was presented at the International Robotics and Automation conference earlier this summer. A person can learn to navigate around obstacles, avoid collisions and drive around freely in the chair by mind control in less than an hour.



14.24 organically powered: ecobot-iii was able to both eat and produce waste inside its lab environment. (photo: bristol robotics laboratory) <http://www.mnn.com/green-tech/gadgets-electronics/stories/waste-powered-robots-the-future-of-machines>

14.26 Seeing with the Tongue!⁴¹²

A company “Wicab” based in Wisconsin, USA has developed a device which allows completely blind persons to partly see with their tongues! A small digital video camera is built into sunglasses worn by the blind person and the digital signals from the camera are transmitted into a small base unit about the size of a mobile phone which converts these signals into electrical



14.26 Lance Corporal Craig Lundberg. The soldier, left blind by a grenade in Iraq, has told how his life has been transformed by ground-breaking technology that enables him to "see" with his tongue. Reproduced with thanks from, <http://phys.org/news187946960.html#jCp>

pulses. The pulses are then transmitted into a “lollipop”-like device which lies on the tongue. The tingling sensations felt by the tongue allow the blind person to sense his surroundings after some training so that he can navigate his way through doors and corridors, identify lift buttons, distinguish a knife from a fork on the dinner table, distinguish letters and perform other such tasks. The device has been developed in association with the University of Pittsburgh Medical Center and is expected to be marketed by the end of this year.

14.27 On Mind Control!⁴¹³

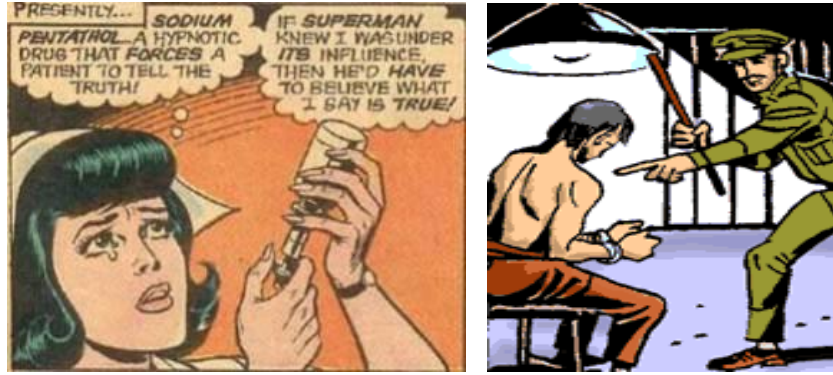
The ability to control thought processes has been a research target for many research establishments and government agencies. The Indian Central Bureau of Investigation (CBI) employed sodium pentothal, a truth drug, to obtain information regarding the November 2008 Mumbai terrorist attacks. CIA and KGB have used this technique widely in their operations and a number of drugs are known which can extract the truth from the unwilling.

Drugs have also been developed that will diffuse your will to fight. A nasal squirt of the hormone oxytocin reduces aggression and increases trust, with the potential to transform hostile armies into a friendly state of mind! Another agent BZ causes delirium by acting on the brain, making it difficult to think or speak coherently. In October 2002, a Fentanyl derivative was employed against Chechen rebel fighters who had held 750 people as hostage in a Moscow theater.

Biotechnology is a double edged sword, with the capability of producing beneficial drugs and industrial materials on the one hand and potent biological weapons on the other.

14.28 UFO-Like “Flying Saucers” are here!⁴¹⁴

Circular flying spaceships carrying aliens to earth have been sighted occasionally since the 1950s. Now, they have been actually invented!



14.27 <http://www.chm.bris.ac.uk/motm/sodium-pentothal/sodiumjm.htm>



14.28 An AESIR UAV takes flight. <http://www.gizmag.com/aesir-unmanned-aerial-vehicle/12813/>

A UK based company (AESIR) has developed circular flying vehicles of various sizes which can take off vertically, and use the “Coanda effect” for generating power from a central fan for hovering and flying. This effect represents the tendency of fluid jets to follow a circular path aligned with the surface of a curved body instead of remaining on their original straight path. It can be simply illustrated by placing a burning candle behind a circular can and blowing air at the can. The flame will be extinguished, even though it lies concealed behind the can, because the air stream will follow the circular path defined by the shape of the can. The various aircrafts developed by the company range in sizes from 30cm in diameter capable of carrying 100 grams of payload to larger aircrafts capable of

carrying over a ton of material. The exotic looking “flying saucers” were displayed recently at the Defense Systems & Equipment International Exhibition in London.

So if you see flying saucer, don't run screaming --- it is likely to be an AESIR circular aircraft!

14.29 Flying Human Jets!⁴¹⁵

In September last year, Yves Rossy donned a special suit fitted with four small jet engines on foldable wings and jumped off a plane above France. He flew about 22 miles across the English Channel, thus becoming the first “birdman” to fly a jet powered personal wing across the Channel. Does this mark the beginning of a new era in personal transportation?

Imagine that you have to take your children to school. All of you don these personal jet powered wings and fly away like birds, soaring high above the city, before descending minutes later in the school compound.

14.30 Perpetual Planes --- that Fly without Refuelling!⁴¹⁶

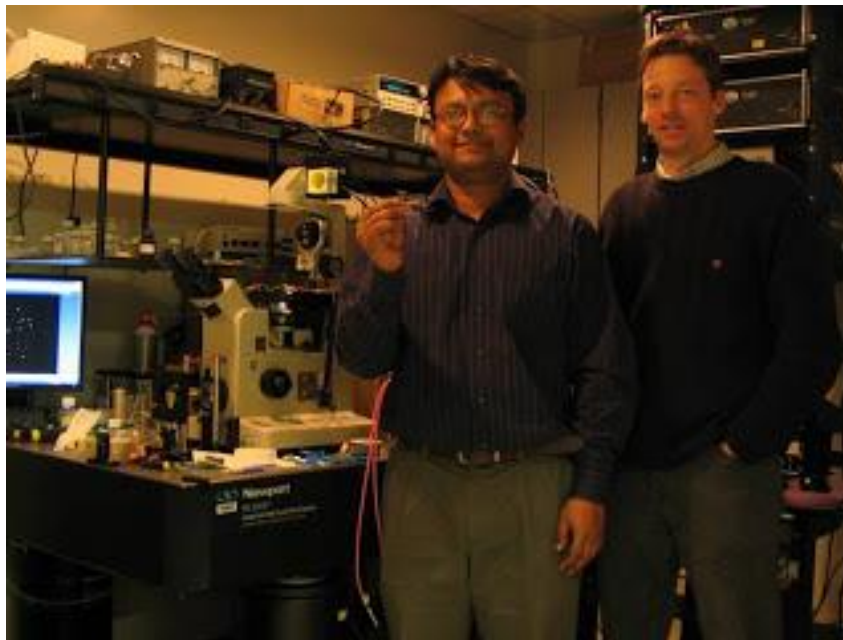
Can we build planes that will fly forever, and never need refueling? Yes! Pentagon's advanced-research organization Darpa has announced a competition under the “Vulture” programme, to build aircrafts that will fly continuously for years without refueling. These will be unmanned surveillance and communications aircrafts that will fly over targets perpetually and transmit information without any interruption. The first entry of such an aircraft called *Odysseus* has a Z-wing configuration with solar cells on the wings designed to capture maximum sunlight that will power it during day and night.

14.31 Nano-Submarines!⁴¹⁷

Peer Fischer and colleagues at Harvard University have developed a tiny device with the thickness of a hair and with a



14.30 Odysseus' radical Z-wing configuration. Odysseus: Aurora's radical, unlimited endurance, solar powered aircraft. <http://www.gizmag.com/auroras-radical-odysseus-solar-powered-aircraft-unveiled/9261/>



14.31 Ambarish Ghosh and Peer Fischer of the Rowland Institute at Harvard University with a microfluidic chiral detector, <http://www.2physics.com/2007/03/chiral-liquid-splits-light-beam.html>

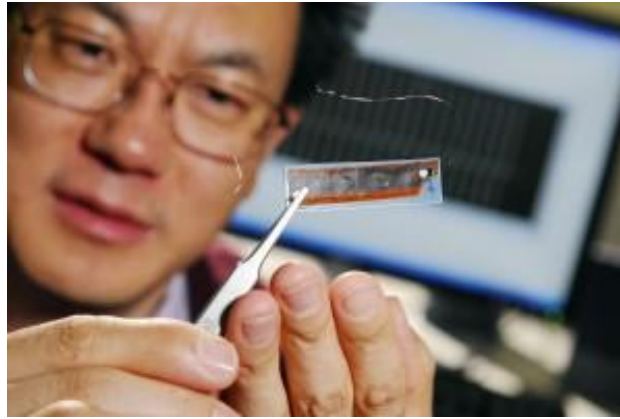
length about one fifth of a millimeter. It has a tiny glass bead, barely visible to the naked eye, at one end and a cork screw-like tail. One end of the device is coated with cobalt. Since cobalt is magnetic, its movement through fluid can be accurately controlled by an external magnetic field. The sperm-like device fitted with cork-screw shaped tail behaves like a small propeller which can swim through blood vessels, and may thus carry the “load” of a drug about a thousand times its own weight to the site of the infection. The device mimics the cork-screw motion of flagella to move through the liquid (*Nano Letters*, DOI: 10.1021/nl900186w).

14.32 World’s First Self-Powered Nanosensors!¹⁸

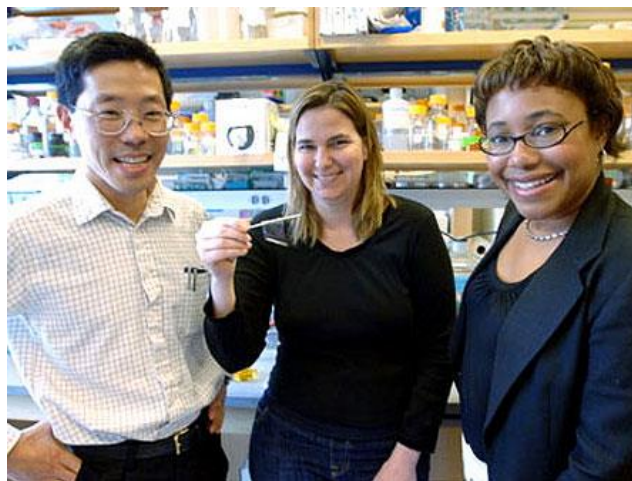
Scientists working at the Georgia Institute of Technology in USA have developed the world’s first self-powered nanosensors. The electricity generators comprise thousands of embedded zinc oxide nanowires that convert mechanical power into electrical power (employing the piezoelectric effect) when the wires are subjected to mechanical stresses. The piezoelectric effect already finds wide applications in many devices, such as the ignition source for cigarette lighters and for igniting propane-barbecues through the push-start process, as well as in several types of scientific instruments. The mechanical stress results in the production of a voltage across the material. The nanosensors are completely enclosed on a flexible surface and do not require contact with metal electrodes. The flexible devices in which the nanosensors are implanted do not require batteries and they can be embedded in running shoes, in microphones using the mechanical vibrations produced by sound to power them or the mechanical energy from sea waves to produce energy. (<http://www.nature.com/nnano/journal/vaop/ncurrent/full/nnano.2010.46.html>).

14.33 Viruses to Serve as Superbatteries!¹⁹

Paula Hammond and her colleagues at MIT have succeeded in developing genetically engineered bacteria that have the ability



14.32 Georgia Tech professor Zhong Lin Wang holds an improved nanogenerator containing 700 rows of nanowire arrays. The generator was used to power nanometer-scale sensors. (Credit: Gary Meek). Reproduced with thanks from, <http://www.gtresearchnews.gatech.edu/self-powered-nanosensors/>



14.33 From left, MIT professors Yet-Ming Chiang, Angela Belcher and Paula Hammond. The three have authored a paper detailing their virus-based method of creating and installing microbatteries by stamping them onto a variety of surfaces. Photo/Donna Coveney. <https://student.societyforscience.org/article/batteries-built-viruses>

to bind with certain electrically conductive materials such as cobalt oxide. The metal coated devices can serve as very powerful and efficient batteries, since they have a thin long structure with the capacity of packing significant charge in a very

small space, thereby making them far more efficient than traditional batteries. Even when the virus structures degrade, the metal coating is strong enough to survive and continue to perform. The “viral batteries” are less than half the size of a living cell, and have the potential of powering tiny medical implants and various miniaturized electronic devices---such as spy “mosquito drones” developed by NASA!

14.34 Printable Batteries!^{A20}

Printable electronics that can be printed on flexible materials by industrial printing machines to produce wearable sensors, smart labels etc. have been known for some time. However, the development of printable batteries has not proceeded so rapidly. A research institution in Chemnitz, Germany, the Fraunhofer Research Institution for Electronic Nano Systems, has now developed paper thin batteries that can be produced by mass printing using silk screens similar to those used for printing t-shirts. Each battery weighs only about one gram and has a voltage of 1.5 volts. Several batteries can be pasted in sequence to produce 3V, 4.5V, 6V etc. Each battery has a zinc anode layer and a manganese cathode layer. Applications may include battery powered bank cards, illuminated greeting cards and a host of other exciting uses.

14.35 Viruses as Batteries!^{A21}

Can we use viruses to work as batteries? Yes, we can. Dr Angela Balcher at MIT has inserted a gene into a harmless virus. These genetically modified viruses have the ability to produce certain proteins which can capture iron and phosphate ions from the surrounding solution.

The long tubular viruses thus become coated with an "armour plating" of iron phosphate and can be regarded as tiny nanowires. A second gene was introduced to increase the flow of electrons, and lo and behold, the result was a viral nanobattery which is claimed to be as good as the best commercial lithium batteries

(those which used lithium iron phosphate materials). This virus based 3-volt lithium ion battery can light an LED.



14.34 The new battery was developed by a research team led by Dr. Reinhard Baumann of the Fraunhofer Research Institution for Electronic Nano Systems ENAS in Chemnitz, Germany. <http://touchswitch.rapidkeypads.com/post/4777368873/printed-batteries-provide-paper-thin-power>



14.35 MIT Professor Angela Belcher and the prototype battery she and her team created using a genetically engineered virus. Photo credit: Donna Coveney, courtesy of MIT. Reproduced with thanks from, <http://www.ianmonroe.com/blog/tag/science/>

The day may not be far when power will be generated in fermentation tanks growing viruses and pocket batteries will contain nanowires made of coated viruses!

14.36 Light Emitting T-Shirts!^{A22}

A light emitting ink has been developed by Dai Nippon Printing which can print luminescent patterns on T-shirts by screen printing. The ink is mixed with silica nanoparticles to form a gel which is used in the printing process. The company is developing light emitting posters and various items of clothing. So if you wish to glow in the dark, wear a luminescent T-shirt!

14.37 Making a Mini-Sun ---- on Earth!^{A23}

Preparations are under way in the south of France for one of the most exciting experiments ever undertaken in human history by man. Known as the International Thermonuclear Experimental Reactor (ITER), it aims to reproduce the way the sun and stars produce heat and light---- by nuclear fusion i.e. lighter elements fusing together to give heavier elements with the production of huge amounts of energy. Our planet has been warmed by the sun due to such fusion reactions for billions of years, and the stars also produce their heat and light through such fusion reactions. The European Union, India, Japan, China, Russia, South Korea and USA are jointly funding this project which is expected to cost about Euros 10 Bln. and take 15 years to complete.

The project aims to fuse two “elder brothers” (isotopes) of hydrogen. These are deuterium and tritium. The fusion of these two isotopes of hydrogen can occur with the formation of a heavier element, helium and the production of a huge amount of heat energy. The heat produced is expected to be 5-10 times greater than the heat energy required for the fusion reaction to take place. To achieve fusion, phenomenally high temperatures of about 100 million K must be achieved. This will require special vessels in which the fusing plasma will be magnetically suspended in the center to prevent the metal of the vessel evaporating due to huge temperatures.

By the end of the century, our cities may well be powered by fusion reactors, with sea water being used as the source of deuterium for the fusion reactions --- man made mini-suns on earth!



14.36 http://www.casesinthebox.com/electro-luminescent-led-shirt-with-music-activated-mr-dj-fm056-led-t-shirt_p4443.htm



14.37 Aerial view of the ITER construction site, September. 2011 © Altivue/ITER Organization. <http://fusionforenergy.europa.eu/mediacorner/newsview.aspx?content=545>

14.38 Cold Fusion --- Is It Finally Here?⁴²⁴

The stars (including our sun) produce their heat and light energy through fusion reactions ---- the fusing of smaller atoms such as hydrogen, helium, lithium etc. to give larger atoms. These reactions normally require very high temperatures and pressures inside stars. There has been a sustained effort of scientists to achieve “cold fusion” i.e. achieve fusion reactions at relatively lower temperatures. Claims in the past of having achieved cold fusion later proved to be wrong. Recently, however Dr. Mosier-Boss and colleagues at the Space and Naval Warfare Systems Command in San Diego, California now claim to have finally achieved cold fusion between deuterium and tritium nuclei in an article published in *Naturwissenschaften* (DOI: 10.1007/s00114-008-o449-x). The work is presently controversial and needs to be independently verified. If correct, it could open up huge new possibilities of production of almost free energy from water.

14.39 Fluorescent Tube Lights with Organic White Light Emitting Diodes.⁴²⁵

Light emitting diodes (LEDs) have been known for several decades. They present a number of advantages over traditional sources of light including robustness, lower energy consumption and small size. Electroluminescent organic conductive polymers which emit light when connected to an external voltage (OLEDs) were later developed which could be produced by inkjet printing on flexible substrates. A number of companies have also developed televisions which use this technology.

Scientists working at the Institut für Angewandte Photophysik in Dresden Germany have reported the development of improved OLED layer structures which can produce white light and attain efficiencies of up to 90 lumens per watt, better than that achieved by fluorescent tubes, which is about 70 lumens per watt. This opens up an exciting new method of efficiently lighting up large areas at cheaper costs (*Nature*, p234, May 2009).



14.38 US Navy research team who see promise in what they call the Fleishmann-Pons effect. Doctors Pam Mosier-Boss (left), Frank Gordon, Stanislaw Szpak.



14.39 (Reineke et al., 2009)

14.40 Judging Economic Growth by Lights!⁴²⁶

An important indicator of the well-being of a society and the level of its economic growth is the brightness of light of its cities at night time. As nations develop, they build more roads and houses with lighting, and the countries get more illuminated. Night-time satellite images can thus provide valuable independent data that can be used to correlate with other statistical data collected. David Weil and colleagues at Brown

University in USA have used the satellite image data for the past 11 years, and correlated it with GDP growth of many countries. This has revealed that the GDP growth estimated by conventional means may not be correct in some cases. Thus the World Bank's figures of 2.6% shrinkage in the economy of the Democratic Republic of Congo fail to match with a 2.4% growth increase indicated by the lighting data, indicating that the statistics on which the World Bank estimates were based may have been wrong. A weighted combination of the two sets of data may provide more accurate information.

14.41 3D Laser Advertising in mid-air!⁴²⁷

A laser system has been developed by Burton of Kawasaki, Japan which allows images to be created in the air. The laser pulse is focused onto a point in the air, causing the air to ionise. The resulting glowing plasma appears as a point of light ("flash point") suspended in mid-air.

By firing hundreds of laser pulses per second, an illusion is created of many constant points of light. By increasing the firing rate to a thousand flash points per second, 3D images have been created which can actually appear to move.

Within a few years, advertising boards may be replaced by empty spaces on the sides of the roads in which moving figures and messages made from various coloured lasers may appear, as if by magic, out of thin air! Other applications could include 3D TV and light displays that appear like fireworks.

The discovery can have defence applications. The Pentagon is developing a military application (Plasma Acoustic Shield System, Pass) which causes the plasma balls to explode violently by use of an additional laser pulse. The idea is to create protective "flash - bang" curtains up to 100 metres away to serve as screens against snipers-a wall of light and sound!

14.42 TV Screens--- Thin as Your Credit Card!⁴²⁸

Certain organic (carbon-based) materials can emit light when charged with electricity. This has become the basis of a new



14.40 New York City shines brighter than any other U.S. city at night. Nighttime lights can indicate relative economic prosperity. (Courtesy R. Fernandez)



14.41 Reproduced with thanks from, http://www.lazershows.co.uk/index.php?option=com_content&view=article&id=56&Itemid=70

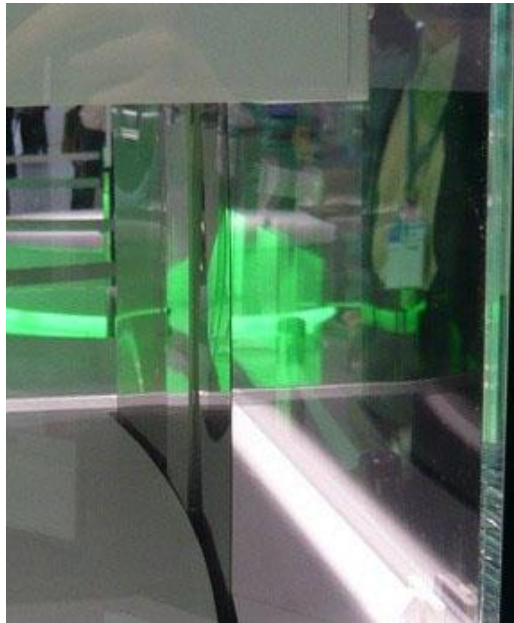
generation of TV screens that are being developed from Organic Light-Emitting Diodes (OLEDs, for short). They have a thickness of only 0.3 mm, about as thick as your credit card and since the OLED materials produce their own light, they therefore have nothing behind the screen, except a thin charged plate that releases electrons onto the screen. In contrast, the LCD (Liquid Crystal Display) screens require a fluorescent or LED lamp to illuminate the pixels, while plasma screens require compartments of electrically charged gas to illuminate them. An advantage with the new OLED based technology is that the light emitting organic molecules from which the screens are built glow in colour. The LCD screens in contrast emit white light which then needs to be passed through filters to create colours. This results in the loss of brightness and purity of colours. The colours from OLED screens are therefore brighter and deeper than those produced by the phosphorescent screens used in plasma TVs. It is expected that the new OLED TVs will become commercially available in 2012.

14.43 OLEDs? No. QLEDs are also Coming!⁴²⁹

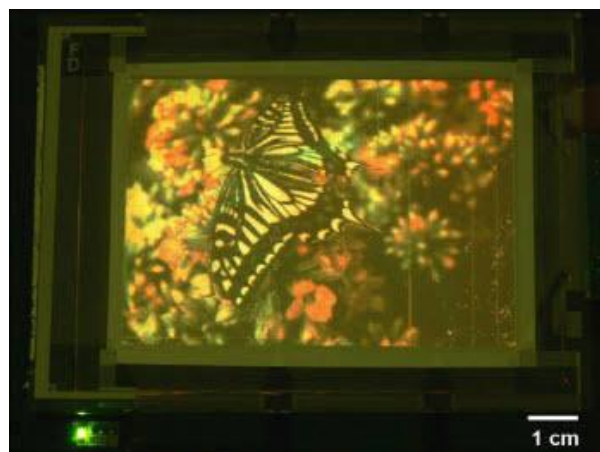
Organic light emitting diodes (OLEDs) comprise thin film of organic compounds that emit light when an electric current is applied. They have found wide use in television screens, computer monitors, smaller screens of mobile phones, watches and other devices. TVs employing them do not require back lighting. Screens made from them are thinner and lighter and the colours are richer and brighter than those employing liquid crystals.

In recent years, a new technology has been under rapid development --- that of quantum dots. These are tiny semi-conductors with properties dependent on the size of the crystals from which they are made. LED displays made from quantum dots (QLEDs) are extremely thin---only a couple of nanometers (millionth of a millimeter)--- and are flexible and transparent, making them very suitable for impregnation on a variety of flexible surfaces. Two US companies, LG Display and QD Vision, have joined hands to develop this exciting technology of the future for next generation televisions, computer monitors and

other applications. While applications of OLEDs are still under development, they may well be taken over by QLEDs which appear to have significant advantages.



14.42 <http://www.oled-info.com/sony-shows-curved-version-their-03mm-thick-oled-tv>



14.43 First full-color QLED-display from Samsung. Reproduced with thanks from, <http://www.qled-info.com/wordpress-resources-at-siteground/>

14.44 A Wireless Pacemaker----At last!⁴³⁰

The US Food and Drug Administration has approved a wireless pacemaker in 2009 that transmits data from the patient using a home transmitter to the doctor via the internet. The device therefore allows constant remote monitoring of the patient's condition and alerts the doctor immediately in case of a medical emergency. A special frequency in a spectrum reserved for medical implants is used for the transmission. The technology approved in July 2009 was developed by St. Jude Medical in California and it should prove useful to heart patients all over the world.

14.45 Detecting Science Frauds—with Software!⁴³¹

Fraud in science has been prevalent all over the world but with the advent of new technologies, it has now become almost impossible for scientists to copy the work of others and publish it as their own. In Pakistan, 'plagiarism' (as this phenomenon is known), was a common problem. To tackle this, the Higher Education Commission forced the universities to take strict action against offenders. When Punjab University failed to act after a disciplinary enquiry committee found five physics faculty members guilty of copying the work of a famous Swiss professor, the development funds of the university were frozen; the chancellor was forced to intervene and dismiss the offenders. Similar action was taken in several other institutions. The software that makes the detection of cheating possible is known as 'Ithenticate' or 'Turnitin'. It works by comparing the material under scrutiny with hundreds of millions of articles available on the internet and identifying specific copied sections in a matter of seconds. It was distributed to various universities by the HEC and a central system to detect cheating was set up to check research publications and theses.

14.46 Cloning Animals --- from Dead Cells!⁴³²

Many plants can now be made by "tissue culture". This is a process where identical clones of plants can be created from plant

parts such as stem, root or bud tips. The plant tissue is grown in a sterilized medium to afford a mass of unorganized cells (callus). Under suitable conditions, this is induced to develop shoots and roots, thereby affording tiny plantlets which are identical to the parent plant from which the material was taken, as they contain the same genetic information. This process of cloning is now widely used on commercial scales for mass propagation of plants with certain desirable properties, such as the colour and size of flowers or taste and yield of fruits etc. If this process of cloning can work in plants, why not in animals?



14.44 New pacemaker by Nanostim is about the size of a AAA battery and does not use wires to connect to the heart.
<http://www.startribune.com/business/227471071.html>

14.45 Reproduced with thanks from, <http://norhayati-comm1043.blogspot.com/>

The first mammal, Dolly, a sheep, was cloned in 1996 in Edinburgh, from the mammary cells of a sheep (A). A developing unfertilized egg cell from another donor sheep (B) was taken, its nucleus removed and the nucleus from sheep (A) was transferred to the egg cell. The hybrid cell thus formed was stimulated to start dividing by an electric shock, and then implanted into a third surrogate mother sheep (C) leading to the birth of Dolly. Since this historic cloning experiment, many animals have been produced by cloning, including bulls and horses.

Extinct animals have also been successfully cloned. A wild mountain goat (Pyrenean ibex) was declared extinct in the year 2,000 but DNA taken from the dead skin of this animal was kept frozen and later inserted into the egg cells of a goat. By a similar cloning process to that described above, Spanish scientist Jose Folch and colleagues succeeded in giving birth to a live ibex, the first time in history that an extinct animal had been produced by cloning, reported earlier this year in Daily Telegraph (<http://www.telegraph.co.uk/science/science-news/4409958/Extinct-ibex-is-resurrected-by-cloning.html>). This opens the door to other extinct animals such as dinosaurs and woolly mammoths being similarly produced tens of thousands of years after becoming extinct. It also allows us to preserve endangered species so that they may be recreated centuries later. The possibility of synthesis of their DNA will further facilitate the process.

This is indeed the fascinating wondrous world of science, where truth is often stranger than fiction!

14.47 Exciting New Technologies --- by Copying Nature!⁴³³

Over millions of years, living organisms have evolved a variety of incredibly efficient ways to fly, swim, and survive against the challenges posed by the environment. These features are providing deep insights to scientists to design devices with novel properties for improved performance. The process known as



14.46a <http://repairstemcell.wordpress.com/2009/02/07/the-associated-press-stem-cell-cloning-expert-jerry-yang-dead-at-49/>



14.46b Photo: fearing the worst, Spanish biologists including Alberto Fernandez and José Folch working for the Aragon regional government captured the last Pyrenean ibex (*Capra pyrenaicapirenaica*) in spring 1999 and took a tissue sample from her ear, to preserve the Pyrenean ibex's cell line in case they needed to clone it. Then they attached an electronic tracer to the animal and released it. Courtesy Advanced Cell Technology, Inc.<http://www.petermaas.nl/extinct/articles/cloning.htm>

“biomimicry” involves bridging of engineering with biology. For example, locusts can fly together in closely packed swarms without colliding as they can see in several directions simultaneously. Learning from them, automobile manufacturers have recently developed anti-collision sensors that can sense movement around a car from several directions and alert the driver to avoid collision.

The huge humpback whale is remarkably agile in water, a puzzle for scientists since it has little protrusions (tubercle) on its leading fins which appear to be located on the wrong side from the aerodynamic point of view. The leading edge of a fin or the blade of a fan or turbine should normally be flat and smooth. Aerodynamic studies however showed that the presence of such bumps on the leading edges of fan blades resulted in a greater air lift, quieter output, and greater power at lower rotation speeds. Air turbines are now being designed based on this technology.

A “smart” breathing pinecone fabric has been designed by the Centre for Biomimetic and Natural Technologies in the UK, the pores of which open up when it is hot due to the perspiration of the person wearing it, and close down when it is cold, just as pinecones do. Similarly, spider silk, which weight for weight is stronger than steel is held together by a special glue which the spider makes. Omer Choresh at the University of Wyoming has found two special proteins in the glue that give it its remarkable strength, and new bioadhesives are being developed based on this discovery. A Swiss engineer George de Mestral noticed how burrs from some plants stuck fast to the fur of his dog --- he copied the hooked structure and “Velcro” was born—a huge commercial success. There are numerous other such examples where engineers have learned from nature.

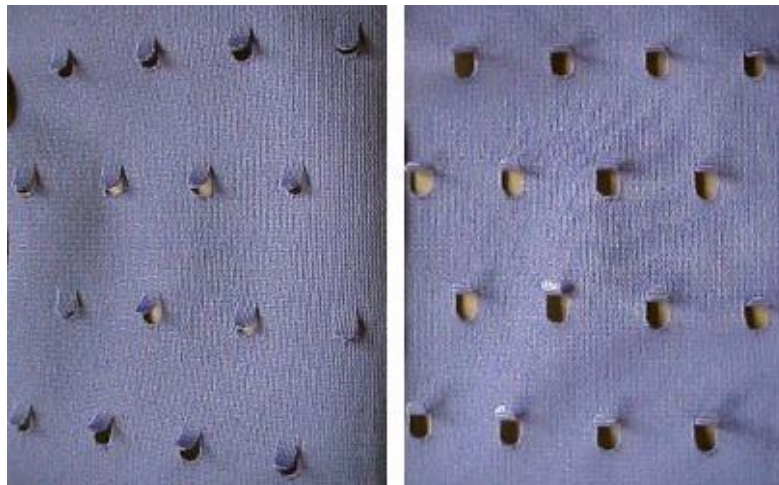
Nature is undoubtedly the best teacher!

14.48 Nanocrystal Conductors: An Exciting Development in Computer Memory Expansion!⁴³⁴

Last year, researchers at Rice University in Houston, USA had demonstrated that how 10 –nanometer strips of graphite could be used as reliable memory “bits”. These strips are hundred



14.46c Scientists Hope Cloning Will Save Endangered Animals
<http://www.earthintransition.org/2013/03/whats-driving-the-cloning-of-extinct-animals/>



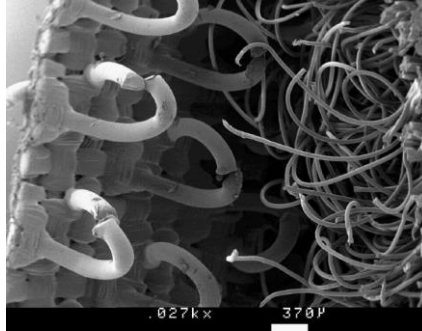
14.47a Professor Julian Vincent, head of the University of Bath's Centre for Biomimetics, said: "The new smart clothing will make wearers' lives much more comfortable by automatically adjusting their clothing to control their body temperature...we're pleased to combine our expertise in technology with cutting-edge clothing design."
<http://www.treehugger.com/clean-technology/smart-clothing-mimics-pine-cones.html>

thousand times smaller than 1 millimeter, much finer than the human hair, and thus offer huge potential for miniaturization as they can pack a huge amount of information in a small area. Now, professors James Tour, Douglas Natelson and Lin Zhong have developed minute silicon based nanocrystal conductors. These fine wires are even smaller--- two-hundred thousand times smaller than 1 millimeter and employ silicon oxide, a material found in sand. These tiny digital switches, once commercialized, are likely to lead to a huge increase in the storage capacity of computers of the future.

Carrying a library of million books on a tiny disk of the size of a small coin is now becoming a reality. The work has been published on 31st August 2010 in the journal *Nano Letters* (DOI: 10.1021/nl102255r).

14.49 Electronic Books----A Silent Revolution!⁴³⁵

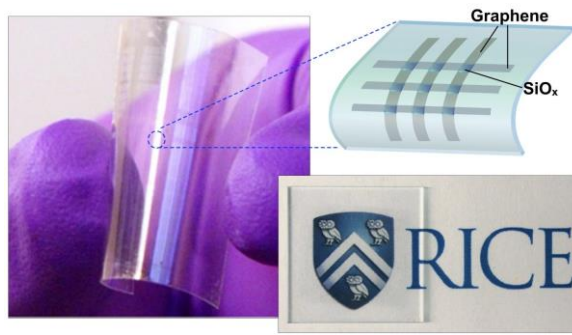
A silent revolution is taking place in the field of book publishing -- -- that of electronic books, thousands of which can be carried in a small electronic book reader. Some 300,000 books are already available in an electronic form, about 30,000 of which are free under "Project Gutenberg". There are two e-book readers dominating the market. Kindle 2 by Amazon costs US\$ 359 and it can store about 1500 non-illustrated books, while a more powerful version (Kindle DX) can store some 3,500 non-illustrated books. Sony also offers a number of different models of e-book readers with various memory sizes. As the screens of these readers are fragile, another company Plastic Logic has now introduced a reader which has a flexible screen. This was achieved by printing polymer transistors on a layer of flexible plastic. It is possible to directly download books via the internet from book sellers onto the e-book readers. The trend away from hard copy publishing and towards electronic publishing is reflected from the recent announcement of the American Chemical Society that from 2010 onwards, members of the Society will only be able to get electronic copies of the journals of the Society.



14.47b best Biomimicry includes the invention of Velcro, which 'mimicked' how the burrs stick to animal fur.



14.47c <http://jalopnik.com/5059706/ford-lincoln-models-get-active-anti-collision-technology-option>



14.48 <http://news.rice.edu/wp-content/uploads/2012/09/Memory-1-web.jpg>; <http://news.rice.edu/2012/10/02/visionary-transparent-memory-a-step-closer-to-reality/#sthash.f0815XUD.dpuf>

In Pakistan, the Higher Education Commission under my supervision introduced one of the best digital libraries in the world some three years ago which provides over 40,000 electronic text books and research monographs (which are keyword searchable and down-loadable) from 220 international publishers, as well as 23,000 international electronic journals with back volumes free of charge to all students in all public sector universities.

14.50 A Mongoose "Scientific" Cricket Bat!^{A36}

Can science help to improve the performance of a cricket bat? Apparently so! The Twenty20 version of the game has created a need of a high performing bat that can wield more power. Just like graphite rackets and titanium-headed drivers revolutionised tennis and golf, the new Mongoose MMi3 cricket bat promises to be the tool that will lead to new records, specially in this shorter more intense version of the game. It is said to have 20% more power and 15% more bat speed than conventional bats, and with a longer handle and a shorter blade it resembles a paddle, but still conforms to the MCC laws governing cricket bats. It is said to have a "sweet spot" about the double the size of a conventional bats resulting in more powerful stroke play. In March this year, the Australian batsman Matthew Hayden used the bat for the first time at international level and managed to score 93 runs off 43 balls!

14.51 3D Laser Televisions!^{A37}

A new class of 3D televisions, based on plasma and LCD screens, will become available this year, allowing the viewing of 3D films at home. These require the use of special shutter eye glasses that need to be worn by the viewer. The glass used in these eye glasses contains a transparent liquid crystal that becomes dark when voltage is applied. The glasses work in synchronisation with the screen, becoming dark first over one eye, and then over the other. The display screen of the TV can

thus transmits separate images sequentially to each of the two eyes, thereby creating a 3D image. These “active shutter” glasses can cause some strain.



14.49 Growing trends for paper books shift into e-books.
<http://batew.com/2013/01/31/e-books-etc-the-new-growing-market-trends/>



14.50 Former Australian Cricketer Matthew Hayden introducing Mongoose Bat. <http://crickethighlights.com/2011/11/cricket-equipment-the-mongoose-cricket-bats/#sthash.pGywmmk5.dpuf>

An exciting new advance in this field has been the recent development of 3D laser televisions by a California based company, HDI. The new types of 3D TVs with 100 inch or larger screens employ lasers that transmit laser light to two sets of full colour images. These images are separated and sent to each

eye through a prism system. This results in very high definition 3D pictures, and needs much cheaper passive glasses for viewing (<http://www.hdi3d.com/>).

14.52 3D TV—Rapid Developments!⁴³⁸

I remember watching the first 3D film “House of wax” at Paradise cinema in Karachi almost 50 years ago. It appeared at the time to be the beginning of a new era of 3D movies but it has taken about 50 years for the revival of 3D movies, and now 3D television is also here.

There have been rapid recent developments in the field of 3D television. A Scottish inventor David Brewster first developed the ‘stereoscope’ that allowed 3D photography. A common method for making the 3D videos is to use two different cameras to record a scene, with cameras being placed at the same distance from one another as the distance between a person’s eyes. The two images are accurately superimposed, and when projected and viewed on a screen, a 3D effect is produced as each of the two eyes sees the object from a slightly different perspective. Arrays of multiple cameras can also be used for image capture. Hectic efforts are underway by a number of TV manufacturers such as Sony, Panasonic, LG etc., to develop high quality 3D TVs. Since the viewers need to wear special glasses, this is a drawback as the glasses can be cumbersome and expensive.

Toshiba launched its 21-inch 3D TV in April 2010 which does not require any special glasses for viewing, but the 3D effect works only within a narrow viewing range (persons sitting beyond a certain angle to the TV will not experience the 3D effect). Sony has also announced its plans to launch a 3D TV without the glasses soon. The ‘Helium 3D’ system being developed by a consortium of companies, the ‘Wedge’ system developed by Microsoft, and a number of other systems under development will allow a wider viewer angle with 3D effects.

The 3D TV war is heating up!



14.51 <http://www.newaje.com/2010/04/20/hdi-3d-laser-tv/>



14.52 L4200 Series: Toshiba's L4200 Series LED TV is available in the 19-, 24- and 32-inch class screen sizes. <http://www.cdrinfo.com/Sections/News/Details.aspx?NewsId=32090>

14.53 Internet Television!^{A39}

Computers are used largely for surfing the web, while television is used for infotainment. This distinction may soon be over as a new breed of machines has been developed that combine the two functions—internet TV is here. Sony and Google have entered into a partnership to produce internet TVs, which will allow you to watch television as well as use the TV screen as a computer screen simultaneously. The latest HD television series announced by Sony comes with internet connectivity, Wi-Fi, USB ports, DLNA, built-in storage and other bells and whistles. If one is surfing the web, then the TV screen becomes a smaller inset in the main screen so that the words are large enough to be easily read.

14.54 Three-Dimensional Glass Printing!^{A40}

A computer-aided design and 3D printing machine have been combined by a group of scientists and engineers at the University of Washington to develop an automated process of 3-D glass printing. Thin layers of glass powder are progressively spread over a surface by an ink-jet printer, and the material is then heated to fusion temperature. The process resembles one developed by ancient Egyptians ---- an ancient method has been transformed into a digital process.

14.55 Robots Learning Navigational Skills from Lobsters!^{A41}

Nature has endowed birds, ants, bees, fish, spiders and other animals with a remarkable sense of direction. This allows them to locate their positions from a built-in global positioning system (GPS) that senses the earth's magnetic field with great accuracy, and allows them to travel in desired directions without getting lost. Lobsters, even when taken 37 kilometres from where they were caught, under conditions that they would not have orientational clues, can still find their way back (*Nature*, vol

421, p 60) because of this uncanny ability to sense their position. This stems from their being able to sense local anomalies in the earth's magnetic field. This remarkable attribute is now being developed in robots by scientists at the University of North Carolina in USA.



14.53 Sony Internet TV. Reproduced with thanks from, http://en.wikipedia.org/wiki/Google_TV



14.54 University of Washington. Grant Marchelli, a UW mechanical engineering graduate student, removes a new object from the Solheim Lab printer. Marchelli led development of the first method for 3-D printing in glass. Reproduced with thanks from, <http://www.washington.edu/news/2009/09/24/uw-lab-demonstrates-3-d-printing-in-glass/>

It is known that buildings have a distinctive magnetic topography, which can be readily mapped using a magnetometer. Such field variations were measured and then stored in the memory of a robot. Using such magnetic maps, the robot was able to find its

way about although it did not have a vision system, thereby effectively mimicking the behaviour of lobsters (*Robotics and Navigational Systems*, DOI: 10.1016/j.robot.2009.07.018). There is still much to be learned from the birds and the bees.

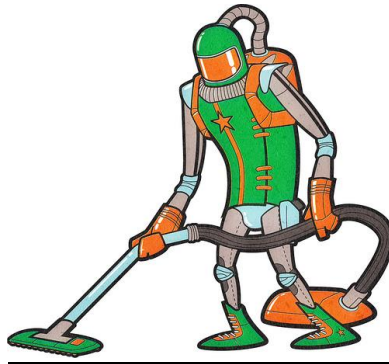
14.56 Bionic Medicine!⁴⁴²

The brain sends signals to the body that then allows it to perform various functions, such as to lift glass or switch on a TV. In paralysed patients, the mechanism by which the neural signals are unscrambled and messages sent to the limb muscles is disrupted. The limbs of a paralysed person do not follow the orders of the brain. Is it possible to implant electronic systems within the brain that can record the neural activity, decipher the commands from other neural chatter, comprehend what the brain wants the body to do, and then transmit the right messages, preferably wirelessly, to the limbs to obey? This is now becoming possible by implantation of “brain chips”, although the technology is in its infancy. “Brain chips” are already helping the deaf to hear, the blind to see, preventing epileptic fits and helping persons suffering from Parkinson’s disease. Spinal cord injury in accidents can paralyse patients, since the spinal cord converts signals of intent from the brain into signals that propel muscles. It has been found that paralysed rats with severed spinal cords could walk, sprint, and step sideways if steady bursts of electricity were applied to their spinal cords in the presence of certain chemicals that could mimic neurotransmitters (*Nature Neuroscience*, DOI:10.1038/nn.2401). Before long, this may become possible for humans too. Bionic medicine is here to stay!

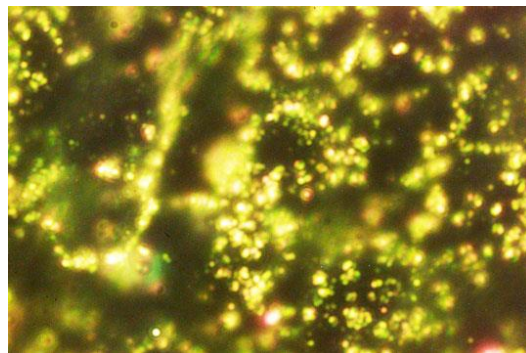
14.57 Discovering Gold---Using Bugs!⁴⁴³

Can bacteria be used to extract gold? Now, they can be. Certain bacteria have been known for a long time to occur where gold deposits exist, but it has not been known if they play a role in the production of pure metallic gold. Dr. Frank Reith at the University of Adelaide has found that dissolved gold is toxic to a certain bacterium (*Cupriavidus metallidurans*) as it forms a toxic

sulphur-containing compound. The bacterium protects itself by converting such soluble gold compounds into harmless metallic gold! By genetically modifying the bacterium so that it produces flashes of light when it comes into contact with the gold, the Australian scientists have developed an interesting gold prospecting technique. Just by mixing the soil with the bacterium it is possible to detect if gold is present in the soil sample (*Proceedings of National Academy of Sciences*, DOI: 10.1073/pnas.0904583106).



14.55 *Image source:* ValtteriMäki. Reproduced with thanks from, <http://coding.smashingmagazine.com/2012/11/05/writing-fast-memory-efficient-javascript/>



14.57 *Cupriavidus metallidurans* which lives in biofilms of gold nuggets. The bacteria detoxify dissolved gold by accumulating it in inert nanoparticles inside their cells. So, these two bacteria can be a useful tool for future mining and detoxification. Reproduced with thanks from, <http://bio-teknology.blogspot.com/2013/03/gold-digging-bacteria-from-waste.html>

14.58 Smartphones — A Revolution in the Offing!⁴⁴⁴

Can you use your mobile phone to monitor your health, store and transfer money, and watch movies, as well as talk with your partner on the other phone with his/her image clearly visible on the screen? Well, now you can. Nokia has already developed prototype phones fitted with biosensors that can monitor your heart and breathing rates as well as blood sugar levels. They can be connected to a central computer system of your doctor, so that any worrying changes can be immediately addressed.

Mobile commerce is already here! Smartphones are being used for shopping and to transfer money. Cell phone users in Japan are able to buy plane and air tickets from their Smartphones, while users of such phones in Philippines, East Africa and Afghanistan can transfer money from these handsets without going to a bank! Work is under way to ensure high quality encryption of messages so that customer security can be guaranteed.

In Pakistan, a revolution in mobile telephony and internet expansion was triggered during 2000-2002. The Ministry of Science and Technology (of which the IT and Telecom Division were a part) played a revolutionary and historic role in the transformation of this sector. Internet was made available at all airports in the country, years ahead of European nations. The crucial decision that the calling party should pay mobile phone bills and not the call receiving party, coupled with the introduction of a competitor U-Fone into the market led to an explosive growth in mobile telephony. Today, the number of mobile phones stands at above 100 million, as compared to only 0.3 million in 2001. Internet was available only in 29 cities in the year 2,000, but by 2002 it had spread to over a thousand towns and villages. Another technological transformation is now at hand. We must introduce 3G technology quickly, and facilitate M-commerce through mobile telephony.

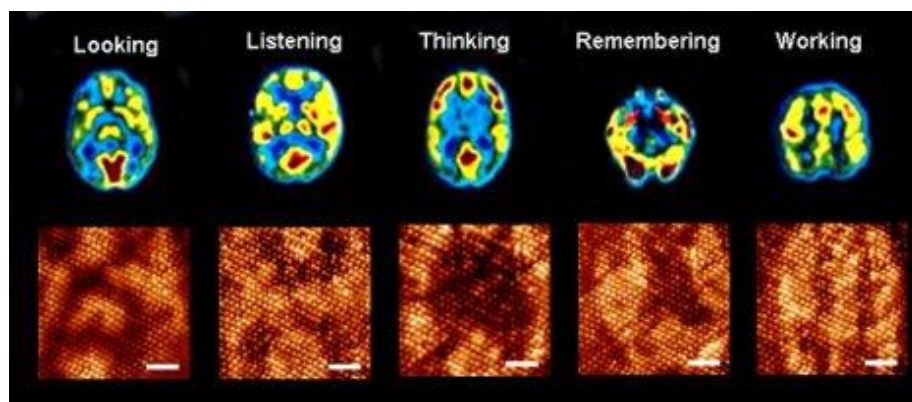
14.59 Molecular Computers!⁴⁴⁵

Our brains have the remarkable capacity to carry out multiple tasks through parallel processing by the neurons in a dynamic

and interactive fashion. Their processing speed can be above 10,000 million billion instructions per second, while the neurons in the human brain fire only a thousand times per second. However, since computers process data sequentially (recent advances in multi-core processing making little difference), while in the human brain millions of neurons act together, computers cannot compete with the processing capabilities of the human brain. Now, we may be on the verge of a new break-through.



14.58 With many of the latest innovations in mobile medical diagnostics technology, the capabilities of modern caregivers are taking giant leaps forward. <http://www.allvoices.com/contributed-news/15474654-med-trek-going-where-no-phone-has-gone-before>



14.59 Evolving patterns on this molecular processor mimic patterns displayed by the human brain. Anirban Bandyopadhyay image. "Massively Parallel Computing on an Organic Molecule Layer," published April 25 online in *Nature Physics*.

A molecular computer has been developed that is based on organic molecules, instead of silicon. The molecular computer built by scientists from Japan and Michigan Technological University can partly mimic the networking processes which the brain employs, with 300 organic molecules in this new computer talking to each other simultaneously (*Nature Physics* **6**, 369 - 375 (2010), DOI:10.1038/nphys1636).

14.60 Tata (India) to Manufacture “Air Car”!⁴⁴⁶

A car that will run simply on compressed air will be manufactured by Tata (India) later this summer. The air pressure from a high pressure cylinder will be used to push the pistons of the car which will be able to go up to 300 kilometers before requiring a fresh refilling of its compressed air cylinder at a cost of about Indian Rs. 85 at specially fitted petrol pumps. The refilling process will be achieved in about 2-3 minutes. The car is fitted with a small compressor which can also refill the air cylinder from the normal home mains in about 3-4 hours. The cost of running the car will be about one-tenth of that of a car running on a normal petrol combustion engine! The technology was developed by a French company “Motor Development International” (MDI) incorporated in Luxembourg. The car, called MiniCAT, has a fibreglass body and will cost about Indian Rs. 350,000. It will be fully automated under microprocessor control and achieve a top speed of 105 kilometers per hour.

Tata made headlines when it started manufacturing the cheapest car in the world and also bought over the Jaguar-Land Rover manufacturing facilities, thereby gaining access to the latest technologies. Now it has taken the lead in becoming the first to manufacture this futuristic zero emission car. Zero Pollution Motors in USA has acquired the license to manufacture the car in USA.

14.61 Talking Traffic Lights!⁴⁴⁷

Much time and petrol is wasted by millions of drivers each day waiting at traffic lights. Now the car manufacturer “Audi” has

World's First Air-Powered Car: Zero Emissions by Next Summer



This six-seater taxi, which should be available in India next year, is powered entirely by a tank filled with compressed air.

14.60 Tata's air-powered "Mini CAT" car first surfaced way back in 2008, and even now it remains one of the most contentious articles on the TMR website



14.61 The only thing more annoying than having to obey the speed limit when driving is having to frequently stop at red lights. So in a brilliant attempt to become the world's awesomest automaker, Audi has created a new in-dash system that tells you how fast or slow you need to drive in order to hit as many green lights as possible. Reproduced with thanks from, <http://www.gizmodo.com.au/tags/audi/>

developed a revolutionary traffic communication system that makes traffic lights and cars talk with each other electronically.

This allows the driver to know on a display system in the car how long it will take for the traffic lights that he is approaching to turn from red to green or green to red. He can then adjust the car speed accordingly to minimise or eliminate waiting times at traffic lights. The system also provides information of traffic congestion at various points in the city and allows automated planning of the route so that one could travel by the best route and at optimum speeds to reach the destination in the shortest possible time and at minimum cost, by avoiding waiting times at traffic lights. In a pilot project, a 17% reduction in fuel costs was achieved by using this system, and a bigger trial is now being conducted in the City of Ingolstadt in Germany.

14.62 Low Cost High Speed String Rails --- in the Air!⁴⁴⁸

Many of us have sat in chairlifts and traversed mountain tops as we travel suspended from steel ropes. Now, the idea is being applied to travel at high speeds, up to 500 kilometres per hour (!), instead of travelling by roads and trains between cities. The Unitsky String Transport (UST) system is being developed in New South Wales, Australia, initially to take goods at high speed over rough terrains for the Australian mining industry. The cost of constructing a UST system is extremely low ---- estimated to be only \$ 50,000 per kilometre, as compared to a cost of \$ 3.45 million per kilometre for normal low speed train systems. This may turn out to be the best option for inter-city and intra-city travel ---- travelling at high speeds in comfortable compartments while suspended from the air on steel ropes!

14.63 Giant Airships—Bigger than Football Fields!⁴⁴⁹

The US army has decided to build huge lighter-than-air airships, and the days of the long gone Hindenburg are returning. A 517-million-dollar contract has been awarded to Northrop Grumman to build a huge airship which is longer than a football field within 18 months. This Long Endurance Multi-Intelligence Vehicle (LMEV) will stay in the air three weeks at a time, and will be primarily employed for surveillance and reconnaissance.



14.62 Artist's rendering a String Transport system.
<http://www.gizmag.com/unitsky-string-transport-rail-suspended/15300/picture/115663/>

14.64 Robotic Exoskeletons—Now a Reality!⁴⁵⁰

In a number of science fiction movies, such as Ironman, one sees human beings climbing into a robotic metal suit of armour which gives them super human strength. Such ideas are now becoming a reality and they will impact industry as well as defence. The US army has been funding a programme to develop such devices since the year 2000 and a US company Raytheon Sarcos has produced various types of robotic exoskeletons that can be worn by soldiers to amplify their abilities. These skeletons are fitted with various kinds of sensors and controllers that allow the wearer to carry large weights for long distances without tiring, and yet remain agile enough to participate in sporting activities such as football. Exoskeletons have also been developed to cover and enhance functions of parts of the human body, such as by wearing on legs or arms. The 'Lower extremity exoskeleton' produced by the University of California, Berkeley can be connected to the legs of the wearer, enhancing their strength and performance.

Our defence organisations should be out-sourcing such projects to the engineering universities so that Pakistan is not left behind in this fast evolving field.

14.65 Your Television is Watching You!⁴⁵¹

Televisions are now being developed that will be fitted with face detection and presence sensors to keep a constant watch on what you are doing. If you are not watching the television, have your face turned away from it or have left the room, the television will automatically dim or turn off. This will save electricity. The feature is being built into the Sony LX 900 3D television, and Hitachi is developing similar features. The ambient light sensor on the TV will also adjust the brightness of the screen according to the level of light in the room to give an optimum image on the screen.

14.66 Media Walls!⁴⁵²

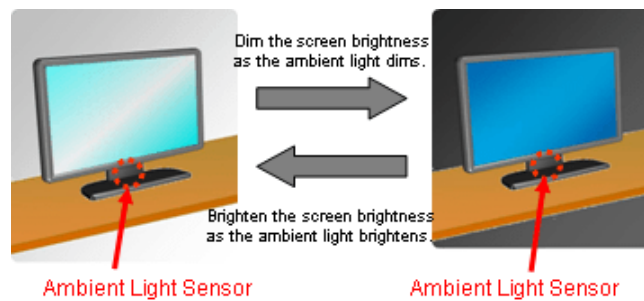
Just imagine yourself sitting in your drawing room, the walls of which are made of a material that can change its hue and colours at the touch of a button. Or if you do not want it to be of any single colour, it can be programmed to change its colour and hue at pre-determined time intervals. If you are in the need of entertainment, the wall can become a super large cinema screen and you can watch larger-than-life high impact images, in three-dimensions. This is the future.

The first zero energy 'media wall' was built in Beijing, China at the Xicui Entertainment Complex. This glass wall covers an entire building and has 2,292 points of light (LED). It is the largest such wall in the world, and comprises photovoltaic cells integrated into the glass curtain which harvest energy from sunlight in day time, and then use it to light up the wall at night.

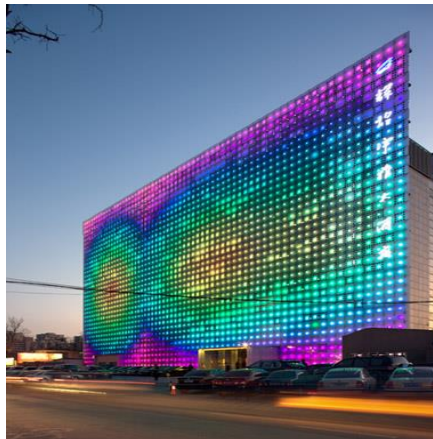
14.67 A Blast-Proof Fabric that Thickens when Stretched!⁴⁵³

Fabrics made of natural or artificial fibres or plastic materials normally become thinner when stretched. However, a completely new type of material has recently been developed that actually becomes thicker when stretched! This property is being utilised for applications in defence. For instance, covers and cloaks are

being developed which can withstand the blasts from explosions by offering increased resistance. This occurs because the fabrics that come under pressure due to flying shrapnel, or due to the tremendous air pressures caused by explosive blasts become thicker at the pressure points instantaneously. Curtains of materials made out of these special fabrics (auxetic materials) can be fitted on windows of buildings that can be targets of terrorists, or to withstand hurricanes. The materials have been developed at the University of Exeter in the UK, in collaboration with Auxetix Ltd., a spin-off company.



14.65 Automatic lighting function for lighting equipments: Turns on/off the lighting according to ambient brightness.
<http://www.semicon.panasonic.co.jp/en/products/opto/photodetectors/ambient/>



14.66 GREENPIX Zero Energy Media Wall Lights up Beijing. GREENPIX Zero Energy Media Wall Lights up Beijing - Gallery Page 0 – Inhabitat - Sustainable Design Innovation, Eco Architecture, Green Building

How does it work? The material is made up of two kinds of fibres. The inner fibre is flexible and stretchy, while another more rigid fibre is wound around it. When pressure is applied at any point, the outer rigid fibre straightens, causing the inner flexible fibre to bulge sideways, thereby allowing the fabric to become thicker. Tiny pores in the fabric open up simultaneously, which allows the pressure from the blast to be released through the pores, thereby preventing the fabric from tearing.

14.68 Flying Cars (Aeromobiles)^{A54}

Sit in a plane, fly off to the horizons yonder. Land the plane, retract the wings, and drive off on the highway in this modified vehicle! This is now possible in the new 'aeromobile' that has recently been granted approval by the US federal Aviation Authority.

The 'Terrafugia Transition', as it is called, can park in a normal parking place for cars, and travel on highways just like a car. As an aircraft, it has a cruising speed of 115 mph and a range of 460 miles.

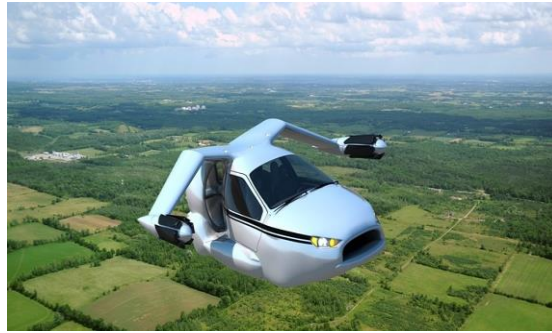
It has extra safety features which are required by cars, such as airbags and a crumple zone, and it costs \$194,000. So the next time you are taking your kids to school in heavy traffic, why not fly over the frustratingly long line of cars in front of you?

14.69 Free ice cream for a smile!^{A55}

Can a machine recognise that you are smiling and if the grin is broad enough, offer a free ice cream as a reward? SapientNitro has helped develop a machine for Unilever which does just that, as a part of the publicity drive for their ice creams.

The machine has a 'smile-ometre' which measures if your smile is good enough and when it is, it takes a photograph for placement on Facebook (with your permission).

A free ice cream of your choice comes out of the machine as a reward. The face-recognition technology on the machine not only measures the smile but also estimates your age and determines your gender. The smile-activated machine was launched at a festival in Lisbon in May this year.



14.68 Terrafugia shows off its impressive Photoshop skills with the TF-X. From terrafugia.com, <http://www.aeromobil.com/about>



14.69 *The world's first smile activated vending machine. Smile and get a Magnum!* <http://msglitz.com/2010/07/facebooking-july/>

14.70 Electric Cars --- Charging without Plugs!⁴⁵⁶

Electric cars are becoming increasingly popular because of their lower running costs, and improvements in performance. However, if we forget to charge them, we could be stranded on the road. Special base units have now been developed which can be installed on the floor of the garage. When a car is parked on them, it is automatically charged without the need of plugging it into an electricity socket. The plug-free technology was demonstrated at a "Plug-in 2010" conference in San Jose, California by a company Evatran of Wytheville, Virginia. It works by induction charging just like electric tooth brushes. A coil in the base unit on the garage floor generates an electromagnetic field which interacts with a coil fitted in the car, converting it into an electric current. Similar wireless charging systems have been developed by several organisations including the Japanese automobile manufacturer Nissan, the Korean Institute KAIST, and WiTricity, a US company which is a spin-out from MIT.

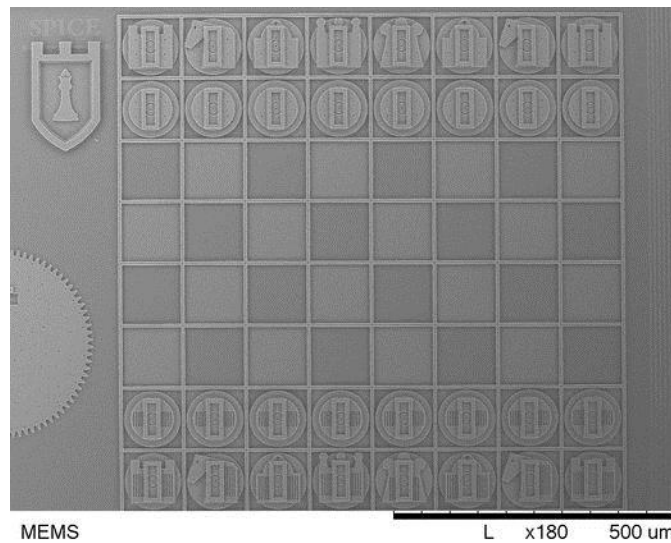
14.71 World's Smallest Chess Set!⁴⁵⁷

Micro Electro Mechanicals Systems (or MEMS, for short) involve technology of very small mechanical devices that are driven by electricity. MEMS technologies find wide use in such devices as cell phones, blood pressure sensors, ink-jet printers, digital cameras, cell research, etc. MEMS devices can be as small as 20 millionths of a millimetre and there is constant research to fabricate even smaller and better components.

In a competition to develop MEMS technologies, sponsored by Sandia labs, students at Texas Tech have succeeded in making a complete chess set which is ***smaller than half the width of the human hair!*** The chess set comes with set pieces that are about 50th the thickness of the human hair, thereby taking the miniaturisation process to a new level. Sandia Labs have established a University Alliance programme that is designed to train engineering students in MEMS technologies and develop their research skills so that they can develop more efficient devices.



14.70 <http://www.wirelesspowerplanet.com/wp-content/uploads/2011/03/Google-wireless-car3.jpg>



14.71 World's smallest chess set and a microbarbershop win big. <http://www.inventorsdigest.com/?p=4757>

14.72 Wikileaks --- A Headache for US Government!⁴⁵⁸

Recently, some 90,000 documents of the Afghan war were placed on Wikileaks, thereby focusing attention on this web site. What makes Wikileaks so powerful is that it is based on a technology that protects the identity of the person leaking the information. This technology was originally developed by the

Pentagon, and uses a network called “The Onion Router (Tor)” hosted in Sweden where the freedom-of-information laws prevent it from being closed down. There are also a number of mirrored sites at secret locations around the world. Therefore, if it is closed down in one place, it can continue operations from another.

The Tor Network uses some 1000 volunteer servers to carry the information. The information is bounced randomly between these servers and while this happens, layers of encryption are added to keep it safe from being decoded. It finally emerges at its destined site—Wikileaks. There are about 1.2 million secret documents posted at the site which range from the leaked US files on the Afghan war to the designs of the Hiroshima atomic bomb, military rules concerning the US prison camp at Guantanamo Bay in Cuba, and details of corruption in Kenya. These documents are a source of acute embarrassment, particularly to USA, as some very secret documentation is now freely available there. A recent video footage released is entitled “*Collateral Murder*” and it shows how 12 innocent civilians, including two Reuter journalists, were killed in a helicopter attack in Baghdad, Iraq in 2007. An Australian Julian Assange, a former computer hacker and a freedom-of-information activist, is behind this initiative along with a number of other colleagues including Ben Laurie, a web security expert.

14.73 Charge Your Cell Phone ---- with Shoes!⁴⁵⁹

A problem often encountered by travellers to remote locations or when hiking or mountain climbing is the non-availability of electrical power needed to charge a cell phone or a GPS receiver. Dr. Ville Kaajakari at the Institute of Micromanufacturing at Louisiana Tech University in USA has developed a very innovative device which when fitted in the heels of a shoe can generate sufficient power to charge a cell phone or other such devices. The advantage of its use is that a considerable amount of power is generated while walking, and a part of it can be harnessed, for instance, by fitting a piezoelectric material in the shoe which converts the mechanical energy into

electrical energy through special circuits. Piezoelectricity involves the generation of electricity when the shape of certain crystals (such as lead zirconate titanate) is deformed by pressure. Piezoelectricity has found a number of applications such as the ignition source of cigarette lighters and to push-start propane barbecues.



14.72 <http://www.giornalettismo.com/archives/1303801/trans-pacific-partnership-adesso-ce-il-quadro-completo/>



14.73 <http://iseeindia.com/2012/02/20/charge-your-cell-phone-on-the-go/>

14.74 Producing Electricity - From Roads!⁴⁶⁰

Can roads produce electricity? Now they may be able to. Experiments are underway to replace the asphalt surfaces on roads by photovoltaic cells. The challenge has been coating them or impregnating them on special glasses that can

withstand the pressure of heavy vehicles traveling on them or the heavy bumps that they receive. Glass has already been fabricated that is stronger than steel. In order to give it resilience against shattering, the technology developed for making bullet-proof glass is being used. One technique being used is to deposit thin-film photovoltaic materials onto flexible plastic, and then laminate specially toughened glass with this plastic. A challenge still to be surmounted is to make this surface rough so that the necessary grip is provided to the vehicles, without reducing the efficiency of the solar cells.

US Federal Highways Administration is providing funds for the project, which could lead to the roads generating sufficient electricity to allow electric cars to be charged by roadside charging stations and power street lights also.

The days when you will use the road to power your electric car (instead of petrol or diesel used in combustion engines) may not be that far away.

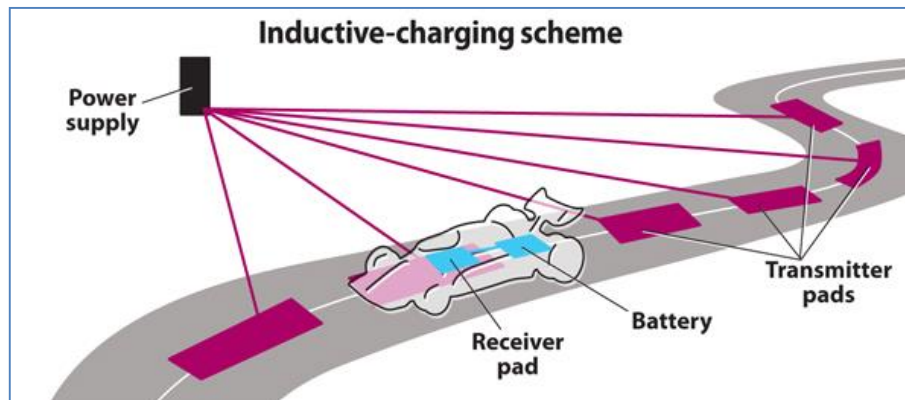
This is the strange and wondrous world of science!

14.75 Artificial Kidneys – Implantable!^{A61}

Tens of millions of people suffer from chronic kidney disease and millions die each year from kidney failure. The disease can only be fully treated with kidney transplants. As the number of kidney donors is limited, one is left with the option of dialysis which is expensive, and, in the case of terminally ill patients, it usually requires three sessions per week, each session taking three to five hours. Moreover, dialysis replaces only about 13% of normal kidney function so that only about 35% of patients on dialysis survive for more than five years.

There is, therefore, a desperate need of science and technology to come to the rescue by developing artificial kidneys that can be implanted into the patients. However, the technology has proved to be extremely difficult to develop. Now, however, there is hope. Dr. Shuvo Roy and coworkers working at the University of California, San Francisco (UCSF), Department of Bioengineering and Therapeutic Sciences, have developed the first fully implantable artificial kidney which contains thousands of

microfilters and a bioreactor that copies the metabolic and water balancing functions of a human kidney. The system developed initially was shown to work successfully with animal models. The technologies were developed to miniaturise it so that it could be implanted into a human body. This phase has been successfully completed and a cup-sized artificial kidney is now being developed. The artificial kidney does not require pumps or an electrical supply as it uses human blood pressure to carry out the filtration and other processes. The work is being carried out in collaboration with 10 research teams including scientists and bioengineers at Cleveland Clinic, Case Western Reserve University, University of Michigan, Ohio State University, and Penn State University. It may take five years or so before the artificial kidney is fully developed and commercialised, but there is hope for the future.



14.74 The Qualcomm Halo inductive-charging scheme wirelessly beams power to receiving coils on an electric vehicle. The tricky part is doing it while the car is moving at track speeds as will be the case with Formula E cars speeding around a city street course.<http://machinedesign.com/news/they-sound-millennium-falcon>

14.76 *Frying Food—with Hot Air!*^{A62}

Do you love fried foods and chips but hesitate because of the calories that you are consuming? Well, hesitate no longer for science has found an answer—fry in hot air! On 3rd September 2010, the world's leading trade show for consumer electronics opened in Berlin with display of a variety of gadgets—3D

televisions, cameras, tablet PCs, etc. Some 1,423 exhibitors showed off their products at this fair which was officially inaugurated by the German Chancellor, Angela Merkel.

On exhibition at the Philips stand was their new product, the Airfryer which uses hot air only for frying. The hot air is circulated around the grill component, and it is claimed that it leads to perfectly fried crispy chips as well as other foods such as pastries, fish, lamb chops, etc., within 12 minutes. The result is that you eat 80 percent less fat than would be present if you fried the materials in oil. It is also claimed to retain the flavours of the foods. There is even a 'separator accessory', that allows several different foods to be air-fried at the same time without mixing of flavours.

So for the obesity conscious, there may be a reason to smile.

14.77 Electric Bicycles!⁴⁶³

We have all heard of electric-powered cars ----- now come the electric bicycles! You can ride on these just like a normal bicycle, but if you find yourself getting hot and tired, just pull a switch and the electric powered batteries take over. You can then travel up to 160 kilometers (about 100 miles) without the need of recharging. The German manufacturer Kalkhoff offers three types of such "ebikes" that come fitted with 6, 12 or 18 amp-hour batteries. If you do not need to travel long distances, then the lighter 6 amp-hour battery should suffice for your needs.

If you want a small portable ebike that folds into a small 18 inch tall carrying case, you may want to opt for The VeloMini. Powered by a lithium ion battery, it can travel at 12 mph for upto 10 miles without needing a recharge.

14.78 Deceiving Robots!⁴⁶⁴

Deception is used as a tool for survival in nature, and insects, fish and higher animals use it to advantage. Robots have been taught a lot of tricks in the past but they did not know how to lie. Under a project funded by the Office of Naval Research (USA) being conducted at the Georgia Institute of Technology, they are



14.76 The Philips AirFryer uses hot air to crisp up chips. Photographs, courtesy: Philips Image: Philips AirFryer. <http://www.rediff.com/business/slide-show/slide-show-1-philips-makes-chips-out-of-hot-air/20120613.htm#6>



14.77a Kalkhoff Pro-Connect Disc electric bike. <http://www.bikeradar.com/gear/category/bikes/electric/product/review-kalkhoff-pro-connect-disc-11-44602/>



14.77b VELOMINI. <http://www.tuvie.com/velomini-light-weight-folding-electric-bicycle/>

now learning to do just that! This sounds a dangerous thing to do, as one day deceptive robots may try their tricks on us. However in a battle situation, a robot that can fool another robot by lying and deception can be an advantage. Using interdependence and game theories with some complex mathematics, Prof. Ronald Arkin and Engineer Alan Wagner have developed robots with “deceptive skills”. The deceiving robot, armed with such skills, was found to have developed the ability of fooling a normal robot without such “talents”. The work was recently published in the International Journal of Social Robotics

(<http://www.springerlink.com/content/p8085451p55u6141>).

14.79 LED Bulbs --- that Remain Lighted When Electricity Fails!⁴⁶⁵

The days when darkness engulfs you if the electricity fails may now be gone. A new type of light bulb has been developed that keeps providing power for up to 3 hours, even when there is no electricity. Made by the Chinese company Magic Bulb, the new LED bulb consumes only 4 watts of power but produces light comparable to a 50 Watt conventional bulb. With a life time of 20,000 hours, it has a built-in rechargeable battery. If you need a torch, just screw it off and walk around with it, as it keeps lighted!

14.80 LIDAR ---- A Technology with Diverse Applications!⁴⁶⁶

LIDAR (Light Detection And Ranging) is a technology that uses laser pulses to sense objects from a distance (remote sensing). The distance of the remote object is measured from the time taken between the transmission of a pulse and its detection after the signal is reflected back. The accuracy with which it works is truly stunning. One can measure the distance between the earth and the moon by using LIDAR with an accuracy of 1 millimeter! This is done by placing reflectors on the moon surface to reflect back the signal. Snow was detected in the atmosphere of Mars by NASA's spacecraft, Phoenix Lander, in September 2008

employing LIDAR. Chemical, biological and nuclear weapons can also be detected from great distances.



14.78 Georgia Tech Regents professor Ronald Arkin (left) and research engineer Alan Wagner look on as the black robot deceives the red robot into thinking it is hiding down the left corridor. (Click image for high-resolution version. Credit: Gary Meek)<http://www.news.gatech.edu/2013/02/20/alan-wagner-receives-air-force-young-investigator-program-award-social-robotics-work>



14.79 SmartCharge™ LED Bulb: No Power - No Problem<https://www.kickstarter.com/projects/127019135/smartcharge-never-be-in-the-dark-again>

LIDAR has found wide applications in forestry as it allows leaf densities and biomass to be measured accurately. It can also be used to help farmers to decide where to apply costly fertilizer on their lands by combining information from topological surveys, slopes and sun exposure with yields in previous years. It can map features beneath forest canopy and thereby reveal exciting archeological features. For instance, a husband and wife team, Arlen F. Chase and Diane Z. Chase, used airborne LIDAR to produce 3D images to study Maya lowlands in Central America. They discovered that concealed under heavy forest cover lay an ancient city, with ground architecture, house mounds, roads and agricultural sites. Using an advanced version of LIDAR, they took only 3 weeks to discover what archeologists had failed to find in 3 decades.

Fitted on car bumpers, LIDAR can detect the slowing down of the vehicle in front and automatically apply breaks if the driver does not react in time. A completely autonomous robotic Boeing flight successfully avoided obstacles in June 2010 and landed successfully. Fitted on blades of wind mills, it can detect the speed, direction and turbulence of incoming winds, and then adjust the angles of the blades so that maximum power output results under different conditions.

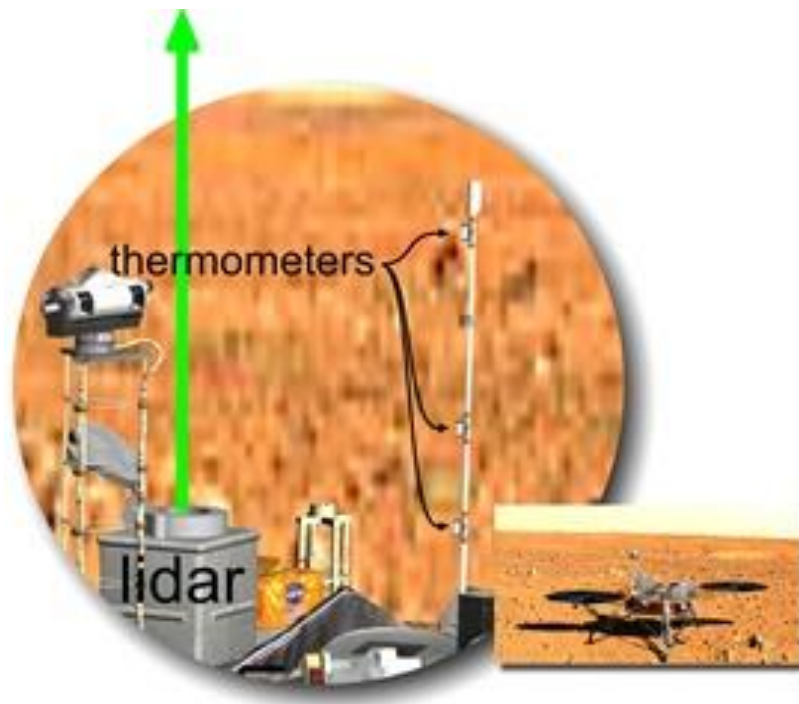
It is proving to be an invaluable tool with both civil and military applications.

14.81 If Batteries Lose Power --- Just Shake and Charge!⁴⁶⁷

A very interesting battery was exhibited at the Techno-frontier Exhibition in Tokyo in July 2010. It has a small power generating unit (electromagnetic induction generator) within the battery casing that can charge the battery simply on shaking. The Vibration Energy Cell manufactured by Brother Industries, a company better known for its printers, can produce sufficient power to operate AA or AAA batteries used in low power consuming devices such as remote control units of televisions or LED torches.



14.80a The Phoenix Lander on the Martian surface with its solar panels deployed.



14.80b Close up of the Phoenix meteorological mast with its three temperature sensors and the LIDAR instrument for determining cloud height as well as providing clues as to the composition of the clouds.
<http://www.tomatosphere.org/teacher-resources/optional-units/martian-environment/background-information.cfm>

14.82 Robotic Suits—for Superhuman Strength!⁴⁶⁸

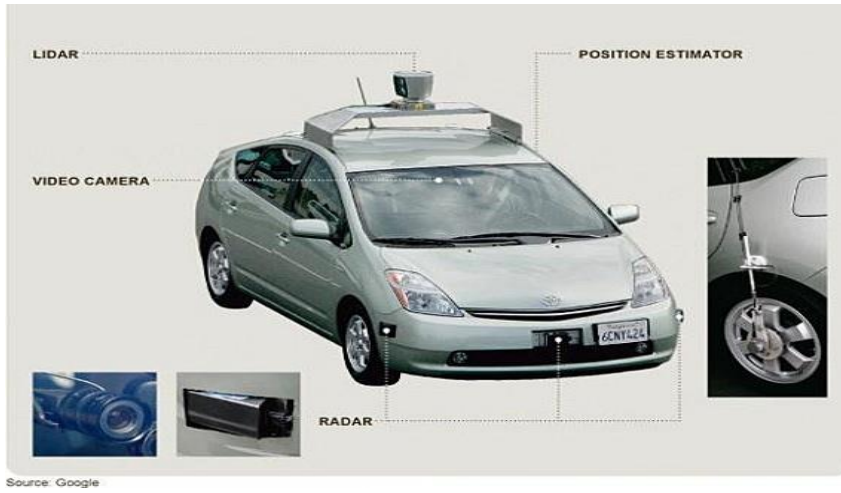
Rapid advances are being made in the fabrication of robotic suits that give superhuman strength to those who wear them. We can think of those who use them as robots with human brains. They allow a person to lift 200 pounds of weight without tiring and enable him/her to easily punch holes through three inches of solid wood. The capacity of individuals wearing such suits to work is enhanced several folds. These suits are now light and graceful, allowing the wearer to be agile and fast so that he can climb stairs and ramps very easily, kick a football accurately or punch a speed bag.

According to the company, Raytheon, that has developed the system, it will allow a person to lift 16,000 pounds of goods in a single day. With developments in new light weight and strong materials, as well as more powerful energy sources, the capacity of such 'exoskeletons' is being constantly enhanced. The US defence agency, Darpa, has been supporting a number of projects to develop such exoskeletons for the last 10 years.

The 'XOS 2', as it is called, is currently connected to a power supply unit which includes an internal combustion engine and lithium ion batteries that provide power to the limbs by high pressure hydraulics. New fuel cell systems are being developed to give greater flexibility and avoid the limitations of lithium batteries which can be explosive.

Armies of tomorrow will rely on such power enhancing devices to impart greater endurance and mobility to soldiers, allowing them to perform tasks that appear to be beyond human capabilities. Darpa has been spending hundreds of millions of dollars to develop such robotic suits.

The Pakistan army should similarly be funding million dollar projects in our engineering universities such as National University of Science and Technology (Islamabad), UET (Lahore) and NED Engineering University (Karachi) to develop powerful robotic exoskeletons. The university that is able to develop suitable robotic suits which are light, powerful and robust enough to be deployed in the field should be rewarded with 100 million rupee grants to support its research.



14.80c <http://imgarcade.com/1/google-driverless-car/>



14.81 Brother's AA-size Vibration Energy Cell battery prototype whose generator and rechargeable battery are installed in two different cases. <http://www.gizmag.com/brother-vibration-energy-cell-batteries/15804/>



14.82 Capable of lifting 200 pounds, but still gentle to the touch. <http://singularityhub.com/2009/06/11/army-exoskeleton-suit-gives-man-superhuman-strength/>

14.83 Strongest Fibre in the World—Spider Silk!^{A69}

Weight for weight, spider silk is stronger than steel. Indeed, it is the strongest fibre in the world—so strong that bullet proof vests, body armour, artificial ligaments, super-strong wound dressings, replacement tendons, parachute cords and many other materials can be made from it.

Darwin's bark spider found in the jungles of Madagascar produces the largest webs known and its silk is 10 times stronger than Kevlar. Kevlar is a synthetic material which is five times stronger than steel on an equal weight basis.

Three different approaches are being explored to make such materials in large quantities. The first is to make synthetic materials resembling natural spider silk. A second approach is to prepare genetically modified silk worms that can produce spider silk in large quantities. An advantage of this approach is that each silk worm can produce about half a mile of silk, and since it is already spun, there is no purification necessary. A third approach is to genetically modify goats so that special milk proteins are produced. These can then be purified and spun into a material resembling spider silk.

Parts of the DNA of spiders were inserted into the DNA of silk worms by US scientists, working at Kraig Biocraft Laboratories Inc. Such 'transgenic' silk worms could then produce silk that had many characteristics of spider silk. It is expected that this new type of silk will be commercially available within a year, and find a variety of applications for civil and military use.

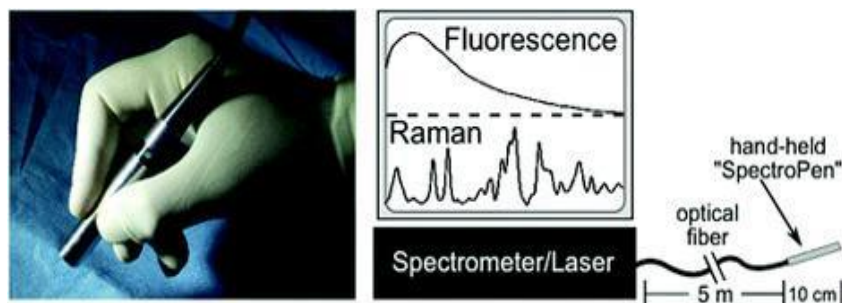
14.84 Wonder Pen to Help Cancer Surgeons!^{A70}

A major challenge for surgeons trying to remove a tumour completely is to identify cancer cells at the edge of the tumour. Now a special pen, SpectroPen, has been developed by biomedical researchers from Emory University School of Medicine, the Georgia Institute of Technology, and the University of Pennsylvania, USA, which combines a near infra-red laser with a special detector that can detect fluorescent dyes and light scattered by gold particles from tumour cells in real time.

The technique involves taking polymer-coated gold particles coupled to a fluorescent dye and an antibody that sticks to the tumour cells. The light emitting biological pigment 'luciferin' present in fire flies was used by the scientists to detect the cells with the special laser pen. The tumour cells at the edge can be more easily seen when one shines the laser at them, as the laser is connected to a spectrometre that detects the signals amplified by the gold particles.



14.83 This metre-wide Darwin's bark spider web found recently in Madagascar is said to be one of the biggest, strongest spider webs ever discovered. Scientists are now working on ways to use spider silk in bulletproof vests and athletic clothing. Credit: MatjazKuntner..<http://www.cosmosmagazine.com/news/gm-silkworms-produce-super-spider-silk/>



14.84 When performing surgery to remove a malignant tumor, a surgeon's biggest concern is ensuring that the margin is clean, i.e. no cancerous tissue is left behind.http://www.medgadget.com/2010/10/spectropen_allows_for_realtime_visualization_of_cancerous_tissue.html

14.85 Pillows and Cushions from Milk!^{A71}

There are constant efforts being made to develop biodegradable materials in order to reduce environmental pollution. Organic materials, such as those of plant or animal origin, break down rapidly and are considered to be desirable.

These include wood, paper, cotton, corn, straw, etc. Materials such as plastic (such as PVC, rayon, nylon), metals, glasses, foams (used to make cups and coolers), and ceramics (used in fibre glass, carbon fibre, etc.) do not break down easily in the environment and are considered to be non-biodegradable. The breakdown of biodegradable materials can occur by a number of processes such as by sunlight (photo-degradation), water (hydrolysis), air (oxidation), etc.

Now, a key milk component, casein, has been found to be useful for the manufacture of a biodegradable foam that can be used in furniture cushions, pillows, packaging and insulating materials as well as a number of other products. Casein has been used in the past in adhesives and paper coatings. David Schiraldi and colleagues in USA in collaboration with a research group in Thailand have now combined milk with clay along with some other chemicals to produce strong foam that can find many useful applications (Biomacromolecules, 2010, 11 (10), pp 2640–2646, DOI: 10.1021/bm100615).

14.86 Stunning Electric Jaguar!^{A72}

At the Paris Car Show 2010 held recently, Jaguar revealed its concept electric car which left many spectators gasping with awe. The Jaguar C-X75 can accelerate an amazing 0 to 100 km/h (62 mph) in just 3.4 seconds! It can also accelerate from 80 to 145 km/h (50 to 90 mph) in only 2.3 seconds. Powered by four 145kW motors, one on each wheel, it produces 780 bhp. Fitted with micro gas turbines to generate energy which is stored in the lithium-ion batteries, it has a range of 560 miles.

It promises to herald a new era in automobile technology.



14.85 Images courtesy *Biomacromolecule*, <http://www.architerials.com/2010/11/new-biodegradable-foam-made-from-milk-protein-and-clay/>



14.86 <http://mashable.com/2011/05/06/electric-jaguar-supercar/>

14.87 Roving Robot Guards—Now on Duty!⁴⁷³

Robots have been previously employed by bomb disposal squads to defuse bombs under remote human control. Now, however, roving robots have been developed by the US military to guard special security sites on their own, without human control. Known as the Mobile Detection Assessment Response System (MDARS), these roving robots move randomly on their own along defined areas.

They are fitted with thermal imaging devices, video cameras, and obstacle detecting lasers for detection and to go around any obstacles in their path. They are also fitted with high intensity strobe lights so that they can dazzle and disorient thieves till human help arrives to arrest them. They also automatically read labels on each carton through a radio-frequency ID tag reader to ensure that nothing is missing.

Built by General Dynamics Robotics Systems of Westminster, Maryland, USA, the robots are in the form of vehicles fitted with

various sensors to detect intruders. They have been deployed at the Nevada National Security Site, part of the US National Nuclear Security Administration (NNSA) to guard nuclear materials and radioactive waste. These robot sentries are now guarding sites at such special security zones. Similar robots are being developed by the Israeli company G-Nius Unmanned Ground Systems which can be fitted with machine guns.

In another related astounding development, the ability of moths to follow certain 'sex scents' (pheromones) has been integrated with the brains of robots so that they can use this fantastic biological capability. Atsushi Takashima and colleagues at the Tokyo Institute of Technology have immobilised a moth on a small wheeled robot and connected the nerves of the moth with electrodes to the robot. The commands of the living moth to the robot in response to chemical smells are conveyed to the robot, thereby guiding it to the source of the smell.

This technique is being developed to sniff out explosives or track the characteristic aroma of the perspiration of a terrorist. Similar connections between robots with fish or cockroach brains can be used to track a light source (<http://www.newscientist.com/article/mg20827855.400-part-moth-part-machine-cyborgs-are-on-the-move.html>). The US Defence Advanced Research Projects Agency (DARPA) is also funding research in this field to develop more powerful weapons. (<http://www.newscientist.com/blog/technology/2006/03/us-army-wants-insect-cyborgs.html>).

This seems to be the description of a scene from a science fiction movie but it is now real. The Star Wars scenario is fast approaching and the age of cyborgs, half machine and half animal, has dawned. While the oil rich states of the Middle East wallow in luxury living from their temporary oil wealth, the western countries invest heavily in research and development of such technologies to maintain world dominance.

14.88 Monitoring Patients - by Remote Sensing⁴⁷⁴

In order to monitor the heart rate and other vital signs of patients, one needs to attach electrodes with cables to the patient's body-

for instance, when the electrocardiogram of a patient is being recorded. This is impractical if a patient needs to move around or if continuous monitoring of the patient is required for a long time.



14.87a These are MDARS, robotic security vehicles that can roam the Nevada National Security Site today. They have mounted cameras on them and are used especially at night to secure the site, where top-secret nuclear projects are still worked on, although not nuclear weapons. <http://eecie.com/b/1139/SPAWAR---Autonomous-Military-Robots-.html>



14.87b AvantGuard Unmanned Ground Combat Vehicle, Israel. <http://www.army-technology.com/projects/avantguardunmannedgr/avantguardunmannedgr1.html>

Now, a plasma physicist, Atsushi Mase, and colleague Daisuke Nagae at Kyushu University in Japan have developed a method using microwaves to monitor patients remotely without the need

of attaching any sensors to the body. Very weak microwaves are used to irradiate the body, and the waves, after scattering from the surface of the body, are sensed by a highly sensitive microwave sensor that detects regular displacement of the chest while breathing and even the slight movement of the chest due to the beating heart.

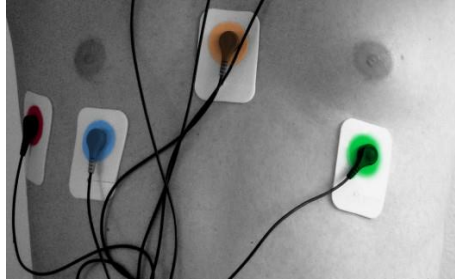
The development can find many applications including overnight monitoring of vital signs, detecting signs of sleepiness in drivers, and even as a security monitor to detect terrorists from the stress related symptoms that they exhibit. The work was recently published in *Review of scientific instruments*, 2010; 81 (9): 094301 DOI: 10.1063/1.3478017.

14.89 Luminescent Trees - that Glow as Street Lights!⁴⁷⁵

Scientists in Taiwan have found that treating trees with gold nanoparticles makes them glow with a reddish luminescence. Dr. Yen-Hsun Su found that when gold nanoparticles (particles that are ground so fine that they have an average diameter of only about a millionth of a millimeter) were allowed to diffuse into the leaves of a plant (*Bacopa caroliniana*) it caused the chlorophyll in the plant to produce a reddish glow. The authors believe that the development may lead to trees being employed as street lights as their leaves will glow and create a magical hue! Gold nanoparticles have found many exciting applications such as their use in the manufacture of nontoxic fragrances and light emitting nanowires that produce light similar to that produced by LEDs.

14.90 Flying with Jet-Packs⁴⁷⁶

Tired of frustrating traffic jams? Wished that you could just take off and fly to office, bag in hand above the traffic? Well, believe it, now you can! The first commercially available jet pack will be available from next year. It is priced at about \$86,000 and with a 10 percent deposit, you can book one with a 12-month delivery time. The prices are expected to decrease sharply as production increases. You can fly for 30 minutes with the engines fuelled by



14.88 Electrodes could become a thing of the past, thanks to new research into the use of microwaves (Photo: Rennett Stowe, CC 2.0)<http://www.gizmag.com/microwaves-to-monitor-vital-signs/16915/>



14.89 <http://gajitz.com/leave-a-light-on-glowing-trees-to-replace-street-lamps/>



14.90 The P12 prototype during a manned flight test (Photo: Martin Aircraft). <http://www.gizmag.com/martin-jetpack-p12/29215/pictures#11>

standard gasoline, and if you have an engine failure in mid-flight (you can fly at an altitude of 8,000 ft), don't worry as the equipment has built-in spare systems that will take over. If the spare systems also fail, there is a built-in parachute system which will bring you and the equipment gently and safely to the ground. The jet-pack has been developed by Martin Aircraft of New Zealand after two decades of research and development of nine prototypes.

Meanwhile, US Federal Aviation Administration (FAA) is in the process of developing GPS based 'highways in the sky' so that flying people, flying motor cycles and flying cars can travel on invisible highways in the skies safely. Science fiction is becoming a reality!

14.91 A Helicopter - for the Price of a Car!⁴⁷⁷

Tired of traffic jams! Want to fly to work in your own private helicopter? Well, you can buy a small personal helicopter for the price of a car. The kit costs under \$ 3,000 while you can have it built up by experts for another \$ 4,000. The Mosquito XE is an ultra-light helicopter. This is an open version ---if you want a fully enclosed version, then you can buy it for about \$ 20,000 ----- still a bargain! It can carry only 5 gallons of fuel, and so has a range of about 90 kilometers.

14.92 3D Holographic Images - in Real Time!⁴⁷⁸

3D cameras and televisions have already arrived ---- the next development on the near horizon is 3D holographic images that can be transmitted in real time. Sounds like a science fiction movie but it is happening. The University of Arizona in USA has recently displayed a system that can display 3D holographic images in almost real time. So the time is near when you will be talking face to face with the 3D holographic image of your family member even though he/she is several thousand miles away.



14.91 Pictured above, The Mosquito XE Helicopter. Reproduced with thanks from, <http://www.innovator.mosquito.net.nz/mbbs2/index.asp>



14.92 Formula 1 driver Lewis Hamilton of Great Britain stands next to a 3D hologram during the Reebok launch of their new Smooth Fit technology. Michael Steele/Getty Images for Reebok <http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/holographic-environment.htm>

14.93 *Playing Games --- by Thought Control!*⁴⁷⁹

A small Toronto-based company, IntraXon, has developed an exciting device which allows games to be played purely by thought control! The player wears a head phone that contains special sensors that come into contact with the left ear and the forehead. The sensors detect the electrical activity occurring in the brain and transmit it through a Bluetooth dongle to an iPad on which the game is being played.

IntraXon caused a lot of excitement at the 2010 winter Olympics by displaying a device through which users could control the lights on the CN tower merely by thought control. The technology will be displayed at the forthcoming Consumer Electronics Show in Las Vegas.

14.94 Superfast Wireless Networks!^{A80}

A revolution may be around the corner in the form of super fast wireless networks that use antennas that use plasma made up of only electrons. These new antennas have been developed by a UK company, "Plasma Antennas", and comprise thousands of tiny diodes on a silicon chip. Each of these diodes generates a little cloud of electrons (the plasma) about 0.1 mm across. These diodes can be activated selectively, thereby allowing the beam of radio waves to be focused and steered in the manner desired. This next generation ultra-fast Wi-Fi technology (known as Wi-Gig, because of its speeds of gigabits of data per second) should be about 100 times faster than the present Wi-Fi technology which reaches a maximum of 54 megabits of data per second. In practical terms, this would mean the ability to download a movie in seconds. Since higher radio-frequencies are used (60 gigahertz instead of 2.4 gigahertz used in Wi-Fi systems), better focusing is needed, which is achieved with these new plasma antennas.

Using this new technology, cars may have built-in miniature radar systems to prevent collisions. They could also see through rain or fog and thus drive easily in difficult conditions.

Technology continues to develop at a mind boggling speed in this wondrous world of science!

14.95 3D TV --- without Glasses!^{A81}

The need to wear special glasses in order to watch 3D TV has put many people off from buying them. A race is on to develop a



14.93 Muse wearable brainwave headband (credit; InteraXon)
<http://www.kurzweilai.net/a-stylish-new-brain-sensing-headband>



14.94 The WiGig Alliance promises to bring gigabit-speed wireless via the 60GHz band into the home – finally ditching the last of your data wires. <http://www.bit-tech.net/news/hardware/2009/05/07/wigig-alliance-offers-new-tech/1>

3D TV which you can watch without 3D glasses. The 3D effects are created by the transmission of two different images to the right and left eyes. However, a major limitation is that the 3D effect is visible only from a narrow viewing range. A system has been demonstrated by a Hungarian company, iPont International in collaboration with Tridelity in New Jersey, USA which allows five persons to experience a 3D effect simultaneously as the system allows light from pairs of images to be sent in five directions simultaneously. However, to create the 3D effect some of the light is blocked, so that the images are relatively dark and the viewer cannot properly enjoy 3D movies unless he is sitting in the dark. The technology is under rapid evolution and it may be a couple of years before a 3D TV with wide angle viewing and a bright screen is available.

Handheld 3D viewing devices manufactured by Nintendo for playing games are also available. Sharp has also developed a 3D touch screen for use in cameras and cell phones.

14.96 Clear Air Turbulence (CAT) - Boeing Finds the Answer!^{A82}

You are flying in clear skies when your plane starts to shudder violently. Ever experienced this? It is quite a common phenomenon caused by severe clear air turbulence (CAT). If you hit a bad air pocket, your plane can suddenly lose height and cause panic. People have been known to have been severely injured or even killed by the injuries caused by such violent turbulence. During the period 2003 to 2009, there were 80 incidents of severe turbulence in which one or more passengers were severely injured. A challenge is that pilots are unable to see such turbulence in advance so that they cannot fly round such turbulent areas. Now, however, Boeing has developed an exciting new device that alerts the pilots fairly accurately about such turbulent areas well before they have been reached and allows them to avoid them.

The device is quite simple. It is a digital camera fitted with a telephoto lens that takes rapid pictures of the horizon and checks them for any changes in the image caused by changes in

refractive index that will be visible if there is any air turbulence. The device was patented on 20th January 2011 (US Patent No. 2011/0013016) and should be available on aircrafts before long.



14.95 www.thetechherald.com; <http://www.amazon.com/Nintendo-3DS-Aqua-Blue/dp/B002I090AG>



14.96 A new sensor could detect invisible clear air turbulence, reducing in-flight injuries. <http://www.engadget.com/2013/08/06/lidar-system-lasers-turbulence/>

14.97 Road Trains - Wireless Car Convoys!⁴⁸³

A common problem on motorways is accidents caused by drivers falling asleep or overspeeding. Now a solution has been developed to connect the cars wirelessly together so that they

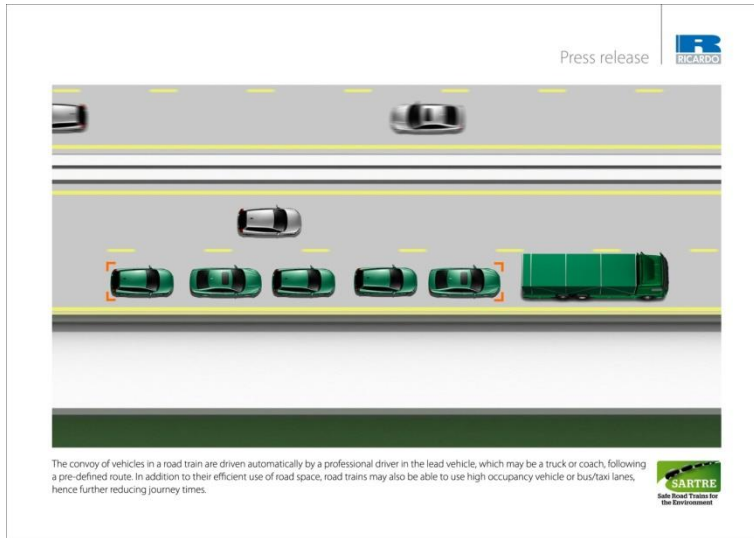
behave together like carriages on a train. The driver can go to sleep, read a book or enjoy a cup of coffee as the cars are under computer control, being part of a semi-autonomous platoon. At the head of this convoy is a truck driven by a professional driver which controls all the cars in the convoy behind it. This leads to significant advantages in terms of road safety, economy of fuel consumption and road congestion. A car can join this convoy when it comes on the motorway, travel the desired distance, and then exit as required.

The system was successfully tested by Volvo in Sweden recently under the Safe Road Trains for the Environment (SARTRE) Project funded by the European Commission at a cost of Euros 6.4 million. The cars are fitted with cameras and sensors that automatically prevent them from coming too close to one another or drifting out of a lane.

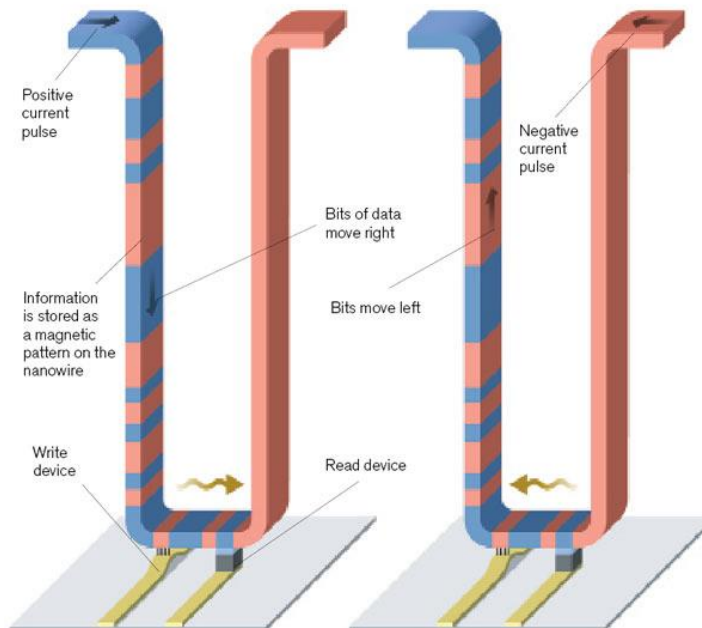
14.98 Exciting Advances in Computer Technologies - Racetrack Memory!⁴⁸⁴

Nanotechnology has found a myriad of applications in the last decade. An exciting recent development is the use of magnetic U-shaped nanowires which are arranged vertically, like trees in a forest, to store information. The technology is fundamentally different from the previous known ones as it uses electric currents (instead of magnetically charged atoms) to push electrons along tiny wires. It is claimed to be a million times faster and uses much less power, thereby overcoming the problem of crashes. Known as “racetrack memory” because it resembles a large number of cars racing together on a racetrack, the technology depends on read/write heads positioned near the nanowires sensing and reading the electric current that passes along the wire.

This exciting new development was announced by IBM recently in a Newsletter. The memory is being developed at Almaden Research Centre of IBM by a team led by Stuart Parkin. It is expected that these new kinds of chips will be able to store hundreds of gigabytes of data on tiny nanowires a few microns in length and 30 nanometers wide.



14.97 <http://www.ricardo.com/Global/IA/News/Press%20Release%20Listing%20images/2009%20download%20images/SARTRE-launch/SARTRE%20-%20road%20trains%20explained%202%20of%205.jpg>



14.98 *Credit: Arthur Mount; source: IBM.* <http://www2.technologyreview.com/article/412189/tr10-racetrack-memory/>

All the books in all the libraries of the world would fit into a tiny match box of such memory chips!

14.99 A Refrigerator that Keeps Cool for 10 Days Without Power!⁴⁸⁵

A problem often encountered in developing countries such as Pakistan is regular power breakdowns. This causes serious problems in storage of foods, and it can be catastrophic if vaccines and other sensitive medical supplies are stored. A refrigerator has now been developed by a company, True Energy, that can keep the temperature at below 10 degrees Centigrade for up to 10 days without external power! It uses an innovative “phase change material” that stores the energy and releases it when required.

Phase change materials can store a large amount of energy because of their high heat of fusion. They can store or release energy when they solidify. Such latent heat storage is achieved through phase changes (solid-solid, solid-liquid, liquid gas, etc.).

14.100 A Fifteen Storey Building – in Six Days!⁴⁸⁶

Amazing advances in building technologies in China were evident in the construction of sports stadiums and lodging facilities at the Shanghai World Expo and the Beijing Olympic Games. Chinese construction engineers have now achieved an even more spectacular feat ---constructed a 15 storey building in only six days after the foundations and underground works had been completed! The building is that of Ark Hotel in the city of Changsha, located in the Hunan province. The frame of the building was erected in 46.5 hours while the external surfaces and other features of the building were completed in 90 hours. Only 200 workers were involved in the construction work. The building is strong enough to withstand an earthquake of magnitude 9.0. The building is 5 times more efficient than conventional buildings, having triple pane windows, heat recovery systems, six inches of thermal insulation, LED lighting systems and external solar shades. The building utilized only

one-sixth of the materials used in similar sized conventional buildings and was built at a much lower cost. There are 15 similar buildings planned to be built in China and 30 such buildings in other countries.



14.99 The True Energy Vaccine Refrigerator can keep its contents cold for ten days without power, <http://www.gizmag.com/true-energy-refrigerators-cool-for-ten-days-without-power/17739/>



14.100 This hotel was built in six days. (ArchDaily), <http://www.theatlantic.com/video/archive/2013/07/building-a-hotel-in-six-days-a-time-lapse-of-chinas-construction-miracle/278191/>

14.101 *Nature, the Best Teacher!*⁴⁸⁷

Engineers of today continue to learn from nature in many ways. A field has involved known as “biomimicry” --- copying nature.

Biomimicry provides novel engineering concepts and designs that lead to new products and processes. For example, termites can maintain constant temperature and humidity in termite mounds in Africa in spite of variations of outside temperatures from 1.5°C to 40°C. Engineers learning from the termites constructed the Eastgate Centre in Harare, Zimbabwe which remains cool without air conditioning and uses only 10% of the power used by other conventional buildings of comparable size. A cane has been developed for the blind, based on the echolocation technique used by bats. Velcro was developed on the basis of hook-like structures present on the surface of burs. Hundreds of other products have been designed, learning from the way nature has solved various problems in the course of evolution.

Nature is the greatest master!

14.102 Thought-Controlled Cars!⁴⁸⁸

Can cars be controlled and driven purely by thought? This appears to be impossible, but in this strange and wondrous world of science, anything is possible. Indeed cars can now be driven purely by mind control!

A team of researchers at the Freie Universität Berlin, using a commercially available Emotiv EPOC brain-machine gaming interface, have succeeded in controlling the driving functions of a car just by thought control. The driver wears a special headset fitted with 16 EEG (electroencephalographic) sensors and the system (appropriately known as “BrainDriver”) detects the mental commands and transmits them to the car’s drive-by-wire computer controls. The steering, acceleration and braking can thus be continuously controlled. The measurement of brain’s electrical activity is called electroencephalography, or EEG. It is a noninvasive technique which means that nothing is inserted into the brain but electrodes are simply placed on the scalp of the user.

The driver needs a short period of training on a software tool kit through which he/she learns to move a cube on a computer screen by alteration of thought patterns. These patterns are then

detected by “BrainDriver” when the car is being driven and transmitted to the control systems of the car.



14.101a Biomimicry’s Cool Alternative: Eastgate Centre in Zimbabwe. The pink-hued Eastgate Centre, with its distinctive chimneys,
http://en.wikipedia.org/wiki/Eastgate_Centre,_Harare

14.101b Blind people are able to learn to use echolocation to varying extents,
<http://jncc.defra.gov.uk/page-5402>



14.101c Daniel Kish (red shirt), who went blind at age 13 months, has been using echolocation for as long as he can remember. Now, he teaches others how to use the technique. (Steve Broxterman/World Access for the Blind)
<http://www.cbc.ca/news/technology/blind-people-echolocate-with-visual-part-of-brain-1.1012642>

14.102a In a second test version, the car drove largely automatically, but via the EEG sensors the driver was able to determine the direction at intersections. (Text: IANS).
<http://ibnlive.in.com/photogallery/3431-9.html>

The technology of controlling computers by thought was first displayed by an Austrian company “g.tec” at a major Cebit trade show in Hanover, Germany in 2007. The demonstration in 2007 involved the operator wearing a cap with sensors which detected tiny changes in electrical voltages in the brain. These were then analysed by the computer which figured out what these messages meant and then transformed into commands to the computer.

14.103 Electronic Clothing --- Glowing Ladies!⁴⁸⁹

Imagine that you are wearing an evening party dress that glows softly, emitting light in various slowly changing colours of the rainbow! Sounds impossible, does it not?

The development of organic light emitting diodes (OLEDs) is now making this possible. Impregnated into special thin film polymeric fabrics, the layer of organic semiconductors is placed between two electrodes so that the resulting material can conduct electricity. The solar cells incorporated into the material allow the production of power needed for lighting up the OLEDs. The light emitting layer comprises certain organic compounds that emit light when a current is applied to them.

It all sounds more like electronic gadgetry than fashion --- but this is the wondrous world of science that we live in. So the next time you walk into a party, light up the environment with your presence --- literally!

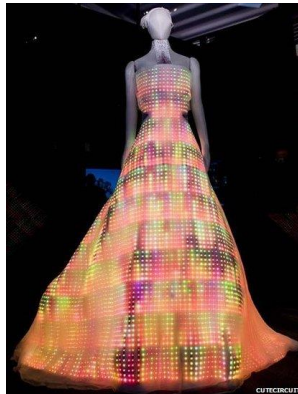
14.104 Giant Kites to Assist Ships!⁴⁹⁰

A German company SkySails has been manufacturing giant kites that can be tied to ships and help save fuel costs by supplementing their own power by wind power. The technology was first successfully demonstrated when a large kite was attached to a 433 foot boat, MS Beluga SkySails, in 2008. Now, a huge 30,000 ton ship belonging to Cargill Ocean Transportation will be fitted in the same manner. A giant kite measuring 382 square yards will be tied to the front of the ship to pull it along flying at a height of 100-400 meters. Its flying

trajectory will be optimally controlled by computers. The launch and retrieval of the kite will be carried out by a built-in mechanical system comprising a winch-equipped telescoping tower installed on the bow of the ship.



14.102b An exhibitor controls a pinball game using his brain waves at CeBIT 2010. Picture: AFP Source: AFP
<http://www.news.com.au/technology/mind-reading-computers-turn-heads-at-cebit-high-tech-fair/story-e6frfo0-1225837200918>



14.103 This wedding dress, containing 24,000 lights, is currently on display in the Museum of Science and Industry, Chicago. It was developed by CuteCircuit.
<http://www.bbc.co.uk/news/technology-10698692>



14.104 MS Beluga equipped with skysails.
http://cleantech-log.de/?attachment_id=10

Using this interesting technology, the system will save up to 35% fuel. The system is claimed to provide 5 to 25 times more power than conventional sails.

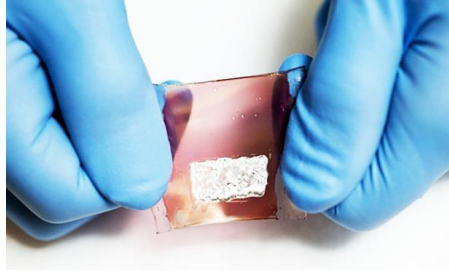
14.105 Ultra-sensitive Artificial Skin --- for Robots!^{A91}

A special highly sensitive artificial skin impregnated with flexible transistors has now been developed by a Stanford scientist, Zhenan Bao, which is so sensitive that it can feel the weight of a butterfly! The rubber layer is highly elastic and is molded on top of microscopic inverted pyramids that transmit the pressure applied on it to sensors located in another rubber layer underneath. The number of the tiny pyramids can vary from a few hundred thousands to 25 million pyramids per square centimeter, depending on the level of sensitivity required. Since it is sandwiched between two parallel electrodes, it detects the changes in pressure on the skin due to compressions and rebounds by changes in the strengths of electrical signals. It is powered by solar cells or can be powered by batteries. Its structure can be modified so that it can detect dangerous chemicals such as explosives or diagnose medical conditions by simply touching a patient. This detection of different diseases is made possible by its ability to recognize specific proteins (biomarkers) associated with that disease.

In an earlier article, I had reported the development of robots which can detect your emotional condition and respond sympathetically. Now, with the development of a sensitive skin that can be coated on such robots, humanoid robots that can sense a touch and respond to your emotional conditions are round the corner.

14.106 Another First from Fujitsu --- Wireless Computer Monitors!^{A92}

Fujitsu Japan, a world leader in the manufacture of laptop and desktop computers, servers and other computer devices, had earlier pioneered the Palm Vein Authentication technology for identification of persons (biometrics) without physical contact of



14.105a The "super skin" developed by Stanford University researcher Zhenan Bao is self-powering, using polymer solar cells to generate electricity. The solar cells are not just flexible, but stretchable -- they can be stretched up to 30 percent beyond their original length and snap back without any damage or loss of power. <http://www.fastcompany.com/1730687/stretchy-solar-cells-power-super-skin>



14.105b Robots could become a lot more 'sensitive' thanks to new artificial skins and sensor technologies developed by European scientists. (Credit: Peratech) http://news.cnet.com/8301-17938_105-10458796-1.html



14.106 Fujitsu 22-inch "Worlds First Wireless Display" Showcases At CeBIT 2011 held at Hannover, Germany. <http://www.onlinesocialmedia.net/20110228/fujitsu-22-inch-worlds-first-wireless-display-showcases-at-cebit-2011/>

their palms with the detecting device. The company has now come out with a new breakthrough technology which will allow you to get rid of messy cables and connect computers wirelessly to monitors. Even power cables are not needed as Fujitsu uses an innovative way to transfer power --- magnetic induction technology! Magnetic induction systems are simpler than the conventional radio frequency systems and use very little power to transmit signals wirelessly through the air.

Working in collaboration with the Fraunhofer Institute, Fujitsu has succeeded in developing the wireless Smart Universal Power Access (SUPA) technology that allows power and pictures to be beamed to computer monitors in a completely wireless manner. The project has been funded by the German Ministry of Economic Affairs. In order to maintain the highest quality of the products, Fujitsu has set up large manufacturing facilities in Germany for its computers, servers and other devices --- hence the Japan-German partnership. The new exciting technology was recently displayed at CeBIT 2011, the world's largest international trade fair in Hannover, and drew large appreciating crowds.

In this wondrous world of science, truth is often stranger than fiction.

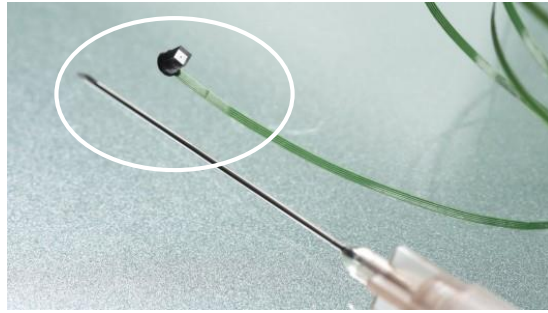
14.107 Miniature Cameras --- Tiny as a Grain of Salt!⁴⁹³

Scientists at the Fraunhofer Institute in Germany have developed an extremely small video camera which is no bigger than a grain of salt. This tiny camera can be used to peer into the various internal organs. It is also so inexpensive that it need not be sanitized after each use but it can be thrown away and replaced with a new one. Such "endoscopes", as they are called, normally use fiber optic cables but the camera developed uses a normal electrical cable. The new system is expected to be commercialized by next year.

14.108 Gunshot Detectors --- Now in Use!⁴⁹⁴

One of the problems encountered by soldiers in a battle situation is to accurately determine where precisely the gunfire is coming from. Both the direction and the distance from where the gun fire is

coming need to be determined accurately before proper counter-action can occur. Now, such a device has been developed and 13,000 such units will be released to US soldiers fighting in Afghanistan, about 1,500 per month. The equipment, known as Individual Gunshot Detector (IGD), is a small box weighing less than 2 pounds carried on the shoulders by the soldiers and it is fitted with four small acoustic sensors and a screen. The IGD detects the exact direction from which the gun fire is coming, as well as the distance from which the shot has been fired.



14.107 German engineers have developed a low-cost disposable endoscopic camera that is the size of a coarse grain of salt (Photo: Fraunhofer) <http://www.gizmag.com/salt-sized-disposable-endoscopic-camera/18108/>



14.108 Individual Gunshot Detector tells soldiers direction of incoming fire, <http://www.geek.com/geek-cetera/individual-gunshot-detector-tells-soldiers-direction-of-incoming-fire-1329151/>

USA has been spending over \$ 200 billion dollar annually in the war effort in Afghanistan and Iraq for a decade. If a third of this

amount had been invested in education and projects related to socio-economic development, Afghanistan would be a prosperous country today instead of being covered in blood, ignorance and poverty! Such wars are not won by spilling of blood. They are won by winning the hearts and minds.

14.109 Robots to the Rescue!⁴⁹⁵

A robot called “*Monirobot*” has been employed to help at the Fukushima Daiichi nuclear power plant. It is designed to function at radiation levels at which human beings cannot function. The robot was developed through researches commissioned by the Japan's Nuclear Safety Technology Centre after a nuclear accident occurred at the Tokaimura nuclear power plant in 1999 in which two workers lost their lives. The robot is fitted with a radiation detector, a 3D camera as well as temperature and humidity detectors. It can collect samples and remove obstacles using its special arms. It has a height of 1.5 meters and rolls along merrily on caterpillar tracks.

14.110 Washing Machines --- Break World Records!⁴⁹⁶

Conventional washing machines take about 90 minutes on average to complete the wash cycle involving rinsing and spinning. Now, a new type of washing machine has been developed by Russell Hobbs in the UK that completes this cycle in just 12 minutes. It involves two nozzles spraying detergent and water directly on to the soiled clothes. The machine is fitted with various detection systems to automatically adjust the washing time if it contains only half a washing load. The manufacturers claim that it cuts energy and water consumption substantially, besides saving valuable time.

14.111 Artificial Arm --- Thought Controlled!⁴⁹⁷

Thought controlled devices are becoming increasingly common. Today, it is possible for paralysed persons to move wheelchairs or



14.109 Monirobo measures radiation following nuclear crisis at Japan's Fukushima Daiichi power plant. <http://www.engadget.com/2011/03/23/monirobo-measures-radiation-following-nuclear-crisis-at-japans/>



14.110 The Russell Hobbs washing machines offering a 12 minute cycle - 7kg white and graphite models and 9kg white model. www.ohgizmo.com

drive cars purely by thought control. Now two undergraduate biomedical engineering students, Thiago Caires and Michal Prywata, at Ryerson University in Toronto have developed an artificial arm that can be controlled by thought control. Powered by compressed air, the device is easy to construct and avoids the

need of invasive surgery that is necessary to fit persons with amputated arms with artificial ones. The person using the arm sends signals to it through a skull cap. The cap has sensors which sense the changes in blood flow in the brain that occur when the thought command is issued. These signals are transmitted to a microprocessor in the arm which already has stored patterns for signals such as “up”, “down”, “left”, “right” etc. The microprocessor compares the signals coming from the brain with those previously stored in it for various movements and acts accordingly.

14.112 Painless Syringes – Learning from Mosquitoes!⁴⁹⁸

Ever feel a mosquito bite? Normally we feel the aftereffects only when the mosquito has had its fill of our blood. This is due to the fact that the itching occurs only after certain bacteria have been inserted along with an anticoagulant through our skin. A Japanese scientist Seiji Aoyagi and his colleague at Kansai University in Osaka decided to take a closer look at mosquitoes and find out what makes the bites almost painless? As a result of the study, they decided to design a painless needle based on the design of a mosquito’s proboscis (the part that it inserts into our skin when it bites us).

It turns out that the reason the bite is painless is that the surface of the proboscis is not smooth but jagged. When a mosquito inserts its proboscis, the tiny serrated outer surface first penetrates the skin with an extremely small surface area, so that there is minimum contact with the nerves in the skin. Once the outer sheath has penetrated the skin painlessly, the inner blood sucking tube is inserted. A syringe was accordingly designed which was etched from silicon forming the outer tube. An inner finer tube was used for drawing blood. The result is a remarkably painless needle!

14.113 Combined Car & Motorcycle!⁴⁹⁹

At the Shanghai auto show held in April this year, the Chinese auto designers were seen in action with their creativity. One item

that drew crowds was a combined car/motor cycle! The car is a two door, four-seater vehicle which has a foldable electric scooter at the rear. It is planned to be manufactured as an all electric car or as an electric-petrol hybrid. Once docked at the back, the battery of the scooter is charged by the car. It meets the need of a vehicle which can serve for medium/long distance driving as well as provide a solution for travelling the last mile through congested areas in a handy scooter.



14.112 The needle mimics the way mosquitoes bite their victims. Mosquito needle 'hurts far less than regular injection'.
<http://www.punemirror.in/index.aspx?Page=article§name=Lifestyle%20-%20SciTech§id=26&contentid=2011032620110326063706512184b1c0>



14.113 GeelyMcCar Combines Car & Motocycle.
<http://technabob.com/blog/2011/04/25/geely-mc-car-electric-car-electric-scooter/>

This novel car has been manufactured by an emerging auto giant in China, Geely, and has been named as “McCar”, derived from the popular McDonald’s brand name, indicating value-for-money and popular appeal. Geely has entered into collaboration with Volvo in China and there is a possibility of Volvo marketing this car internationally.

14.114 Recycling Wastes --- using Robots!⁵⁰⁰

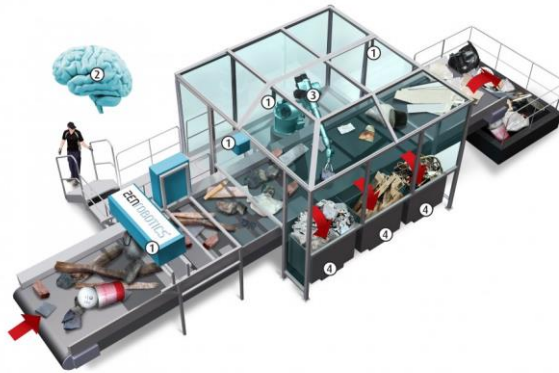
The recycling of paper, cardboard, glass, plastics and metals is routinely carried out in the West. This is normally done by house wives who place different types of objects into differently colored bins.

Now, a company in Finland, ZenRobotics, claims to have developed a robot fitted with various types of sensors that will do this task. The robot can be fitted above a moving conveyor belt on which various articles of trash are placed. It automatically senses the article, picks it up and drops it into an appropriate container. The sensing systems on the robot include various types of cameras, metal detectors, and a whole array of other detecting systems that allow it to distinguish between cables, glass bulbs, cans, pipes, bricks, cloth pieces, etc.

14.115 Reducing Food Spoilage with Ozone!⁵⁰¹

About 30% of all harvested fresh fruits and vegetables are spoilt by fungal contamination each year. A number of techniques have been developed in the past to preserve food, which include the use of synthetic pesticides, special packaging, and pre-package treatments with chlorine or bromine. Dr. Ian Singleton and plant biologist Prof. Jerry Barnes at the University of Newcastle have now found that the spoilage can be substantially controlled if tomatoes, plums, grapes and other fruits and vegetables are stored in an atmosphere which contains small amounts of ozone. The spoilage can be reduced by 95% if batches stored with or without the ozone are compared after 8 days. Tomatoes stored under ozone also developed resistance

to fungal attacks even when taken out of the ozone containing atmosphere, indicating that they had acquired some kind of memory, comparable to the vaccination process that led to the development of resistance.



14.114 1.Sensors, 2. Control system ZenRobotics Brain, 3. Industrial robot , 4. Recovered fractions <http://www.zenrobotics.com/news/media/>



14.115 Dr. Ian Singleton at ozone research lab. <http://www.foodproductiondaily.com/Safety-Regulation/Ozone-storage-system-slashes-fresh-produce-spoilage-research>

14.116 Plastics --- from Chicken Feathers!⁵⁰²

Chicken feathers have so far been used for mixing in low quality chicken feed and are largely considered useless. Over a billion tons of chicken feathers are produced each year world-wide. They contain a large amount of keratin, a tough protein found also in cow hoofs and animal horns. A thermoplastic film made from keratin has excellent properties since it is very strong and tear resistant. Now, Dr. Yiqi Yang and colleagues at the Institute of Agriculture & Natural Resources at the University of Nebraska-Lincoln in USA have found that they can make excellent tough bioplastics from keratin obtained from chicken feathers.

Earlier work in this direction by scientists met with little success as the plastic produced was not very water resistant. Yang and coworkers have overcome this problem by combining the material with another chemical used for making synthetic plastics (methyl acrylate). The result is a very exciting new substance which is both tough and water resistant. This should lead to the large scale utilization of chicken feathers for a variety of different types of plastics.

14.117 Rolling Robots—Designed on Caterpillars!⁵⁰³

Life has evolved over millions of years to produce innumerable functions in various plant and animal species on our planet. These are being used by man today to learn and apply in various ways, a process known as “biomimicry”.

A particular family of caterpillars has proved to be particularly interesting in the development of new robot types. These caterpillars, when faced with danger, can twist themselves into a wheel-like structure and roll away at lightning speed. Now Huai-Ti Lin at the Department of Biology, Tufts University, has developed a soft robot that does just that.

The “GoQBot”, as it is called, can wriggle into tight spaces when it is flat, but it can adopt a wheel shape within a fraction of a second and roll away at an amazing speed of half a metre per second when ordered to do so. It represents a new class of

robots which can copy the behavior of caterpillars and change shapes as required.



14.116 Photo: Dr. Yiqi Yang says chicken feathers could be used to produce furniture, films, fibres and fast-food containers. Chicken feathers may fuel plastic revolution. Map: United States



14.117 Photos: Barry Trimmer/Tufts U.
http://spectrum.ieee.org/automaton/robotics/robotics-software/robotic_caterpillar_as_a_piece_of_art

14.118 *Synthetic Brains in the Making!*⁵⁰⁴

The most amazing part of the human body is the brain. The brain has about a hundred billion neurons. These electrically excitable nerve cells can transmit information by electrical and chemical signaling processes. Each of these 100 billion neurons is connected to other neurons in the brain by about 7,000 connections (synapses). In an adult brain, there can therefore be about 100 to 500 trillion such connections which play a critically important role in performing the various functions of the brain.

In order to make a synthetic brain, the development of synthetic connections is of vital importance. Now, scientists at the University of Southern California, Professors Alice Parker and Chongwu Zhou, have succeeded in using carbon nanotubes to make a functioning synapse circuit. The circuit is made up of aligned nanotubes that resemble human synapses. The input waveforms and its output signals closely resemble the biological waveforms produced by real neurons. It may be several decades before a complete synthetic brain may be produced in the laboratory, but the first important step has been taken. The discovery is expected to find applications in treating traumatic brain injuries.

14.119 Viruses Improve Solar Cell Efficiencies!⁵⁰⁵

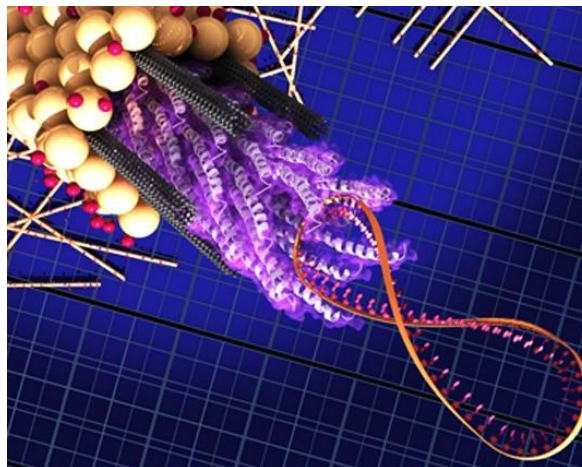
The advent of nanotechnology is transforming our lives in many ways—safer drinking water through nanofiltration techniques, paper which is stronger than steel made from nanocellulose, new sensors that can detect the onset of disease well before the disease has developed and a variety of other applications. Carbon nanotubes are carbon tubes that are 10,000 times thinner than a human hair. Such nanotubes have found many applications too—in electronics, optics, thermal conductors and even body armour.

Scientists at MIT had developed nanotubes last year which could funnel and concentrate electrons in photovoltaic cells. This allowed solar cells to be fabricated so that more electricity could be produced than was possible from conventional solar cells much larger in size. These nanotubes can be considered as a forest of very fine hairs.

However, there was one problem. These fine hairs tended to clump together during the coating process, thereby reducing their efficiency. Now, MIT scientists have developed a novel way to keep these hairs (nanotubes) apart—by using a virus that binds to the nanotubes, and prevents them from clumping together! Each virus can hold five to 10 such nanotubes in place and apart from each other, before they are coated with a special material (titanium dioxide) attached to a light sensitive dye.



14.118 The Artificial Brain. <http://siliconangle.com/blog/2013/01/02/ai-on-the-rise-weekly-artificial-brain-fraud-buster-portable-er-and-twitter-police/>



14.119 MIT Harnesses Viruses to Improve Solar Efficiency. <http://inhabitat.com/mit-researchers-harness-viruses-to-improve-solar-efficiency-by-a-third/>

The result is the development of novel solar cells which are 30 percent more efficient than those which had not been treated with the virus prior to the coating process. Commercialisation of the discovery is expected to lead to new types of films and paints with embedded solar cells that could be coated on window glasses or used as special paints on buildings to provide the power requirements within.

14.120 Fujitsu Notebooks—with Built-in Projectors⁵⁰⁶

Fujitsu, a world leader in laptops (manufactured in Germany instead of China to maintain the highest quality), has now come forward with another first—a notebook (“LIFEBOOK”) that has a built-in projector to display slides and make Power Point presentations. The projector is thin enough to slide into the narrow slot normally used for an optical drive. Two models will be launched in Japan in May 2011 and are likely to find much demand as competitors such as IBM, Dell, Hewlett Packard, Sony or Toshiba have yet to offer anything comparable.

The new notebook is likely to be of wide interest to universities, research centres and business executives who would not need to carry cumbersome projectors and messy wires around when making presentations.

14.121 Charging Batteries --- with Sea Water⁵⁰⁷

Scientists at Stanford have developed novel batteries that can be charged on the basis of difference of salt content between fresh water and salt water. These batteries use new types of electrodes made of nanoscale rods of manganese dioxide and silver resulting in up to a hundred fold increase in surface area. The electrodes are alternatively dipped in fresh and salt water to produce electrical power. The method comprises charging the battery in fresh water, and then replacing the fresh water with salt water. This leads to a hundred fold increase in the ions, so that the battery can discharge at a much greater voltage, resulting in production of electricity. The cycle is then repeated.

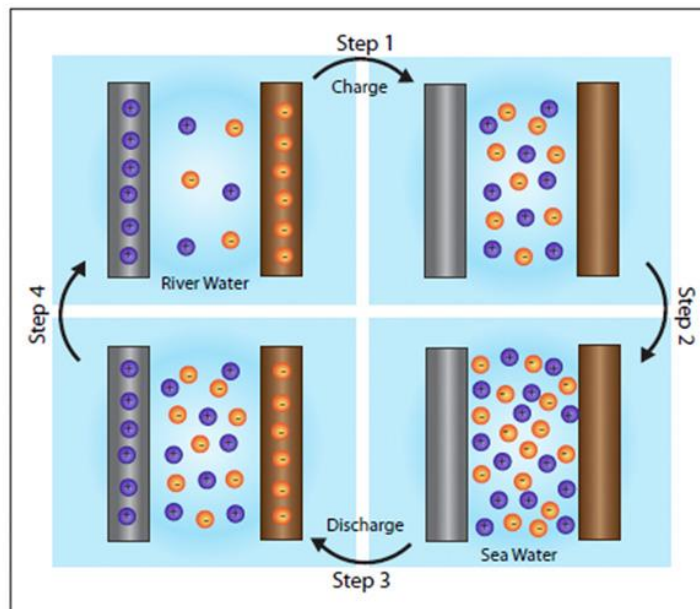
It has been calculated that by installing such a power plant at a location where a river discharges its water into the sea, it can generate 100 Megawatts of electrical power, if 50 cubic meters per second of fresh water is passing through. This would be sufficient for meeting the needs of 100,000 households.

A pilot power plant to use sea water for electricity production is also being developed based on a different principle, osmosis, by a Norwegian company. The principle of osmosis is based on the fact that a special (semi-permeable) membrane has salt water

on one side, and fresh water on the other side, then the membrane acts a one-way valve and the water passes through the membrane from the fresh water side to the salt water side. This leads to an increase in the pressure of the compartment containing the salt solution, which can be used for driving a turbine to produce electrical power.



14.120 Fujitsu's latest Lifebook packs a pico projector in place of a DVD drive, <http://www.techradar.com/reviews/pc-mac/laptops-portable-pcs/laptops-and-netbooks/fujitsu-lifebook-e743-1172393/review/2>



14.121 Stanford researchers have developed a rechargeable battery that uses freshwater and seawater to create electricity. <http://news.stanford.edu/news/2011/march/saline-rechargeable-battery-032811.html>

The use of ocean water for generating clean renewable energy has enormous potential for the future.

14.122 Detecting Explosives: With Mice and Moths!⁵⁰⁸

Before long, you may find mice or moths sniffing you for explosives before you are allowed to board a plane. This may feel strange, but may be more acceptable than full body scanners through which strange eyes peer at your naked body and you are exposed to radiation as you pass through the detecting systems.

Mice have sensitive noses --- indeed more sensitive than dogs since dogs have 756 olfactory receptor genes while mice have 1120 such genes. This imparts mice with a more acute sense of smell. An Israeli company, Bioexplorers, established by Eran Lumbroso, a former Israeli navy officer, has developed a body scanner that resembles a normal metal scanner. However, this scanner is different from standard body scanners in that it does not contain X-ray equipment but has a section with mice in it! The mice are trained to react to the smell of eight explosives. When they detect such a smell from the air that passes over them if a person carrying explosives crosses the scanner, the mice react instantaneously by running away from the smell into a side chamber, triggering an alarm.

Another technique being used is to employ moths. The antennae of moths are extremely sensitive to different smells, a property that has been used to detect explosives by a team of scientists at the Pennsylvania State University in USA led by Andrew Myrick and Tom Baker. Live moths are immobilized in an aerated tube and their antennae connected to a voltage detector. As the smells of different explosives are passed over the moths, the changes in voltage are detected, even at distances of up to 23 meters, alerting the observer of the presence of explosives by an alarm.

14.123 Roll-out TVs—with OLEDs!⁵⁰⁹

Can you imagine a television that is as thin as a bar of chocolate and so flexible that you can roll it out like a carpet? This is now

happening, because of the developments in flexible Organic Light Emitting Diodes (OLEDs). OLEDs belong to two broad families—those made of small organic molecules or those made of polymers. OLEDs have a thin layer of light emitting (electroluminescent) organic molecules coated on a glass or plastic surface which emit light in response to an electric current. Televisions with screens made of such materials do not need a back light, and have a much better black/white contrast than liquid crystal displays. An 80 inch wide television of this type will consume less electricity than the “normal” much smaller TVs.



14.122 Israel trains sniffer mice. The new Bio-sensor based explosives detection system, which uses mice to detect explosives through their sense of smell Photo: AFP/Getty Images<http://www.telegraph.co.uk/news/worldnews/middleeast/israel/9676911/Israel-trains-sniffer-mice.html>



14.123a On June 11th the National Museum of Emerging Science and Innovation in Tokyo displayed Mitsubishi Electric's “Geo-Cosmos”, the world's first large-scale spherical OLED. It was breathtaking, the video below is proof. <https://www.miraikan.jst.go.jp/en/sp/tsunagari/geocosmos.html>

An advantage of having TV or computer screens made of OLEDs is that they can be printed onto suitable flexible surfaces using an inkjet printer or by screen printing. This should result in considerable cost reductions as compared to liquid crystal or plasma screens that are currently used. Since OLEDs can be printed onto flexible plastics, one can envisage having roll-out TVs. If printed on textiles, they can lead to luminescent dresses which emit various changing shades of light, powered by small batteries. As mass production techniques are developed and new types of OLED materials come into the market, a new revolution in electronics and textiles is on the horizon.

On June 11, 2011, Mitsubishi Electric unveiled a huge 21-foot wide sphere of planet earth made of OLEDs at the Tokyo's National Museum of Emerging Science and Innovation as part of their 10th anniversary celebrations. Known as "Geo-Cosmos", the sphere is made up of over 10,000 strips of OLEDs, each measuring about 4 inches by 4 inches. The globe will convey real time images of the clouds, storms and weather patterns that are transmitted directly from a satellite. It is the largest sphere constructed from OLEDs and showcases the exciting developments currently taking place in this technology.

OLEDs may illuminate electronic displays on TVs, carpets, curtains and textiles, and the ladies of tomorrow will actually "radiate"!

14.124 A Bicycle? No --- A Self-Balancing Unicycle!⁵¹⁰

Most of us have ridden bicycles some time in our lives. Now, a new kind of cycle has been developed --- a monocyte (so called since it has just one wheel). Monocycles have been known for decades but they never gained popularity because it was difficult to maintain one's balance while riding them. The new invention has two interesting features --- it has no pedals and it is self-balancing! There are several sensors, gyros and an accelerometer that maintain the balance and a hub-mounted motor that drives the monocyte forwards and backwards. All that you need to do is to lean forward in order to make the monocyte to move forward and lean back for it to brake, as sensors detect your body movement and feed it to the motor.

You can also stop it by putting your foot down on the ground. You can learn to drive it within 20 minutes. The motor is driven by a rechargeable lithium ion battery that provides a top speed of 16 km/h and a range of 20 km on a single charge. The company “Focus Designs” is marketing it for a price of \$ 1,500. The monocycle can be readily packed in a car trunk, making it useful for carrying you to places where you do not want to take your car.



14.123b <http://hdtv.biz-news.com/news/tags/en/oled>



14.124 No hands, no pedals: the electric self balancing unicycle.
www.gizmag.com/electric-self-balancing-unicycle/10216/

14.125 A Smart Bed -- that Makes Itself!⁵¹¹

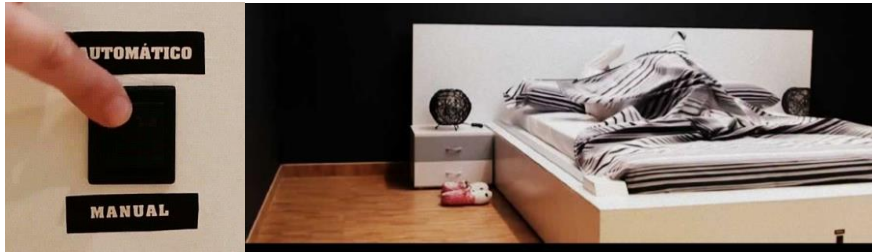
When you get up in the morning, a daily chore that you, your wife or a servant has to perform is to make the bed. Now a Spanish furniture company, OHEA, has made a futuristic "Smart Bed" that automatically tidies the sheet and pillows as soon as you get off the bed.

The pillows are tied by cords to a mechanism on the headboard. The sheet is stuck to the foot of the bed with Velcro and cords are also sewn to its sides. The bed is fitted with weight sensors that detect whenever you are not lying or sitting on it. There is a mechanism on the headboard that pulls the sheets straight as soon as you get off. Robotic arms remove any ruffles and the pillows are then dropped.

14.126 Adjust Focus --- After Taking Photographs!⁵¹²

We have often experienced the frustrating experience of taking a photograph and then discovering that the focus was not quite right. The photograph had to be discarded. Now, an exciting new development in camera technologies means that you may never have to experience this frustration again ----you can adjust the focus after the photograph has been taken! This allows you to readjust the focus in the photograph on the foreground, medium or background objects. You can also adjust it so that all objects are in good focus. Both 2D and 3D photographs are possible from the same shot, and you can also take photographs in low light conditions. Normal digital cameras combine all the light rays together to one amount of light. The new "light field" camera however records the colour, intensity and vector position of the light rays separately, thereby allowing the data to be manipulated by the software embedded in the camera.

The new camera has been launched in June 2011 by a company "Lytro" based in Mountain View, California and will be available in the shops later this year.



14.125 Self Making Smart Bed by OHEA is very useful for everyone!
<http://www.designrulz.com/product-design/sofa-product-design/2012/06/tired-of-making-your-bed-try-self-making-smart-bed-by-ohea-video/>



14.126 The Lytro camera lets you create and share living pictures that you and your friends can endlessly refocus after you take them. Your pictures are about to surprise you — and everyone else.
<https://www.lytro.com/camera/>

14.127 *Airships to Fly Again!*⁵¹³

In June this year, the US army awarded a \$517 million contract to Northrop Grumman and British firm Hybrid Air Vehicles to build three huge airships, each as big as a football field, to monitor the trouble spots in Afghanistan. Airships are lighter-than-air flying vehicles that have no fixed wings, and are propelled and steered by using propellers and rudders. They get their lift by having a large internal envelope filled with a gas that is lighter than air. Hydrogen was initially used which is flammable, and was responsible for the German passenger

airship Hindenburg disaster on 6th May 1937. Helium, an inert gas, is now commonly employed instead of hydrogen.

Airships were widely used before the 1940s but they were subsequently replaced by aircraft. Now, they are all set to return as they are suited for intelligence, surveillance, and reconnaissance missions and for transporting of multi-ton payloads to locations that cannot be easily reached by conventional transport. They can continuously monitor trouble spots over long time periods, weeks or even months at a time, without the need to land for refueling, and use much less energy for steering and flying.

14.128 An Indoor Garden --- on Your Windows!⁵¹⁴

Did you ever want a garden on your windows? If this was one of those secret desires, it can now become a reality. The "Windowfarms" system has been developed by Britta Riley in New York. The vertical hydroponics home farm system grows round the year and employs recycled plastic bottles for growing a variety of plants including lettuce, strawberries, herbs like basil and stevia, peas and cress. The light entering through the windows is utilized by the plants for their growth. The plants hang in two reservoirs, one above the other, and a nutrient rich solution drips from the upper reservoir to the one below. An air pump fitted with a timer is used to send bursts of nutrient-rich liquid to the top reservoir at regular time intervals and the nutrient rich liquid then trickles down the column of plants till it reaches the reservoir below before being reused.

14.129 The Biggest Telescope in the World --- Chinese!⁵¹⁵

The biggest single aperture radio telescope in the world is located at the Arecibo Observatory in Puerto Rico. It has a diameter of 1000 feet and a total collecting area of 790,000 square feet. Now, China is all set to beat this record by a wide margin. A five-hundred-meter Aperture Spherical radio Telescope (FAST) is to be built in Guizhou Province in southern China that will be able to see three times farther into space and

scan the skies ten times faster. Construction of this gigantic radio telescope commenced in March this year and it will be completed in 2016.



14.127 *The U.S. Army Long Endurance Multi-Intelligence Vehicle (LEMV), an airship made for surveillance and reconnaissance, made its maiden flight Aug. 7.*<http://www.aopa.org/News-and-Video/All-News/2012/August/15/Army-airship-makes-maiden-flight-in-Lakehurst.aspx>

14.128 <http://our.windowfarms.org/tag/suspension/page/2/>



14.129 China and India are joining forces for a project to build the Thirty Meter Telescope, the world's largest telescope, being built at the summit of Mauna Kea volcano in Hawaii. <http://wordlesstech.com/2012/01/14/worlds-biggest-telescope-by-china-and-india/>

14.130 Biological Computers⁵¹⁶

Computers employ electronic logic gates that process information by switching “on” and “off”. Now, Professor Martin Buck and colleagues at the Department of Life Sciences, Imperial College, London have shown that DNA (and bacteria) can be employed as logic gates, thereby laying the foundations of biological computers of tomorrow. The scientists employed the bacteria *Escherichia coli* to carry out the switching on and off operations, just like electronic logic gates, under the influence of chemicals. These biological gates can be connected together to form more complex circuits.

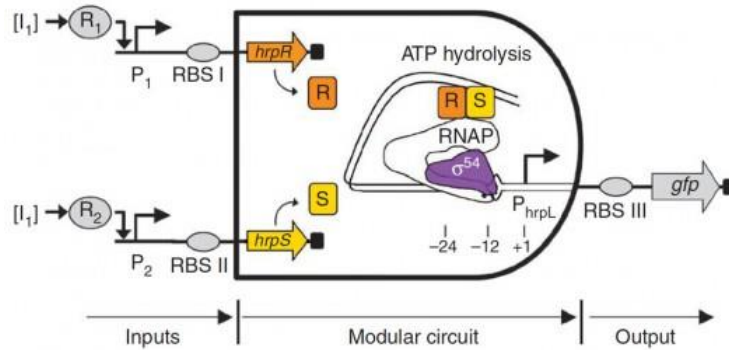
So, tomorrow’s laptops may be gluey jars of bacteria, dancing to your commands!

14.131 Car and Building Manufacture --- by 3D Printing!⁵¹⁷

Advances in 3D CAD software with mechanical extruders are progressing at a stunning rate. Starting from toys, chess pieces and other minor trinkets, the technology has evolved and is now being used for doing bigger things. The frame of a small car has been produced by 3D printing using a process known as “fused deposition” by a company Stratasys that pioneered 3D printing. An inventor Enrico Dini has made a huge D-shaped building by employing a very large 3D printer combined with an extruder containing a liquid adhesive compound mixed with a solid catalyst on a bed of sand. Similarly, artificial jaws, bones and other body parts are now being produced employing 3D printers and suitable extruders. The process is making it faster and easier to produce various small and large sized objects.

14.132 Cars with Pedestrian Airbags⁵¹⁸

Airbags are now compulsory in most cars. However, they are designed to protect the driver and passengers --- not the pedestrians. Volvo has now launched a car that has airbags



14.130 The design of an 'AND gate' created by Imperial College London scientists using E-Coli bacteria and DNA that could form the building blocks of a new generation of microscopic biological computer. <http://www.gizmag.com/biological-logic-gates/20237/>



14.131 The Urbee's entire body was 3D printed (Image: Kor Logic), <http://www.gizmag.com/urbee-3d-printed-car/16795/>



14.132 Swedish carmaker, Volvo, has unveiled the world's first car with external airbags to ensure the safety of pedestrians and protect them from serious head and neck injuries. The airbag is located under the hood and inflates at the base of the windshield while enabling the driver to see ahead. The new Volvo V40 hatchback goes on sale in Australia today. Volvo Introduces the World's First Car Equipped With Pedestrian Airbags | Inhabitat - Sustainable Design Innovation, Eco Architecture, Green Building

outside the car to protect the pedestrians during a collision! The car, Volvo V40, made its first appearance at the Geneva Motor Show recently. When a collision occurs, a section of the bonnet nearest the windscreen is raised with an airbag that inflates to cover a part of the windscreen and the front area of the car. This results in less severe injuries to pedestrians on collision.

14.133 Chocolates --- by 3D Printing!⁵¹⁹

Want to buy a box of chocolates with individual pieces designed to specified shapes? Your children or grandchildren may love to have little chocolate Ferrari's or Rolls Royce's---- or like to much tasty chocolate F-16 fighter aircraft. Now, this has become possible using a 3D chocolate printer built by the University of Exeter, UK.

The printer could be used by chocolate companies to design products to your specifications. All you would have to do is to send the design by web, from a catalogue of designs, to the chocolate company and the box of chocolates would be delivered to your home. The technology could be used for designing a host of other products such as jewelry, leather bags and house hold goods, to customer specifications.

The device works by depositing layers of materials successively according to the design required. Chocolate designing was more difficult as it required successive cooling and heating cycles to be incorporated. New heating and cooling systems were developed to keep the chocolate so that the chocolate was just at the required consistency for shaping and setting.

14.134 Computer Chips that Copy the Human Brain!⁵²⁰

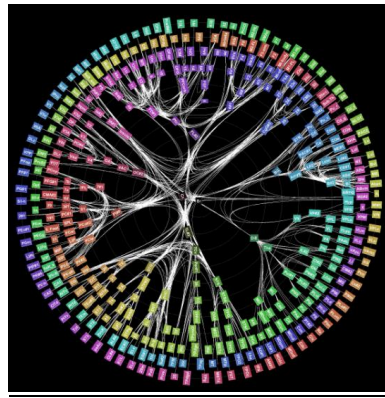
The human brain is truly the most amazing piece of machinery designed by nature. There are about 100 billion neurons in the human brain. They signal to each other through some 500 trillion chemical junctions (synapses). For each of the 100 billion neurons, there are therefore several thousand connections between each neuron and other neurons and cells. This huge labyrinth of interconnected neurons allows us to think, learn, store images and recall them when needed. It also allows us to

pass commands to the appropriate centres in the brain when we want to perform any actions.

Now, IBM is developing completely new type of computer chips that will be used in “cognitive computers” ---computers that will be able to think, feel and react like humans. This new class of computer chips ---- “neurosynaptic computer chips” ---- will copy the functions of the human brain that lead to perception, action and cognition. They will also learn and improve themselves through experiences, rather than simply perform tasks according to programmes fed into them ---- just as a baby learns and grows intellectually.



14.133 How very oddly and endearingly Japanese: using a 3D scanner, a Tokyo café is offering chocolate truffles molded in the shape of your lover's face for Valentine's Day. <http://www.luxury-insider.com/luxury-news/2013/01/eat-your-lover-japanese-cafe-offers-3d-printed-face-truffles>



14.134 IBM Research has reached a milestone in the field of cognitive computing in collaboration with DARPA's cognitive computing program, called Systems of Neuromorphic Adaptive Plastic Scalable Electronics or SyNAPSE. <http://www.stuff.co.za/ibm-research-darpa-hit-cognitive-computing-milestone-simulate-100-trillion-synapses/>

Scientists at IBM's Almaden research center have completed the first phase of this project that has huge implications in defense. The project is funded by DARPA, a US government agency that funds projects of a military nature. They have built the biggest artificial brain ever with 1.6 billion virtual neurons connected by 9 trillion synapses. This simulates the capacity of a cat's brain and they are now well on their way to build a system that would resemble the human brain. The chips were able to recognize patterns and perform other simple tasks such as navigation, machine vision, classification and associative memory. IBM is planning to build an artificial brain made of such chips that will have 10 billion artificial neurons and hundred trillion synapses, but within a volume of only 2 litres.

14.135 Computers Learn to Read Manuals!⁵²¹

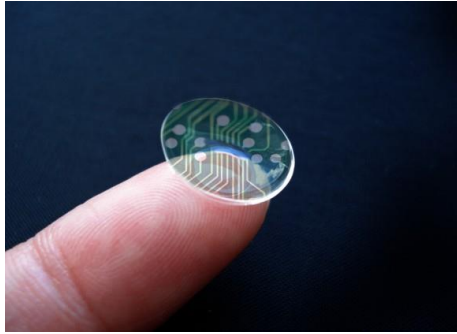
In a potentially ominous development, scientists at the MIT's Computer Science and Artificial Intelligence Lab have found that computers can read manuals and then learn to perform tasks without external assistance. They could thus improve their skills and perform tasks on their own. This may represent the first steps of world domination by machines able to learn and eventually acquire a superior knowledge and intelligence than man.

One task assigned to the computer was to learn from a manual on how to install a particular software on a Windows PC by following instructions. The computers did not have any prior information as to the task that they were expected to perform. They could only move the cursor and perform left and right clicks. They also did not understand the language in which the instructions were provided but were able to judge their success if a specific step was correctly performed. So by a trial and error approach, they quickly learned what was needed to be done.

They also learned to play a game from the instructions provided. Normally, creation of computer games involves programmers developing strategies that are to be followed by computers. Algorithms are written by these human programmers for execution of these strategies. What is ominous about the MIT computer systems is that they could potentially write their own algorithms that are better than those designed by humans.

14.136 Contact Lenses -- for Augmented Reality!⁵²²

The US Defense agency DARPA is funding a project that will equip US soldiers in the field with augmented reality. The project involves the use of contact lenses with embedded microelectronics that will allow useful battle information to be visible simultaneously to the viewer, superimposed on the actual real images, so that he can get important battlefield information, such as the distance of the enemy, the surrounding landscape that could be hiding potential threats and other such information without even blinking an eye lid. Previously, the technology has been embedded in special helmets that are worn by fighter pilots so that they have information on their consoles visible to them constantly without the need to bend their heads and look away from the dog fight that may be taking place. That precious fraction of a second may be all the difference between life and death.



14.136 DARPA Creating Virtual Reality Contact Lenses for Viewing Aerial and Sensor Data. <http://www.gotgeoint.com/archives/darpa-creating-virtual-reality-contact-lenses-for-viewing-aerial-and-sensor-data/>

The ultra-small form-factor head-up display (HUD) is incorporated into the contact lenses that the soldier wears, allowing him to focus on two planes simultaneously. The project is the DARPA's Soldier Centric Imaging via Computational Cameras (SCENICC) program. The iOptik display system comes with special glasses that are equipped with tiny projectors on both sides. These allow 3D video images to be projected also. While such technologies have certainly given considerable strength to US troops, the courage and human spirit is what

finally matters, as is seen in Afghanistan, where first the Soviets were driven out and now the NATO troops have decided to withdraw due to the sheer guts of the Taliban fighters.

14.137 Converting Heat into Electricity --- by an Alloy!⁵²³

A new alloy has recently been discovered by scientists at the College of Science and Engineering at University of Minnesota, that converts heat into electricity directly. It could lead to a cheap and efficient way of converting waste heat from boilers, industrial power plants or air conditioners into electricity. The research team is headed by aerospace engineering and mechanics professor Richard James. The alloy, prepared from nickel, manganese, cobalt and tin, is non-magnetic but as the temperature is increased it absorbs heat and becomes strongly magnetic. It simultaneously undergoes an exciting phase change with the production of electricity.

This new “green” way to produce electricity may also be used to convert the heat emitted from computers to be converted into electricity, in order to power certain devices.

14.138 Cook Your Food --- From Across the World!⁵²⁴

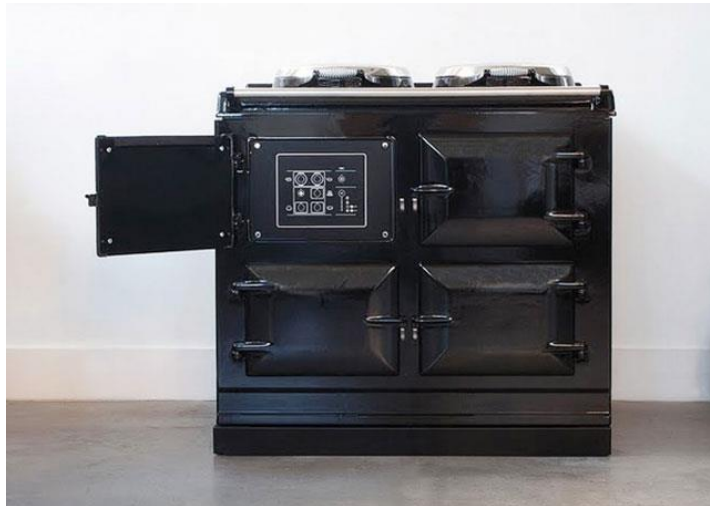
Wouldn't it be nice if you could turn on a cooker by remote control from your office so that you are ready to have freshly cooked food by the time you reach home? The AGA's new electric iTotal Control Cooker does exactly that. Fitted with three separate independently-operating ovens, for roasting, baking and simmering of foods, it can be turned on remotely from anywhere in the world by a telephone message, or from a command given on a dedicated website.

14.139 Data Storage --- Using Salmon DNA!⁵²⁵

Storage of information can be carried out in many ways. Hand-written materials, gramophone records, magnetic tapes, computer chips and neurons in the human brain --- all are



14.137 University of Minnesota engineering researchers discover new source for generating 'green' electricity. During a small-scale demonstration in the lab, University of Minnesota researchers showed how their new material can spontaneously produce electricity when the temperature is raised a small amount. Pictured (from left) are aerospace engineering and mechanics professor Richard James, Ph.D. student Yintao Song and post-doctoral researchers Kanwal Bhatti and Vijay Srivastava. http://www1.umn.edu/news/news-releases/2011/UR_CONTENT_343439.html



14.138 AGA iTotal Control: This oven is controllable completely by smartphone, computer, or text via regular phone. Get the oven preheating before you get home or turn it off remotely if you forgot before you left the house. Reproduced with thanks from, <http://www.brit.co/the-ultimate-guide-to-automating-your-home/>

various forms of storage devices --- but could you imagine salmon as a storage device? Scientists working at the National Tsing Hua University in Taiwan and the Karlsruhe Institute of Technology in Germany have developed a “write-once-read-many-times” (WORM) device by combining electrodes, silver nanoparticles and salmon DNA.

A thin film of salmon DNA is first prepared that is impregnated with silver atoms and then sandwiched between electrodes. When UV light is shone on the material, the silver atoms cluster together in the form of nanoparticles. By applying voltages below or above a certain threshold, it was found possible to have the material in an “off” or “on” state. These changes in conductivity were found to be permanent, thereby providing the basis of information storage in optical computing devices of the future.

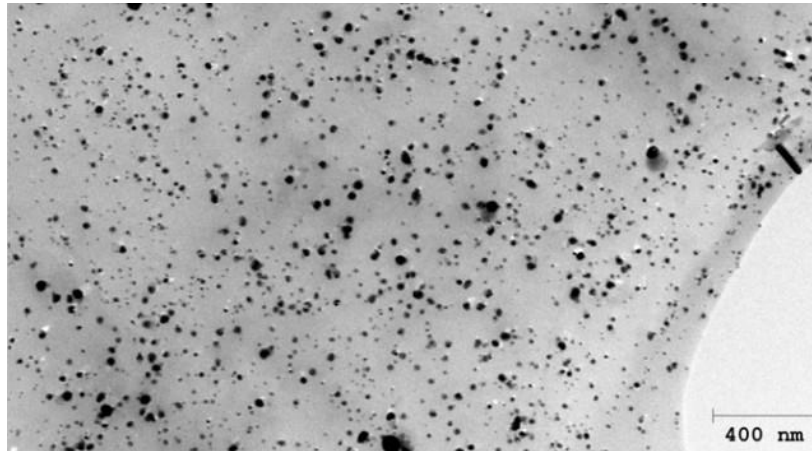
14.140 Dead Artist Performs --- by Holograms⁵²⁶

In April this year, a remarkable “live” music performance was seen by dazzled spectators. Tupac Shakur, who died 15 years ago, suddenly appeared on the stage and gave a live performance. It was actually his real life looking holographic image that performed and sang. One song was performed with his lifelong friend Snoop Dogg. At the end of that show, Tupac Shakur disappeared in a burst of light. The event at which this remarkable performance was witnessed was the 2012 Coachella Music Festival in USA. The deceased rapper was brought back to life with the 3D effects created by AV Concepts and effects studio, Digital Domain. It opens up possibilities of seeing Elvis Presley or Michael Jackson on stage again --- in the weird world of ghost singers.

14.141 Detecting Bombs ---- With Lasers⁵²⁷

The detection of explosives in the field is a challenging task as there are many chemicals in the environment that make it difficult to differentiate explosives from normal environmental pollutants. There is therefore need of a detecting method that

will allow ready detection of roadside bombs --- a problem often encountered by security agencies in Pakistan.



14.139 A crack team of nanoengineers and biologists have created a non-volatile memory device out of salmon DNA and silver nanoparticles.<http://www.extremetech.com/extreme/117191-computer-memory-made-out-of-salmon-dna>



14.140 Sixteen years after his death, rapper Tupac Shakur performed alongside Snoop Dogg at the Coachella Valley Music & Arts Festival. And that may just be the beginning for the hologram version of the late rapper. <http://blog.zap2it.com/pop2it/2012/04/coachellas-tupac-shakur-hologram-may-go-on-tour.html>

Researchers at Michigan State University may have found the answer. They have developed a simple laser based system to detect roadside bombs and explosives. The device used looks like a normal laser pointer. It is pointed at the suspicious object and the laser light, both of short and long wavelengths, falling on it causes the molecules in the materials to vibrate. These vibrations are unique for each explosive substance and allow it to be detected and identified readily. The method is so sensitive that even a billionth of a gram can be detected easily.

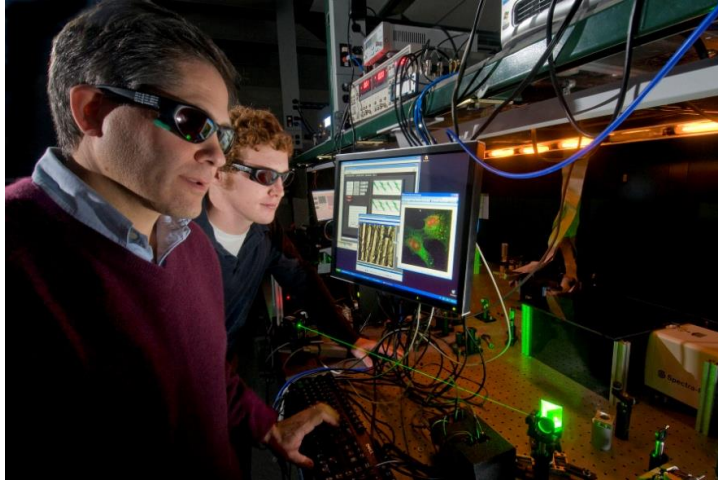
14.142 Detecting Counterfeit Gold Bars!⁵²⁸

As the price of gold rises to new heights, each 400 ounce gold bar stored as bullion in banks and government securities can cost about three quarters of a million dollars. Counterfeit gold has therefore been on the rise with the outside of the bar being coated with real gold but the inside of the bars having a core of tungsten that has a similar density and weight. Tungsten however differs from gold in its hardness, but there was no way to detect it without physically drilling into the gold bars.

Many governments are nervous that much of the gold held by them may be counterfeit. The possibility has been deliberately played down by the international media in order to prevent worldwide panic. Now General Electric with its Phasor series of portable ultrasonic detectors has found a solution to this problem. Ultra-sound has been used for peering into the fetuses of pregnant mothers, but it can also be used to detect tungsten. The computer controlled phase array probes fitted to the GE ultra-sound detectors allow the ready identification of counterfeit gold bars.

14.143 Detecting Explosives with Lasers!⁵²⁹

About 60% of deaths of coalition army personnel in Afghanistan and Iraq are due to improvised explosive devices (IEDs) that can be placed by the roadside. Intensive efforts are under way to detect such explosives. Detecting explosives can be tricky



14.141 Michigan State University research has put the possibility of bomb-detecting lasers at security checkpoints within reach. Credit: MSU, <http://www.ineffableisland.com/2013/09/bomb-detecting-lasers-could-improve.html>



14.142. New Phasor XS Allows All the Benefits Of Phased Array Inspection In A Conventional Portable Flaw Detector, <http://www.ge-mcs.com/en/news-and-press/76-press-releases/755-new-phasor-xs-allows.html>

business. Traces of explosives may be detected by trained dogs or even by bees. Mechanical methods include “ion mobility mass spectrometry” (IMS) but such methods only work when the explosive is not present in a sealed container. Once sealed, say inside a metal canister, the task of detection becomes much

more challenging. Specially designed X-ray machines have been used to detect explosives from the density of objects under investigation.

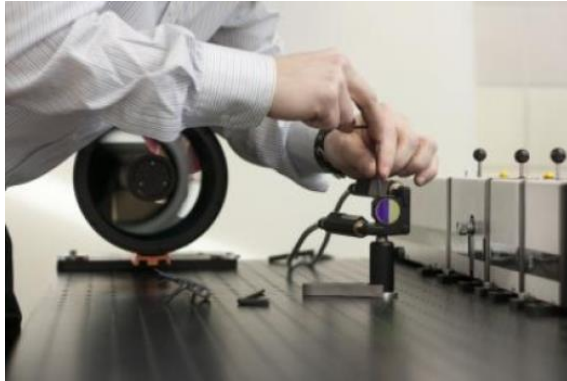
Now, scientists at the Vienna University of Technology (TU Vienna) have further improved a procedure that involves the use of laser light for detecting explosives at distances of 100 meters or more. The explosives can be detected even if they are sealed in opaque containers. The technique was originally developed by researchers at the Michigan State University and a spin-off company BioPhotonic Solutions was formed to commercialise the development. The Austrian researchers led by Professor Bernhard Lendl have used an efficient telescope and very sensitive light detectors to magnify the very weak signal, thereby enabling explosives to be detected from a distance, even in sealed containers.

14.144 Electricity/Music from Plants -- "Living Furniture"⁵³⁰

Furniture that produces electricity? It sounds like a fantasy, but it is now true. The technology used is known as biophotovoltaics (BPV), and it utilises the energy produced in photosynthetic processes of algae, mosses, vascular plants and cyanobacteria. A "Moss Table" that works on this principle was demonstrated at an exhibition of new technologies, the Salone Satellite, during the Milan Design Week in Italy recently. The table has a cluster of moss plants growing on it. The BPV technology taps into the photosynthetic energy of these plants during the day that is stored in a battery. It can then be used to power various devices such as clocks or to light a bulb during the night. The table was invented by Dr. James Moultrie of the Institute of Manufacturing at the University of Cambridge. It is believed that such tables will be able to generate 3 Watts of electricity per square meter. As new low energy consumption laptops are developed that require only 1 watt to operate (such as XO-1 by Quanta Computer) such tables could power these computers for up to 14 hours.

At the same exhibition, the plants were demonstrated to "sing characteristic tunes", based on their photosynthetic patterns and the corresponding energy variations. This was shown by the Maltese designer Noel Zahra through the "Koishi" concept. Koishi

involves the sensing of the photosynthetic variations of each plant and their conversion into musical notes in real time. As each plant has a different photosynthetic profile, it can therefore produce music characteristic for that particular plant, emphasising that plants are living beings, with their own unique life patterns.



14.143 The Raman spectroscope emits laser light, which is scattered at the sample and then collected by the telescope (left). Credit: Vienna University of Technology. <http://www.sciencedaily.com/releases/2012/02/120227093952.htm>



14.144a Moss Table. <http://design-milk.com/moss-table/>



14.144b Koishi Planter Pot Transforms Your Plant Activity To Beautiful Music. Designer :Noel Zahra. <http://www.tuvie.com/koishi-planter-pot-transforms-your-plant-activity-to-beautiful-music/>

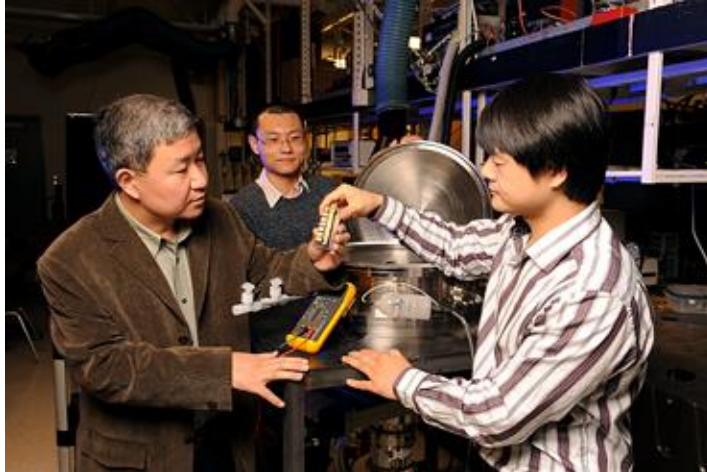
14.145 Electronics from Spider Silk!⁵³¹

Normally, living tissues and materials derived from them are not good conductors of heat. However, associate professor of mechanical engineering Xinwei Wang from Iowa State University has found that spider silk has a remarkable property ---- it is a better conductor of heat than any other material derived from living organisms. It turned out to be even better than silicon, aluminum and iron! It conducted heat at 416 watts per meter and was found to be 800 times better in conduction of heat than any other organic material known. Another interesting property exhibited was that when the spider silk was stretched by 20%, the conductivity increased by 20% instead of decreasing. In the case of other materials, the thermal conductivity drops when they are stretched. This discovery opens up a number of applications. Spider silk may be useful in the manufacture of “cool fabrics” as the body heat would be dissipated very quickly through them. It may also be used as a flexible heat dissipating material for electronics, resulting in “cool computers”. Similarly, it may be used in the manufacture of cool bandages.

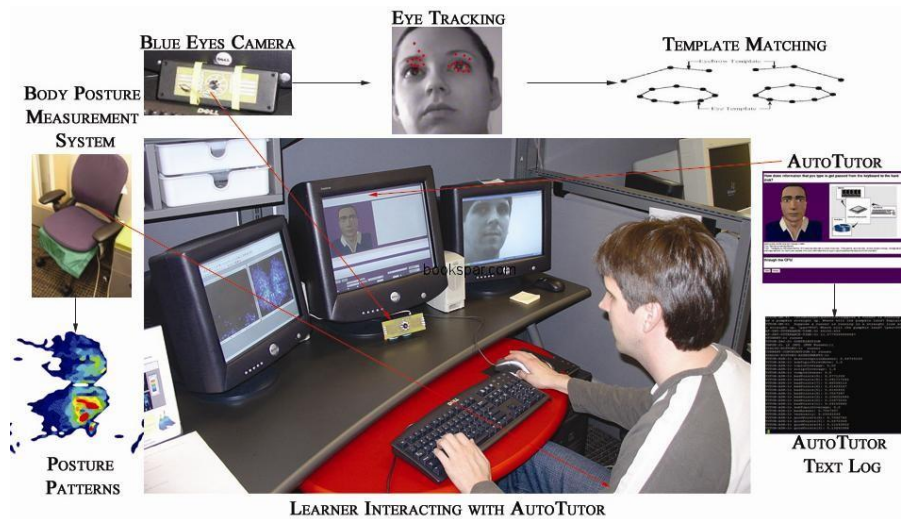
Spider silk is finding applications in many different fields. Scientists led by Tufts University's Prof. David Kaplan found that a genetically modified spider silk protein could selectively attach itself to cancer cells and then deliver a special gene that can manufacture “glow proteins” (those that make fireflies glow). Dr. Omer Chosh from the University of Wyoming has identified two proteins in spider silk that have evolved over hundreds of millions of years and are responsible for its adhesive properties. This holds the clue to making excellent bioadhesives instead of relying on petroleum based adhesive products.

14.146 Emotion Detecting Digital Teachers!⁵³²

Students often find the lectures delivered by some teachers very boring because of the manner in which they are delivered or the lack of interesting contents or both. Technology now is coming up with an answer --- a digital teacher that senses the emotional



14.145 Xinwei Wang and his research team at Iowa State University found that spider silks – particularly the draglines that anchor webs in place – conduct heat better than most materials, including silicon, aluminum and pure iron. <http://www.electronics-cooling.com/2012/03/researchers-find-spider-silk-conducts-heat-as-well-as-metals/>



14.146 A team of scientists from The University of Notre Dame, The University of Memphis and Massachusetts Institute of Technology have developed a computer which can respond to various emotions of the student. <http://www.bookspar.com/tech-buzz/auto-tutor-interactive-computer-which-senses-the-learners%E2%80%99-emotions-like-a-real-tutor/>

state of the student and changes the teaching method in order to reignite interest! The system, named “AutoTutor”, was invented by Assistant Professor of Psychology, Sidney D'Mello, at the University of Notre Dame, Dr. Art Graesser at the University of Memphis and an MIT colleague. The system works by posing different questions to the students. From the answers it receives, it is able to judge their emotional state and their state of knowledge. It can introduce images, simulations and animations to make the lecture more interesting. It is initially being used to teach concepts in critical thinking, computer literacy and Newtonian physics.

14.147 Floating House Technologies!⁵³³

With global warming comes the increasing risk of low lying coastal areas in many regions of the world going under water. Countries such as Bangladesh, Netherlands and many island states in the Indian Ocean and the Pacific are at the greatest risk, as are the coastal cities in many countries. Now a Dutch company, Dura Vermeer, has come forward with an interesting concept of a floating city, in which the houses will not be submerged when water rises, but will simply float on it. This is done by an innovative method. The foundations of the house are lined with layers of light plastic foam that support the concrete and allow it to float. The material used is expanded polystyrene (EPS).

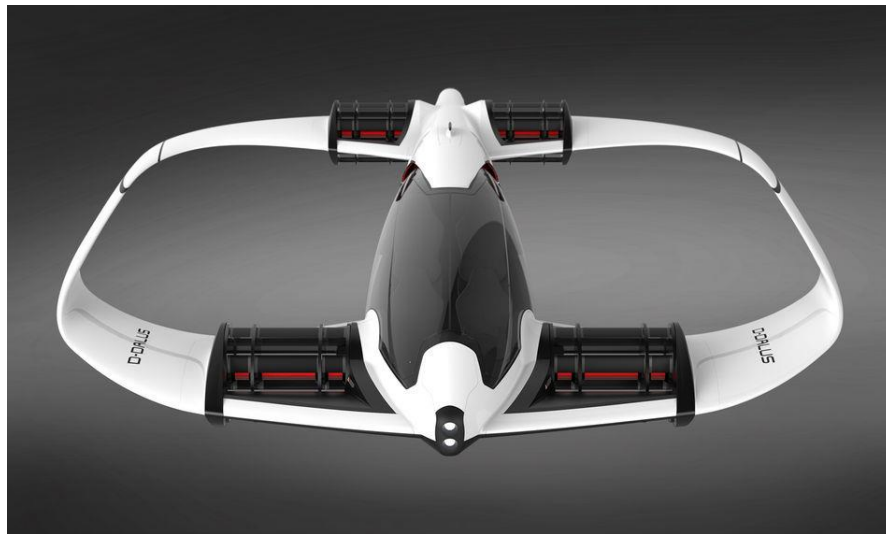
14.148 Flying Aircraft within Buildings!⁵³⁴

An Austrian company D-Dalus has developed a new type of aircraft that can fly within buildings without crashing as it has no vulnerable external moving parts. It can take off vertically, hover and fly at any angle without any problems since it does not employ fixed wing or rotors. Instead, it has four rotating turbines that can accurately control its trajectory. The sense-and-avoid system fitted on the aircraft prevents collisions with walls and other objects, so that it can be employed as a drone to search

for explosives and carry out other tasks while flying through corridors and rooms.



14.147 Credit: Google Images. <http://amphibioushomes.weebly.com/what-exactly-is-an-amphibious-house.html>



14.148 The dream of flying has been around since time began. Yet the D-Dalus can do more. Start and land vertically, fly, float, turn on its axis. When the engines are switched off for a fraction of a second, the D-Dalus can even suction itself onto the landing surface, thus enabling it to land on ships or other planes. <http://www.formquadrat.com/en/transportation-design/iat21-d-dalus-manned.html>

14.149 Flying Bicycles!⁵³⁵

A group of Czech companies (Technodat, Evektor and Duratec) are planning to build a flying bicycle that will allow you to fly above the traffic, when needed! The Flying Bike ("FBike") will have a number of electrically driven propellers fitted on a light alloy frame of a two-wheeler bicycle. The bicycle will be able to take off vertically by bringing its six electrically driven propellers into action. This will allow it to keep flying as long as batteries last. It is planned to have with lithium - polymer batteries fitted under the cross bar. The FBike is being fitted with gyroscopes and accelerometers that will provide stability and ensure a smooth take-off, flight and a gentle landing. The rider will be strapped on to the specially designed seat in order to ensure safety. The first flights are expected to occur in mid-August this year.

14.150 Flying in Water --- "Ghosts"!⁵³⁶

Stealth flying machines --- but flying through water! They use the principle of "supercavitation" to reduce the friction while flying through water. Supercavitation involves creating a bubble of gas inside a liquid that is large enough to surround an object travelling through it. As the object travels in water enclosed in the gas bubble, the friction is reduced to a minimum, thereby allowing it to attain very high speeds. Supercavitation has been used in high speed torpedoes in the past but now Juliet Marine Systems (JMS) in New Hampshire, USA have applied it to the world's first supercavitating watercraft. The flying watercraft is being developed for the US navy as a super-fast stealth system that can approach enemy ships undetected by their radar. The watercraft is fitted with the latest stealth technologies and since it is travelling in water surrounded by a giant bubble, it experiences 900 fold less friction. Ideal for transporting soldiers to enemy beaches or carrying thousands of pounds of weapons and torpedoes to enemy territories, the "flying machine" is considered as an important element in next generation warfare equipment.



14.149 F-Bike Flying Bicycle. Reproduced with thanks from, <http://3pol.cz/1268/print>



14.150 GHOST Is the First Super-Cavitating Ship That Can Travel Over and Underwater! GHOST Is The First Super-Cavitating Ship That Can Travel Over And Underwater! | Inhabitat - Sustainable Design Innovation, Eco Architecture, Green Building

***14.151 Flying Machines --- with Flapping Wings!*⁵³⁷**

Man has been learning from nature since time immemorial. The way birds can fly inspired the Wright brothers to design and develop the first flying machine capable of carrying human beings. That was over a hundred years ago. In this small period of time, man has landed on the moon, ventured into the remote

regions of the solar system and has started exploring the distant regions of our galaxy by powerful telescopes. However, there are still some ways in which the birds are better at flying in terms of control and maneuverability than our aeroplanes. They can fly, glide and flap their wings. Now, researchers in Europe (at the Bionik-Innovations-Centrum at the University of Applied Science in Bremen and the Ocean Ecosystems Department at the University of Groningen in the Netherlands) have developed a flapping wing micro aerial vehicle (MAV) which combines the advantages of fixed wing and rotary flying vehicles. It will have high endurance with greater maneuverability. It could be used for aerial photography since it has excellent flying and hovering capabilities.

Before long, you may be sitting in an aeroplane that flaps its giant wings as it takes off to fly to distant lands, carrying you in its bosom.

14.152 Flying Mini-Robots --- Tomorrow's Warfare!⁵³⁸

Remote controlled robots that can fly in swarms to enemy areas and gather information or release nerve gases ---- this horrifying scenario is becoming a reality. The General Robotics, Automation, Sensing and Perception (GRASP) laboratory at the University of Pennsylvania in USA is one of many labs in USA and Europe that are aggressively developing tomorrow's warfare machines. Millions of small flying "birds", controlled remotely by enemies from thousands of miles away, will be able to decimate entire armies without sacrificing a single soldier.

The "Nano Quadrotors" developed at the lab in Pennsylvania are small bird sized machines with four rotors that can fly in swarms in complex formations, interact with one another and perform astounding maneuvers. They can avoid obstacles and perform "complex autonomous swarm behavior". A European team recently demonstrated how such robotic swarms could build a tower by acting together at the FRAC Centre in Orléans, France. Our armed forces should be massively funding research programmes at our various engineering universities to examine defenses against such attacks of tomorrow and developing our

own weaponry of the future, before we become slaves and surrender our nation in the face of advanced technologies of foreign lands.



14.151 Researchers inspired by the wings of swifts and swiflets have developed an experimental Micro Air Vehicle which combines flapping and gliding flight modes for improved efficiency. <http://www.gizmag.com/swift-inspired-mav-flapping-gliding-flight/19131/>



14.152 The GRASP Lab, University of Pennsylvania have been advancing the use of synchronised quadrotors (quadcopters) with the aim to develop the technology for the US Government. <http://rc-modeller.com/news/>

14.153 Flying Personal Vehicles!⁵³⁹

The European Union has begun funding a major programme to develop flying personal cars in order to solve the problems of road congestions in major European cities. The Personal Aerial Vehicles (PAVs) programme will receive US\$ 6.2 million this year towards the development costs. The PAVs will initially be used to fly small distances between homes and offices. They may be required to fly below 2,000 feet so that they do not interfere with the normal air traffic. According to Prof Heinrich Bühlhoff of the Max Plank Institute for Biological Cybernetics in Tübingen, Germany, the EU grant will be used for developing new technologies to make such systems viable. Some air spaces may need to be completely protected from civilian traffic for security purposes. Proper “air lane” systems will need to be developed so that the aircars travel according to certain predefined paths, and do not collide with one another.

What was science fiction is now in the process of becoming a reality.

14.154 Flying Robots to Build Towers!⁵⁴⁰

The time is fast approaching when entire buildings will be constructed within a few days by thousands of flying robots working feverishly day and night on various assigned tasks. The first steps will be taken in this direction at the FRAC Centre in Orléans, France when flying robots (quadrocopters) will construct a 6 meter high tower. The tower will be built from 1500 prefabricated polystyrene foam modules. The flying robots are programmed to interact with one another, lift the foam bricks, transport them to the site and assemble them into the tower. The tower is being built to track 50 moving vehicles simultaneously with an accuracy of within one millimeter.

The flying robots are fitted with various sensors and controls that allow them to communicate with one another while flying on preprogrammed paths and accomplishing specific tasks. They are able to fly in various ways--- loops, spirals and curves—and



14.153 The myCopter project aims to pave the way for personal aerial vehicles (PAVs) to be used by the general public within the context of such a transport system. <http://wordlesstech.com/2011/06/28/mycopter-personal-aerial-vehicle/>



14.154a Using four quadcopters at the same time, first the robots grab foam bricks from a special brick dispenser on the ground. Next the quadcopters receive the exact coordinates of where the bricks should go based on a detailed digital blueprint of the tower. Then they fly off. <http://www.evarobotics.com/latest-articles/flight-assembled-architecture>



14.154b Reproduced with thanks from, http://www.robarch2012.org/wpcontent/uploads/2012/09/robtic_drone_assembling_structure_ethzurich.jpg

are highly maneuverable. They do not collide with one another because of built-in sensors that can sense and quickly avoid collisions. The flying robots will demonstrate their capabilities at the Flight Assembled Architecture exhibition at the FRAC Centre from December 2 to February 19, 2012.

14.155 Flying to Work?⁵⁴¹

Are you tired of the daily traffic? Well, it may not be long before you will strap a jet engine on your back and fly to work! The former Swiss jet pilot Yves Rossy (known as “Jetman”) flew across the Grand Canyon in May this year using a wearable jet propelled wing. He has been able to cross the English Channel in 2008, fly in loops, as well as fly in formation with jet aircraft. He uses a lightweight carbon fiber that carries four small jet engines. The flight trajectory is controlled by his body movements.

Tomorrow our cities may have invisible aerial lanes at different heights on which we fly our children to school each morning!

14.156 Fly to Work --- on a Hoverbike!⁵⁴²

We have all heard of hovercraft on which daily crossings are routinely made over the English Channel. These ships however hover only a foot or two above the surface of water as they “fly” across it. Now, an Australian innovator, Chris Malloy, has developed a flying motor cycle --- a “Hoverbike” that will fly several thousand feet above the ground. The hoverbike is made of Kevlar reinforced carbon fiber, and has two ducted spinning propellers that should give it a speed of up to 173 miles per hour while flying in the air. The first flight of this prototype flying motor cycle is expected to take place by August this year.

Before long, we may all be flying to work in defined air lanes on hoverbikes!

14.157 Free Internet—Near Every Vending Machine!⁵⁴³

Access to internet today is a daily need for most of us. However, wireless access may not be easily available when you are out on

the road. Now, a Japanese drinks company, Asahi, has come forward with an interesting idea to advertise and sell its



14.155 Swiss pilot and inventor Yves Rossy, known as Jetman, has performed another breathtaking flight. This time he spread his wings over Rio de Janeiro. <http://www.kenyan2013.com/2012/05/04/jetman-soars-over-rio-i-believe-i-can-fly/>

14.156 Jedi Hover Bike Is as Awesome as It Looks, But You'll Never Fly One. <http://www.wired.com/2012/08/aeroflex-jedi-hover-bike/>



14.157 Japanese Vending Machines Double Up as Free WiFi Hotspots. <http://www.techpowerup.com/157660/japanese-vending-machines-double-up-as-free-wifi-hotspots.html>

products --- too provide free access to internet to anyone standing near its vending machines. It is similar to mobile hotspots available in coffee shops ---except that here you can have access without purchasing anything. No login password is needed, and after the first 30 minutes have expired, you can login again and continue surfing. With the growing number of smart phones and tablets, the need for Wi-Fi access has also grown. In addition, while you are standing next to such a vending machine and surfing, you may feel thirsty and buy a drink too --- so besides advertising, it could boost sales too.

In Pakistan, the IT wave began in the year 2000 and there was a phenomenal expansion of internet from 29 cities to over a thousand towns and villages within 18 months. The first public Wi-Fi access was introduced also in 2001 at all major airports, well before such facilities were available at most US and European airports. Alas! This IT boost was short-lived and today, ten years later, most national and international lounges in our airports do not provide Wi-Fi access.

14.158 Fujitsu --- a World Leader in Super “K Computers”!⁵⁴⁴

At the 26th International Supercomputing Conference (ISC'11) held in Hamburg, Germany, recently, Fujitsu scored first place in the list of TOP 500 companies, after its super “K computers” achieved a stunning speed of 8.162 petaflops, leaving others lying in the dust. The system employed 68,544 CPUs to achieve an incredible 93% computer efficiency. Recently, Fujitsu also launched the world’s smallest Windows 7 PC/smart phone. This small PC offers a full version of Windows 7 in the palm of your hands while combining it with all the features of a smart phone. The phone comes with a license of Microsoft Office Personal 2010, and includes Word, Excel and Outlook. This smartphone, which is also a PC, has a slide-out QWERTY keyboard.

Fujitsu has been one of the world leaders in laptop computers, largely because of the high quality of its products. Fujitsu laptop computers are manufactured in Germany, in contrast to other companies such as Hewlett Packard, Dell etc. that have opened up factories in China or made manufacturing arrangements with other Chinese companies because of cheaper labour costs.



14.158 Fujitsu Builds Most Powerful Supercomputer. The June 2011 ranking of the top 500 supercomputers was unveiled at a conference in Hamburg, Germany. <http://spectrum.ieee.org/tech-talk/computing/hardware/fujitsu-builds-most-powerful-supercomputer>

14.159 Fujitsu Leads Again: World's Smallest Palm Vein Scanner!⁵⁴⁵

Fujitsu, a Japanese world leader in the manufacture of computers, servers and storage devices, has now invented the world's smallest palm vein scanner. This biometric scanner is expected to be widely used in mobile products such as tablet computers because of its accuracy and size, offering excellent security. Its advantage to users is that it recognises the characteristic structure of their palm veins from a hand held a



14.159 Fujitsu to launch first ever laptop with palm vein authentication technology, <http://www.itproportal.com/2013/12/18/fujitsu-announce-laptop-palm-vein-authentication/#ixzz2xtg8TmWE>

little distant away, without any physical touch being necessary, as is required in fingerprint recognition biometric devices. This contact-free palm vein authentication system not only recognises the structure of the veins in the palm that is normally invisible to the naked eye, but also recognises the structures of the fingers and then identifies the user by developing a composite picture. Since no touch is necessary, it is particularly suitable for hospitals and other public places where high standards of hygiene are needed.

Fujitsu laptops, desktops, servers and storage are manufactured mostly in Germany and in Japan, ensuring the very highest quality. Most other manufacturers (IBM, Dell, Hewlett Packard etc) have shifted their manufacturing plants to China and Malaysia and other developing countries. Fujitsu has over 33,000 patents in the field of technology, and is one of the very few IT firms that manufacture their own motherboards for the computer systems. At the end of last year, Fujitsu also achieved the ranking of having the world's fastest Supercomputer: (<http://www.fujitsu.com/global/news/pr/archives/month/2011/20111114-02.html>).

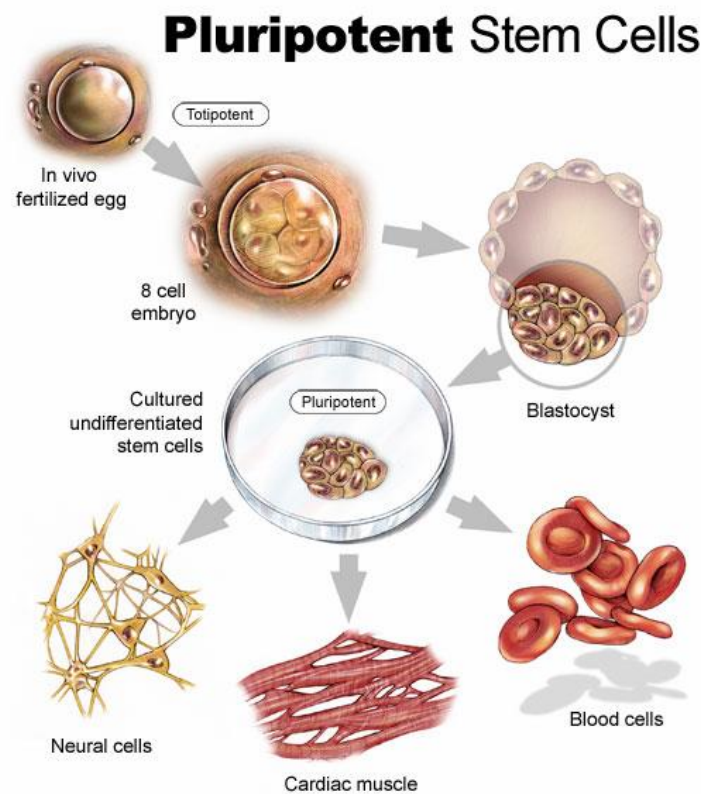
14.160 Growing Human Eye Tissues --- from Blood!⁵⁴⁶

Therapy based on stem cells is a rapidly growing field. Previously, stem cells were produced by harvesting them from embryos (a highly controversial process) or from the bone marrow of patients. However, now a special kind of stem cells (induced pluripotent stem cells) can be produced from normal cells taken from the blood or skin. These special stem cells can then be converted into heart, kidney or other types of tissue.

A major cause of blindness in adults is the onset of diseases that affect the retina (macular degeneration and retinitis pigmentosa). There are some medicines that can lead to the slowing down of the degeneration process but a complete cure is still not in sight. One answer to the problem could be to grow brand new retinal tissue. While this may appear far-fetched, scientists at the University of Wisconsin-Madison in USA have now succeeded in growing human retinal tissue from stem cells.

The stem cells needed were prepared from the white blood cells taken from the blood of human patients. These were then

“reprogrammed” (by using a plasmid containing the reprogramming proteins to infect the white blood cell). The result of this procedure was to produce a special kind of stem cell (induced pluripotent stem cell). This could then be coaxed into producing human retinal tissue. This opens the door for retinal tissue transplants for the future, where the damaged retinal parts could be replaced by disease free retinal tissue produced from the blood of the same patient.



14.160 Process of Obtaining Embryonic Stem Cells, <http://intrad187-f11-grosovsky.wikispaces.umb.edu/Group+6+-+Stem+Cells>

14.161 Historic Transatlantic Electric Flight!⁵⁴⁷

Making transatlantic flights in novel ways has held a fascination of its own since Charles Lindbergh made his historic flight in May

1927 on the Spirit of St. Louis in May 1927, setting a world record. Now, another world record holder Chip Yates is planning to fly the first all-electric aircraft some 3,600 miles across the Atlantic on the same route that Charles Lindbergh one took. Chip Yates holds the current world record for the world's fastest electric motorcycle. The "Flight of the Century" (FOTC), as his newly formed company is appropriately called, has developed a new battery system that will replenish depleted batteries during the flight. The concept of the "Infinite Range Electric Flight" technology developed by the company envisages the docking of the mothership in mid-flight with flying battery pods that will be used to continue to provide power to the aircraft while the depleted batteries will be gently ejected and undergo guided descent for recharge and reuse. When docking may not be practical, for instance in bad weather, then an alternative solution developed is to have the battery packs divided into segments and as batteries in each segment get discharged, they are ejected and guided down by GPS-fitted parachutes, recovered and recharged. The remaining battery packs are used to fly the plane. NASA-based software is being used to identify the best locations along the flight path to launch and recover the battery pods. With ten such battery packs that are sequentially eliminated, the weight of the plane is considerably reduced allowing a doubling of its range.

Erik Lindbergh, the grandson of the legendary Charles Lindbergh, is also involved in this exciting project that could mark the beginning of commercial all-electric flights of the future.

14.162 How Crispy are Your Apples?⁵⁴⁸

Some of us like to eat apples that are crisp in texture, while others prefer them to be nice and soft. The day is not far when you will be able to buy apples in the super market with a numerical indication, prepared after computerized measurement that tells you how crisp the apples actually are. Scientists Kate Evans and colleagues working at the Washington State University have developed a "computerized penetrometer" that

precisely measures the crispness and firmness of apples. This obviates the need of this being done by human "apple biters". The device developed by the Washington State University researchers is claimed to be the first to provide information of the crispness also, as opposed to existing acoustic resonance devices and penetrometers that provide information only on the hardness of the fruit.



14.161 Chip Yates prepares to race his 196-horsepower electric superbike against the gas-guzzlers, <http://www.gizmag.com/chip-yates-electric-superbike-america/17293/>



14.162 When it comes to apples, consumers like a crisp bite. Apple breeders know that crispness is one of the most important "sensory attributes" in apples. Because new apple varieties must be tested for these attributes, <http://phys.org/news/2013-08-apples-crunch-global.html#jCp>

14.163 Hover Cars --- and Cars of Tomorrow!⁵⁴⁹

The German automobile manufacturer, Volkswagen, has built a prototype of the car of the future that will travel while hovering above the road on a cushion of air, never touching it. The "Hover Car", as it is called, is the result of an initiative launched by the German company in China, known as the "People's Car Project" (PCP). Ideas about novel cars were invited and some 33 million persons visited the website. As a result, 119,000 new and novel ideas were submitted. From them, the Hover Car is one of the three ideas that were selected by Volkswagen to actually build prototypes.

Another related development in cars was to use a compressed air cylinder to power a car instead of a combustion engine. India's auto giant Tata Motors had acquired the license to manufacture this car from Motor Development International's (MDI) in Luxembourg in 2007 and the project has now entered its second final phase. The Kevlar cylinder in the car will need to be filled with compressed air, that will carry it for 200-300 kilometers before a refill is again needed. The cost of running it will be a fraction of that for running normal combustion engines. Meanwhile, work on improving engine efficiencies continues. The husband and wife team of John and Helen Taylor is known for being "the world's most fuel efficient couple" because they have already won 40 world records for fuel efficient cars. Now, they have another record --- the longest distance travelled of 2,616 kilometers (fuel efficiency of 84.1 miles per gallon). The record was set while driving a stock 2012 Volkswagen Passat.

14.164 Hybrid Air Vehicles!⁵⁵⁰

Following the Hindenburg disaster in 1937, when the giant hydrogen-filled airship burst into flames in New Jersey, killing 37 persons, the airship industry appeared to have come to a permanent end. Scientists and engineers have been trying for the last 4 decades to develop "lighter than air" aircraft that will provide



14.163 Volkswagen's flying car Seeing a flying cars in a sci-fi movie is a common site. The flying car has won hearts of many science fiction fanatics. Be it the glass bubble from "The Jetsons" or the cab from "The Fifth Element," all these vehicles have mesmerized audiences for a long now <http://www.impactlab.net/2012/11/12/volkswagens-futuristic-flying-car-concept/>



14.164 Hybrid Air Vehicles will be making some futuristic giant blimps to supply remote communities in the Northern parts of Canada. <http://technabob.com/blog/2011/08/31/discovery-air-innovations-airships-canada/>

safety as well as economy. Finally, they have succeeded. A relatively new British company that came into existence in 2007, "Hybrid Air Vehicles", in association with Northrop Grumman succeeded in winning a contract for US\$ 517 million to build and

deploy an airship that will be able to fly continuously for 21 days and carry 200 tons of cargo. The airship that will be deployed in Afghanistan in 2012, derives 40% of the uplift from helium, while the remainder comes from on-board engines. The aircraft has the capability of landing on earth, water or concrete without needing any ground crew. A Canadian company, "Discovery Air Innovations" plans to purchase smaller versions of the airships to carry cargo to the frozen northern areas at significantly reduced cost.

14.165 Helicopters? --- No, Multicopters!⁵⁵¹

The first ever manned flight of a "multicopter" was accomplished in southwestern Germany by Thomas Senkel. Mounted on a seat in the centre of the aircraft, he was surrounded by 16 propellers with accompanying motors. The flight of the multicopter could be controlled with a hand held remote device. The rotational speed of the propellers and the direction of the multicopter were controlled by an on-board computer. The aircraft continues to fly even if four of its propellers fail, thereby making it very safe. The German developer "e-Volo" expects to commercially manufacture these new electric multicopters before long.

Electric vehicles have been now in the market for several years, but batteries were not used to power helicopters till earlier this year when the French company "Solution F" had the world's first electric helicopter built by Pascal Chretien and flown by him on 12th August 2011. Helicopters are more difficult to fly on batteries because they require sustained high power throughout their flight, in contrast to electrical planes that require significant power only when taking off but require much less power when cruising.

14.166 Indian Made Tablet Computers---for \$ 35 each!⁵⁵²

Tata India made history a couple of years ago by producing the cheapest car in the world, the "Nano", for only \$ 2,500. It is about to do the same now in tablet computers that will cost \$35 for schools and colleges, and may eventually cost under \$ 10!

The laptop has 2 Gb RAM, wireless connectivity and a resistive touch screen. It was launched by Kapil Sibal, India's minister for human resources development (whose portfolio includes education), last year.



14.165 Multicopter, http://www.fpvmodel.com/eve-uav-hexa-multicopter-rtf-total-solution-for-fpv_g65.html



14.166 Indian Human Resource Development Minister KapilSibal on Thursday launched a \$35 Android tablet, it will be made available to students right from primary schools to universities. *image credits: The Hindu, Indian Express*, <http://www.androidos.in/2010/07/35-android-tablet-is-here-in-india-price-can-go-down-to-10/>

The computer has been designed by the Vellore Institute of Technology, the Indian Institute of Science in Bangalore, the Indian Institute of Technology in Madras and the state-controlled Semiconductor Complex. It is India's response to the much publicised One Laptop Per Child (OLPC) project launched by Nicholas Negroponte of the Massachusetts Institute of Technology Media Lab in 2005 at a claimed cost of \$ 100 per

computer. The MIT project failed due to high manufacturing costs. The success of the Indian computer still remains to be demonstrated.

14.167 Insect Cyborgs!⁵⁵³

Tiny little creatures, half-insect half-robot, have been developed under a project funded by the US defense agency DARPA. The electronics are incorporated into live insects in the early stages of the insect growth (metamorphosis) so that the insect body grows around the electronic systems and the insect learns to accept these as parts of its own body. The electronics can then be used to control the flight paths of insects and carry them to strategically important locations. Carrying tiny cameras and microphones, they can be manipulated to perch themselves at a suitable place on the wall or roof of the Prime Minister, President or the Army Chief of a country, and transmit all that goes on to a foreign embassy a few miles away. These insect cyborgs can be powered by energy captured from the movement of insect wings or using biofuels. The natural camouflage offered by harmless looking insects can be invaluable in preventing detection.

The rapidly developing field of insect cyborg engineering is providing novel ways of espionage. So, the next time you see a fly on the wall of the room of a key government official, watch out! It may be a spy from a foreign embassy placed there by remote control!

14.168 Internet Speed: 800,000 Times Increased!⁵⁵⁴

Internet speeds have experienced phenomenal increases in the last two decades. The broadband cables presently available can support speeds of about 30 megabits per second. Now, we are witness to another huge break-through. Researchers at the University of Southern California (USC) have succeeded to increase speeds of data transmission by 85,000 times using twisted beams of light to transmit data. Transmission of data can then be carried out at speeds that are up to 2.56 terabits per second! The data transmission is achieved at ultra-high speeds

using eight twisted beams of light that are inter-coiled in a helical shape, resembling the DNA. Each of the eight beams has its own characteristic twist that can be encoded with "1" and "0" data bits. This leads to the data being carried in the form of eight independent data streams. The data can be transmitted through space or in optical cables.



14.167 <http://omnibusintelligence.blogspot.com/2013/08/hi-mems-hybrid-insect-micronized.html>



14.168 This is Professor Jürg Leuthold of the Helmholtz Association of German Research Centres. Credit: Photo: Gabi Zachmann. Reproduced with thanks from, <http://phys.org/news/2011-05-world-ultra-rapid-transmission.html#jCp>

Meanwhile, a team of scientists led by Professor Jürg Leuthold at Germany's Karlsruhe Institute of Technology (KIT) have achieved even faster speeds of data transmission --- they succeeded data transmission at a rate of 26 terabits per second (800,000 times faster than currently achievable speeds) on a single laser beam. This was transmitted over a distance of 50 km (31 miles). This amounts to transferring an enormous amount of data (that will require 700 DVDs to store) in a single second! At this fantastic speed, some 400 million telephone calls can be made at the same time. Other partners involved in this project include members of the staff of Agilent and Micram Deutschland, Time-Bandwidth Switzerland, Finisar Israel, and the University of Southampton in Great Britain.

14.169 Intelligent Glasses!⁵⁵⁵

Google has developed an amazing set of intelligent glasses that can augment reality if you are wearing them. The requested information magically appears on the glasses --- if you need to know the route to a certain place, all that you have to do is to softly ask your glasses to show the map of the relevant street and it will appear on your glasses in a manner that it does not block your view. Similarly, if you see a beautiful sunset, all you have to do is to request the glasses to take a photograph, and it will do that for you. It will book you a theater ticket, tell you where a book may be located in a bookshop or tell you the state of congestion on a particular road. You no longer need to use a smart phone to search for the information that you need --- it is all sitting at the end of your nose --- all that you need to do is to ask! It even translates a foreign language.

The exciting futuristic device has been invented by Google X (Google's futuristic technology development lab). According to the New York Times, the glasses should be commercially available by the end of this year. A huge amount of work has gone into its development including optimizing battery life, network speed, software, and graphics performance. It has intelligent personal software embedded in it so that you have a smooth and seamless experience.



14.169 With so much new information surrounding Google Glass, we have completely updated this 'what you need to know' feature. Enjoy! <http://www.techradar.com/news/video/google-glass-what-you-need-to-know-1078114>

14.170 *Lighting the Home—with Bacteria.*⁵⁵⁶

The exciting developments in science and engineering continue to prove over and over again that truth can be far stranger than fiction. All sorts of ideas have been used for home lighting --- from normal bulbs, to energy savers and more recently to LEDs. However, an astonishing recent development by the Dutch electronics company Philips employs a novel lighting system using bacteria! We know that a number of insects and deep sea jelly fishes can produce light. In Pakistan during the summer months, it is not unusual to see glowing fireflies (“jugnoo”) specially in gardens in Punjab. The light (bioluminescence) is produced by the reaction of an enzyme luciferase on the substrate luciferin. The “Microbial Home” concept developed by Philips uses glowing bioluminescent bacteria to produce natural light. The bacteria are fed with methane that is generated from normal household wastes.



14.170 Philips Bio-Light: Bacteria as Energy Source. <http://www.artandsciencejournal.com/post/26217329425/philips-bio-light-bacteria-as-energy-source>

So, now you need never curse the electricity company when the power goes off --- just smile and bask under the natural light of glowing bacteria!

14.171 Massive Ordnance Penetrators!⁵⁵⁷

One of the aims of military research has been to develop weapons that can penetrate solid concrete bunkers and destroy enemies hiding in them. These include the 5000 lb bunker buster, the 15,000 lb BLU-82 "Daisy Cutter", the 15,650 lb "Aviation Thermobaric Bomb of Increased Power", the 22,000 lb "Grand Slam earthquake bomb", and the 22,600 "Massive Ordnance Air Blast". However, even these massive bombs become useless if there is 200 ft of hard concrete between the attacking force and the enemy.

Now, however the US army has been handed weapons that will easily penetrate 200 ft. of concrete and destroy the enemy behind it. This is the 30,000 lb GBU-57A/B (Massive Ordnance Penetrator) that will go deep into 200 ft of concrete before exploding. It is ideal for destroying nuclear facilities that lie deep behind mountain rocks or concrete protections. The bomb is accurately guided by a GPS system to the site to be attacked. It can be carried by B-2 and B-52 bombers.

14.172 Mind Controlled Weapons!⁵⁵⁸

According to a report entitled "*Neuroscience, conflict and security*" published by the prestigious Royal Society (London), the wars of tomorrow may well be fought using mind control weapons. Weapons are being developed that will be controllable by human minds, through interfacing with neural systems. Such "Neural Interface Systems (NIS)" will add a new dimension to warfare, greatly extending human capabilities of destruction. The interfacing of the human brain with computer systems was demonstrated by an American company, Cyberkinetics, in 2004. A small implant ("Braingate") of the size of an aspirin tablet inside the human brain allowed the control of computer systems by thought control. The field has since progressed rapidly and

computer systems can be controlled without any implants by just having sensors fitted on a cap worn by a human being.



14.171 A 15,000 lb BLU-82/B on display at the National Museum of the United States Air Force, <http://en.wikipedia.org/wiki/BLU-82>

A neurally interfaced weapons system could provide extremely rapid responses as a human brain can process commands far faster than conscious response times. The US military agency DARPA is funding such programs massively in various institutions so that the US military domination of the world remains unchallenged.

Already such devices are allowing persons to drive cars purely by mind control. Completely paralysed persons can move computer-controlled motorized wheelchairs by sending thought signals. The electromagnetic signals detected by the brain can be sent to a computer that then controls the manner in which the car is driven or the direction in which the wheelchair is moved. For a demonstration on how the technology works visit http://www.youtube.com/watch?v=iDV_62QoHjY

14.173 Mind Reading Computers --- to Prevent Accidents⁵⁵⁹

A fraction of a second delay in applying brakes can lead to the death of a pedestrian. Human reaction times to emergencies are often not fast enough to react appropriately to emergencies. Researchers at the Berlin Institute of Technology have now

developed a computer system that reads your thoughts and responds at lightning pace to emergencies, thereby preventing serious road accidents. Two small electrodes attached to a cap that the driver wears recognize the electroencephalographic (EEG) signals from the brain providing faster responses. Simultaneously, other sensors were employed to detect the muscle tension in the lower leg. The result was astonishing. The braking distance of a car travelling at 100 km/hour was reduced by as much as 12 feet as compared to a car where the driver did not have such fittings (Stefan Haufe *et al* 2011 *J. Neural Eng.* **8** 056001 doi: [10.1088/1741-2560/8/5/056001](https://doi.org/10.1088/1741-2560/8/5/056001)).

14.174 Mining with Bacteria!⁵⁶⁰

The world's largest known deposits of copper are located in Chile and this metal represents about 70% of the exports of Chile. The metal can be present in up to 30% yield in the ore but in many places only small amounts of copper with only 1-2% yields of copper are left. This is usually not extracted but treated as waste. The normal chemical process of extraction involves crushing of the ore, grinding it, followed by heating it to high temperatures so that the sulfides in it are converted to sulfoxides. It is then subjected to a number of refining processes including treatment with sulfuric acid and electrolysis. However, even small amounts of copper can be extracted if nature's tiny workers --- bacteria --- are given the task. The process known as "biomining" is used in Chile, South Africa, Brazil, Australia and some other countries and about 20% of world copper is produced in this manner. Bioleaching with suitable bacteria is also used for extraction of gold and uranium. The bacteria use the metals as a source of energy and thrive on them.

14.175 Missile Killers!⁵⁶¹

USA successfully carried out a test to shoot down a ballistic missile on May 9th 2012. The missile interceptor had earlier



Car with
drive-by-wire

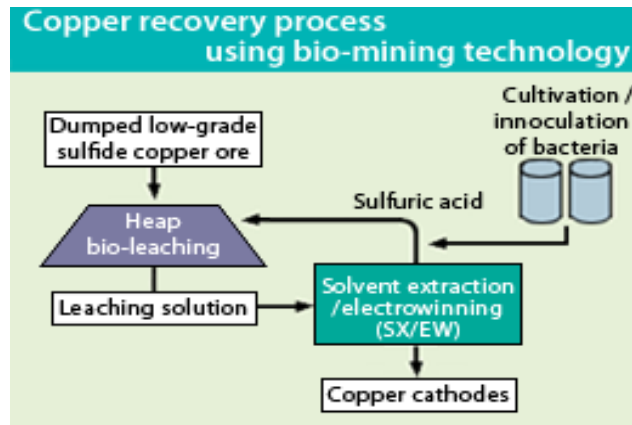


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14.173 Reproduced with thanks from, <http://ibnlive.in.com/photogallery/3431-9.html>



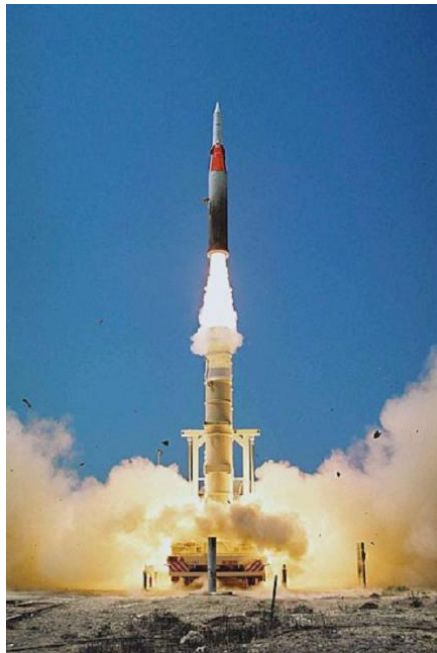
14.174 Bio-leaching technology enables the efficient extraction of copper from ores using an oxidation reaction from which autotrophic bacteria such as iron-oxidizing bacteria gains energy. Thus, as it is not necessary to supply energy from an outside source, bio-leaching is expected to become a mining technology with a low environmental load. Reproduced with thanks from, http://www.nmm.jx-group.co.jp/english/industry/ind07_01.html

failed in its maiden attempt in September last year but the new version "Missile 3 Interceptor" succeeded when it successfully shot down a ballistic missile near Hawaii. The test represented the 53rd successful interception of a missile out of 67 such tests carried out since 2001 when the deployment of the shield began. The missile interceptor was co-built with Raytheon, a US company specialising in defense manufacture. It has an improved target seeking system, the latest signal processors and it can adjust its course more accurately.

The United States has been developing anti-missile missiles for over a decade. Feeling increasingly threatened by North Korea and Iran, the efforts have been redoubled in recent years. A shield against missiles is being developed for Europe that is expected to be deployed in Romania by 2015 and in other European countries by 2020. This is part of President Obama's "phased adaptive" approach to deployment of missile defense systems. The missile killers will be deployed on ships equipped with the "Aegis" system of Lockheed Martin Corp. that integrates computers, displays, sensors, weapon launchers and weapons in a seamless manner. The shield that is being built in Europe involves sensors in space and hardware deployed on the ground and on ships. There are presently some 27 ships equipped with the Aegis system, of which 23 are in the US navy while other 4 ships are in the Japanese navy.

14.176 Nanotechnology --- An Exciting New Frontier!⁵⁶²

One of the most exciting advances in science during the last couple of decades has been the development of nanotechnology. It is now finding myriad applications in medicine, food, water purification, cosmetics, electronics and many other fields. US has the largest share (28%) in the nanotechnology market, followed by Japan (24%), and Europe (25%, main players Germany, France and UK). Nanomaterials owe their special properties due to their size. They are typically between 1 nanometer (nm) and 100 nm in size. One nanometer is one-billionth of a meter. The relative scale can be judged from the statement that a nanometer is of about the same proportion to a meter, as a marble is to the earth.



14.175 Launch of prototype anti-ballistic missile interceptor,
<https://02varvara.wordpress.com/2008/04/20/american-scientists-criticise-the-effectiveness-of-the-pentagon%E2%80%99s-planned-missile-defence-programme/>

The emergence of this field was triggered by two major advances in the 1980s. The first was the development of the scanning tunneling microscope in the early 1981 which allowed images to be seen at the atomic level. The second was a serendipitous discovery of molecular “carbon footballs” in 1985 by Harry Kroto, Richard Smalley, and Robert Curl, who together won the 1996 Nobel Prize in Chemistry. A host of developments followed ---- carbon nanotubes, thin carbon sheaths (graphene), and different methods to develop useful nanomaterials.

The applications in medicine include improved drug delivery of nanomedicines due to improved absorption in the human body. Their use in medical imaging can provide better pictures of cancerous tissues. Suitably engineered nanoparticles can deliver drugs, heat, light, and other materials only to diseased cells without damaging healthy tissues. In the field of electronics, lighter display screens have been developed that consume less power, including flexible display panels made from nanowires.

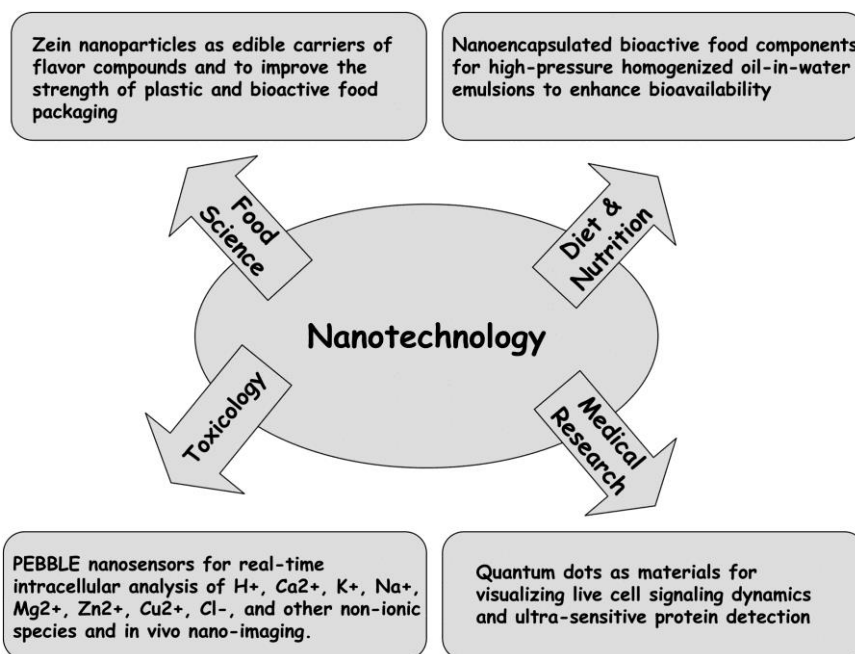
High density memory chips and much smaller transistors used in integrated circuits are being developed so that much smaller and more efficient computers can be produced. The market size of nanoelectronics is presently estimated to be above \$ 4 trillion.

In food science, nanotechnology is finding applications on improved methods to grow and store food. Silver nanoparticles have been incorporated in plastic storage bins so that harmful bacteria are killed on contact. Zinc oxide nanoparticles incorporated into packaging plastic films block UV light, and provide anti-bacterial protection while making the films stronger and increasing their stability. Pesticides incorporated in nanocapsules release the toxic materials only in the stomach of insects that consume them, thereby protecting the plants (and us) from their harmful effects. Nanosensors are being developed that recognize when individual plants need water, fertilizers or nutrients and trigger their release as and when needed, thereby optimizing the growth of each plant and reducing the consumption of water, nutrients and fertilizers. Nanofood products are estimated to have a market size of about \$ 20 billion.

Other applications of nanotechnology include the development of bulletproof paper made from nanocellulose which is stronger than steel, new light weight and stronger materials used in spacecrafts and aeroplanes, and longer lasting light-weight batteries. Nanotechnology has also been used for the economical production of stronger light weight textiles, tennis racquets and other sports goods. Textiles using nanotechnology are estimated to have a market size of \$ 115 billion.

Pakistan too had started making significant strides in this field during 2000 to 2007. The Ministry of Science & Technology and the Higher Education Commission approved projects worth over Rs. 1 billion during 2001 – 2005 to support nanotechnology. A National Commission on Nano-Science and Technology was established by the Ministry of Science & Technology which carried out valuable work under its chairman Dr. N.M. Butt. A number of excellent research units were established during 2004-2007 with support from the Higher Education Commission. For example, to address the dearth of semiconductor processing facilities in Pakistan, the Department of Physics at COMSATS

Institute of Information Technology (CIIT), Islamabad undertook a project on the designing and fabrication of micro and nanoelectronic devices. The project resulted in setting up state-of-the-art teaching and research laboratories and strengthening of the ongoing undergraduate and graduate courses in Microelectronics/Nanoelectronics and Optoelectronics.



14.176 <http://free-downloadz.net/archive/nutrition%20science%20and%20applications%20pdf>

However, the substantial reductions in funding by the government to the science and higher education sectors in the last three years have adversely impacted these developments. The National Commission on Nano-Science and Technology Commission was closed down. The Higher Education Commission was almost shredded to pieces because of corrupt politicians, 50 of whom were found to have forged degrees, and the slashing in its funding led to its stopping approval of new projects in the field of nanotechnology. Fortunately, the Supreme Court intervened to declare the government notification to shred HEC unconstitutional, thereby preventing a national disaster.

Some wonderful beginnings made in the field of Nanotechnology in Pakistan are alas now in the doldrums.

14.177 Operating Computers ---- with Thought Control!⁵⁶³

In earlier articles, I have described the use of thought control in operating wheelchairs or driving cars. These however required the operator to wear a cap fitted with sensors that could read the signals from the brain. These thought reading caps are now available commercially for \$100 upwards.

An exciting new recent development has been the development of an armband instead of a cap that can read the brain signals and operate such devices remotely. This bio-feedback armband is called BodyWave and it has been developed by a company "Freer Logic", named after Peter Freer, a North Carolina elementary-school teacher who invented the device. The iPod size device is strapped onto the arm (or leg) of the user. The armband has three sensors that detect the thoughts in the form of neurotransmission signals. The device works by reading the signals generated in the brain neurons and that are flowing through the nerves of the user. These signals are then sent to a computer.

The brain generates four kinds of signals in the form of various types of waves. The most important of these are the cognitive beta signals that are used when your concentration has peaked to a point that you are about to make an important decision such as putting on the brakes of your car, getting up from the bed, or lifting an object. Other signals are the delta signals (commonly observed when one is sleeping), theta signals (when a person is daydreaming or during a catnap), and alpha signals (when a person is relaxed but fully conscious). In order for the device to work, a certain level of concentration has to be reached that is then detected. Thus if you are pondering over something the device will ignore the signals but once you have focused your thoughts to a level that you would like to take a specific action, the neurons start to fire in a uniquely synchronous manner. The unique signature is read by BodyWave that then immediately

acts on your behalf. As soon as you have stopped concentrating, the signature from the neuronal firing disappears.



14.177 The BodyWave is the first device of its kind to measure brainwaves through the body rather than the scalp, allowing you to control a computer with your mind via an armband alone. <http://www.gizmag.com/bodywave-arm-band-pc-mind-control/21116/>

The impact of this development can be staggering in medicine, defense and industry, particularly when split second decisions may be required and that fraction of a second may make the difference between life and death. For instance, in an aerial dogfight when flying a supersonic fighter jet, the fraction of a second delay in decision making regarding when to turn the plane in a particular direction or fire a missile may determine the winner. A similar situation may apply when a surgeon decides at what point of time to use his scalpel. The fraction of a second gained may prevent a nerve from being accidentally cut and save the life of the patient.

BodyWave is being marketed at a cost of \$ 1795. The price includes the software “Play Attention” and tutorials for two hours on the telephone by specialists that teach you how to use the software properly.

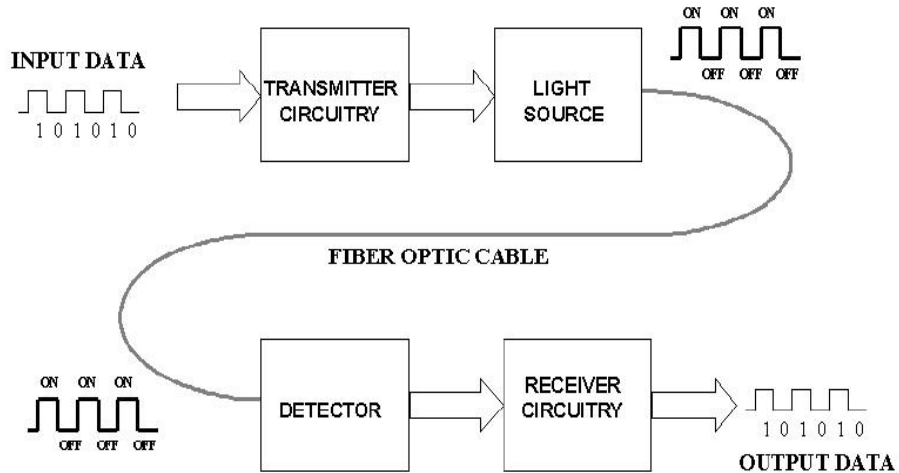
14.178 Optical Fibre Communications --- Exciting Breakthrough!⁵⁶⁴

Information is transmitted today from one place to another by pulses of light that travel through fibre optic cables. The optical signal is relayed across a certain distance in a thin flexible glass fibre cable, almost as thin as a human hair. In the process of transmission, it can become weaker and gets distorted, so researchers have been looking for ways on how the strength of the optical signal could be boosted. With advances in technology, the costs of fibre optic cables have dropped sharply over the last decade and it is cheaper now to have fibre to the home than to use copper for telephone communications and other information transmission needs.

Intense research on new ways of amplifying optical signals has now led scientists at Sweden's Chalmers University of Technology to develop a new method of amplifying the optical signals so that they are carried to a distance which is four times farther than is presently possible ---- up to 4000 kilometers ---- without signal weakening or distortions!

14.179 Palm Reading ATMs!⁵⁶⁵

After the Tohoku earthquake in Japan, a large number of persons could not access the ATMs because they had lost their wallets in the resulting mayhem. ATMs are normally operated by credit or debit cards. The advent of biometrics technologies has allowed the use of fingerprints or other physical features to be read, in order to beat the card thieves. However, such methods still require the insertion of cards into the ATM machines. Now, a Japanese bank has announced the development of a new type of machines that do not require any cards at all, so that if they were to lose their cards, they can still withdraw cash from the machines. These machines will be introduced at 10 sites in September this year by Japan's Ogaki Kyoritsu Bank. All that required to authenticate a customer will be his/her palm print, a four-digit PIN and his/her date of birth. The machine will scan the palm and compare the characteristic lines on the palm with those fed in its memory -- no cards of any sort needed.



14.178 The block diagram of a fiber optic communication system is display below: <http://www.expertsmind.com/questions/with-a-block-diagram-explain-fiber-optic-communication-30166130.aspx>



14.179 Source: PSFK. Starting in September, you'll be able to use your palm – and not your debit card – to withdraw cash at Ogaki Kyoritsu Bank ATM's in Japan. Reproduced with thanks from, <http://www.digitalforreallife.com/tag/ogaki-kyoritsu-bank/#sthash.vTUrcJeK.dpuf>

14.180 Performing Actions --- by Thought Control!⁵⁶⁶

In previous articles, I have described the exciting developments that are taking place in integrating the human brain with computers in order to recognize thoughts and perform specific actions purely through thought control. This has allowed completely paralysed persons to drive battery-powered wheelchairs or persons to drive cars by giving brain commands. All one needs to do is to wear a skullcap fitted with sensors that recognizes the commands and sends them through computers to the machines.

Now, researchers at the University of Maryland are further refining the technology to allow complex 3D movements of hands, arms, knees and hip joints to be reproduced. This will be particularly useful to persons who are paralysed after an accident or a stroke and cannot move their limbs. The brain activities, used to move arms, ankles, hips etc. on a treadmill, have been carefully analysed by researchers and correlated with limb movements. The information gained is being used to design a prosthetic device known as an "anklebot" that will allow movement of ankles by thought control. Once the thoughts are decoded, it is possible to teach the paralysed to use their minds in certain ways that will allow the device to recognize the commands and assist the person in walking or moving the hands in desired ways. The rapid advances in Brain Computer Interface (BCI) technologies are creating new hopes for the paralysed.

14.181 Portable Remote Body Scanners!⁵⁶⁷

Given the security situation in Pakistan, there is urgent need of technology that will allow scanning of bodies for concealed weapons to be carried out from a distance. This will prevent criminals from coming too close with weapons concealed under their clothing. No such technology existed --- till now!

The New York Police Department and the United States Department of Defense have been involved together in the development of remote sensing devices that will detect weapons

remotely. The portable scanner relies on the infra-red rays produced from the body. An image of these rays can be detected by the scanner. If a weapon is present, then the infra-red rays are blocked by the metal and a silhouette of the weapon can be seen. The range of the equipment is being extended so that it can detect concealed weapons from a distance of 82 ft.



14.180 (Left) Subject in robot group playing videogame with anklebot assistance; (Right) Control subject undergoing manual stretching. <http://www.umrehabortho.org/research/robot-assisted-training-of-ankle-movements-in-subacute-strok.htm>



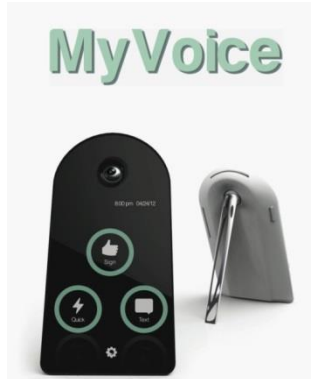
14.181 <http://sleepless.blogs.com/george/science/>

14.182 Portable Sign Language Translators⁵⁶⁸

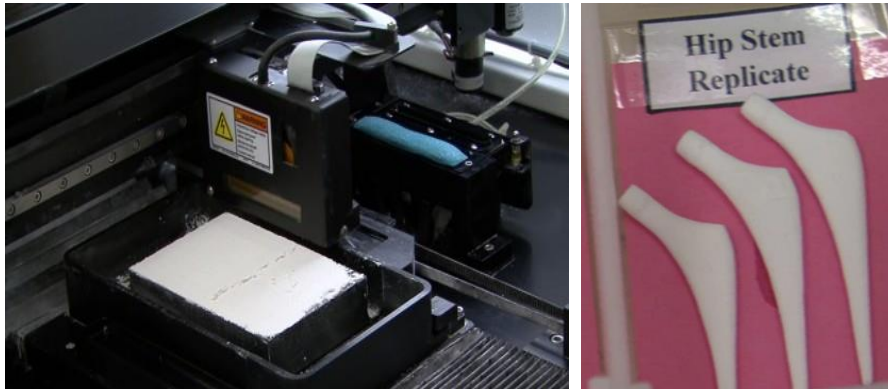
The deaf may be able to communicate with one another using sign language but this language is not understood by non-deaf persons unless they are trained to recognise what each gesture means. Now a group of engineering technology and industrial design students from the University of Houston have created a prototype translator, appropriately called MyVoice that can recognise the signals and translate them into sound. It is a portable device that incorporates a microphone, speaker, soundboard, video camera and monitor. The device reads the hand gestures and then audibly states the message. It can also do the reverse---listen to the message from a non-deaf person and translate it into hand gestures that could be understood by the deaf person. Still in its early stages of development, the device is expected to compete with an already-existing product known as the AcceleGlove that however works only as a one-way deaf-to-hearing translator. Worn as a glove, it determines the hand gestures, and expresses those in written text or as spoken words.

14.183 3D Printers – for Making Household Objects and Bones⁵⁶⁹

Bone-like materials can now be created using 3D printers! The rapid advances in 3D bio-printer technology are now opening up possibilities of making organs on demand as required by surgeons for replacement surgery. Researchers at Washington State University have developed a 3D bio-printer that sprays a plastic binder on a powder in fine layers that are thinner than a human hair. The bone-like material can be paired with actual bones, and with a suitable supply of growth factors, it can act as a scaffold on which new bone structures can grow before it dissolves away. Researchers at MIT have been using similar techniques to stimulate the growth of bones and cartilage in knees. The 3D printing technology is thus beginning to find a variety of applications in medicine.



14.182 UH Students Develop Prototype Device That Translates Sign Language. <http://www.uh.edu/news-events/stories/2012/may/0529MyVoice.php>



14.183 The re-purposed ProMetal 3D printer used by the WSU researchers to create objects in a bone-like material. Reproduced with thanks from, <http://www.gizmag.com/bone-like-material-3d-printer/20663/picture/149216/>

14.184 Print and Fly an Aircraft!⁵⁷⁰

Print an aircraft on a 3D printer, snap together the body and fly. It sounds impossible, but it is now true! Using CAD software, one can print a 3D design and create different objects without any machine tooling. Professors Andy Keane and Jim Scanlan, from Southampton's Computational Engineering and Design Research group, University of Southampton have now used a nylon laser sintering machine that employs a successive layering

technique to build up plastic or metal parts. After printing, the various parts are fitted together without tools in minutes and the unmanned electric aircraft with an autopilot is ready to fly in a jiffy! It has a wingspan of two meters and a speed of 100 mph while cruising. The design may be modified quickly so that the flying characteristics of various structures can be studied.

14.185 Printable Robots!⁵⁷¹

Imagine being able to manufacture robots on a 3D printing machine. During the last couple of years, there have been exciting developments that allow various inanimate objects to be produced by a 3D printing machine. The machine is computer controlled and various layers of polymeric material can be laid on sequentially to produce toys, spectacle frames, valves, and a variety of other materials. Now, even robots may be produced in this manner. A project has been funded by a US\$10 million grant from the National Science Foundation involving scientists and engineers from Massachusetts Institute of Technology (MIT), in collaboration with the University of Pennsylvania and Harvard University. The manufacture of various types of robots by 3 D printing could revolutionise their use in defense, industry and for household chores.

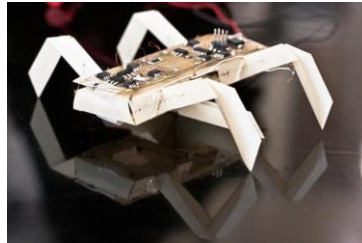
14.186 Robot Air Purifiers!⁵⁷²

Air purifiers are commonly used in offices and homes in the West to remove particles of dust and make the air cleaner to breathe. They are particularly useful for asthmatics who may be allergic to certain types of air-borne impurities. However, the air purifiers are usually installed at a particular point in a room and they can be effective within a certain defined area. Now a company, Moneual in South Korea, has come up with a novel concept of robotic air purifiers that can go from room to room in search of dirty air and purify the air for you! The robot (Rydis 800) moves about on wheels and it is fitted with sensors that allow it to avoid collisions with objects as it travels around

various nooks and corners. When not being operated, it sits on a charging station so that it is ready for use when needed.



14.184 3D Systems Releases In-house 3D Modelling Software.
<http://www.solidsmack.com/cad/3d-systems-releases-in-house-3d-modelling-software/>



14.185 MIT Project Aims to Deliver Printable, Mass-Market Robots.
Insect printable robot. Photo: Jason Dorfman, CSAIL/MIT,
<http://www.wired.com/2012/04/print-your-own-mit-robot/>



14.186 World's First Air Purifier Robot, <http://www.gadgethealth.com/moneual-rydis-h800-worlds-first-air-purifier-robot.html>

14.187 Robotic Helicopters for Army Supplies!⁵⁷³

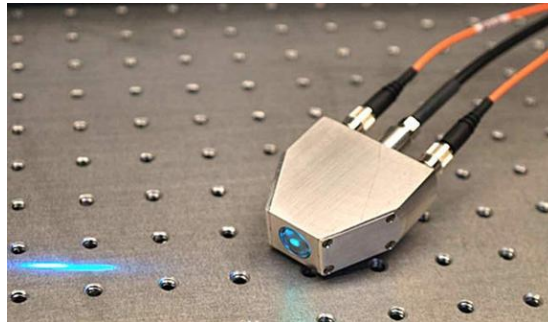
The Office of Naval Research in USA has announced a \$ 98 million program to develop the Autonomous Aerial Cargo Utility System (AACUS) that will allow soldiers to instantly order supplies through robotic helicopters by using hand-held application devices. This will eliminate the need of human operators to carry out this highly skilled and delicate task. Robotic vertical take-off and landing aircrafts have been developed in USA to carry cargo to war front lines without risking the lives of pilots. Now, the automatic control systems are being developed to integrate with the helicopters. This will allow front line troops to order specific items needed on a mobile hand-held device, and a swarm of helicopters carrying urgently needed supplies will fly off instantaneously on receipt of the command. The system will employ the latest developments in Artificial Intelligence to carry out the complicated tasks.

14.188 Scanner for Vegetable Consumption!⁵⁷⁴

Have you eaten your daily requirement of vegetables? To answer this question is not easy. It can be achieved by blood and urine tests or by skin and serum biopsies through which it is possible to detect telltale substances. This can be unpleasant and time consuming. Now, scientists at Yale University and the University of Utah have developed a completely non-invasive method that involves a hand held laser scanner that will tell you if you have had your daily quota of vegetables within a minute. The flexible fiber optic probe is attached to a unit connected to a laptop. The probe throws blue laser light onto the skin of the palm, and the light that bounces off is analysed for the presence of carotenoids using Resonance Raman Spectroscopy (RRS). The frequency of the light is detected so that only carotenoid levels are detected. This marks the development of a new procedure that can be potentially applied to many areas including diet related obesity and many metabolic disorders.



14.187 US Navy Solicits Bids to Test Autonomous Vertical Take-off UAV. <http://www.unmanned.co.uk/unmanned-vehicles-news/unmanned-aerial-vehicles-uav-news/us-navy-solicits-bids-to-test-autonomous-vertical-take-off-uav/>



14.188 A blue laser light shining on human skin can help detect the amount of fruits and vegetables in a person's diet. Credit: Yale University | University of Utah. Reproduced with thanks from, <http://www.livescience.com/20696-laser-reveals-eating-veggies.html>

14.189 Self-Healing Electronics!⁵⁷⁵

The breakage of electronic circuits due to cracked wires is a common problem in electronic gadgets. Now, the development of self-healing electronics is coming to the rescue. Materials can be coated with microcapsules that burst when a crack occurs, thereby releasing a liquid that hardens on contact with air. This technology has been applied previously to concrete and polymers. Now researchers at the University of Illinois have extended it to electronics. The microcapsules are coated on a conducting material. When a crack occurs, the microcapsules burst and repair the crack instantaneously, thereby restoring the conductivity in the damaged circuit.

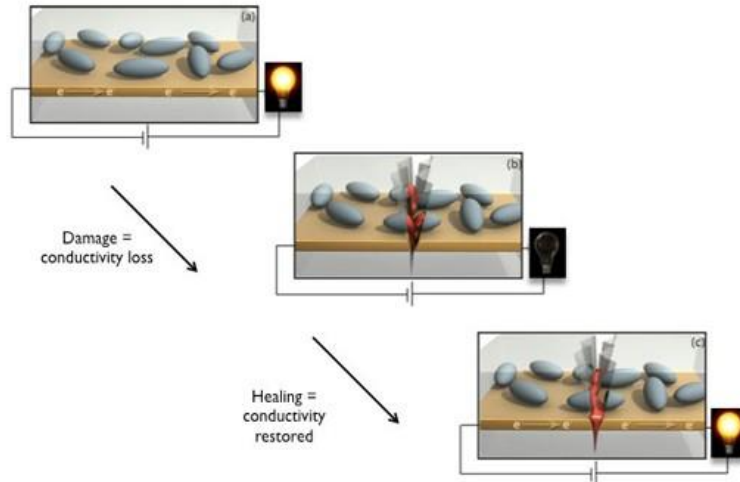
Such a system will have significant advantages. It would prevent long hours being spent in detecting the breakage, for instance in aircraft with miles of electrical wiring. Cracks would also heal themselves on chips, thereby saving costs. The need for building in redundancies in the circuitry or using expensive diagnostic equipment to detect the breakage point will also be eliminated.

14.190 Sensitive Robotic Fingers!⁵⁷⁶

Scientists at the University of California's Viterbi School of Engineering have developed an amazing technology that mimics a human finger in the sense of touch. Indeed, it outperforms humans in being able to recognise a material from its feel. The "Bio Tac sensor" comprises a finger-like unit that has a soft flexible skin filled with a liquid. The skin has finger-print like patterns embossed on it that give it additional sensitivity. When the robotic finger is allowed to slide over a surface, it vibrates in characteristically different ways, depending on the nature and texture of the surface. These vibrations are then sensed by a microphone and recognised. The robotic fingers use an exploratory movement when touching the surface, just as we move our fingers over an object and try to recognise it by its feel. The mathematical model of such a movement was developed by Professor Gerald Loeb, Professor of Biomedical Engineering and Dr. Jeremy Fishel. The technology is now being sold to manufacturers of industrial robots and prosthetic hands.

Earlier, engineers at the University of California in Berkeley had developed a pressure sensitive artificial skin made from semiconductor nanowires. This was done by growing germanium/silicon nanowires on a cylindrical drum. The material was then rolled across a sticky polyimide film to afford the basic material of the "e-skin". The sheet was then coated with a pressure sensitive rubber.

So the next time you happen to shake hands with a robot, remember that his fingers are just as sensitive as yours, if not more so!



14.189 Researchers develop self-healing electronics, adamantium sadly not included. Reproduced with thanks from, www.engadget.com



14.190 USC Viterbi School of Engineering/YouTube. Reproduced with thanks from, <http://techland.time.com/2012/06/20/these-robot-fingers-can-feel-objects-better-than-a-human-can/>

14.191 *Shopping Carts that Follow You Around*⁵⁷⁷

Pushing a shopping cart across large shopping malls can be a bind. Would it not be nice if there were intelligent shopping carts that could follow you around like a pet dog while you carried out your shopping with both hands free? That has now happened in this wondrous world of science! A cart has been invented that detects the items purchased, compares them with your shopping list, reminds you if you have forgotten an item and obediently follows you in the super market, avoiding colliding with others and maneuvering its way around objects and sharp corners. The

invention has been made by Chaotic Moon Labs in USA. The cart is fitted with a voice recognition system that allows the buyer to ask the cart where exactly a particular item is located in the shop and to remind the buyer when the shopping on the shopping list has been completed. The cart is fitted with a “Kinect” sensor connected to Windows 8 tablet that allows it to perform these functions. If the shopper makes a mistake and accidentally grabs a wrong item, the cart also reminds the shopper of the mistake. The cart is undergoing trials in a number of stores in USA. Before long, the stores may be full of such intelligent carts that follow shoppers like obedient puppies!

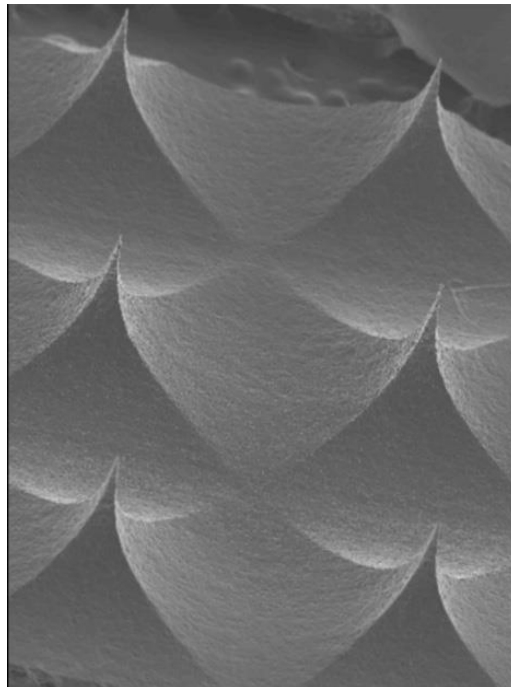
14.192 Silk Microneedles⁵⁷⁸

Syringes have been around for 150 years but now there is a new painless version that has been developed --- microneedle patches! These comprise an array of very fine needles on the patch that pierce only the upper section of the skin when the patch is applied. They therefore pierce the skin without causing any pain since they do not reach the nerve receptors. The patch then delivers the vaccine or other medicine and the needles dissolve away with time. The whole procedure is completely painless and no waste needles are left over that can be a cause of disease. Animal trials have established that vaccinations applied in this manner are more effective than deeper applications with conventional syringes. The adhesive patches, bearing the array of microneedles, can be applied on any area of the skin by the patients themselves without the need to go to a doctor. The advantages of this new technology have been demonstrated by researchers at Emory University and the Georgia Institute of Technology in USA. Pioneering work in this area was carried out by scientists at the Institute of Materials Research and Engineering in Singapore.

Researchers at Massachusetts' Tufts University have now further improved the microneedles by fabricating them with silk. The structure of the silk needles is modified to control the rate of drug release. The silk microneedles did not cause infections and were more user-friendly.



14.191 Whole Foods is testing a Kinect-powered shopping cart that will follow shoppers around and detect the items they pick up, <http://www.gizmag.com/kinect-grocery-cart/21714/>



14.192 A research team at Tufts University has taken the microneedle concept and moved it one step further by creating the tiny needles out of a type of silk. <http://gajitz.com/tiny-silk-microneedles-deliver-meds-better-than-syringes/>

14.193 “Smelling” by Electronics!⁵⁷⁹

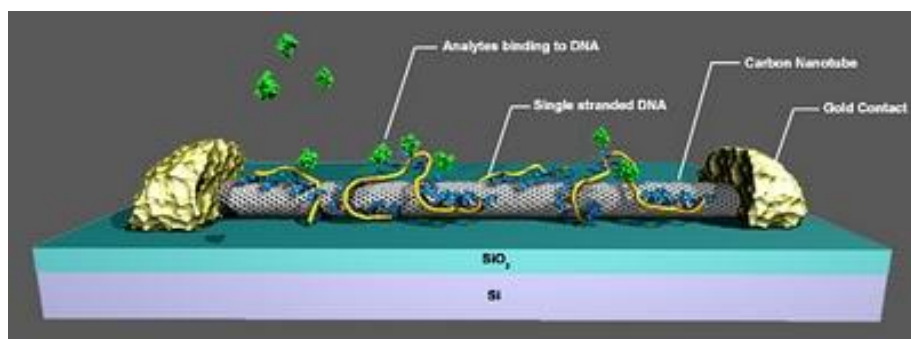
Nanotechnology is finding applications in electronics, medicine, textiles and in so many other fields. The applications include bulletproof paper, light and flexible TV display screens, medical imaging devices, engineered nanoparticles that can target diseased cells, nanofoods as well as materials that can be used in aeroplanes and space craft. Now, researchers at the University of Pennsylvania led by Prof. Charlie Johnson have used nanotechnology to create an “electronic nose”. They used carbon nanotubes and grafted certain receptor proteins into them. They could then mimic the nose. The way our nose works is that when different chemicals enter our nose, they react with certain receptor proteins that are located on the outer membrane, and trigger a cellular reaction. The artificial nose developed by the Penn scientists employed proteins obtained from the noses of mice, and then interfaced with a carbon nanotube transistor. The chemical signals were converted into electrical signals before being detected by electronic sensors. This allowed various chemicals present in the air to be detected with high sensitivity.

The electronic nose may be used at airports for detecting explosives, and find many other such applications. The integration of nanotechnology with biology is leading to many exciting new frontiers in science.

14.194 Software for Active Reading!⁵⁸⁰

As examination time approaches, students are found concentrating on various ways to remember the passages that they are reading, a process known as “active reading”. Active reading techniques may involve highlighting important sections, making brief notes on the side, setting aside pieces of important information, making flow charts/diagrams and reading passages out aloud. The brain seems to retain information better if “memory points” are created in this manner. Now, researchers at the Georgia Institute of Technology have created a special software called “Liquid Text” that assists in active reading.

The software is based on touch screen technology on a computer screen where the text is on one side while the other side is empty work space. One can highlight materials using finger tip gestures and drag important materials to the work area. One can also expand certain sections by panning and zooming. Sections can be collapsed by pinching them. The software is planned to be marketed later this year by a new start up company.



14.193 Image credit: Johnson Group, University of Pennsylvania . Functionalized Carbon Nanotube Electronic Nose Can Quickly Detect Dangerous Chemicals in the Air, <http://beforeitsnews.com/science-and-technology/2010/04/functionalized-carbon-nanotube-electronic-nose-can-quickly-detect-dangerous-chemicals-in-the-air-32030.html>



14.194 Craig Tashman (left) and Keith Edwards, creators of the LiquidText active reading software (Photo: Georgia Tech), <http://www.gizmag.com/liquidtext-active-reading-software/19083/>

14.195 Super Fast Chinese Trains (500km/h)!⁵⁸¹

China has been progressing at breathless speeds in technology development and exports. The world markets are flooded with Chinese shoes, clothes, and electrical appliances. Now, China is joining the “Big Boys” in the production of more sophisticated items such as aircrafts, trains, ships, etc. A recent exciting development in China is the manufacture of super fast trains. These trains can travel at 500 km/hr (311 mph). Designed on the shape of a sword, the train has been developed by China South Locomotive & Rolling Stock Corporation Limited (CSR). It offers competition to Japan’s magnetic levitation train (MagLev, top speed 581 km/h) and French TGV (top speed 574.8 km/h).

14.196 Talking Cars --- Avoiding Collisions!⁵⁸²

A large number of motor way pile ups occur each year, specially when there is low visibility on foggy days. Now a solution has been found to this problem by scientists at University of Bologna, Italy. They have developed a device that allows cars to communicate with another, and send warnings, whenever an accident occurs, to other approaching cars. The warning system would be triggered by special motion sensors on board that will detect the accident when it occurs. Toyota is assessing this system on roads near Los Angeles.

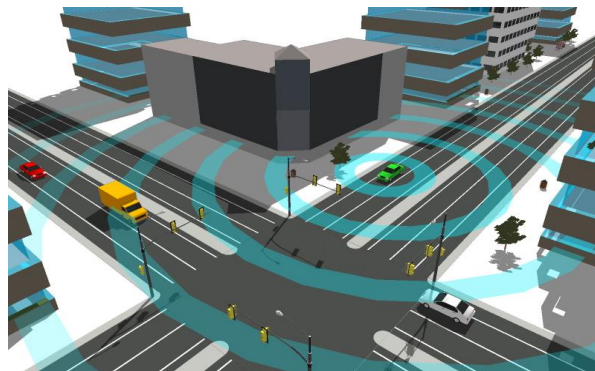
The European Intelligent Car Initiative is aimed at achieving safer roads through the use of modern wireless technologies. It has been estimated that 24% of the driving time in Europe is consumed by traffic congestion, and there are 7,500 kilometers of traffic jams each year causing an annual loss of Euros 8 billion. The system will also allow vehicles to alert others about such road blocks or dangerous slippery road patches.

14.197 Tata India --- to Build World’s Cheapest Houses!⁵⁸³

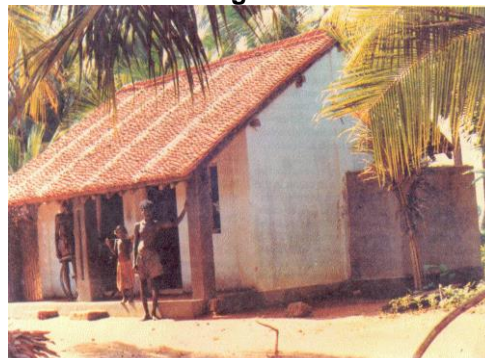
Tata Nano made history when the company developed the world’s cheapest car a few years ago, for under \$2,500. Now



14.195 Showpiece: Although not yet operational, the new bullet train has achieved speeds of 300mph, <http://www.popularmechanics.com/technology/engineering/infrastructure/4232548>



14.196 Better Living with cooperative Intelligent Transport Systems: safe, clean. <http://blog.nxp.com/better-living-with-cooperative-intelligent-transport-systems-safe-clean-and-green/>



14.197 HOME CONSTRUCTED UNDER INDIRA AWAS YOJANA IN RURAL AREAS. http://mospi.nic.in/Mospi_New/site/inner.aspx?status=2&menu_id=108

Tata is all set to achieve another milestone --- to build the cheapest houses in the world for Rs. 32,000 (\$715). Each house will be built within a week under the Indira Awaas Yojana shelter rehabilitation scheme and have an area of 20 square meters. With India's population at 1.2 billion, and growing at a rate at which it will overtake China's by 2030, there is dire need of affordable and hygienic houses for the 800 million people who live in poverty. The houses are being marketed at Rs.40, 000 and they will set a new trend of housing for the poor in place of the unhygienic slums around major cities.

14.198 Tata (India) --- Introduces a "Megapixel" Car!⁵⁸⁴

Tata Motors, a leading automobile manufacturer in India, has launched an exciting new electric car. It has four 10 KW electric motors that can carry it to a distance of 87 kilometers on a single charge. It is also fitted with a small 325 cc single cylinder petrol engine that extends its range to 900 kilometers by charging a lithium ion phosphate battery. The car has some truly remarkable features. It is able to turn in very narrow streets as it has acutely turning wheels. This gives it a turning radius of only 9.2 feet. It comes with an inductive home charging system that allows it to be charged when it is parked above the charging pad --- no need to plug it into a socket! The car is beautiful looking and has been designed by Tata to serve as a global car suitable for urban environments.

Tata had huge revenues of \$ 27 billion last year. It is already the manufacturer of Jaguar Land Rovers and is the distributor of Fiat cars in India. It has also operations in UK, South Africa, South Korea, Thailand and Spain. It has become the 3rd largest bus manufacturer in the world and is also the 4th largest truck manufacturer in the world.

14.199 Tiny Robots: Soldiers of Tomorrow!⁵⁸⁵

Tomorrow's armies will surely be intelligent robots controlled from thousands of miles away. The precision with which drones

can be controlled, manipulated and used to achieve devastating results has been demonstrated by the repeated US attacks in the northern areas of Pakistan. However, the development of



14.198 Tata Megapixel – a new global car concept. Reproduced with thanks from, <http://www.geektech.in/tata-megapixel-a-new-global-car-concept/>



14.199 The autonomous squadron made up of 20 quadrotor robots from KMeI Robotics (Photo: KMeI Robotics) <http://www.gizmag.com/grasp-nano-quadrotor-robots-swarm/21302/>

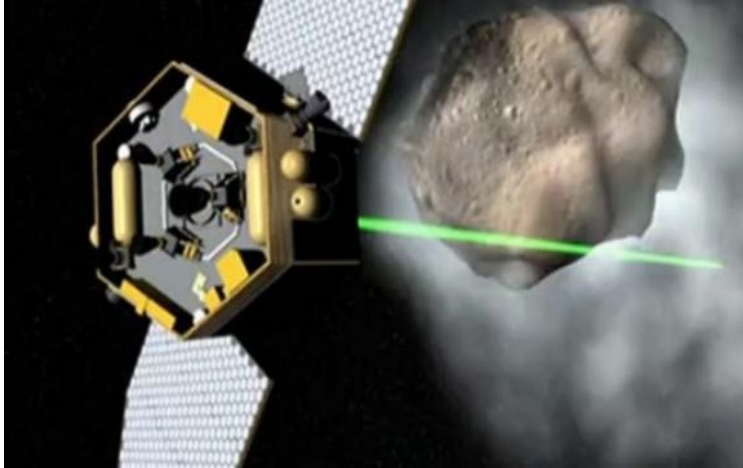
tiny remote controlled remote-controlled "quadrotor robots" that can fly in complex formations adds a completely new dimension

to modern warfare. Scientists at the University of Pennsylvania's General Robotics, Automation, Sensing and Perception (GRASP) Lab have recently demonstrated how swarms of flying robotic helicopters, tiny in size, can perform fantastic maneuvers and be made to work together in harmony to achieve specific tasks. This is science fiction becoming reality. They were named "quadrotor robots" since they have four propellers that give them stability and maneuverability during flying. They can carry pouches of nerve gases to paralyse enemy soldiers or be armed with explosives that can simultaneously be delivered to hundreds of sites in a coordinated manner, thereby causing devastation and havoc in enemy lines. The flying robotic machines can navigate around objects and interact with each other intelligently, exhibiting complex "autonomous swarm behaviour". Fitted with mini-cameras, they can also prove to be invaluable in surveillance and search/rescue operations.

14.200 "Tractor Beams" for Transporting Matter!⁵⁸⁶

Tractor beams have often been shown in science fiction movies such as Star Trek to transport human beings or cargo instantaneously over vast distances. The principle of transporting matter using light or electromagnetic beams has now been demonstrated to work, at least for transporting particles, though it may take another few centuries before we are able to use this form of transportation.

Professor Andrei Rode and coworkers at the Laser Physics Centre, Australian National University (ANU) showed in autumn last year that it was possible to move particles across a distance of one and half meters using the power of light only! The beam of light acts as an optical pipe line. The particles in the centre of the dark core of the beam are displaced by random motions of air molecules, with the result that one side of the particles is intermittently exposed to light while the other side of each particle is dark. This creates a tiny thrust (due to a special phenomenon known as the "photophoretic" effect) which pushes the particles along the optical pipe line.



14.200 Artist's conception of a future space probe using a tractor beam to gather samples of material from an asteroid. Credit: NASA, <http://www.universetoday.com/90605/nasa-developing-real-life-tractor-beams/>

Another technique developed that can work in the vacuum of space involves the use of electromagnetic beams. Optical solenoid beams are employed in this method. The spiraling waves create a force that drives particles in the opposite direction to that of the beam of light. NASA, the US space agency, is now investigating the use of these techniques to transport matter across long distances in space using such methods.

14.201 Turn Your Wheelchair ---into an Electric Vehicle⁵⁸⁷

Many of our elderly are confined to wheelchairs. If they have full use of their arms, they may not normally require an electric powered wheel chair, but on occasions when they need to travel longer distances or they are unwell and do not wish to exert themselves, a temporary conversion to an electric vehicle can come in handy. Now an innovative device developed in Japan can provide this option. The device clamps onto the wheels of the wheelchair, thereby providing it with electric drive. The control is built on a bridge that curves over the waist of the

person sitting on the wheelchair. Each of the hubs contains 24 volt motors powered with lithium ion batteries. These give the wheelchairs a top speed of 20km/h and a range of 30 km. The users can steer the wheelchairs by leaning in the direction that they want the wheel chair to move. This is achieved by a built-in force sensing mechanism that alters the rotational speed of the wheels of the vehicle.

The prototype has been developed by the Japanese company WHILL and it is undergoing field testing prior to being introduced commercially.

14.202 Understanding "Chicken Talk"!⁵⁸⁸

Having contented birds is the desire of every poultry farmer, as that translates directly to higher productivity. The degree of contentment of chickens can be judged by the sounds they make. Modern computer technologies are now being used to decipher the various sounds and gauge the extent of contentment from them. Scientists at the Georgia Institute of Technology and the University of Georgia have teamed up to examine various sounds and scientifically determine the level of stress in an experimental chicken barn.

Different levels of stress were first created by increasing the temperature in the barn or spraying various levels of ammonia and recording the various sounds produced, thereby developing correlations between stress levels and the nature of sounds. The volume and pitch of the sounds as well as the speed at which they are repeated are then analysed by computers after they have been recorded.

The work is aimed at developing an automated software that will continuously monitor and determine stress levels within chicken barns through a real time audio-feed. Specific problems would be automatically detected and the situation rectified through a control system in a timely manner without the need of human intervention. This should result in increased productivity and profitability for the farmers.



14.201 The WHILL being tried out. Reproduced with thanks from, <http://www.gizmag.com/whill-powered-wheelchair/20784/picture/150389/>



14.202 Researchers from the Georgia Institute of Technology and the University of Georgia examine recordings of bird vocalizations from a small flock of chickens at the University of Georgia's Poultry Research Center. Shown are (l-r) Wayne Daley, Bruce Webster, Doug Britton, David Anderson and Casey Ritz. (Click image for high-resolution version. Credit: Gary Meek). Reproduced with thanks from, <http://www.gtresearchnews.gatech.edu/bird-vocalization-research/>

14.203 Unmanned Helicopters at Work!⁵⁸⁹

The first unmanned cargo carrying helicopters flew missions in Afghanistan in December 2011. They can carry up to 2.7 tons of cargo and will be used instead of manned trucks that often become targets of attacks from Taliban fighters. The Kaman-KMAX helicopters have been built in a joint venture between Lockheed Martin and Kaman Aerospace. The flight path of the helicopters will be controlled from a central base, and they will be regularly employed in combat missions to provide urgent supplies to the front line troops. They will be largely flying the combat missions at night to avoid enemy fire.

14.204 Using Body Parts as Transistors!⁵⁹⁰

Researchers at Tel Aviv University (TAU) have succeeded in transforming blood, milk and mucus proteins into transistors. These could become the basis of new biodegradable and flexible electronic devices of the future. Using various combinations of milk, mucus and blood proteins, they found that it was possible to fabricate semi-conducting films on a nano-scale. Complete electronic circuits could be created from these films with useful electronic and optical properties. By using the different characteristics of these proteins, they found it possible to create transistors with varying degrees of conductivity, memory storage, and fluorescence. The silicon based transistors presently used suffer from the disadvantage that they are easily broken when bent. Transistors based on proteins however will be highly flexible, allowing them to be used in TV displays, mobile phones, tablets, biosensors and microchips. As such materials are also biodegradable, they will also address the problem of electronic waste disposal.

14.205 US Developing Hypersonic Aircraft!⁵⁹¹

The US government is funding a programme through the Defense Advanced Research Projects Agency (DARPA), an



14.203 The Unmanned K-MAX® named one of the 50 Best Inventions of 2011 by Time Magazine <http://www.kaman.com/news/the-unmanned-k-max-named-one-of-the-50-best-inventions-of-2011-by-time-magazine/#sthash.pS7n6EX0.dpuf>



14.204 Tel Aviv University develops biodegradable transistor, literally man made. <http://www.engadget.com/2012/03/11/tel-aviv-university-develops-biodegradable-transistors/>

agency that promotes new military technologies, to develop hypersonic aircraft (named Falcon HTV) that will allow it to maintain its air supremacy over other nations for the rest of this century. These aircrafts are so fast that they can reach any location on earth within an hour, and circle the earth completely at the equator within 2 hours! Capable of flying at speeds of 16,700 miles per hour, about 22 times the speed of sound, the aircraft becomes red hot with a surface temperature of an incredible 3,500°F as it travels through the atmosphere. The aircraft made its maiden flight in April 2010 but crashed after flying for about 9 minutes. A modified version of the aircraft, HTV-2, was then developed and flown on 11th August 2011 but it met the same fate, crashing into the Pacific Ocean after flying for 8 minutes. The data collected during the flight will help the engineers to modify the aircraft. If successful on its third flight, it could herald a new era in air warfare at hypersonic speeds. The future world military domination by USA depends on such fantastic weaponry under intensive development.

14.206 US Develops New Weapon System!⁵⁹²

Meanwhile, the US army has been developing new weapon systems that will allow any site on earth to be attacked in a precision conventional strike within one hour, (just like an intercontinental ballistic missile (ICBM) that uses nuclear war heads). A successful test of such an Advanced Hypersonic Weapon (AHW) was made recently, as a part of the Conventional Prompt Global Strike (CPGS) programme in the Pacific Missile Range Facility in Hawaii.

14.207 Warm Clothes --- From Coffee!⁵⁹³

Clothes made out of ground coffee? Yes. This is what a Californian sports clothing company, "Virus" has succeeded in developing. The "Stay Warm" line of clothing developed by the company does just that --- keeps you warm. The fabric is made



14.205 <http://www.mixtechs.com/fail-test-flight-of-the-aircraft-because-darpas-htv-2-thermal-pressure-at-mach-20-0873744.html>



14.206 The Advanced Hypersonic Weapon (AHW) is a demonstrative long-range glide vehicle capable of flying within the planet's atmosphere at hypersonic speed. The AHW technology demonstration programme is managed by the US Army Space and Missile Defence Command (USASMDC) / Army Forces Strategic Command (ARSTRAT). Reproduced with thanks from, <http://www.army-technology.com/projects/advanced-hypersonic-weapon-ahw/>



14.207 California based company Virus sets a green example with its StayWarm line by using coffee grinds in its constructions as a main ingredient. <http://bikereviews.com/2012/03/virus-staywarm-clothing-line-recycled-coffee-bean-cycling-apparel/>

from coffee charcoal which is recycled, and converted to an amazing comfortable base fabric that increases the surface temperature (by trapping heat between the skin and the fabric) by 10° F. The fabric shields the body against UV radiation and it fights odour as it contains compounds that kill microbes.

Turning coffee into clothing? Why not? After all, this is the “Wondrous World of Science”!

14.208 Wash Your Clothes --- with Sunlight!⁵⁹⁴

Washing clothes can be an arduous daily chore for housewives. Wouldn't it be nice if you could simply “wash” them by hanging them in the sun? Does that sound impossible? Well, this is another one of those wonders in this wondrous world of science. Mingce Long and Deyong Wu of Shanghai Jiao Tong University, China, have found that if clothes are treated with titanium dioxide and a nitrogen compound, they could be cleaned simply by hanging them in the sunlight! Dirt on such treated fabrics breaks down in the sunlight so that soil stains disappear magically, and the germs also die. Even orange colour stains can be removed in this manner. The ability to remove stains by sunlight improved even further when silver and iodine nanoparticles were added in the coating. The coating remained effective even if the fabric was washed and dried.

Researchers at Monash University, in Victoria, Australia, led by the nanomaterials researcher Walid Daoud, were the first to discover in 2008 that if fibres are coated with titanium dioxide nanocrystals, they could break down food and dirt in sunlight. Light activated self-cleaning fabrics had been made before but they required strong doses of ultra-violet light whereas the Chinese coating, with a nitrogen compound added, works in natural light. Titanium dioxide is a commonly found substance that is used in toothpastes, paints and sunscreens. It acts as a strong photocatalyst: in the presence of ultraviolet light and water vapor, it can generate hydroxyl radicals, which can decompose organic matter by oxidation reactions. Titanium dioxide can also be used to coat glass with a thin 10 nanometer layer --- this results in self-cleaning windows!

14.209 Water Purification ---with USB-powered Pen!⁵⁹⁵

You can now disinfect half a liter of water with a small rechargeable UV water purifier. The germicidal pen that resembles a USB device emits UV light that kills 99.9% of bacteria, viruses and protozoa in 48 seconds. The pen, known as SteriPEN Freedom, can be charged from a USB port on a computer, an AC outlet or a solar charger, and it can be employed 48 times before needing a recharge. Priced at \$120, it has a battery and UV lamp life allowing it to be used 8,000



14.208 The scientists involved with this innovation are Mingce Long and Deyong Wu. They applied a coating from a compound of titanium dioxide – the white material being used in white paint to food and to sunscreen lotions. When exposed to some kinds of light, titanium dioxide breaks down dirt and kills microbes. <http://www.prescouter.com/2013/01/self-cleaning-cotton-fabric-when-flaunted-to-sunlight/>



14.209 SteriPEN Freedom. <http://www.gizmodo.com.au/2012/02/everything-you-need-to-battle-those-terrifying-invisible-invaders-germs/>

times. After dipping into the water, a green light comes on as soon as the water is safe to drink. The manufacturer SteriPEN expects to sell the device for travelers through the developing world where tap water is usually not fit for drinking.

14.210 WiFi Hotspots -- on Pavements!⁵⁹⁶

Access to internet everywhere that one goes has become a daily necessity. Some restaurants do roaring business as they offer free WiFi hotspots on their premises. All that is about to undergo a further evolution as the pavements on which the pedestrians walk may soon be fitted with continuous WiFi hotspots.

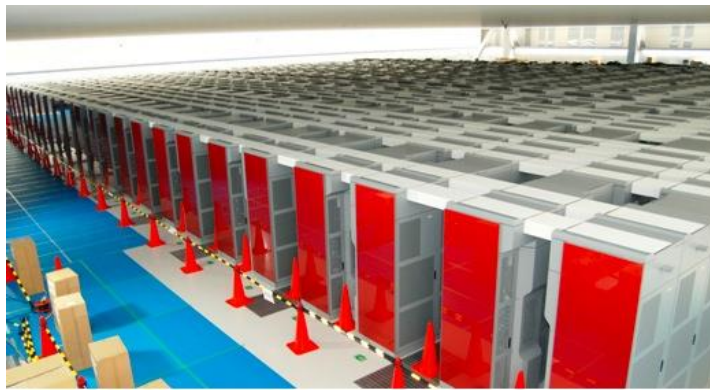
A Spanish tech company has come forward with a novel invention -- sidewalk paving stones that can also serve as WiFi hotspots! Each stone is fitted with a 5 GB microprocessor that can communicate with mobile devices via Bluetooth and WiFi. A 1,000-watt cable runs under the pavement to supply power and internet access to the stones. The individual stones can be installed 20 meters from one another in order to ensure continuous coverage on the pavement.

iPavement also offers several cloud-based apps that include access to a digital library, maps showing the location of local superstores, restaurants, hospitals and schools, alerts about any street works and obstructions in nearby roads and streets as well as a music service to entertain you. The services offered are available in many languages and they can operate on a number of different browsers.

14.211 World's Fastest Super Computer!⁵⁹⁷

Fujitsu, a world leader in computer technologies, has boasted of having the world's fastest super computer, "Fujitsu K" for quite some time. IBM has been trying to overtake Fujitsu but without success. Now, however, IBM has announced its latest super computer ("Sequoia") that has a performance of 16.32 petaflops

per second, beating Fujitsu to second place. With Fujitsu's dominance in high quality laptops, desktops, servers and other computer accessories that are largely manufactured in Germany, it is fast gaining a strong foothold in world markets. It is for the first time since November 2009 that a US computer manufacturer can claim to have the fastest computer in the world. So, it is anyone's guess how long IBM that has been in second place for a long time, will be able to maintain its lead over Fujitsu in having the fastest super computer in the world.



14.211 Fujitsu K supercomputer now ranked fastest in the world. Reproduced with thanks from, <http://www.engadget.com/2011/06/20/fujitsu-k-supercomputer-now-ranked-fastest-in-the-world-dethron/>



14.212 An artist's depiction of Russia's huge Spektr-R radio astronomy satellite in Earth orbit. The satellite launched on July 18, 2011. CREDIT: NPO Lavochkin. <http://crisisboom.com/2011/07/19/russia-launches-long-delayed-deep-space-radio-telescope/>

14.212 World's Largest Telescope Launched --- by Russia!⁵⁹⁸

Russia has launched a spacecraft, named RadioAstron, from Kazakstan in July 2011 into space that will combine signals from radio telescopes on earth (by a process called "interferometry") to form a giant virtual telescope. While the antenna of the Russian spacecraft is only 10 meters, after combining with other telescopes, it will form one giant dish that will be about 30 times wider than the earth, some 350,000 meters in diameter. Although this is a virtual telescope, it is being heralded as the largest telescope ever made by man.

Interferometry involves the combination of signals from two or more telescopes so that the resulting image has a higher resolution than that which can be obtained from any of the individual telescopes. The images that the Russian telescope will capture, after combining its signals from West Virginia , Puerto Rico and Germany, will have a resolution 10,000 times higher than that obtainable by the famous Hubble telescope.

The Russian scientists hope to study a black hole that is located at the center of a nearby galaxy.

14.213 World's Tallest Building --- in 90 Days!⁵⁹⁹

Plans are afoot to construct the world's tallest building "Sky City One" in a record time of 90 days! The 220 storey building will take only one-twentieth of the time taken by Burj Khalifa in Dubai, that is currently the tallest building in the world. The Chinese construction company Broad Group plans to construct this building in the city of Changsha, Hunan in south-central China. It will be 838 meters tall and will be taller than Burj Khalifa by 33 feet. The building will be largely prefabricated, about 95% of the building being assembled in modular form before work commences on site. Burj Khalifa cost \$450 per square foot to construct whereas Sky City One will be constructed at a cost of only \$ 63 per square foot. It will have 220 floors, 104 elevators and will be able to accommodate about 100,000 persons in it, providing space for offices, leisure and retail facilities. The total cost will be about \$ 628 million, in contrast to Burj Khalifa that cost about \$ 1.5 billion.



14.213 As recently as July 1, cattle apparently grazed in the fields intended for the world's tallest skyscraper in the rural outskirts of Changsha in China's Hunan province. That wasn't the original plan: Sky City, as the concept is known, was scheduled for completion earlier this year after a mere 90 days of construction. <http://www.macdonaldandcompany.com/chinas-sky-city-building-to-go-10-meter-higher-than-dubais-burj-khalifa>

In view of the environmentally friendly design, the energy consumed will be about one-fifth of that expected from other buildings of its size. This is achieved by its six inch thick exterior walls and quadruple glazed glass windows.



14.214 Jet Man Yves Rossy to rocket across English Channel. A Swiss pilot will defy death by attempting to become the first person in history to fly across the channel with a home-made jet-powered wing strapped to his back. Flying at speeds approaching 125mph, it is expected that the 22-mile televised flight across the Channel should take Rossy around 12 minutes to complete. Photo: AFP/GETTY. Reproduced with thanks from, <http://www.telegraph.co.uk/news/worldnews/europe/france/3078320/Jet-Man-Yves-Rossy-to-rocket-across-English-Channel.html>

14.214 Yves Rossy -- the Flying "Jetman"!⁶⁰⁰

The Swiss pilot, inventor and aviation acrobat is the first person in history to demonstrate that man can fly like a bird for extended time periods. He achieved sustained human flight with a fixed wing tied to his back powered by jet engines. The carbon fibre wings had a span of about 8 feet and were powered by four small jet engines.

His first flight that lasted for about six minutes occurred in November 2006. In September 2008, he successfully flew over the English Channel in about 9 minutes, reaching a speed of about 186 mph. Subsequently, he has flown over the Alps, across the Grand Canyon, and flown alongside jet aircraft in amazing feats: see the following: (<http://www.youtube.com/watch?v=h4arnATc04U>). On 8th May 2012, Rossy flew over the Rio de Janeiro coast. The "Jetman", as Rossy is called, could attain a speed of 186 mph at the push of a throttle powered by 4 jet engines each weighing 48 pounds. Amazingly, Rossy can control the flight movements using his body movements, appearing like a giant flying bird.

Rossy is breaking new barriers of technology, showing that it is now possible to fly to office like a bird! The world of tomorrow may have lanes in the air, and the "Star Wars" scenario is gradually becoming a reality.