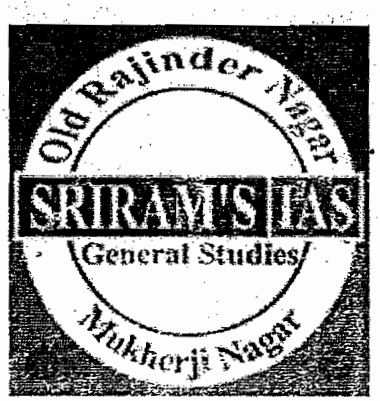
SRIRAM'S IAS



GENERAL STUDIES

(NEW DEVELOPMENT IN SCIENCE & TECHNOLOGY)

(PAPER-III)

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INDIA ENTERS NEW ERA OF SPACE APPLICATION

India embarked on a landmark journey into a new era of space application with the successful launch of its first navigation satellite ISNSS-1A on Monday. The satellite was launched by India's space workhorse PSLV on its 23rd consecutively successful mission. The PSLV C-22 rocket carrying the satellite lifted off at from Satish Dhawan Space Centre, India's space port in the southern state of Andhra Pradesh, at 11.41 p.m. on Monday. It was the first night-time launch of a satellite from Indian soil. The launch was perfect and the satellite was released into orbit 20 minutes later. IRNSS-1A is the first of seven satellites of the Indian Regional Navigation Satellite System, or IRNSS, an indigenous version of the Global Positioning System, operated by the US. The satellite weighs 1,450 kilograms and has a working life of 10 years.

Monday's launch was the first step in India's plans to develop its own global positioning system by setting up a constellation of seven satellites by 2015. The remaining six satellites will be launched every six months over the next 30 to 36 months. The system will become operational once all the seven satellites are in position. When fully operational, the system will provide two types of services: standard positioning service and restricted service. The first will be provided to all users while the second will be an encrypted service for authorised users such as the military and security. Currently, the US-based Global Positioning System or GPS and Russia's GLONASS are the only two satellite-based navigation systems in operation. China, Japan and Europe are in the process of developing their own regional navigation satellite systems.

The seven satellites of the Indian system, which are being indigenously designed and built, will provide accurate positioning services for users across India and up to 1,500 kilometres beyond its borders. They will provide an absolute position accuracy of better than 10 metres. The system is intended to provide navigation services on land, sea and air and also help in disaster and fleet management. Like GPS, the services of IRNSS will be accessible with mobile phones. An advantage of the Indian system is that the design of the payload makes the IRNSS system inter-operable and compatible with existing GPS.

Unlike the GPS and GLONASS, which use 24 satellites each, the Indian system is based on only a constellation of seven satellites. All seven navigation satellites of the system will be placed at a height of about 36,000 km, which will make them circle the Earth once in 24 hours, making them constantly accessible day and night. Three of the satellites will be placed directly over the equator, in the geostationary orbit from where they would appear from the ground to remain at a fixed position in the sky. The remaining four satellites will be in pairs in two inclined geosynchronous orbits. From the ground, these satellites will appear to move in a figure-of-8 path in the sky during the course of a day. This would mean that from any location in India and at any time, all the satellites will be visible from ground and their navigational services can be accessed. Unlike GPS satellites, none of the satellites of the Indian system will ever go below horizon and out of link with the user.

The perfect launch of PSLV C-22 on Monday adds another feather to ISRO's cap. The reliability rate of PSLV has been superb. With the latest mission, there have been 23 continuously successful flights of PSLV. It has three variants, the most powerful being the extended version called PSLV-XL, fitted with more powerful, stretched strap-on boosters, which was used for Monday's launch. This success will not only boost India's stature among

the spacefaring nations of the world, but also strengthen the country's resolve to make the best of space technology for national development and self-reliance.

INDIA JOINS ARCTIC COUNCIL AS OBSERVER

The announcement on 15 May 2013 of India joining the eight-nation Arctic Council as an observer came as a big morale booster for India's five-year-old Arctic Programme. The new status gives India a foothold in the future of the resources-rich Arctic Ocean as the ice melts and everything from navigation to deposits of oil, gas and minerals become available for exploration and exploitation. The Arctic also has rich reserves of gold, tin, lead, nickel and copper that would offer tremendous potential and opportunities in the future. The Arctic riches have set off a global competition for influence and economic opportunities in the region.

The Arctic Council comprises eight Arctic nations: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the US. Along with India, China, Italy, South Korea, Japan and Singapore also joined the council as observers. Observer status gives countries the right to attend meetings and propose and finance policies.

Although India is not an Arctic state, as one of the rising economies of the world, it has a stake in the Arctic Ocean and would like to be able to influence the decisions taken by the permanent members, especially on matters involving sharing of resources of the region. India is a signatory to the Svalbard Treaty of 1920, which permits it to operate in the Svalbard archipelago, which is under the sovereign control of Norway.

India launched its first scientific expedition to the Arctic in August 2007 to mark the beginning of long-term scientific research by Indian scientists through global scientific endeavour in the region. An Arctic research station named 'Himadri' was launched at Ny-Alesund in Svalbard region of Norway on 1st July 2008. An MoU was also signed between National Centre of Antarctic & Ocean Research, an autonomous body under India's Ministry of Ocean Development, and the Norwegian Polar Research Institute on cooperation in polar research. Since 2007 four Indian scientific expeditions to the Arctic have been undertaken. Scientists of India's National Institute of Oceanography have also been visiting the Arctic region to collect data for climate change studies.

India has a three-fold interest in the Arctic, namely, environmental protection, economy, and policy. The interest in the Polar region is determined by the need to study global phenomena such as climate change. Research made by Indian scientists shows that by the end of 21st century the average global temperature is likely to go up by 3-6 degrees Celsius. Another vital issue is the impact of the Northern Polar region on the strength of monsoons in South Asia. The Indian specialists have detected this relation but not yet figured out the mechanisms. The volume of monsoon rains is critically important for agriculture in India.

All the above factors led to a rapid intensification of Indian scientific research in the Arctic. The Arctic exploration has become a priority program for India to strengthen the economic and political positions of the country in this region. That is why, in its application to the Arctic Council, India had focussed on its science and technology expertise as the primary reason for joining up.

Antarctica — complete with snow

Arctic — floating coast

India still doesn't have sufficient capabilities for taking up large-scale projects in the Arctic, but it is dedicated to secure a footing in the Arctic with the assistance of its partners. Now the observer status in the Arctic Council will make it possible for India to actively get involved and to conduct the Arctic research at the world level standards.

THIRTY METRE TELESCOPE: A NEW WINDOW TO THE UNIVERSE

After the Large Hadron Collider at CERN, Indian scientists are again going to contribute significantly to yet another international mega science project – the Thirty Metre Telescope (TMT). Dubbed as the world's most advanced ground-based observatory operating in optical and mid-infrared wavelengths, the giant telescope will be built just below the summit of Mauna Kea volcano in Hawaii. The total cost of the TMT project is estimated at about $1.4 billion out of which India's contribution will be about $140 million (about Rs.770 crore). Seventy-five per cent of India's contribution will be in the shape of key components and software for the telescope and the rest in cash. India's contribution to TMT will be jointly funded by the Department of Science and Technology and Department of Atomic Energy, Government of India. The other partner nations contributing to TMT are China, Japan, Canada and the US.

The Thirty Metre Telescope is a reflecting telescope. As the name suggests, it will use a mirror with an effective diameter of 30 metres that will have nine times the light-collecting area of the largest optical telescopes in use today. But it will not be a single-piece mirror; it will be made up of 492 hexagonal mirror segments, each 1.44 m in size, 74 of which will be fabricated in India. India will also provide the complete segment support assemblies consisting of the edge sensors and actuators for the TMT. A major part of the observatory control software will also be developed and provided by India.

The TMT will use 'adaptive optics' to counter atmospheric turbulence. In adaptive optics, a computer-controlled deformable mirror is used to correct wave front errors in an astronomical telescope, allowing astronomers to achieve an unprecedented sharpness of faint astronomical sources at optical wavelengths.

Despite being ground based, the TMT will be much more powerful than the orbiting Hubble Space Telescope or the upcoming James Webb Space Telescope because of the enormous light gathering power of its giant primary mirror. When completed in 2021, the TMT will allow astronomers to directly explore the early Universe, from the end of the cosmic dark ages through the formation of the first stars and re-ionisation and into the epoch of galaxy formation.

India's involvement in the TMT project is recognition of its capability in astronomical research and offers a unique opportunity to carry out frontline research in astronomy. It will also help develop cutting-edge science and technology that is required to build and operate the next-generation observatories. It will also provide Indian astronomers and students a share of the observation time at TMT.

=> Nuclear fusion does not involve or produce radio activity but fission creates Radioactivity, bcz stars do fusion we SRIRAM'S IAS
require more energy (1 million degree)

INDIA PLAYS KEY ROLE IN BUILDING ITER

The international nuclear fusion project known as ITER (International Thermonuclear Experimental Reactor) is based on the 'tokamak' concept of magnetic confinement in which the plasma is contained in a doughnut-shaped vacuum vessel. India is a major partner in this biggest scientific collaboration on the planet. India is developing the heaviest and the largest parts of the Tokamak, aimed at producing unlimited supplies of cheap, clean, safe and commercial energy from atomic fusion.

The fuel used in the machine will be a mixture of deuterium and tritium, two isotopes of hydrogen, which will be heated to temperatures in excess of 150 million degrees Celsius forming hot plasma. The temperature within the gigantic machine will, therefore, reach 10 times the temperature at the core of the Sun.

Strong magnetic fields will be used to keep the plasma away from the walls. Superconducting magnets will be kept at liquid helium temperature in the world's largest high-vacuum cold storage vessel which will be fabricated in India for ITER. Scientists and engineers at the Institute of Plasma Research (IPR), in Gandhinagar near Ahmedabad will manufacture this mammoth cryostat in segments at a cost of 100 million euros and ship it to France for being assembled at the site. The ITER cryostat will be a fully welded stainless steel cylindrical vacuum/pressure chamber with overall dimensions of roughly 29.4 metres in diameter, 29 metres in height and a finished weight of 3,850 metric tons.

ITER-India Project, a part of the IPR – an autonomous unit of the Department of Atomic Energy, will make the 'in-kind' contributions including the cryostat that form India's share to the ITER project. The cryostat is very crucial to the ITER experiment. It houses the fusion reactor in its entirety, including support to all internal systems. The first of the ITER cryostat's components will arrive on site from India beginning December 2015.

CYBER SECURITY – A GROWING CHALLENGE

Cybercrime is a term used to broadly describe criminal activity in which computers or computer networks are used as a tool, a target, or a place of criminal activity. It includes everything from electronic cracking to web defacement, virus and malware attacks, and denial of service attacks. Of late, mobile phones have become a major target for committing cybercrime. The term is also used to include traditional crimes such as theft, fraud, forgery, defamation and mischief, in which computers or networks are used to enable the illicit activity.

Often the malicious codes or malware pass through our computer security system when we access a particular website or open an e-mail. These codes exploit the loopholes in various applications and insert themselves within the computer system which enables them to replicate and infect other computers by attaching themselves to the e-mails that we send out through our local network.

Cyber security is actually aimed at reducing cybercrimes. It is really all about protecting our personal information or any kind of digital asset stored in our computers or in any digital storage device. There are different kinds of threats that we could encounter in cyberspace and each one has its own degree of seriousness which requires a certain level of solutions. The

In Virtual keyboards position of keys change frome to frome so can't hacked

threats range from simple malicious codes, otherwise known as malware and spywares, to serious virus that can erase the whole contents of our computer, and hackers that can access and use our personal information for their own personal gain. The higher the level of the threat, the more advanced or complicated the approach would be to implement safety measures to protect ourselves from such harm.

Cyberspace security is a global challenge – one that cannot be solved by a single company or country alone. The defence of cyberspace has a special feature. The national territory or space that is being defended by the land, sea and air forces is well defined. Outer space and cyberspace are different. They are inherently international, even from the perspective of national interest. So it is not possible for a country to ignore what is happening in any part of this space if it is to protect the functionality of the cyberspace relevant for its own nationals. The effectiveness of cyber security measures are limited at present because the technologies that are used in cyberspace are still very new and are still evolving. Hence investing in technological capacities to keep track of global developments, developing counter-measures and staying ahead of the competition is as central to cyber security as the more conventional security measures. Significantly, the Indian government declared that it would invest around 200 million US dollars in the next four years to strengthen cyber security infrastructure.

NATIONAL CYBER SECURITY POLICY

The government has formulated the National Cyber Security Policy 2013 with the prime objective of protecting information and building capabilities to prevent cyber-attacks and safeguard both physical and business assets of the country. There is need to protect critical infrastructure such as air defence system, power infrastructure, nuclear plants, telecommunications system to thwart attempts to create economic instability. The cyber policy was necessary in the wake of possible attacks from state and non-state actors, corporates and terrorists as the Internet world has no geographical barriers and was anonymous in nature.

The policy lays out 14 objectives which include creation of a cyber-ecosystem in the country, providing fiscal benefits to businesses for adoption of standard security practices and processes, developing effective public private partnerships and collaborative engagements through technical and operational cooperation.
The main objectives of the new policy would be:

- To develop suitable indigenous security technologies through frontier technology research, solution oriented research, proof of concept, pilot development, transition, diffusion and commercialisation leading to widespread deployment of secure ICT products/processes in general and specifically for addressing National Security requirements.
- To create a workforce of 500,000 professionals skilled in cyber security in the next 5 years through capacity building, skill development and training.
- To enable protection of information while in process, handling, storage and transit so as to safeguard privacy of citizen's data and for reducing economic losses due to cyber-crime or data theft.
- To develop effective public-private partnerships and collaborative arrangements through technical and operational cooperation and contribution for enhancing the security of cyber space.
- To enhance global cooperation by promoting shared understanding and leveraging relationships for furthering the cause of security of cyber space.

In order to create a secure cyber ecosystem, the policy plans to set up a national nodal agency to coordinate all matters related to cyber security in the country with clearly defined roles and responsibilities.

The policy plans to operate a 24×7 national level computer emergency response team (CERT) to function as a nodal agency for coordination of all efforts for cyber security emergency response and crisis management. All organisations would be asked to earmark a specific budget for implementing cyber security initiatives and for meeting emergency response arising out of cyber incidents.

THE SCIENCE, TECHNOLOGY AND INNOVATION POLICY 2013

The Government of India announced the Science, Technology and Innovation Policy (STI) 2013 in January 2013. The new Policy seeks to send a signal to the Indian scientific community, both in the private and public domain, that science, technology and innovation should focus on faster, sustainable and inclusive development of the people. The policy seeks to focus on both STI for people and people for STI. It aims to bring all the benefits of Science, Technology and Innovation to the national development and sustainable and more inclusive growth. It seeks the right sizing of the gross expenditure on research and development by encouraging private sector participation in R & D, technology and innovation activities.

The policy also seeks to trigger an ecosystem for innovative abilities to flourish by leveraging partnerships among diverse stakeholders and by encouraging and facilitating enterprises to invest in innovations. It also seeks to bring in mechanisms for achieving gender parity in STI activities and gaining global competitiveness in select technological areas through international cooperation and alliances. The policy goal is to accelerate the pace of discovery, diffusion and delivery of science led solutions for serving the aspirational goals of India for faster, sustainable and inclusive growth. A Strong and viable Science, Research and Innovation system for High Technology led path for India (SRISHTI) are the goal for the STI policy.

The key features

- Promoting the spread of scientific temper amongst all sections of society.
- Enhancing skills for applications of science among the young from all social sectors.
- Making careers in science, research and innovation attractive enough for talented and bright minds.
- Establishing world class infrastructure for R&D for gaining global leadership in some select frontier areas of science.
- Positioning India among the top five global scientific powers by 2020 (by increasing the share of global scientific publications from 3.5% to over 7% and quadrupling the number of papers in top 1% journals from the current levels).
- Linking contributions of scientific research and innovation system with the inclusive economic growth agenda and combining priorities of excellence and relevance.
- Creating an environment for enhanced private sector participation in R &D.
- Enabling conversion of R & D output with societal and commercial applications by replicating hitherto successful models, as well as establishing of new PPP structures.
- Seeking S&T-based high risk innovation through new mechanisms.
- Fostering resource optimised cost-effective innovation across size and technology domains.

- Triggering in the mindset and value systems to recognise respect and reward performances which create wealth from S&T derived knowledge.
- Creating a robust national innovation system.

INDIA'S FIRST DOMINO KIDNEY TRANSPLANT

In June, in a rare surgical feat, a team of over 40 senior doctors worked on the domino kidney transplantation and carried out 10 surgeries simultaneously in three city hospitals of Mumbai, The Bombay hospital, Dr. L.H. Hiranandan Hospital and P.D. Hinduja Hospital which turned out to be a success. They saved five lives that were suffering from end-stage kidney failures. The process involved a total of five families. One pair of donors was from Rajasthan while the other four were from Mumbai. While one pair was a father-daughter pair, the other four were husband-wife pairs.

Domino transplantation involves a series of surgeries wherein a donor provides an organ to a recipient not related to him or her while the donor's relative in turn receives the organ from another donor. In a domino transplant, despite the blood groups not matching, with the help of five-way swap exchange, they are able to undergo kidney transplant. It is a system of swap transplantations where the relative of Patient A will donate a kidney to patient B and Patient B's relative will donate to Patient C. This process will go on till the last patient's relative will donate a kidney to Patient A. Domino kidney transplantation is a common practice in the US and its success stories have been published in many journals.

MIDDLE EAST RESPIRATORY SYNDROME (MERS)

Coronaviruses are common viruses that most people get some time in their life. Human coronaviruses usually cause mild to moderate upper-respiratory tract illnesses. There are three main sub-groupings of coronaviruses, known as alpha, beta and gamma, and a fourth provisionally-assigned new group called delta coronaviruses.

Middle East Respiratory Syndrome (MERS) is viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. Most people who have been confirmed to have MERS-CoV infection developed severe acute respiratory illness. They had fever, cough, and shortness of breath. About half of these people died.

So far, all the cases have been linked to four countries in or near the Arabian Peninsula (That's why it is called Middle East Respiratory Syndrome). Of the 82 cases detected so far, 45 have died. This virus has spread from ill people to others through close contact. However, the virus has not shown to spread in a sustained way in communities. The situation is still evolving.

Most MERS cases so far have been reported from Saudi Arabia – 66 cases with 38 deaths. Health officials in that country have warned visitors, particularly those coming to Mecca and other holy places, to wear masks to avoid the spread of MERS. No cases of MERS have been identified in the India till date. As a precautionary measure India has increased surveillance at international airports and ports to prevent the entry of a deadly virus that has claimed 45 lives across the world so far. One can avoid catching the infection by maintaining good hand hygiene. There is no vaccine for the MERS virus and the treatment is mostly symptomatic.

→ India has two slots in Geosynchronous orbit 24° & 44°

The source of the MERS virus is still not know, and until researchers can determine what animal is the natural host of the virus, and how MERS spreads from the host to humans, each new outbreak is dangerous and mysterious. The science is still unfolding.

GREEN INTERNET

Internet-based technologies come at a cost – extensive energy consumption. A few technologies have been developed to reduce energy wastage during Internet use and more are in the offing. Around the world, data centres consumed over 270 terawatt hours (TWh) of energy in 2012 and it is estimated that they will consume about 20 per cent more in 2013. Current networks, devices and data centres do not have power management options. Consumption remains high even when there is low level of Internet traffic, leading to wastage of energy. So, technologies are being developed to make these networks more energy-efficient. New technologies "smart standby" allows unused parts of a network to be put into very low power states and save energy. Another technology called "Dynamic frequency scaling" ensures that when the system is under partial load, parts of it can be cut off without hitting overall performance.

Some of these technologies are still beset with glitches. For instance, smart standby make hardware take a long time to wake up. Certain aspects of the problem have been identified that can be streamlined to take care of such problems.

Using these technologies, over 50 per cent of the energy being spent on Internet traffic currently can be saved. Some US companies that manufacture networking equipment are already implementing greening techniques in their devices.

Both telecom industries and producers of electronic devices need to work closely in developing new devices with energy saving devices. The next generation of devices would be able set up and synchronise their energy-saving capabilities. Once new green devices are available, the only barrier would be to replace the old equipment, which may involve huge costs. But appropriate government subsidies as incentives could encourage users to opt for green devices for networking.

INDIAN ROTAVIRUS VACCINE

India has developed the first indigenous vaccine against rotavirus, the major cause of diarrhoea deaths among children. Rotavirus is responsible for approximately 4,53,000 child deaths due to diarrhoea globally each year. It is particularly threatening in India where – according to a recent study – around 1,00,000 children die each year from severe diarrhoea and dehydration caused by rotavirus.

The new vaccine called Rotavac has cleared all clinical trials and it will be available for sale in the market by next year, subject to clearance from the Drug Controller General of India (DCGI). The cost of Rotavac is likely to be around Rs 54 per dose which is 1/40th of the imported vaccines available in the market at present.

The vaccine has been developed through private-public partnership (PPP). The Hyderabad-based Bharat Biotech International, in collaboration with the Department of Biotechnology and with support from a host of national and international agencies like the Program for

Appropriate Technology in Health, has developed this vaccine. It has taken over two decades of research work and trials.

Rotavac vaccine is similar to the oral polio drop. It will be given under the same regimen – 6, 10 and 14 weeks. It is given alongside routine immunisations in the Universal Immunisation Programme (UIP) vaccines recommended at these ages. Trials have shown an efficacy of 56% in severe diarrhoea and 61% in very severe diarrhoea cases. There is no side-effect or safety issue.

The new vaccine has been created out of a strain of the virus that was isolated, manufactured and tested in India. The trial represents a significant victory for India's scientific community. The vaccine is affordable, safe and effective, besides being specific to the virus that causes diarrhoea in India.

AGRICULTURAL BIOSECURITY AUTHORITY

A Bill has been introduced in the Lok Sabha today to provide for establishment of an Agricultural Biosecurity Authority for prevention, control, eradication and management of pests and diseases of plants and animals and unwanted organisms. The proposed legislation will ensure agricultural biosecurity of the country for common benefit and for safeguarding the agricultural economy. It will also meet international obligations of India for facilitating imports and exports of plants, plant products, animals, animal products, aquatic organisms and regulation of agriculturally important microorganisms.

The Bill seeks to bring together the plant, animal and marine protection and quarantine set ups under the proposed Authority which will have adequate powers. The Authority's mandate will cover the four sectors of agricultural biosecurity, viz. plant health, animal health, living aquatic resources (fisheries, etc.) and agriculturally important micro-organisms.

There was a need for a common authority on agricultural biosecurity in view of the challenges brought in by the new avenues for growth and diversification of agriculture created by liberalisation of global trade in agriculture. There is an increased risk of introduction of exotic pests and weeds in the country with the potential to cause serious economic losses. Advances in genetic engineering leading to the introduction and release of living modified organisms or their products (e.g. genetically modified organisms) require proper risk assessment and management. Climate change has the potential to alter the habitat of known pests and even cause introduction of new pests. We have to contend with the ever increasing threat of bio-terrorism. The emergence and spread of trans-boundary diseases such as the avian influenza and the Ug-99 wheat stem rust fungus pose new threats to human, animal and plant safety.

Over the years, systems have been developed and put in place separately for protection of plant, animal and marine health. The existing systems including infrastructure for agricultural biosecurity of the country need major changes to meet the emerging challenges which have highlighted agricultural biosecurity as an urgent issue requiring policies and technological capabilities to prevent, detect, and respond to such threats. An integrated approach towards agricultural biosecurity would not only increase the national capacity to protect human health, agricultural production and livelihood, safeguard the environment, and protect against uncertain technologies and products, but also equip the country to meet obligations under

international trade and sanitary and phytosanitary (related to control of plant diseases especially in agricultural crops) agreements in food and agricultural products.
The proposed authority would improve safety, efficiency, transparency and compliance of quarantine and pest management regulations and respond swiftly to contain emergent biosecurity problems. It will also ensure conduct of biosecure international trade in agriculture.

AIR POLLUTION KILLS MORE THAN 2 MILLION A YEAR

Air pollution is a problem of modern civilisation that is known to affect health in general and it is considered to be one of the major environmental risks facing the world's population. But till recently the real threat that air pollution poses to human health was grossly underestimated. A new study by researchers from the University of North Carolina, USA, has shown that more than two million people may be dying around the world every year due to air pollution. This is in addition to an estimated 470,000 deaths each year due to increases in ozone at ground level produced by human activity. On the other hand, climate change only has a minimal effect on air pollution and rising death rates.

Air pollution has been steadily rising since the beginning of the industrial revolution in the middle of nineteenth century, especially after widespread use of coal and oil started. Since then human activities have significantly increased the concentrations of ozone and fine particulate matter less than 2.5 micrometre in size (also known as PM 2.5) in both urban and rural regions. Ozone is a highly reactive gas – a different form of oxygen made up of three atoms joined together. If inhaled, ozone causes severe respiratory problem including cough, throat irritation, or reduced lung function leading to discomfort in the chest when taking a deep breath. PM 2.5 in the air reduces visibility and cause the air to appear hazy when levels are elevated. These tiny air particles can penetrate deep into the lungs and cause cancer and other severe respiratory illnesses.

Most ground-level ozone that causes health concerns is formed when sunlight reacts with air pollutants, especially nitrogen oxides (NO_x) released into the atmosphere by human activities, especially internal combustion engines. PM 2.5 particles primarily come from car, truck, bus and off-road vehicle (e.g., construction equipment, diesel locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal, and natural sources such as forest and grass fires. Fine particles also form from the reaction of gases or droplets in the atmosphere from sources such as power plants.

The North Carolina study was conducted through computer simulation. The researchers simulated the concentrations of ozone and fine particulate matter air pollution in 1850 – when the industrial era began – and in the year 2000. They used 14 different climate models to simulate levels of ozone and another six to simulate fine particulate matter caused by humans. In order to reach their estimate, the researchers compared the results from a range of earlier mathematical models on deaths from air pollution.

According to the study, most of these deaths due to air pollution occur in East Asia and South Asia, where population is high and air pollution is severe. India has one of the highest mortality rates due to ozone (208,000) and due to PM 2.5 (549,000) per year. This is quite alarming, yet little is being done to tackle the situation.

The major sources of PM 2.5 pollution in India include the rampant burning of fuelwood and biomass such as dried waste from livestock as the primary source of energy by the poor, and fuel adulteration, vehicular emission and traffic congestion in cities. India is the world's largest consumer of fuelwood, agricultural waste and biomass for energy purposes. Traditional fuel (fuelwood, crop residue and dung cake) dominates domestic energy use in rural India and accounts for about 90% of the total. The recent study should be an eye-opener for our planners and policy makers who should think of providing cleaner energy alternatives at affordable cost to the country's poor.

INDIA PAYS A HIGH ECONOMIC PRICE FOR POLLUTION

The annual cost of environmental degradation in India is about $80 billion, or 5.7 per cent of the country's gross domestic product, says a new report by the World Bank. The report, "Diagnostic Assessment of Select Environmental Challenges in India," released in July, analyses the trade-offs between economic growth and environmental sustainability.
The study focusses on PM10, which refers to suspended solid particles up to 10 micrometres in size, mostly from the burning of fossil fuels. The study includes scenarios showing the economic effects of reducing the PM10 particulates. If India were to reduce its particulate emissions 10 per cent by 2030, for example, it would represent a loss of 0.3 per cent to the GDP. Reducing particulate emissions by 30 per cent would lower GDP by about $97 billion, or 0.7 per cent, the study says.

Yet the study points out that the health benefits under both scenarios compensate, to a large extent, for the projected GDP loss. Savings from reduced health costs range from $105 billion under the 30 per cent emission reduction model to $24 billion under the 10 per cent reduction model. The study says that nearly 25 per cent of child mortality cases in India can be attributed to environmental degradation as well as an inadequate availability of clean water and sanitation.

The Organization for Economic Cooperation and Development last month said that India "has probably recently" surpassed Japan to be world's third largest economy, after the United States and China. But the World Bank in its report says that India cannot continue on a path of "grow now and clean up later" and warns that failure to address environmental challenges could constrain the country's long-term productivity.

"India has performed remarkably economically, but that's not reflected in its environmental outcomes," said Muthukumara Mani, the World Bank's senior environmental economist and author of the report. "Grow now, clean up later" really doesn't work.

MAKING LONG-TERM ANTIBIOTIC USE SAFER

It is well known that indiscriminate and prolonged use of antibiotics does more harm than good, often leading to bacteria developing resistance to even the most powerful antibiotics. Doctors often prescribe antibiotics freely, thinking that they harm bacteria while leaving human tissue unscathed. But over the years reports have piled up about the occasional side effects of various antibiotics, which can range from mild allergic reactions to severe and debilitating adverse events. Yet the mechanisms underlying these effeets of antibiotics in the body remained unclear. Now a team of US scientists has discovered why long-term treatment with many common antibiotics can cause harmful side effects – and they have uncovered two easy strategies that could help prevent these dangerous responses.

All forms of life maintain a reducing environment within their cells. This reducing environment is preserved by enzymes. Disturbances in this normal redox state can cause toxic effects through the production of peroxides and free radicals that damage all components of the cell, including proteins, lipids, and DNA. A condition known as oxidative (taking place in presence of oxygen) stress is caused by an imbalance between the production of reactive oxygen and a biological system's ability to readily detoxify the reactive intermediates or easily repair the resulting damage. In humans, oxidative stress is involved in many diseases, such as atherosclerosis, Parkinson's disease, heart failure, Alzheimer's disease, and chronic fatigue syndrome.

Reactive oxygen species can, however, be beneficial, as they are used by the immune system as a way to attack and kill disease-causing organisms. Reactive oxygen species are also used in cell signalling. Problem arises only when the production is in excess. It has been suggested that bactericidal antibiotics (antibiotics that kill bacteria) induce the formation of toxic reactive oxygen species in bacteria. The researcher showed that clinically relevant doses of many of the commonly used antibiotics cause mitochondrial dysfunction and overproduction of reactive oxygen species in mammalian cells. The researchers found that it is these bactericidal antibiotic-induced effects that lead to oxidative damage to DNA, proteins, and membrane lipids, and that these harmful effects of antibiotics can be relieved by antioxidants. The researchers treated mice with bactericidal antibiotics and found the animals exhibited elevated oxidative stress markers in the blood, oxidative tissue damage, and other symptoms which indicated the potential physiological relevance of these antibiotic effects. However, the harmful effects of bactericidal antibiotics were relieved in cell culture and in mice by the administration of the antioxidant N-acetyl-L-cysteine, or prevented by preferential use of antibiotics that did not kill bacteria but only stopped their multiplication. According to the researchers, this work highlights the role of antibiotics in the production of oxidative tissue damage in mammals and also suggests possible strategies to mitigate or prevent the resulting damage, with the goal of improving the safety of antibiotic treatment in people.

INDIA'S MARS MISSION

India is planning to send an unmanned mission to Mars later this year. Named *Mangalyaan* it will be an absolutely indigenous mission any foreign involvement. The project would mark another step in India's ambitious space programme, which placed a probe on the Moon four years ago and envisages its first manned orbital mission in 2016.

Mangalayaan will be a purely scientific mission. The Rs 450-crore project will carry 24 kg of payload experiments – cameras and sensors to study the upper atmosphere as well as the "chemical and mineralogical" features of the Red Planet and send data continuously back to Earth. The spacecraft will be launched by ISRO's polar satellite launch vehicle (PSLV-XL) and will be placed in an orbit around Mars with farthest and nearest orbital points of around 80,000 km and 500 km respectively.

The technological objective of the mission is to design a spacecraft capable of reaching Mars and getting into orbit around the planet. This will take around nine months. Another technological challenge is to realise related deep space mission planning and communication management at a distance of nearly 400 million km.

The *Mangalyaan* mission is currently scheduled to take off in November 2013 and will take around eight months to reach the Red Planet. However, it does not take off as scheduled,

ISRO scientists will have to wait at least until 2016 to get the required favourable distance from Mars again followed by another window in 2018 when the planet will be closest to the Earth.

If all goes well, India will be the sixth country to launch a mission to the Red Planet after the US, Russia, Europe, Japan and China. According to former ISRO chairman and Planning Commission member K Kasturirangan, "The mission will be a technology demonstrator. A successful mission will prove that we have capability to reach the far away planet and orbit around Mars. This will pave the way for more intense exploratory missions in future."

INDIA ENTERS NEW ERA OF SPACE APPLICATION

India embarked on a landmark journey into a new era of space application with the successful launch of its first navigation satellite ISNSS-1A in July. IRNSS-1A is the first of seven satellites of the Indian Regional Navigation Satellite System, or IRNSS, an indigenous version of the Global Positioning System, which is operated by the US. The Indian satellite weighs 1,450 kilograms and has a working life of 10 years.

The launch of IRNSS-1A was the first step in India's plans to develop its own global positioning system by setting up a constellation of seven satellites by 2015. The remaining six satellites will be launched every six months over the next 30 to 36 months. The system will become operational once all the seven satellites are in position. When fully operational, the system will provide two types of services: standard positioning service and restricted service. The first will be provided to all users while the second will be an encrypted service for authorised users such as the military and security. Currently, the US-based Global Positioning System or GPS and Russia's GLONASS are the only two satellite-based navigation systems in operation. China, Japan and Europe are in the process of developing their own regional navigation satellite systems.

The seven satellites of the Indian system, which are being indigenously designed and built, will provide accurate positioning services for users across India and up to 1,500 kilometres beyond its borders. They will provide an absolute position accuracy of better than 10 metres. The system is intended to provide navigation services on land, sea and air and also help in disaster and fleet management. Like GPS, the services of IRNSS will be accessible with mobile phones. An advantage of the Indian system is that the design of the payload makes the IRNSS system inter-operable and compatible with existing GPS.

Unlike the GPS and GLONASS, which use 24 satellites each, the Indian system is based on only a constellation of seven satellites. All seven navigation satellites of the system will be placed at a height of about 36,000 km, which will make them circle the Earth once in 24 hours, making them constantly accessible day and night. Three of the satellites will be placed directly over the equator, in the geostationary orbit while the remaining four satellites will be in pairs in two inclined geosynchronous orbits. This would mean that from any location in India and at any time, all the satellites will be visible from ground and their navigational services can be accessed.

PRINTING IN 3 DIMENSIONS

3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes).

A materials printer usually performs 3D printing processes using digital technology. The 3D printing technology is used for prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, civil engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields.

To perform a print, the machine reads the design from an .stl or stereolithography file and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Traditional techniques like injection moulding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Though the printer-produced resolution is sufficient for many applications, printing a slightly oversized version of the desired object in standard resolution, and then removing material with a higher-resolution subtractive process can achieve greater precision.

TRADITIONAL KNOWLEDGE DIGITAL LIBRARY (TKDL)

Traditional Knowledge Digital Library is an Indian digital knowledge repository of the traditional knowledge, especially about medicinal plants and formulations used in Indian systems of medicine. Set up in 2001, as a collaboration between the Council of Scientific and Industrial Research (CSIR) and Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (Dept. of AYUSH), Ministry of Health & Family Welfare, Government of India, the objective of the library is to protect the ancient and traditional knowledge of the country from exploitation through bio-piracy and unethical patents, by documenting it electronically and classifying it as per international patent classification systems. Apart from that, the non-patent database also serves to foster modern research based on traditional knowledge, as its simplifies access to this vast knowledge, be it of traditional remedies, or practices.

As of 2010, it had transcribed 148 books on Ayurveda, Unani, Siddha and Yoga in public domain, into 34 million pages of information, translated into five languages — English, German, French, Spanish and Japanese. Data on 80,000 formulations in Ayurveda, 1,000,000 in Unani and 12,000 in Siddha had already been put in the TKDL. Plus it has also signed

agreements with leading international patent offices such as European Patent Office (EPO), United Kingdom Trademark & Patent Office (UKPTO) and the United States Patent and Trademark Office to protect traditional knowledge from bio-piracy, by giving patent examiners at International Patent Offices access to the TKDL database for patent search and examinations purposes.

MAKING INDIA A GLOBAL SOLAR ENERGY HUB

Addressing the Fourth Clean Energy Ministerial meeting in New Delhi in April 2013, Prime Minister Manmohan Singh urged global companies on to make India a solar energy hub as the country seeks to cut its chronic power shortages. The meeting was attended by representatives of over 20 nations. India, which has an average of 300 sunny days a year, sees solar power as a potentially vital energy source that could be key to boosting power supplies and reducing greenhouse gas emission in the world's third-worst carbon polluter.

India is working urgently to develop alternative power sources and wean itself away from polluting coal-fired generation to power an economy that is expected to grow by at least six per cent this financial year. It has just 551 megawatts of solar capacity installed currently, according to government figures, and some 70 per cent of the equipment comes from abroad. India's National Solar Mission launched in 2010 aims to generate 20 gigawatts of solar power by 2022 – equivalent to one-eighth of the nation's current installed power base. The solar energy drive is also part of efforts to tackle frequent power outages especially in rural India that economists say knock an average 1.2 percentage points off annual growth. But barriers to widespread introduction of solar power such as lack of technology and subsidies to consumers remain. Once installed, however, experts say the costs are low and are mainly confined to maintenance. The Indian government has unveiled draft legislation that would allow the solar industry to obtain grants covering up to 40 per cent of installation costs.

TURNING GARBAGE INTO GAS

Delhi produces more than 8,000 tonnes of garbage the disposal of which is becoming an uphill task for the municipal authorities. Delhi has run out of land for landfills, and none of the neighbouring States intends to surrender any to meet its needs.

The obvious answer to Delhi's problem seems to be to burn the solid waste. Cities all over the world are doing it. The Delhi Municipal Corporation's effort to reopen a small waste incineration plant at Timarpur, that had been closed down soon after it was built in 1980s did not succeed. It was proposed to use the plant to convert 214,000 tonnes of solid waste a year into 69,000 tonnes by sifting out inorganic matter, and drying and palletising the rest to increase its fuel value. Burning this garbage, it was estimated, would produce six megawatts of power per hour, or 5.5 billion units of electricity a year.

At present Delhi has one incineration plant at Okhla, burning almost 2,000 tonnes a day, and two more are being set up to incinerate another 4,300 tonnes a day. What's more, these plants will generate 50 MW of power every hour of the day. More incineration plants are on their way: since the Okhla plant went on stream, the Union Ministry of Environment and Forests has approved eight more plants in various cities.

However, garbage burning plants pose some health threats. The threats come from particulate emissions that greatly exacerbate lung diseases from bronchitis and asthma to emphysema

and lung cancer, and from dioxins and furans in addition to the usual nitrogen and sulphur oxide gases in the flue gas.

A better way of disposing garbage that not only eliminates all pollutants, but turns garbage into fuel is to gasify garbage. Gasification is an incomplete combustion of organic matter that replaces a large part of the carbon dioxide we get from combustion with carbon monoxide and hydrogen. These two gases are, and have been for a hundred years, the basic building blocks of the world's petrochemicals industry. They are also ideal for driving gas turbines to generate power. From India's perspective, their best feature is the ease with which they can be synthesised into any transport fuel one desires. Gasification also eliminates the threat from dioxins.

Ironically, India already has employed plasma gasification technology — for the past four years, two 68 tonnes-a-day commercial plants employing this technology have been disposing of medical and other hazardous wastes in Pune and Nagpur. Since Indian states do not share information, however, these have remained isolated ventures.

NANOGRAPHENE: A NEWLY SYNTHESISED CARBON FORM

A new form of carbon has been reported is a wildly distorted from of graphene, with five 7-membered rings and one 5-membered ring embedded in the hexagonal lattice of carbon atoms. The new form of carbon was synthesised by chemists at Boston College in USA and Nagoya University in Japan. This new material consists of many identical piece of grossly warped graphene, each containing exactly 80 carbon atoms joined together in a network of 26 rings, with 30 hydrogen atoms decorating the rim. These individual molecules, because they measure somewhat more than a nanometre across, are referred to generically as "nanocarbons," or more specifically in this case as "grossly warped nanographenes."

Until recently, scientist had identified only three forms of pure carbon, namely: diamonds, graphite, and fullerenes. Since the discovery of fullerenes in 1985, scientists have also learned how to make long, ultra-thin, hollow tubes of carbon atoms, known as carbon nanotubes, and large flat single sheets of carbon atoms, known as graphene.

Graphene sheets are planar, 2-dimensional sheets as a consequence of the hexagonal, chicken wire-like, arrangements of carbon atoms. The new form of carbon just reported, however, is wildly distorted from planarity as a consequence of the presence of five 7-membered rings and one 5-membered ring embedded in the hexagonal lattice of carbon atoms. Odd-membered-ring defects such as these not only distort the sheets of atoms away from planarity, they also alter the physical, optical, and electronic properties of the material.

The new grossly warped nanographene is dramatically more soluble than a planar nanographene of comparable size and the two differ significantly in colour, as well. Electrochemical measurements revealed that the planar and the warped nanographenes are equally easily oxidised, but the warped nanographene is more difficult to reduce.

ORGANS MADE TO ORDER

During embryonic development, specialised cells (e.g., muscle or immune cells) arise from a common stem cell that differentiates via a series of cellular changes triggered by specific gene expression patterns. Scientists can recover these embryonic stem cells from embryos and manipulate them *in vitro* to study early development. They can also differentiate embryonic stem cells into cell types that are useful for therapeutic purposes, such as transplantation. This technology raises a significant ethical concern because most embryonic stem cells arise from human embryos. Some ethical concerns may be circumvented by the discovery that somatic cells can be reprogrammed to a pluripotent state. The reprogrammed cells, called induced pluripotent stem (iPS) cells, exhibit functional similarities to embryonic stem cells and present an exciting area of research. The ability to reprogram somatic cells into iPS cells that are pluripotent and can self-renew has transformed the fields of developmental biology and regenerative medicine.

Producing fully functional human organs using induced pluripotent stem cells (iPS cells) will, in the foreseeable future, cease to remain in the realm of science fiction. A team of Japanese scientists has taken a giant step by providing proof-of-concept demonstration of a "functional" miniature human liver that produced blood proteins and broke down drugs when transplanted into a mouse. This is the first time a rudimentary functional human organ has been produced using iPS cells. The same technique can be used to grow other organs like kidneys and pancreas.

Recently the Japanese government has approved the world's first clinical trials to use induced pluripotent stem cells harvested from the bodies of human patients. The approval is likely to allow Japanese researchers to begin tests aimed at treating age-related macular degeneration, a common medical condition that causes blindness in older people, using iPS cells. Scientists hope these macular degeneration clinical trials could offer hope to millions of people robbed of their sight.

BREAKTHROUGH IN DNA STORAGE OF DIGITAL DATA

Ever since the double-helix structure of DNA, chemically known as deoxyribonucleic acid, was deciphered by James Watson and Francis Crick in 1953, scientists have manipulated DNA in innumerable ways for a variety of purposes – to improve crop varieties, and produce better drugs and vaccines, to name a few. The most recent achievement is of storing enormous amounts digital data in synthetic DNA strands that can revolutionise data storage and retrieval. The contents stored in DNA are "read" by sequencing the DNA – as is routinely done today, in genetic fingerprinting and so on – and turning it back into computer code.

In the latest research, Nick Goldman and colleagues at the European Bioinformatics Institute near Cambridge in UK succeeded in storing digital information by encoding it in the four different bases that make up DNA. Goldman and colleagues claim to have achieved a density of 2 petabytes (10^{15} bytes) per gram of DNA which, they calculate, would allow at least 100 million hours of high-definition video to be stored in a teacup. This is a thousand times larger than that achieved by Sriram Kosuri of Harvard Medical School and colleagues last year.
The researchers collected data, which included an MP3 recording of Martin Luther King's "I have a dream" speech; a digital photo of their lab; a pdf file of the landmark paper of 1953

that described the structure of DNA; a file of all of Shakespeare's sonnets; and a document that describes the data storage technique, in the form of zeros and 1s in computer binary code, and transcribed them into "Base-3" code, which uses zeros, 1s and 2s. The data was transcribed for a second time into DNA code, which is based on the bases adenine (A), cytosine (C), guanine (G) and thymine (T). The letters (bases) were then turned into DNA molecules, using lab-dish chemicals.

Since only short strings of DNA can be made, it means the data has to be chopped up into small sections of 117 letters, each attached to a tiny address tag, rather like packet-switching in Internet data, which enables data to be reassembled. In the study, the data could be recovered and the files could be read with 100-percent accuracy. The work did not entail using any living DNA, nor does it seek to create any life form. In fact the man-made code would be quite useless in anything biological, the researchers said.
The main advantage of the technique is that a speck of man-made DNA can hold mountains of data that can be freeze-dried, shipped and stored, potentially for thousands of years. However, according to the researchers, the main disadvantage of the technique is the time needed for data retrieval. Sequencing and reading the DNA takes a couple of weeks with present technology, so it is not suitable for jobs needing instant data retrieval. But it would be ideal for long-term storage of data.

A HORMONE TO TREAT DIABETES

Diabetes, often referred to by doctors as diabetes mellitus, describes a group of metabolic diseases in which the person has high blood glucose (blood sugar), either because insulin production is inadequate, or because the body's cells do not respond properly to insulin, or both. Insulin is normally produced by beta cells in the pancreas. Basically, there are two types of diabetes. In type-1 diabetes the pancreas does not produce insulin; it is also known as insulin-dependent diabetes. In type-2 diabetes, the body does produce insulin but not enough for proper function or the cells in the body are unable to utilise insulin. Type-2 diabetes is the most common form and almost 90% of all cases of diabetes worldwide are of this type. Daily insulin injections are the routine for many people with type-2 diabetes. But they might be able to break free from that daily chore with the discovery of a new hormone called betatrophin, which may radically change the way the disease is treated.

Researchers at the Harvard Stem Cell Institute (HSCI) in Cambridge, Massachusetts, USA, have discovered a hormone that holds promise for a dramatically more effective treatment of type 2 diabetes. The researchers believe that the hormone might also have a role in treating type-1, or juvenile, diabetes. The researchers – HSCI co-director Doug Melton and postdoctoral fellow Peng Yi – found that betatrophin causes the production rate of insulin-secreting pancreatic beta cells in mice to increase by as much as 30 times normal levels. According to the researchers, the new beta cells only produce insulin when called for by the body, offering the potential for the natural regulation of insulin and a great reduction in the complications associated with diabetes. If successful in clinical trials, betatrophin treatment could augment or replace insulin injections by increasing the number of internally produced insulin-producing cells in diabetics. However, the researchers caution that much work remains to be done before it could be used as a treatment in humans. "If all goes well, tests in people could follow fairly quickly", said Melton. When this treatment is eventually used in people, it could eventually mean that instead of taking insulin injections three times a day, a diabetic might take an injection of this hormone once a week or once a month, or in the best case maybe even once a year.

SOURCE OF COSMIC RAYS DISCOVERED

Cosmic rays were discovered more than 100 years ago, but their origin had remained a mystery till recently. Cosmic rays are mostly extremely energetic pieces of atoms: protons, electrons, and atomic nuclei which have had all of the surrounding electrons stripped during their high-speed (almost the speed of light) passage through the Milky Way galaxy. About 90 per cent of them are protons. During their journey across the galaxy, the electrically charged particles are deflected by magnetic fields. This scrambles their paths so much that it is no longer possible to point back to their sources in the galaxy. So the source of cosmic rays can be determined only by indirect means. A new study by an international team of more than 160 researchers using observations from NASA's Fermi Gamma-ray Space Telescope now provides the first clear-cut evidence of production of cosmic rays by the expanding debris of exploded stars. This discovery is considered a major step toward understanding the origin of cosmic rays.

After analysing four years of data, the Fermi scientists found a distinguishable feature in the gamma-ray emission of both supernova remnants. They detected the characteristic pion-decay feature in the gamma-ray spectra of the two supernova remnants, IC443 and W44, with the Fermi Large Area Telescope, which provided direct evidence that cosmic-ray protons are indeed accelerated by supernova shockwaves.

Researchers now have conclusive proof that supernova remnants, long the prime suspects, really do accelerate cosmic rays to incredible speeds. In other words, supernovas are indeed the source of cosmic rays.

OPTICAL VORTICES

In a breakthrough, scientists, including one of Indian-origin, have devised a new fibre optic technology that promises to increase bandwidth dramatically that can easing Internet congestion and video streaming. The technology centres on doughnut-shaped laser light beams called optical vortices, in which the light twists like a tornado as it moves along the beam path, rather than in a straight line.

Widely studied in molecular biology, atomic physics and quantum optics, optical vortices (also known as orbital angular momentum, or OAM, beams) were thought to be unstable in fibre, until Boston University Engineering Professor Siddharth Ramachandran designed an optical fibre that can propagate them. In the paper in journal Science, he and Alan Willner of University of Southern California, demonstrated the stability of the beams in optical fibre and also their potential to boost Internet bandwidth.

In experiments in the study, researchers created an OAM fibre with four modes (an optical fibre typically has two), and showed that for each OAM mode, they could send data through a one-kilometre fibre in 10 different colours, resulting in a transmission capacity of 1.6 terabits (10^{12} bits) per second.

DRIVERLESS CAR

A driverless car is also known as an autonomous car, or a robotic car. It is an autonomous vehicle all the capabilities of capabilities of a traditional car but needs no driver to drive it. It is equipped with instruments capable of sensing its environment and navigating without human input. Robotic cars exist mainly as prototypes and demonstration systems, but are likely to become more widespread in the near future.

Driverless cars are guided by a system of sensors and cameras and are seen as potentially safer and more efficient than regular vehicles. They sense their surroundings with such techniques as radar, lidar (light detection and ranging), GPS, and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage. Some driverless cars update their maps based on sensory input, allowing the vehicles to keep track of their position even when conditions change or when they enter uncharted environments.

Driverless cars will be tested on public roads by the end of 2013, says the UK government. So far, UK trials of the autonomous vehicles have taken place only on private land. For now, the cars will be driven on lightly-used rural and suburban roads in a "semi-autonomous" mode which gives human passengers the choice to intervene.

RADIOACTIVE BACTERIA TO TREAT CANCER

Till recently the low survival rate of patients of pancreatic cancer was mainly because of the disease's vicious ability to metastasise, or spread to other parts of the body. But researchers at Albert Einstein College of Medicine in New York have succeeded in halting the spread of pancreatic cancer using a novel method of delivering radiation directly to the cancer cells using genetically modified bacteria. The modified bacteria infected and killed the cancer cells directly, while having no effect on healthy tissue. The researchers used a weakened strain of the bacteria *Listeria monocytogenes* labelled with the radioactive isotope rhenium-188. According to the researchers, rhenium-188 was chosen because it emits beta particles, which are very effective in treating cancer. In a study using mice carrying human tumours, the researchers were not only able to shrink the rodent's primary tumours while sparing healthy tissue but were also able to kill cancer cells that had spread throughout the animals, reducing their number by up to 90%.

The method combines two special characteristics of cancer cells and bacterium. Although in its wild form the *Listeria monocytogenes* bacterium can cause food-borne illness, a healthy person's immune system can usually destroy it before any damage is done. So the weakened bacterium does not cause any damage to normal cells. At the same time, cancer cells tend to suppress the immune reaction to avoid being destroyed and so cannot destroy the bacterium. As a result, while the bacterium is cleared from normal cells by the body's immune system within three to five days, it accumulates in the immunity-suppressed cancer cells, which makes it an ideal vehicle to carry radiation-emitting atoms into cancer cells. This meant that when the radioactive bacteria are injected, the tumour cells receive continuous exposure of radiation but normal cells are spared. According to the researchers, with further improvements, the new approach has the potential to start a new era in the treatment of metastatic pancreatic cancer.

MARS MAY HAVE HARBOURED LIFE IN THE PAST

The first analysis of powder samples drilled out from the inside of once water-soaked rock shows Mars was a suitable place for microbial life to evolve. Analysis of Mars rocks by the Curiosity rover uncovered the building blocks of life – hydrogen, carbon and oxygen - and evidence the planet could once have supported organisms. The analysis showed that water which once soaked the rock had a neutral pH – not too acidic and not too salty. Analysis of data from Curiosity indicates that an ancient network of rivers on Mars once made parts of the planet habitable for microbial life.

Rock dust drilled from sediments in the giant Gale crater on the red planet were found to contain clay minerals that could have formed only in water, according to NASA scientists. Clay minerals made up at least 20 per cent of the composition of this sample. Curiosity's drill collected the sample at a site just a few hundred metres away from where the rover earlier found an ancient streambed in September 2012. The discovery of other substances alongside the clays, such as calcium phosphate, suggests the soil was neutral or mildly alkaline, making the environment suitable for microbes. The rock from which the sample was collected is estimated to be at least 3 billion years old. The first detailed analysis from the Curiosity rover's sampling of the Martian atmosphere also bolsters the case that the planet was once warmer, and possibly wetter and friendlier to life.

The nuclear-powered Mars rover Curiosity has been exploring an area in the basin of the Gale crater called Yellowknife Bay since its dramatic landing on 6 August 2012. Analysis of dust drilled from the bedrock found it was made from fine-grained mudstone containing clay minerals and other chemicals used by living organisms, including sulphur, nitrogen, hydrogen, oxygen, phosphorus and carbon. Clues to this habitable environment came from data returned by the rover's Sample Analysis at Mars (SAM) and Chemistry and Mineralogy (CheMin) instruments. The data indicate the Yellowknife Bay area was the end of an ancient river system or an intermittently wet lake bed that could have provided chemical energy and other favourable conditions for microbes.

HUBBLE DETERMINES COLOUR OF A DISTANT EXOPLANET

Astronomers have used the Hubble Space Telescope to determine the true colour of the distant world; the first time such a feat has been achieved for a planet that circles a star other than the Sun. The planet is HD 189733b, and orbits a star 63 light-years away and is cobalt blue in colour. If seen directly, this planet would look like a deep blue dot, reminiscent of Earth's colour as seen from space. Although the planet resembles Earth in terms of colour, it is not an Earth-like world. On this turbulent alien world, the daytime temperature is nearly 1,100 degrees Celsius, and it possibly rains glass, accompanied by winds blowing at more than 7,200 km per hour.

The cobalt blue colour comes not from the reflection of a tropical ocean as it does on Earth, but rather a hazy, blow-torched atmosphere containing high clouds laced with silicate particles. Silicates condensing in the heat could form very small drops of glass that scatter blue light more than red light. HD 189733b is among a bizarre class of planets called 'hot Jupiters', which orbit precariously close to their parent stars. HD 189733b was discovered in 2005. It is only 4.7 million kilometres from its parent star, so close that it is gravitationally locked. One side always faces the star and the other side is always dark.

HINTS OF DARK MATTER FOUND

Physicists have puzzled over the nature of dark matter since the 1930s, and billions of dollars have been spent building experiments to track it down. One possible candidate for dark matter are theoretical particles known as 'weakly interacting massive particles', or WIMPs, which are being searched for by an experiment called the Cryogenic Dark Matter Search, or CDMS experiment in an underground lab in USA. The CDMS experiment is designed to pick up the signal of WIMPs as Earth passes through the Milky Way galaxy's sea of dark matter. The CDMS consists of a network of silicon and germanium crystals cooled to near absolute zero. Scientists working with the CDMS experiment reported on 13 April 2013 that they have detected three potential signatures of exotic dark matter particles hidden in the readings recorded with silicon detectors. The findings were presented at the American Physical Society meeting in Denver, USA. The interactions seen by the CDMS team point to the existence of WIMPs with a best-guess mass of 8.6 billion electron volts, which would be about nine times as massive as the proton. The scientists say there is a 99.8 per cent chance that their results reflect a real phenomenon rather than an experimental error. If the results are confirmed by further experiments that would point to the existence of WIMPs that could help account for the 27 per cent of the Universe that is thought to consist of dark matter.

THREE-PARENT BABY

Three-parent babies are potential human offspring that will have three genetic parents. The procedure is intended to prevent mitochondrial diseases including muscular dystrophy and some heart and liver conditions. It is the subject of considerable controversy in the field of bioethics. The UK government is moving toward allowing a new type of in vitro fertilisation that would enable patients with mitochondrial diseases to avoid passing the condition to their children.

The process of producing a three-parent baby involves taking the nucleus of one egg with defective mitochondria and inserting it into the cytoplasm of another egg which has had its nucleus removed, but still contains normal mitochondrial DNA, and then fertilising the hybrid egg with a sperm. The purpose of the procedure is to remove a nucleus from a cell with defective mitochondria and place it in a donor cell with healthy mitochondria, which after fertilisation will contain a nucleus with genetic material from only the two parents. The technique is also termed as 'mitochondrial replacement'.

JUNK DNA TOO IS USEFUL

The genome of any living organism is composed of a collection of genes, made up of sequences of coding DNA which contain the hereditary information. Human genome has 3.3 billion nucleotides, of which less than two per cent code for proteins while the remaining 98 per cent is non-coding in nature and generally described as "junk DNA". Decoding the functions of non-coding DNA has been a big challenge to the scientific community, and scientific research has been gradually finding functional aspects of these parts. Recently, scientists from the Centre for Cellular and Molecular Biology (CCMB), Hyderabad have found that all that non-coding part is not junk. They have determined the function of certain elements, called simple sequence repeats in the human genome. The findings will help

⇒ chernobyl reactor blasts because of produced gas (highly inflammable gas) by the reaction b/w treated Graphite & coolant water. Such type of reactors

develop genome-based personalised medicine for gene therapy for various genome-based disorders, including certain types of cancers.

In the study conducted by CCMB scientists it was found that the repeat of the sequence GATA had significant regulatory role in gene expression by functioning as a boundary, separating functional domains of genome. The accumulation of non-coding part of the genome appears to be the driving force behind the evolution of complexity in living organisms. This indicates that the biological complexity had not evolved by the addition of more genes to the genome but by more sophisticated regulation of the pre-existing genes. The scientists found that there are variations in size of the repeat sequences at different locations in the genome within a population. Such variations were the basis of DNA finger printing that could establish the genetic identity of a person. In the study, the scientists inserted simple sequence repeats of human DNA into the fruit fly to assay its functions.

Kudankulam Nuclear Power Plant

The reactors at the Kudankulam Nuclear Power Plant are PWRs which use 4% enriched uranium-235 as fuel and ordinary water both as coolant and moderator. Each of the two VVER-1000 reactors has a generating capacity of 1000 MW, making them the largest nuclear power reactors in the country. (VVER stands for Vodo-Vodyanoi Energetichesky Reactor.)

During the recent agitation against the Kudankulam plant, which has been continuing for months, thousands of fishermen were mobilised to stop loading of fuel in the reactors. However, contrary to some misguided propaganda, there is no reason to have doubts about the safety of the reactors at the Kudankulam atomic power plant in Tamil Nadu. The VVER-1000 reactors have some advanced safety features like passive heat removal system, double containment, core catcher, and hydrogen re-combiner instead of conventional systems. A core catcher is a device provided to catch the molten core material of a nuclear reactor in case of a nuclear meltdown and prevent it from escaping the containment building. Incidentally, Russian VVERs are inherently safer designs than the RBMK reactors that exploded in Chernobyl.

The design of the reactors at Kudankulam has been evolved from serial design of VVER-1000 reactors, of which 15 units are under operation in more than ten countries around the world for the last 25 years. It may be pointed out in this context that the Russians have credited and acknowledged on several occasions the improvements in their reactors which were recommended by Indian experts. When negotiations were going on for the Kudankulam plant, the Indian experts did not agree to adopt the then current VVER-1000-megawatt reactor model V-320 and suggested improvements for the reactors to be constructed at Kudankulam. The Russians agreed to the Indian suggestions and the Russian designers worked upon the agreed specification to produce the advanced VVER-1000 'Generation 3+' model named V-396. The Kudankulam reactors are an advanced version of the same.

The VVER design adopted for Kudankulam has in additional many additional unique safety features, which include (i) Negative power coefficient, wherein any increase in reactor power is self-terminating, and (ii) Negative void coefficient, which will cause the reactor to shut down if there is loss of water. Design safety of the plant incorporates defence-in-depth concept, which comprises a five-barrier system to prevent release of radioactivity in the

= In Fukushima blast due to backup generators.

environment. The five-barrier system includes: (i) Fuel matrix; (ii) Fuel cladding; (iii) Main circulation circuit; and (iv) and (v) Inner and Outer containment shields. Five tiers of engineered features and administrative measures are provided to protect these barriers.

Each reactor also incorporates active safety systems, which include: Emergency reactor shutdown; Emergency boron injection; Containment spray; High-pressure safety injection; Primary system emergency and planned cool down and fuel pool cooling; and Primary circuit shut-down cooling systems.

The Kudankulam reactors and buildings are designed to withstand external effects involving earthquake, tsunami/storm, tidal waves, cyclones, shock waves, fire, and aircraft impact on main buildings.

As compared to the design basis flood level of 5.44 metres, the Kudankulam reactors are located more than 8.7 metres above mean sea level at the site. Safety diesel generator sets are located at a height of 9.3 metres above mean sea level. As a further protection, the supplementary control room and the four diesel generator-safety train rooms are provided with water-tight doors to protect them against flooding.

The Kudankulam site is located far off (about 1,500 km) from any geologic fault that may cause tsunamis. So, if there is a tsunami, it would take time and lose its energy by the time it reaches Kudankulam site. In contrast, the source of the tsunami that hit Fukushima in March 2011 was only 130 km away.

It is worth remembering that the nuclear power industry has always been aware of the potential hazards of the radioactive nature of the nuclear fuel and nuclear waste in nuclear power generation. For this reason, extreme care is taken in the design and operation of nuclear power plants to minimise the likelihood of accidents, and avoid major human consequences when they occur. As a precautionary measure, Environmental Survey Laboratories are set up before any major nuclear facility is established and these laboratories continue to monitor the surrounding environment throughout the period of existence of the facility. Stringent safety provisions are made in nuclear reactors to avoid any accident. Safety is ensured in the design of plants and in their operation. Nuclear reactor safety includes control of reactor (control rods), removal of heat generated in the core (coolant), and containing the radioactivity (containment shield).

The design of the reactor also includes multiple back-up components, independent systems (two or more systems performing the same function in parallel), monitoring of instrumentation and the prevention of a failure of one type of equipment affecting any other. By regulation, the design of the nuclear reactor must include provisions for human error and equipment failure. Nuclear plants use a system with multiple safety components, each with back-up and design to accommodate human error.

In order to ensure availability of trained manpower to safely run the country's nuclear power plants, the Department of Atomic Energy (DAE) has established a number of new institutes and educational programmes to augment its on-going, well established nuclear training programmes.

The Nuclear Power Corporation of India Limited (NPCIL), the country's sole constructor and operator of nuclear power plants, also has its own nuclear training centres close to nuclear power plant sites. The majority of training for non-graduate technical staff as well as for new engineering graduates and other technical staff is provided through these centres. More

recently, some Indian universities too have begun courses in nuclear engineering. In 2008, the Jawaharlal Nehru Technological University started a two-year master's course in nuclear engineering for candidates holding engineering degrees in mechanical, chemical, civil or metallurgy fields.

Printing in 3 dimensions

3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes).

A materials printer usually performs 3D printing processes using digital technology. The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, civil engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields. To perform a print, the machine reads the design from an .stl or stereolithography file and lays down successive layers of liquid or powder material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Traditional techniques like injection moulding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Production of guns by 3D printing was in the news recently. An American group has been steadily working its way up the 3D printed firearms evolutionary ladder, making parts for guns, then guns themselves, and then firing a gun. However, according to reports, the 3D printed gun made of plastic costs a small fortune to produce and requires a highly specialised and even more expensive 3D printer to produce. Moreover, it is fragile and liable to self-destruction after a few rounds are fired.

A Dutch firm is currently attempting to build the world's first 3D-printed house. Based in Amsterdam, the builders are using a six-metre-tall, purpose-built printer to print components of the house from plastic. Each part of the property is initially printed in a scale of 1:20 on a smaller printer, before being printed in its final size, layer by layer, by the main printer. The production process has already begun – developers aim to have the entire front façade of the canal house constructed before the end of the year, along with the building's internal lobby. As development continues, a 3D-printed kitchen, study, storage room and guestroom are to be added to the building.

A for creating biological shapes, a 3D printer works like an injet printer, but here the cartridge, which usually holds ink, is filled with living human cells and inplace of paper in the tray, a specialised gel sits ready to catch the finished product. A computer-programmed

script instructs the printer to deposit the cells in layers upon layers, slowly forming a vaguely biological shape.

Recently, scientists, including an Indian-origin researcher, have created a 3D printed 'bionic' ear that can "hear" radio frequencies far beyond the range of normal human capability. Using off-the-shelf printing tools, the scientists at Princeton University explored 3D printing of cells and nanoparticles followed by cell culture to combine a small coil antenna with cartilage, creating a 'bionic' ear. While the bionic ear isn't designed to replace our own ears, it is a successful proof of concept of the combining of 3D printed living, biological materials with electronics. Future versions of the bionic ear could help restore hearing, but its other potential applications are far more interesting. The research could lead to synthetic replacements for actual human functions, and to a sort of electronic sixth sense.

Scientists are also experimenting with bioprinted liver tissue prototypes. The vision is that within decades, scientists will be able to take a biopsy of the liver of someone needing a replacement and then print a new 3D version.

1st human liver made from stem cells

Japanese scientists have for the first time grown a functional human liver tissue from stem cells. The breakthrough opens up the possibility of growing human organs in the lab, thus paving way for ending critical shortage of donor organs. Though it could take a decade to actually grow organs on a large scale for transplants, the latest study by Japanese scientists using stem cells derived from skin and blood are being looked at as "proof of concept." This study also demonstrates a proof-of-concept that organ bud transplantation can be an alternative approach for treating organ failure by generating 3D and vascularised organ. Critical shortage of donor organs for treating end-stage organ failure highlights the urgent need for generating organs from pluripotent stem cells.

Since the discovery of embryonic stem cells in 1981, decades of laboratory studies have failed to generate a complex vascularised organ such as liver from pluripotent stem cells (PS cells), giving rise to the prevailing belief that *in-vitro* recapitulation of the complex interactions among cells and tissues during organogenesis is considered to be essentially impractical.

So the experts actually used the induced pluripotent cells or iPS cells to create the three different cell types that are actually required for the natural formation of a human liver in an embryo — hepatic endoderm cells, mesenchymal stem cells, and endothelial cells. Scientists then mixed them together with the hope to see them grow. To their amazement, the cells went on to form a three-dimensional structure called liver buds, a mixture of liver cells that can develop into a full organ. When they transplanted them into mice, the researchers saw the human liver buds mature, following which they began to perform many of the functions of mature human liver cells.

Glaciers around Mount Everest retreating fast

According to a survey of scientific literature produced over the past two decades that claims to be the most comprehensive of its kind, an overwhelming majority of scientists agree that humans have caused global warming. And one of the major consequences of global warming is loss of snow and ice cover in the Polar Regions and on the world's mountains. A glaring example is the extensive retreat of glaciers in the Mount Everest region in the Himalayas. A recent study has shown that glaciers in the Mount Everest region have shrunk by 13 per cent in the last 50 years and the snowline has shifted upward by 180 metres. The study was conducted by a research team led by Sudeep Thakuri, who led the team as part of his PhD graduate studies at the University of Milan in Italy. The findings were presented at the Meeting of the Americas – a scientific conference organised and co-sponsored by the American Geophysical Union, held in Cancun, Mexico from 14 to 17 May 2013. The researchers suspect that the decline of snow and ice in the Everest region is from human-generated greenhouse gases altering global climate.

For the study, Thakuri and his team determined the extent of glacial change on Everest and the surrounding 1,148 square kilometres Sagarmatha National Park by compiling satellite imagery and topographic maps and reconstructing the glacial history. Their statistical analysis shows that there is a significant increase in the rate at which majority of the glaciers in the national park are retreating. According to the researchers, glaciers smaller than one square kilometre in area are disappearing the fastest and have experienced a 43 per cent decrease in surface area since the 1960s.

To evaluate the temperature and precipitation patterns in the area, Thakuri and his colleagues analysed hydro-meteorological data from the Nepal Climate Observatory stations and Nepal's Department of Hydrology and Meteorology and found that there has been a 0.6 degree Celsius increase in temperature and 100 millimetre decrease in precipitation during the pre-monsoon and winter months in the Everest region since 1992.

For India, this is worrying news because the Himalayan glaciers and ice caps are considered a water tower for much of Asia, and especially India, since they store and supply water downstream during the dry season. A large part of the Indian population, especially in the Indo-Gangetic Plain is dependent on the melt water for agriculture, drinking, and power generation during the summer months.

Economic and other losses due to extreme weather events

The year 2012 set major records in climate extremes. It was the hottest year in US history and second wettest one in the UK. Data from 2011 and 2010 show similar extremes. But not only is climate change getting worse, it is also getting costlier. A report by United Nations International Strategy for Disaster Reduction (UNISDR) reveals 2012 is the third consecutive year to suffer economic losses of over $100 billion due to extreme weather events.

Developed nations tend to accrue large economic losses in the face of a natural disaster as they have more assets and infrastructure. Most developing countries, however, rank far higher in terms of number of disasters that hit each year, number of deaths and percentage of population affected, but do not show large financial losses owing to negligible number of insured assets.

Asia was the worst affected in terms of casualties due to natural disasters; 65 per cent of those killed in 2012 were Asians. Most were victims of floods and droughts, which were responsible for nearly 80 per cent of all deaths. But as they occurred in poorer countries, the economic losses are low.

Significantly, economic as well as environmental impacts of climate change are not felt evenly and those who pollute the most might not suffer the most. This raises the question of liability and compensation. At the climate change meet in Doha (CoP-19), under the United Nations Framework Convention on Climate Change (UNFCCC) in November 2012, countries fought a bitter battle to answer just this. In what was considered a mighty win for developing nations, CoP-19 agreed upon "institutional arrangements, such as an international mechanism," to address loss and damage due to climate change in particularly vulnerable developing countries. The agreement was very significant in accepting the concept of loss and damage as going beyond adaptation. It recognises that there are situations where developing countries will not be able to have any adaptation response but will suffer loss and damage like loss of land, crops, etc.

However, UNFCCC still does not have a working definition for loss and damage. Many parties are concerned that losses could be narrowed down to economic loss. What about the non-economic losses, they ask? Who would be liable for the loss of cultural identity and indigenous knowledge when an island goes down or when an area turns to desert? While this makes reaching at a solution more challenging, it is crucial to the issue.

Experts, however, believe that even if a consensus is reached on loss and damage, there's a pressing need for developed nations to mitigate emissions and check further environmental damage.

New home for Gir lions

In order to save the Asiatic lion it has been decided to relocate some animal from the Gir sanctuary in Gujarat to Kuno sanctuary in neighbouring Madhya Pradesh. In India, the Asiatic lion is at present found in only one pocket located in the Gir National Park with its annual diet preferring large prey species – nilgai, cheetal, sambar, chinkara and four-horned antelope. The Asiatic lion is considered to be one of the most endangered carnivores in the world.

For over 18 years, conservationists have been attempting to move a pride of Gir lions to the Kuno sanctuary, but the Gujarat government had been stubbornly refusing to let the lions go. The decision to relocate came after a Supreme Court order on 15 April 2013, which cleared the translocation of the lions after eight years of litigation.

The Supreme Court did acknowledge the Gujarat government's role in saving the lion from extinction that seemed almost certain only a few decades ago. But at the same time it ruled: "No state can claim the right over an animal merely because the animal is housed in a particular state. It does not become the property of that state, it belongs to the country." The Court directed that the lions be moved within six months.

The latest census put the lion population in Gir sanctuary at 410 (97 males, 162 females and 152 cubs), up from 359 in 2005. But most wildlife experts agree that while the state has done well, the lions have outgrown the Gir forest, and a single epidemic or calamity could wipe out the entire population. Already, Gir is getting crowded and making the animals more vulnerable to disease.

The Kuno sanctuary in Sheopur district of Madhya Pradesh, about 400 km from Bhopal is ideally suited for establishment of an alternate home for the lion. Kuno was chosen because of its size - 3,000 sq km - and diverse prey base. Lions need lots of space, plenty of prey, and protection from people. Wildlife studies have shown that the prey count in Kuno is actually higher than that of Gir. 24 villages were relocated in Kuno, at considerable expense, to make way for the lions and reducing the biotic pressures drastically.

India's new weather satellite

INSAT-3D is a meteorological data relay and satellite-aided search and rescue satellite designed and developed by the Indian Space Research Organisation which was launched using an Ariane 5 launch vehicle from French Guiana on 26 July 2013. INSAT-3D supplements the decade-old and fading Kalpana-1 and INSAT-3A with four sophisticated payloads and is expected to sharpen weather observation and forecasting and also enhance land and sea surface monitoring over the sub-continent and the Indian Ocean region. The primary objective of the mission is "to provide an operational, environmental and storm warning system to protect life and property and also to monitor Earth's surface and carryout oceanic observations and also provide data dissemination capabilities".

The satellite is equipped with a six-channel imager that takes weather pictures of the Earth with better resolution than its predecessors. Its 19-channel sounder is the first such over the region and gives layered vertical profiles of temperature, humidity and integrated ozone.

The data relay transponder on-board the satellite will be used for receiving meteorological, hydrological and oceanographic data from remote, uninhabited locations over the coverage area from unmanned data collection platforms (DCPs) like automatic weather station, automatic rain gauge and agro met stations. India Meteorological Department and ISRO have established more than 1,800 DCPs for round-the-clock data gathering and relay.

INSAT-3D is equipped with a search and rescue payload that picks up and relays alert signals originating from the distress beacons of maritime, aviation and land based users and relays them to the mission control centre to facilitate speedy search and rescue operations. The

major users of Satellite Aided Search and Rescue service in India are the Indian Coast Guard, Airports Authority of India, Directorate General of Shipping, Defence Services, and fishermen. The Indian service region includes a large part of the Indian Ocean region covering India, Bangladesh, Bhutan, Maldives, Nepal, Seychelles, Sri Lanka and Tanzania for rendering distress alert services.

New rules for clinical trials

Clinical trials are sets of tests in medical research and drug development that generate safety and efficacy data (or more specifically, information about adverse drug reactions and adverse effects of other treatments) for health interventions (e.g., drugs, diagnostics, devices, therapy protocols). They are conducted only after satisfactory information has been gathered on the quality of the nonclinical safety, and health authority/ethics committee approval is granted in the country where approval of the drug or device is sought. Depending on the type of product and the stage of its development, investigators initially enrol volunteers and/or patients into small pilot studies, and subsequently conduct larger scale studies in patients that often compare the new product with others already approved for the affliction of interest.

Many multinational drug companies have been known to carry out clinical trials in developing countries like India with lax regulations in which patients or individuals are often given a new drug without informed consent. Often adverse effects of the drug under trial lead to death of the unsuspecting individuals. According to reports available, as many as 2,868 deaths have occurred during clinical drug trials across India in the past eight years. But only 89 have been attributed to such trials and compensation has been paid in 45 cases.

Following a recent observation by the Supreme Court that uncontrolled clinical trials "are causing havoc to human life", the Ministry of Health and Family Welfare decided to tighten guidelines for conducting these trials. The Drugs and Cosmetics Rules have been amended by passing three notifications. The notifications specify procedures for compensation and functioning of the ethics committee, which is constituted by an institution conducting the trial.

However, health activists say the notifications are rife with loopholes. The first one deals with compensation in case of injury or death during clinical trial, but the onus of deciding the injury continues to be with those carrying out the trial. Also, the notification does not define injury. Further, claiming compensation would to be difficult. As per the first notification, the Drugs Controller General of India (DCGI) will be the final authority to determine cause of injury and compensation amount. There is a provision that the victim, if not satisfied with the compensation decision, can approach the Centre. However, it is not clear which Central body should be approached. In the absence of an appellate body, the final authority should have been a neutral body, say activists.

In July the Drug Technical Advisory Board (DTAB), the apex decision-making body on drugs safety recommended that a person undergoing clinical trial would not become eligible

for financial compensation just because a new investigational potential drug fails to deliver the desired results. It has also suggested, that if the subject is put under a placebo in a clinical trial, but is not taken off his standard medical regimen, he cannot claim financial compensation for an adverse event. But it recommends that the patient must be explained in detail about the lack of therapeutic effect, at the time when informed consent is taken from him/her, before the trial starts. However, if the patient has been directed to stop his/her regular medication during the placebo trials, and he or she suffers an adverse event, the volunteer can claim compensation for the same. The current rules do not make any distinction between a study-related side-effect and a non-related adverse impact that a clinical trial patient may suffer.

The DTAB has also clarified that the pharmaceutical companies or other sponsor of the clinical trial would have to pay for the free medical management of a subject, only if the injury in question is related to or caused by the trial.

Lithium-sulphur batteries are safer and longer-lasting

Today we have ultra-fast means of telecommunication and versatile portable electronic devices that bring the world to our fingertips anywhere and at any time. But no matter how high-tech these gadgets are, they still need electric power provided by the humble battery for sustenance. Batteries have evolved much over the years. Lithium-ion batteries have replaced the basic carbon-zinc and alkaline ones, which are still used in flashlights and TV remotes. As electronic gadgets become increasingly high-tech, scientists scramble to create batteries that are small, inexpensive and long lasting, and lithium-ion batteries appear to fit in ideally. But recent incidents involving fire risk in lithium-ion batteries in Boeing Dreamliner aircraft had raised doubts about the safety of lithium-ion batteries. Although the issue has been resolved, scientists are looking for better and safer alternatives.

Recently, a team led by Chengdu Liang at the Oak Ridge National Laboratory, USA has designed and tested an all-solid lithium-sulphur battery with approximately four times the energy density of conventional lithium-ion technologies that power today's electronics. Using the new technology the researchers were able to maintain a capacity of 1200 milliamp-hours per gram (mAh/g) after 300 charge-discharge cycles at 60 degrees Celsius. For comparison, a traditional lithium-ion battery cathode has an average capacity between 140-170 mAh/g. The new battery design, which uses abundant low-cost elemental sulphur, also addresses flammability concerns experienced by other chemistries.

The new batteries would also be more environmental friendly compared to current designs. According to the researchers, "not only does sulphur store much more energy than the transition metal compounds used in lithium-ion battery cathodes, but a lithium-sulphur device could help recycle a waste product into a useful technology".

Generic drugs may cut hepatitis care cost

Treatment of Hepatitis B and C, two of the most common liver infections, may soon cost less. New Delhi's All India Institute of Medical Sciences is in the process of developing an exclusive treatment module for Asian patients, who, they claim, suffer from infection of a different genotype (a group of organisms sharing a specific genetic constitution) compared to the western population. There are five main hepatitis viruses, of which B and C is the most fatal as these can lead to liver cirrhosis and cancer. They both spread through contamination of blood by infected blood or blood products. In India, about one lakh people die every year due to acute or chronic consequences of Hepatitis C and four to five million people die due to Hepatitis B. Many patients die as they cannot afford the treatment

Hepatitis C in India is caused predominantly by genotype 3 which is more responsive to treatment than genotype 1, the predominant cause for infection in the West. The difference in genotype not only reduces the need for prolonged treatment, it also opens up possibilities for use of generic drugs. It has observed that regular interferons – cheaper version of antiviral drugs administered to Hepatitis C patients – are effective". A full course of the standard drug – pegylated interferon (a class of antiviral drug that includes three different drugs) – costs between Rs 3.5 and Rs 5 lakh while the generic ones cost less than Rs 1 lakh.

An effective vaccine against Hepatitis B is available and is recommended for all new-borns. If one person in the family has Hepatitis B, chances of others having it are very high. It is important to screen them for the virus before vaccination because the vaccines can only protect uninfected patients.

Fighting drug-resistant kala-azar

Black fever or kala-azar is the second biggest killer in the world after malaria. In India, over 160 million people are at a risk from the disease widespread in Jharkhand, Bihar, Uttar Pradesh and West Bengal. Kala-azar is spread through an insect vector, the sandfly. Sandflies are tiny creatures and are found in tropical or temperate regions throughout the world. Sandfly larvae grow in warm, moist organic matter (such as old trees, house walls, or waste) making them hard to eradicate. Worse, the parasite that causes it, *Leishmania donovani*, has grown increasingly drug resistant in recent years.

But there is some good news. A joint research team from Indian Institute of Chemical Biology (IICB), Kolkata, Indian Institute of Science, Bengaluru, Banaras Hindu University, Varanasi, and Institute of Tropical Medicine and University of Antwerp in Belgium has deciphered how the parasite develops drug resistance. Their study shows *L. donovani* produces a complex sugar molecule to remove drugs from the host cells. This observation can help design new therapeutics against this dreaded disease.

World's Fastest Electrical Switch

Electrical engineers at the United States Department of Energy's National Accelerator Laboratory have built the world's fastest electrical switch - the one that takes just a trillionth of a second to operate. The research team says that this could lead to breakthrough innovations in the transistors designs making them faster, more powerful and reliable with potential use if future computers. Scientists using SLAC's Linac Coherent Light Source (LCLS) X-ray laser found that it takes only 1 trillionth of a second to flip the on-off electrical switch in samples of magnetite, which is thousands of times faster than what the current generation of transistors can achieve.

The researchers say that the breakthrough reveals for the first time the 'speed limit' for electrical switching using magnetite – a naturally magnetic material. The experiment showed the researchers how the electronic structure of the sample they studied rearranged into non-conducting islands. These islands were surrounded by electrically conducting regions which formed very quickly after the laser pulse struck the sample. The experiment also showed the researchers how both conducting and non-conducting states co-exist and can create electrical pathways to be used in the next generation of transistors.

Potential new drug for TB

Tuberculosis (TB) is an infectious disease that is caused by a bacterium called *Mycobacterium tuberculosis*. TB primarily affects the lungs, but it can also affect organs in the central nervous system, lymphatic system, and circulatory system among others. The disease was called "consumption" in the past because of the way it would consume from within anyone who became infected and was fatal in most cases.

TB is the second biggest cause of deaths worldwide, second only to HIV/AIDS. India has the highest incidence of TB with about 2.2 million cases out of a global incidence of 8.7 million, according to WHO (2011). It continues to be the biggest health problem in India and remains one of the largest on India's health and wellness scale. What makes the problem worse is the prevalence of multidrug-resistant tuberculosis (MDR-TB) and the recently discovered global phenomenon of extensively drug-resistant tuberculosis (XDR-TB), which is widely prevalent in India. Now there is hope with the discovery of an entirely novel treatment for the disease that is also effective against resistant bacteria that cause MDR-TB and XDR-TB.

Researchers at the New Jersey Medical School of University of Medicine and Dentistry of New Jersey, USA, have synthesised a small molecule called Q203 that thwarts drug resistant tuberculosis infections in mice by dissolving its protective fatty coating that cripples the TB bacteria – a mechanism distinct from that of existing drugs. The finding could eventually be used to improve TB treatment in humans (*Nature Medicine*, 4 August 2013 | doi:10.1038/nm.3262). Q203 is effective in mice and bears no similarity to existing TB drugs, many of which have become inadequate as drug-resistant bacterial strains have developed. The new compound acts by novel mechanism and is effective in mice, offering a

potential new weapon to improve therapeutic options for the treatment of drug-resistant TB in humans.

A few anti-TB drugs are known that disrupt the fatty coating of *M. tuberculosis,* but so far no single drug has been able to kill the bacteria completely. The researchers, Kevin Pethe and colleagues investigated more than 120,000 compounds over 5 years, infecting mouse immune cells called macrophages with *M. tuberculosis* and observing whether the compounds being tested inhibited bacterial growth. They discovered a class of compounds called thiophenes that killed the bacterium in culture without the emergence of drug resistance. And the combination of thiophene and the existing coat-busting drug isoniazid achieved 100 per cent bacterial killing. Subsequent tests showed the compound to be successful at treating TB in mice.

The new drug molecule belongs to a new class of synthetic chemicals with no similarities to existing drugs. The researchers showed that the synthetic antibacterial compound has a novel mechanism of action: it targets part of the *M. tuberculosis* electron chain and inhibits ATP synthesis, which is needed for cellular energy production, and thereby blocks the growth of the bacterium. This factor could make it tougher for the bacteria to develop resistance to it.

In addition, according to the researchers, Q203 displays safety properties compatible with once-daily dosing. Together, the research data indicate that Q203 is a promising new clinical candidate for the treatment of tuberculosis.

However, before Q203 can be used for effectively treating TB in humans, more studies are needed. The candidate drug will be put on phase I clinical trials next year to assess its safety and tolerability in a small group of healthy human volunteers. And only 5% of drugs that make it to phase I in all disease areas ultimately end up as marketed pharmaceuticals. But, still, the new discovery marks significant breakthrough in treatment of drug-resistant TB.

The Kepler spacraft

The Kepler spacecraft, launched by NASA in 2009 to look for Earth-like planets in a narrow region of the sky, was finally put out of action by the loss of a second gyroscope-like "reaction-wheel"– a mechanism that helped accurately point the craft at a certain star. It needed at least three out of its four original wheels to continue collecting data, and after May 2013 it was left with only two.

The Kepler spacecraft was NASA's extra-solar planet hunter. The first of its kind, the spacecraft successfully confirmed the existence of 136 planets around other stars before it became inoperative.

The way it found those planets was relatively simple: It monitored a rich star field for the dimming of starlight when a planet would orbit in front of its respective Sun – known as the

technique of 'transit'. Specifically, the Kepler spacecraft would read the light from stars near the constellations of Cygnus and Lyra – it closely monitored over 100,000 stars simultaneously during its tenure. Not only did Kepler confirm hundreds of planets outside our own solar system – so called "exoplanets" – it collected evidence suggestive of thousands of planets not yet confirmed. According to NASA, with the help of the Kepler spacecraft astronomers have discovered 2,740 planet candidates orbiting 2,036 other suns in a search for Earth-sized worlds.

Though the spacecraft can no longer be used to search for exoplanets using the transit technique, it can still be used for collecting information about extra-solar planets by using yet another technique known as 'microlensing'. This method looks for magnification of a star's light when two stars align themselves with respect to the telescope. Any star with orbiting planets could even double the brightness of the other star's light. Even as Kepler's fate is being decided, there can be no denying that it has revolutionised our understanding of stars and earth-twins.

Micro Pulse Lidar

Micro pulse lidar (MPL) is a versatile tool for atmospheric observations and weather forecasting. It is a sophisticated laser remote sensing system that provides continuous, unattended monitoring of the profiles and optical properties of clouds and aerosols in the atmosphere. Based on the same principle as radar, a micro pulse lidar transmits green laser pulses that scatter off particles in the atmosphere. The laser pulses go through atmospheric layers that include air molecules, aerosols (pollutants) and clouds. Return pulses give information on atmospheric composition. The micro pulse lidar lab collects the data and measures the intensity of backscattered pulses using photon-counting detectors, and transforms the signal into atmospheric information in real time.

Recently an indigenously designed micro pulse lidar has been installed in the second campus of Indian Institute of Technology in Challakere in Chitradurga District, Karnataka. The first of its kind in India, it will be used to improve weather forecasts. The data collected from the laser beam can make an extensive study of the climate in areas within 200-plus km radius. According to scientists of IISc, the installation will be of great help in foretelling the nitty-gritties of capricious weather such as, whether it will be a cloudburst or heavy winds; how strong or weak the next monsoon will be; whether the mercury will soar higher next summer; or how cold next November will be? These are some of the questions that can be answered with more precision with help from data gathered by the micro pulse lidar.

Meteorologists can use a micro pulse lidar to improve the quality of weather and air quality forecasts. Atmospheric and environmental researchers and regulators can use it to improve

models and emission estimates by determining the extent of manmade and natural aerosols and measuring the height of the Micro pulse lidar can also be used by airports and air traffic controllers to optimise aviation safety through enhanced cloud and volcanic ash profiling

In addition to improving weather models and forecasts, micro pulse lidar cloud profiles can also provide detailed information to air traffic control for pilots near airports and thereby enhance aviation safety.

Google Glass (Youtube Video)

Essentially, Google Glass is a camera, display, touchpad, battery and microphone built into spectacle frames so that you can perch a display in your field of vision, film, take pictures, search and translate on the go. Google Glasses look like a pair of normal eyeglasses, but the lenses of the glasses are an interactive, smartphone-like display, with natural language voice command support as well as Bluetooth and Wi-Fi connectivity. Google Glass is powered by the Android mobile operating system and is expected to offer compatibility with both Android-powered mobile devices and Apple iOS-powered devices.

Google Glass uses display technology instead to put data in front (or at least, to the upper right) of your vision courtesy of a prism screen. This is designed to be easily seen without obstructing your view. According to Google the display is "the equivalent of a 25-inch high definition screen from eight feet away".

The embedded camera obviously does not need a viewfinder because it is simply recording a first-person perspective, allowing the wearer to take snaps or footage of what he or she is actually seeing. Any function that requires the wearer to look at a screen could be put in front of him or her.

All data is controlled with a microphone and touchpad on one arm of the frame and one can select whatever one wants to do with a brief gesture or by talking to the device, and Google Glass will interpret the commands.

Low-cost microsatellites

Imaging from a satellite is a standard technique of remote sensing for natural resources and cartography (map making). Satellites offer a unique vantage point that can reveal things on ground that no other imaging technology can offer. But commercial satellites used for remote sensing are large and expensive, costing millions of rupees. Very soon, inexpensive, low-orbiting microsatellites will be sending back frequent, low-cost snapshots of most of Earth's populated regions from space. Commercial companies, universities, space research agencies such as NASA and ESA, are all in the development of a new spacecraft generation called microsatellites.

The new satellites, some weighing even less than 10 kg, built with some of the same off-the-shelf miniaturised technology that has made smartphones and laptops so powerful, will be far less expensive than their larger counterparts. Moreover, since putting a satellite in orbit is a function of its size, these new satellites can be put into orbit at a much lower cost. The companies operating such satellites do not have to spend millions of rupees for a rocket to get them into space. Instead, they can hitch a ride as a secondary payload on a rocket already making the trip.

The view from high up is rich in untapped data, and the new satellite services may find many customers. Insurance companies, for example, could use the satellites' "before" and "after" views to monitor insured property and validate claims after a disaster. Businesses that update online maps for geologists, city planners or disaster relief officials could be customers, too. The images could also be used to monitor problems like deforestation, melting icecaps and overfishing. In addition, food companies and commodities traders could use the images to keep track of crops and agricultural yields all over the planet. And these service could be had at much less cost than available from commercial remote sensing satellites today.

At the same time, however, the frequency with which images can be updated could raise privacy questions. The images are also likely to be viewed as the latest mixed blessing by people already apprehensive of Big Brother-like surveillance in their lives.

Sun Changing Its Magnetic Polarity

The Sun's magnetic field changes polarity approximately every 11 years during the peak of each solar cycle as the Sun's inner dynamo reorganises itself. This next reversal which will occur in the coming three to four months will be only the fourth observed since tracking began in 1976 and will mark the midpoint of Solar Cycle 24. The flipping of the Sun's magnetic field marks the peak of the star's 11-year solar cycle and the halfway point in the Sun's "solar maximum" – the peak of its solar weather cycle.

During a magnetic field reversal, the Sun's polar magnetic fields weaken, go to zero and then emerge again with the opposite polarity. This is a regular part of the solar cycle. The magnetic pole reversal is likely to have ripple effects throughout the solar system. It will lead to more geomagnetic storms but will also provide extra shielding from dangerous cosmic rays which are produced by supernova explosions and zip through the universe at nearly the speed of light. They can harm satellites and astronauts in space, and the changes produced during Sun's pole reversal better protects the planet from these particles.

According to experts, the current solar maximum is the weakest in 100 years and there have been fewer sunspots seen than is usual during a solar maximum. Usually, at the height of a solar cycle, sunspot activity increases and there are increased incidence of solar flares and coronal mass ejections. But the number of sunspots seen during the current solar maximum is far less than in the number of sunspots observed during maximums of previous cycles.

Type-1 diabetes:- Insulin is not produced
Type-2 " → produced insulin is not sufficient
→ 90% of world diabetic patients has type

Lunar Atmosphere and Dust Environment Explorer (LADEE)

For nearly a half century, planetary scientists have been puzzled by tenuous "clouds" of dust hovering over the lunar surface. With observations from a soon-to-be-launched spacecraft, they finally hope to understand just what's going on.

First seen by the Surveyor 7 lander in 1968 and later by Apollo astronauts, clouds of fine dust sometimes levitate above the lunar surface. Since these localised "flurries" occur at dawn and dusk, researchers have speculated that some kind of static charging might be involved. But the true cause remains unknown.

To help unravel this longstanding mystery, NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE) was launched towards Moon on 6 September. 30 days after leaving Earth, a final rocket blast will nudge LADEE into a looping retrograde orbit over the lunar equator. Eventually that will be trimmed first to a circular altitude of about 250 km, and then to an even lower circuit that at times skims no more than 20 km from the lunar surface.

LADEE will use its ultraviolet spectrometer and neutral mass spectrometer to analyse the ultra-tenuous wisps of gas hovering over the Moon. This exosphere probably arises due to the continual bombardment of the lunar surface and is likely rich in helium (derived from solar-wind ions trapped on grain surfaces) and argon (produced by the decay of radioactive potassium in the lunar crust).

Meanwhile, the Lunar Dust Experiment will sweep up high-flying motes as small as 2 microns across. After striking the instrument's hemispherical target, they'll vaporize into tiny clouds of ions and electrons that reveal the particles' mass and composition.

The $280-million spacecraft is expected to spend about 100 days exploring moon's atmosphere and the role of dust in the lunar sky before running out of fuel and crashing into the Moon's surface.

Indian scientists find endogenous water on the Moon

It was the Indian Moon probe Chandrayaan-1 that found evidence of water on Moon for the first time in 2009. But the source of the lunar water was not known. Now a team of Indian scientists from the Space Applications Centre (SAC) in Ahmedabad, led by Satadru Bhattacharya, has found evidence of water of volcanic origin — water that has originated from deep within the Moon's interior — rather than water-bearing igneous surface lunar material detected hitherto by different lunar missions including Chandrayaan-1. The finding is based on an analysis of high-resolution spectral data of the Compton-Belkovich Volcanic Complex region on the far side of the Moon obtained by the NASA instrument Moon Minerology Mapper (M3), which was sent aboard the Indian lunar mission Chandrayaan-1.

Thus far scientists had believed lunar rocks were "bone dry" and that any water detected in lunar samples was either due to contamination from the Earth or produced by solar wind and other exogenous extra-lunar sources. Significantly, the concentration of the water detected by Indian researchers — 0.55 per cent by weight — is the highest ever found on the Moon. The presence of such endogenous water could call for revision of models of Moon's origin

Stem cells

Introduction

During embryonic development, specialized cells (e.g., muscle or immune cells) arise from a common stem cell that differentiates via a series of cellular changes triggered by specific gene expression patterns. Scientists can recover these embryonic stem (ES) cells from embryos and manipulate them in vitro to study early development. They can also differentiate ES cells into cell types that are useful for therapeutic purposes, such as transplantation. This technology raises a significant ethical concern because most ES cells arise from human embryos. Some ethical concerns may be circumvented by the discovery that somatic cells can be reprogrammed to a pluripotent state. The reprogrammed cells, called induced pluripotent stem (iPS) cells, exhibit functional similarities to ES cells and present an exciting area of research. The ability to reprogram somatic cells into iPS cells that are pluripotent and can self-renew has transformed the fields of developmental biology and regenerative medicine.

Reprogramming Somatic Cells into Pluripotent iPS Cells

Earlier experiments in cell fusion and nuclear transfer showed that gene expression in differentiated cells remained dynamic and reversible. Silent genes in a specific cell type can be reactivated by fusing the cells with a different cell type. Subsequently, several studies showed that introduction of defined transcription factors could convert specialized cell types from one lineage to another. When somatic cells were reprogrammed by transferring their nuclei into oocytes or by fusion with ES cells, genome-wide transcriptional activity and DNA methylation patterns were converted from the somatic state to an embryonic state.

In 2006, Kazutoshi Takahashi and Shinya Yamanaka established for the first time murine ES-like cell lines from mouse embryonic fibroblasts (MEFs) and skin fibroblasts by simply expressing four transcription factor genes encoding Oct4, Sox2, Klf4, and c-Myc (Takahashi & Yamanaka 2006). They called these somatic cell-derived cell lines induced pluripotent stem (iPS) cells. These iPS cell lines exhibit similar morphology and growth properties as ES cells and express ES cell-specific genes. Transplantation of iPS cells into immunodeficient mice resulted in the formation of germ-cell-tumor (teratoma)-containing tissues from all three germ layers, confirming the pluripotent potential of iPS cells. However, there were two problems: the low efficiency of establishing iPS cell lines and some variations in gene expression profiling between iPS cells and ES cells. The latter issue raised the concern that cell reprogramming may be insufficient to restore full pluripotency in somatic cells as exhibited by ES cells.

The most stringent test for pluripotency is known as the tetraploid blastocyst complementation assay. The method involves merging the embryonic (ES or iPS cells) and extraembryonic tissue (tetraploid cells) from two different species of animals and then testing to see if the embryonic tissue is sufficient for the normal development to the adult stage. Using this assay, several studies now show the production of fertile adult mice derived entirely from iPS cells, therefore confirming the true pluripotency gained by iPS cells during the reprogramming process.

Modeling Human Diseases with iPS Cells

Availability of patient-specific iPS cell lines provides unprecedented opportunities to elucidate disease mechanisms in vitro, to carry out drug screening and toxicology studies, and

to advance cell replacement therapy in regenerative medicine (Colman & Dreesen 2009). Reprogramming of fibroblasts from patients with Mendelian and complex genetic disorders — such as amyotrophic lateral sclerosis, type 1 diabetes, Parkinson's disease, and Duchenne muscular dystrophy — allows the establishment of disease-specific iPS cell lines. To study the disease mechanism, a key issue is whether the affected cell type derived from iPS cells can recapitulate the disease phenotype.

However, the use of iPS cells to model adult-onset diseases such as Parkinson's disease and amyotrophic lateral sclerosis proves to be more elusive. Relevant cell types derived from patients' iPS cells of these diseases have so far failed to exhibit disease-related phenotypes. Exposure of the differentiating cells to stress conditions by increasing the level of nitrogen and oxygen reactive species, proinflammatory factors, or even toxins may be necessary to speed up the emergence of pathological status in relevant cell types derived from iPS cells.

The other limitation in modeling human diseases with iPS cells is that a single cell type may not be sufficient to manifest the full spectrum of pathogenesis. Interaction among different cell types may be important to reconstruct the disease phenotypes faithfully. In this case, we first need to identify the interacting cell types and then work out a protocol for iPS cell differentiation into these cell types so as to recapitulate full disease phenotypes. Ultimately, it may be necessary to transplant iPS-derived cells into immunodeficient mice to reveal disease phenotypes.

The Limitations of Reprogrammed iPS Cells

The most noted problem is the use of retroviral and lentiviral vectors to introduce the four transcription factor genes into somatic cells for cell reprogramming. These viral vectors preferentially integrate into active genes and therefore have the potential to activate flanking cellular genes and transform the transplanted cells. In addition, most of the four introduced transcription factors possess oncogenic potentials, and persistent expression of any of them may provide cell growth advantage and increase the chance for cell transformation. Although expression of these four genes for the most part is silent in established iPS cell lines, residual expression or reactivation of their expression in transplanted iPS cells can induce tumors in mice. Thus, although iPS cells derived from this route may be suitable for the study of disease mechanisms or for drug screening and validation, they definitely are not suitable for cell replacement therapy.

Many alternative gene delivery strategies — including the use of episomal vectors, nonintegrating viral vectors, transient DNA transfection, transposons, and protein transduction — can overcome this problem. A general principle common to all these strategies is the transient expression of the four transcription factors at sufficient levels to trigger the initiation of the cell reprogramming event without permanent integration of the four genes into the host genome. Although these strategies work for the most part, the efficiency of generating iPS cell lines is significantly reduced compared with the approach of retroviral and lentiviral vectors.

Use of small molecules to activate the pluripotency program in somatic cells represents perhaps the safest approach to create reprogramming factor-free iPS cells. Several small molecules, when used singly, could substitute for some of the reprogramming factors. However, so far it is not possible to use only small molecules to reprogram somatic cells. High throughput screening of small molecules for cell reprogramming is ongoing in many laboratories, and the ultimate goal would be to establish iPS cells free of any exogenously introduced DNA fragments.

Yet another problem with iPS cells in the study of disease mechanism is that defining a disease-related phenotype is frequently hindered by the intrinsic variability in differentiation potentials observed among different iPS cell lines. This variability makes it less certain that any observed phenotype in cells derived from a single iPS cell line is caused by the defective gene function. Therefore, to ensure that the exhibited phenotypes are not unique to a specific iPS cell line or a particular patient, it is important to evaluate several iPS cell lines generated from the same patient as well as those generated from different patients with the same disease. Alternatively, restoration of the missing gene function in mutant iPS cells provides an ideal isogenic control for any observed phenotype.

Clinical trial

The first human clinical trial using autologous iPSCs is approved by the Japan Ministry Health and will be conducted in 2014 in Kobe. iPSCs derived from skin cells from six patients suffering from wet age-related macular degeneration will be reprogrammed to differentiate into retinal pigment epithelial (RPE) cells. The cell sheet will be transplanted into the affected retina where the degenerated RPE tissue has been excised. Safety and vision restoration monitoring is expected to last one to three years. The benefits of using autologous iPSCs are that there is theoretically no risk of rejection and it eliminates the need to use embryonic stem cells.

Lifestyle diseases to cost India $6 trillion

The Harvard School of Public Health has, in a study on economic losses due to non-communicable diseases (NCDs), estimated that the economic burden of these ailments for India will be close to $6.2 trillion for the period 2012-30, a figure that is equivalent to nearly nine times the total health expenditure during the previous 19 years of $710 billion.

NCDs, chiefly cardiovascular diseases (including heart disease and stroke), diabetes, cancer and chronic respiratory diseases, are defined as diseases of long duration and generally slow progression. They are the major cause of adult mortality and illness worldwide.

The Harvard report, which is based on WHO projections of the mortality trajectory associated with NCDs, says ischemic heart disease is going to be the single most costly non-communicable disease in India (causing an output loss of about $1.21 trillion over 2012-30), followed by chronic obstructive pulmonary disease (COPD).

Most of the non-communicable diseases, for example diabetes or heart disease, affect the person in the productive years. They cause reduced productivity and early retirement. Also, they put immense pressure on public health expenditure as in most cases the treatment costs are higher compared to communicable diseases.

The increasing burden of NCDs could rob India of the 'demographic dividend' it is projected to reap on account of a predominantly young population. A recent report published by IRIS Knowledge Foundation in collaboration with UN-HABITAT states that by 2020, India is set to become the world's youngest country with 64% of its population in the working age group.

The WHO has suggested 'best buy' interventions (policy measures) for reducing NCDs that include increasing tax on tobacco products and alcohol and ban on their advertising. It also

proposes interventions such as reduced salt intake in food, counselling and multi-drug therapy for people with a high risk of developing heart attacks and strokes, and hepatitis B immunization to prevent liver cancer.

"The implementation of these 'best buy' interventions for reducing NCDs in low-and-middle income countries (LMICs) could lead to a 10-15 percent reduction in premature death from NCDs (and in their economic costs)," the Harvard researchers have pointed out.

An earlier study conducted by the World Economic Forum and Harvard School of Public Health estimated that a 12.5% reduction in ischemic heart disease, for example, could lead to economic savings of $25 billion per year over the period 2011-2025.

Dr Renu Garg, WHO's regional advisor of non-communicable diseases for South East Asia, said that India is going to adopt the New Delhi declaration on high blood pressure in the WHO meet to be held in the national capital next week. The declaration, a policy framework, aims to reduce hypertension, a major risk factor for NCDs like heart attack and stroke.

The New Delhi Declaration on September 10 will be followed by the 66th Session of the WHO regional committee which meets once a year to review progress and regional implications of the World Health Assembly decisions and to map the way forward. The focus areas include universal health coverage, adoption of the global targets for prevention and control of non-communicable diseases and measles and rubella control.

The targets include 10% reduction in alcohol consumption, halt in rise of obesity and diabetes and 50% reduction in households using solid fuels for household cooking.

National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular diseases and Stroke (NPCDCS) is the pilot programme that the GoI has started to tackle the growing menace of non-communicable diseases. It entails health education and mass media efforts at country level, opportunistic screening of persons above the age of 30 years, establishment of Non Communicable Disease (NCD) clinics at CHC and district level, development of trained manpower and strengthening of tertiary level health facilities.

Polypill for CVDs

For the first time, doctors and researchers have come up with a single pill for all cardiovascular diseases (CVD), including high blood pressure and vulnerability to stroke, doing away with the pain of popping multiple pills to keep your heart healthy.

In India, compliance to multiple pills for CVD is as low as 10%.

While studies have shown that patients with CVD do not take recommended medications in the long-term, the use of fixed-dose combinations (FDCs) like a polypill improves adherence to a large extent. The study showed adherence rate increasing by 20% with use of the polypill, a combination of aspirin, statin (cholesterol lowering drugs), and two blood pressure-lowering agents.

Polycap is a specific five-in-one fixed dose combination polypill created by Cadila Pharmaceuticals Limited of Ahmedabad, India that combines moderate levels of five

different medications in a single, one-a-day pill aimed at reducing/preventing heart attacks and strokes. A prominent 2009 study found that this pill's combination of three blood pressure medications, a cholesterol reducer, and aspirin had cut the risk of heart attack and stroke in half, with no more adverse effects than taking the components separately.

As tested, "Polycap" combines 100 milligrams of aspirin, with simvastatin (a generic version of Zocor, the cholesterol-lowering statin; 20 mg) and low doses of three blood pressure medications, atenolol (50 mg), ramipril (5 mg) and thiazide (12.5 mg). And despite containing multiple drugs, the pill has a fairly small size which can facilitate swallowing.

Obesity and liver cancer

Obesity has become more prevalent in most developed countries over the past few decades, and is increasingly recognized as a major risk factor for several common types of cancer. As the worldwide obesity epidemic has shown no signs of abating, better understanding of the mechanisms underlying obesity-associated cancer is urgently needed. Although several events were proposed to be involved in obesity-associated cancer, the exact molecular mechanisms that integrate these events have remained largely unclear.

It has now been shown that senescence-associated secretory phenotype (SASP) has crucial roles in promoting obesity-associated hepatocellular carcinoma (HCC) development in mice. Dietary or genetic obesity induces alterations of gut microbiota, thereby increasing the levels of deoxycholic acid (DCA), a gut bacterial metabolite known to cause DNA damage. The enterohepatic circulation of DCA provokes SASP phenotype in hepatic stellate cells (HSCs), which in turn secretes various inflammatory and tumour-promoting factors in the liver, thus facilitating HCC development in mice after exposure to chemical carcinogen.

Notably, blocking DCA production or reducing gut bacteria efficiently prevents HCC development in obese mice. Similar results were also observed in mice lacking an SASP inducer or depleted of senescent HSCs, indicating that the DCA–SASP axis in HSCs has key roles in obesity-associated HCC development. Moreover, signs of SASP were also observed in the HSCs in the area of HCC arising in patients with non-alcoholic steatohepatitis, indicating that a similar pathway may contribute to at least certain aspects of obesity-associated HCC development in humans as well.

Plants communicate via underground fungus

Mycorrhizae are mutualistic - they both need and are needed by the plants whose roots they inhabit

Plants can communicate the onset of an attack from aphids by making use of an underground network of fungi, researchers have found.

Instances of plant communication through the air have been documented, in which chemicals emitted by a damaged plant can be picked up by a neighbour.

But below ground, most land plants are connected by fungi called mycorrhizae.

The new study, published in Ecology Letters, demonstrates clearly that these fungi also aid in communication.

It joins an established body of literature, recently reviewed in the Journal of Chemical Ecology and in Trends in Plant Science, which has suggested that the mycorrhizae can act as a kind of information network among plants.

Researchers from the University of Aberdeen, the James Hutton Institute and Rothamsted Research, all in the UK, devised a clever experiment to isolate the effects of these thread-like networks.

The team concerned themselves with aphids, tiny insects that feed on and damage plants.

Many plants have a chemical armoury that they deploy when aphids attack, with chemicals that both repel the aphids and attract parasitic wasps that are aphids' natural predators.

The team grew sets of five broad bean plants, allowing three in each group to develop mycorrhizal networks, and preventing the networks' growth in the other two.

To prevent any through-the-air chemical communication, the plants were covered with bags.

As the researchers allowed single plants in the sets to be infested with aphids, they found that if the infested plant was connected to another by the mycorrhizae, the un-infested plant began to mount its chemical defence.

Those unconnected by the networks appeared not to receive the signal of attack, and showed no chemical response.

"Mycorrhizal fungi need to get [products of photosynthesis] from the plant, and they have to do something for the plant," explained John Pickett of Rothamsted Research.

"In the past, we thought of them making nutrients available from the [roots and soil], but now we see another evolutionary role for them in which they pay the plant back by transmitting the signal efficiently," he told BBC News.

Prof Pickett expressed his "abject surprise that it was just so powerful - just such a fantastic signalling system".

The finding could be put to use in many crops that suffer aphid damage, by arranging for a particular, "sacrificial" plant to be more susceptible to aphid infestation, so that when aphids threaten, the network can provide advance notice for the rest of the crop.

"Now we've got a chance in a really robust manner of switching on the defence when it is needed - not straining the plant to do it all the time - and to reduce the development of resistance (of the aphids to the plants' defences)," Prof Pickett said.

Universal testing for HIV every five years would be cost effective for India

In India most people who are HIV positive don't know it, yet testing and treatment are relatively cheap and available. It would therefore meet international standards of cost-effectiveness — and save millions of lives for decades — to test every person in the billion-plus population every five years according to a new study published in the journal *PLoS One*.

"Testing even 800 million adults is a public health undertaking of a historic magnitude, but what we were able to show is that ... even under those dire circumstances, testing this frequently and this widely still was reasonable."

The findings are based on a careful analysis of India's HIV epidemic using the Cost-Effectiveness of Preventing AIDS Complications (CEPAC) International model, a sophisticated statistical tool that has already been used in HIV policymaking in France, South Africa, and other countries. A team of researchers at Brown, Yale, Massachusetts General Hospital, Harvard, and in Chennai, India, integrated scores of factors specific to the country to find that testing for the whole country, with greater frequency for high-risk groups and areas, would pay off despite India's huge population and even in cases where conditions are worse than the researchers assume.

"Testing even 800 million adults is a public health undertaking of a historic magnitude," said study co-lead author Dr. Kartik Venkatesh, a postdoctoral fellow at Brown University and Women & Infants Hospital. "But what we were able to show is that even if you increase the cost of HIV treatment and care pretty significantly and really decrease the number of individuals who would link to care, even under those dire circumstances, testing this frequently and this widely still was reasonable."

Co-author Dr. Soumya Swaminathan, director of the National Institute for Research in Tuberculosis in Chennai, India, said the projections of the model will help the country in its battle with the epidemic, one of the world's largest.

"The paper explores various strategies and suggests cost-effective options for HIV testing in India," Swaminathan said. "As India moves ahead in its HIV prevention activities and aims for zero new infections, expanding testing will be a key priority and this analysis should help policymakers make the best decisions."

Dollars per life-years saved

The main results from the model are projections of the dollar cost per year of extended lifespan. The World Health Organization's standard for cost effectiveness is an expenditure that is less than three times the per capita GDP of a country. In India in 2010, per capita GDP was $1,300. A program is therefore cost-effective in India if the expense is less than $3,900 to save a year of someone's life.

Modern antiretroviral therapies can give HIV-positive people a normal lifespan, and in India, which has a thriving generic pharmaceutical sector, first-line therapy costs only $8.61 a month (second-line therapy for those whose viruses prove resistant is $55.12 a month). HIV tests, meanwhile, cost only $3.33.

They ran the models not only for the general population but also for people in high-risk districts and high-risk groups (e.g., with a higher prevalence of the virus but with more frequent testing today).

As they ran the numbers to determine the costs and effects on patients of broader and more frequent testing, they compared the results to what would happen under the status quo, in which there is less-than-universal testing.

Here is what they found:

- Testing the general population just once would be "very cost-effective" because it would cost $1,100 per year of life saved (YLS) in general and $800 per YLS among high-risk populations.
- Testing the population every five years would be "cost-effective" with a price of $1,900 per YLS saved in general, and $1,300 per YLS among high-risk groups.
- Testing annually would not be cost-effective for the general population ($4,000/YLS), but would be for high-risk people ($1,800/YLS).

The general trends of cost effectiveness remained even after "sensitivity" analyses in which the researchers entered different statistical assumptions in the model in case their assumptions were too optimistic. But to make testing the general population every five years no longer cost-effective, the researchers had to tell the model that only 20 percent of the general population would agree to testing and only 20 percent of positive patients would get care.

Addressing an epidemic

Venkatesh said the main benefit of national testing would simply be getting more people to learn they are positive and therefore to seek effective care before they have full-blown AIDS and a complication. A secondary benefit, however, would be to curb transmission of the virus, both because behavior can change and because therapy can reduce transmissibility.

National AIDS Control Programme

NACP-IV seeks to consolidate the gains of NACP-III and learn from the lessons of the previous phases of programme implementation. It aspires to further strengthen and decentralize the programme to state and district levels. NACP-IV remains a prevention-oriented plan with adequate coverage of HIV care in the context of the concentrated epidemic situation in India.

Taking into account the successful implementation of NACP III and outcome of wider consultation, the salient features of NACP IV are:

· Preventing new infections by sustaining the reach of current interventions and effectively addressing emerging epidemics

· Preventing Parent-to-child transmission

· Focusing on IEC strategies for behaviour change in HRG, awareness among general population and demand-generation for HIV services

· Providing comprehensive care, support and treatment to eligible PLHIV

· Reducing stigma and discrimination through Greater involvement of PLHIV (GIPA)

· Ensuring effective use of strategic information at all levels of programme

· Integrating HIV services with the health system in a phased manner

· Mainstreaming HIV/AIDS activities with all key central- and state-level Ministries/departments and leveraging resources of the respective departments.

New WHO guidelines on treatment of HIV

New HIV treatment guidelines by WHO recommend offering antiretroviral therapy (ART) earlier. Recent evidence indicates that earlier ART will help people with HIV to live longer, healthier lives, and substantially reduce the risk of transmitting HIV to others. The move could avert an additional 3 million deaths and prevent 3.5 million more new HIV infections between now and 2025.

Call to initiate treatment at 500 CD4 cells/mm³ or less

The new recommendations encourage all countries to initiate treatment in adults living with HIV when their CD4 cell count falls to 500 cells/mm³ or less – when their immune systems are still strong. The previous WHO recommendation, set in 2010, was to offer treatment at 350 CD4 cells/mm³ or less. 90% of all countries have adopted the 2010 recommendation. A few, such as Algeria, Argentina and Brazil, are already offering treatment at 500 cells/mm3.

WHO has based its recommendation on evidence that treating people with HIV earlier, with safe, affordable, and easier-to-manage medicines can both keep them healthy and lower the amount of virus in the blood, which reduces the risk of passing it to someone else. If countries can integrate these changes within their national HIV policies, and back them up with the necessary resources, they will see significant health benefits at the public health and individual level, the report notes.

Further recommendations

The new recommendations also include providing antiretroviral therapy - irrespective of their CD4 count - to all children with HIV under 5 years of age, all pregnant and breastfeeding women with HIV, and to all HIV-positive partners where one partner in the relationship is uninfected. The Organization continues to recommend that all people with HIV with active tuberculosis or with hepatitis B disease receive antiretroviral therapy.

Another new recommendation is to offer all adults starting to take ART the same daily single fixed-dose combination pill. This combination is easier to take and safer than alternative combinations previously recommended and can be used in adults, pregnant women, adolescents and older children.

The Organization is further encouraging countries to enhance the ways they deliver HIV services, for example by linking them more closely with other health services, such as those for tuberculosis, maternal and child health, sexual and reproductive health, and treatment for drug dependence.

Challenges remain

Challenges still remain. Alongside the new treatment guidelines, a treatment progress update by WHO, UNAIDS, UNICEF identified areas in need of attention.

While the number of all eligible children on ART has increased by 10% between 2011 and 2012, this is still too slow compared to the 20% increase in adults. A further complication is that many key populations such as people who inject drugs, men who have sex with men, transgender people and sex workers, continue to face legal and cultural barriers that prevent them getting treatment that otherwise would be more easily available. Another factor that needs to be addressed is the significant proportion of people who, for many reasons, 'drop out' of treatment.

HIV vaccine: SAV001-H

Phase I Clinical Trial (SAV CT 01) of the first and only preventative HIV vaccine based on a genetically modified killed whole virus (SAV001-H) has been successfully completed with no adverse effects in all patients, Western and Sumagen Canada Inc. announced today.

Developed by Dr. Chil-Yong Kang and his team at the Schulich School of Medicine & Dentistry, with the support of Sumagen Canada, the vaccine (SAV001-H) holds tremendous promise for success in the final phases of clinical testing now that the first hurdle has been accomplished.

This vaccine is the first genetically modified killed whole virus vaccine (SAV001-H) in human clinical trial to evaluate its safety, tolerability and immune responses. The human clinical trial was initiated in March 2012 and completed in August 2013. This trial was a randomized, observer-blinded, placebo-controlled study of killed whole HIV-1 vaccine (SAV001-H) following intramuscular (IM) administration. HIV-infected, asymptomatic men and women, 18-50 years of age, have been enrolled in this study and randomized into two treatment groups to administer killed whole HIV-1 vaccine (SAV001-H) or placebo.

No serious adverse event was observed in any volunteer vaccines throughout the observation periods.

In addition to safety evaluation, HIV-1 specific antibody detections have been performed throughout the follow up period. The antibody against p24 capsid antigen increased as much as 64-fold in some vaccines and antibody against gp120 surface antigen increased up to eight-fold after vaccination. The increased antibody titers were maintained during the 52 week study period. The boost antibody production in HIV-positive volunteer vaccines is highly encouraging, since it forecasts a success of the Phase 2 human clinical trial, which will measure the immune responses.

In particular, the antibody against gp120 surface antigen is considered to be very important, since some of these antibodies may represent the broadly neutralizing antibodies, which seem to be the most important parameter of an effective HIV vaccine for prevention of HIV-infection.

HIV/AIDS has killed 35 million people worldwide, and more than 34 million people currently live with the virus infection. Since the virus was characterized in 1983, there have been numerous trials through pharmaceutical companies and academic institutions around the world to develop vaccines; however, no vaccine has been successful to date. Other HIV vaccines evaluated through human clinical trials have focused on either one specific component of HIV as an antigen, genetic vaccine using recombinant DNA, or recombinant viruses carrying the HIV genes. Kang's vaccine is unique in that it uses a killed whole HIV-1, much like the killed whole virus vaccines for polio, influenza, rabies and hepatitis A. The HIV-1 is genetically engineered so it is safer and can be produced in large quantities.

Health and recession

There is evidence that the full consequences of recessions may extend beyond employment to health broadly and behavioral health specifically. Seminal work by economist Christopher Ruhm raised the surprising possibility that health and health behaviors may actually *improve* during recessions (Ruhm, 1995, 2000). His central hypothesis was that recessions change the relative prices of both behaviors and goods and services that impact health, and economists

tend to believe that individuals respond to price changes in predictable ways. Ruhm suggested that during recessions people lose their job, permitting more time for investments in health (e.g., preparing healthy meals, exercise). This mechanism is often problematic for non-economists (and many economists), but when a person's opportunity cost of time (i.e., the income that could have been gained from working in this example) declines, the cost of time-intensive activities declines and economic theory predicts that the quantity demanded of these activities will increase. Moreover, reduced incomes attributable to recessions may prevent individuals from consuming health-harming goods such as alcohol, illicit drugs, and high calorie/high fat restaurant meals. Lastly, reduced work hours may protect against job-related strain, both physical and mental.

In a series of studies Ruhm found support for his hypotheses. For example, Ruhm shows that problematic alcohol use (e.g., alcohol-related traffic fatalities, binge drinking) declines in recessions (Ruhm, 1995, 2000; Ruhm and Black, 2002). Interestingly, the one health metric Ruhm found to decline during recessions was mental health (Ruhm, 2000). For this health outcome the recession-induced strain may off-set the protective mechanisms proposed by Ruhm.

Subsequent work on recessions and behavioral health has called to question some of Ruhm's findings, particularly for alcohol use (Davalos et al., 2012; Dee, 2001). Unlike Ruhm, these studies show that problematic alcohol use increases in recessions. Such studies suggest that during recessions individuals may self-medicate in response to increased economic stress. Further, these studies are more consistent with studies that focus on individual level employment (e.g., losing one's job) that show substance use levels are higher among those who experience unemployment. For example, Deb et al. (2011) find that adults who lose their job increase their daily alcohol consumption up to 42%. Ruhm's finding that mental health declines in recessions is generally supported by more recent research (Charles and DeCicca, 2008; Davalos and French, 2011; Tefft, 2011). Differences between studies may be driven by analysis of different recessions (Pacula, 2011). For example, the severe 2007 to 2009 recession is potentially more health harming that the relatively mild recessions of the early 1990s or 2000s.

Less controversial is the impact of recessions on health insurance. Because of the tight link between employment and health insurance in this country, access to health insurance (specifically employer-sponsored insurance) declines during recessions. Cawley et al. (2011) estimate that 9.3 million adult Americans lost health insurance due to a higher unemployment rate alone during the 2007 to 2009 recession. Lack of health insurance may prevent individuals from accessing needed health services. At the same time, federal, state, and local governments may reduce health services in recessions. For example, Willard et al. (2012) find that 53% of local health departments experienced cuts to their core funding during the most recent recession. Such cut backs may exacerbate access problems.

The recent recession has been shown to increase the new HIV infection rate amongst the Greeks by 50% in 2010 as compared to 2010. This has been in those who are intravenous drug abusers. This may have to do with the pared down needle exchange programme and increased drug abuse.

The research in Spain has shown that suicide rates in Spain have increased by 8% during this crisis. This is concentrated among the people who have recently lost job.

The recent crisis has also shown an increase in obesity. In Australia, the risk of being obese in 2010 was 20% higher among those who experienced financial stress in 2008 or 2009.

mTor and human health

Mammalian Target of Rapamycin or mTOR plays a particularly important role in metabolic organs — such as the liver, muscle, and fat tissue — to regulate whole body energy homeostasis. Thus, deregulation of mTOR signaling leads to metabolic disorders, such as obesity and type 2 diabetes, and cancer, that is, some of the most common causes of death in Western society. Furthermore, consistent with its role as a nutrient and growth factor sensor, decreased mTOR signaling reduces aging and thereby extends lifespan. Importantly, aging is a major risk factor for the development of cancer and metabolic disorders. Thus, mTOR underlies both aging and age-related diseases, suggesting that insight in mTOR signaling may provide a means to counter both aging and age-related disease by a single 'treatment'. In other words, an understanding of mTOR signaling may allow one to collectively 'treat' age-related diseases by delaying aging.

TOR in aging

Aging is defined as an accumulation of cellular damage over time, promoting disease and death. Genetic or pharmacological inhibition of TORC1 signaling extends lifespan in yeast, worms, flies and mice. Importantly, rapamycin delays the onset of age-related disease and extends lifespan even in old mice. When started at a young age, rapamycin also delays decline in cognitive function. Another intervention that slows the aging process is dietary restriction (DR) — a reduction in nutrient intake without malnutrition. DR prolongs lifespan in yeast, worms, flies, rodents, and possibly primates. In mammals, DR also retards the onset of age-related disease. At the molecular level, the life-extending effects of DR appear to be due largely to inhibition of TOR.

mTOR in cancer

mTOR is frequently activated in human cancers. Accumulating evidence suggests that aberrant regulation of both cell growth and metabolism significantly contribute to cancer development and progression. The notion of causal changes in metabolism during cancer development is supported by the observation that obesity and diabetes are risk factors for cancer and that diet can affect tumor growth.

Fasting, gut bacteria and longevity

Scientists have found that apart from virtues like healthy eating and exercising, calorie restriction can help achieve longevity and good health, the two major goals of biological research today.

A team of scientists in China have found that calorie restriction can enhance the population of gut microbes that have a positive co-relation with life span.

For their experiment, they divided mice in two groups: one was kept on a low fat diet and other on a high fat one. Each group was then subdivided into three smaller groups—one performed sedentary activity, second performed sedentary activity and was kept under 30 per cent calorie restriction and the last exercised but had no calorie restriction. When scientists analysed the type of microbes present in each of the six groups, some interesting facts came up. They noticed that with every change in diet and lifestyle the composition of microbial population in the gut of the mice also changed.

In their study, the scientists wrote that irrespective of whether the diet was high-fat or low fat, calorie restriction increased the population of bacterial species linked with longer life span and decreased those that were negatively correlated with lifespan. The group subjected to both low fat diet and calorie restriction turned out to be the healthiest at the end of the experiment. The gut population of this group had astonishingly high population of bacteria of Lactobacillus species and lowest levels of Streptococccae and TM7. Studies have shown that Lactobacilli increase gut's ability to fight infection whereas Streptococcae and TM7 perform no such roles and can be linked to inflammation. Yoghurt or curd, which is routinely consumed in Indian households, is loaded with Lactobacilli.

Many other aspects of calorie restriction have also been studied. A 2011 study, published in Biochemical and Biophysical Research Communications by a team of researchers from Central Drug Research Institute in Lucknow, evaluated the effect of calorie restriction on neurodegenerative disorders like Parkinson's disease. Working with Caenorhabditis elegans—the favourite worm of scientists for aging-related studies—they found that calorie restriction enhances production of sirtuin protein. "This protein mediates the protection of dopamine synthesizing neurons, thereby increasing the levels of neurotransmitter dopamine. We believe that calorie restriction can have major implications in prevention and cure of age-associated diseases like Parkinson's," says lead author Aamir Nazir.

He also says the same protein is produced in excess while exercising. This makes one wonder if calorie restriction can be a replacement for exercise. Aamir says the benefits of exercise span far beyond just burning calories. "Hence a healthy exercise regime cannot be replaced," he says. Aamir further cautions that the meaning of calorie restriction may vary from individual to individual and will depend on the body weight, fat storage and activity level.

Gut bacteria may help fight obesity

Different kinds of bacteria that live inside the gut can help spur obesity or protect against it, say scientists at Washington University in St. Louis who transplanted intestinal germs from fat or lean people into mice and watched the rodents change.

And what they ate determined whether the good germs could move in and do their job.

It raises the possibility of one day turning gut bacteria into personalized fat-fighting therapies, and it may help explain why some people have a harder time losing weight than others do.

We all develop with an essentially sterile digestive tract. Bacteria rapidly move in starting at birth — bugs that we pick up from mom and dad, the environment, first foods. Ultimately, the intestine teems with hundreds of species, populations that differ in people with varying health. Overweight people harbor different types and amounts of gut bacteria than lean people, for example. The gut bacteria we pick up as children can stick with us for decades, although their makeup changes when people lose weight, previous studies have shown.

To start finding out, Washington University graduate student Vanessa Ridaura took gut bacteria from eight people — four pairs of twins that each included one obese sibling and one lean sibling. One pair of twins was identical, ruling out an inherited explanation for their different weights. Using twins also guaranteed similar childhood environments and diets.

She transplanted the human microbes into the intestines of young mice that had been raised germ-free.

The mice who received gut bacteria from the obese people gained more weight — and experienced unhealthy metabolic changes — even though they didn't eat more than the mice who received germs from the lean twins, said study senior author Dr. Jeffrey Gordon, director of Washington University's Center of Genome Sciences and Systems Biology.

Then came what Gordon calls the battle of the microbes. Mice that harbored gut bacteria from a lean person were put in the same cages as mice that harbored the obesity-prone germs. The research team took advantage of an icky fact of rodent life: Mice eat feces, so presumably they could easily swap intestinal bugs.

What happened was a surprise. Certain bacteria from the lean mice invaded the intestines of the fatter mice, and their weight and metabolism improved. But the trade was one-way — the lean mice weren't affected.

Moreover, the fatter mice got the bacterial benefit only when they were fed a low-fat, high-fiber diet. When Ridaura substituted the higher-fat, lower-fiber diet typical of Americans, the protective bug swap didn't occur.

Why? Gordon already knew from human studies that obese people harbor less diverse gut bacteria. "It was almost as if there were potential job vacancies" in their intestines that the lean don't have, he explained.

Sure enough, a closer look at the mice that benefited from the bug swap suggests a specific type of bacteria, from a family named Bacteroidetes, moved into previously unoccupied niches in their colons — if the rodents ate right.

Determining the best combinations of intestinal bacteria to match a person's diet, and then growing those bugs in sterile lab dishes — like this study could — and turning them into pills.

Toxic nanoparticles entering humans through food

Ingestion of commonly encountered nanoparticles at typical environmental levels is unlikely to cause overt toxicity, according to US researchers. Nevertheless there is insufficient evidence to determine whether chronic exposures could lead to subtle alterations in intestinal immune function, protein profiles, or microbial balance.

Writing in a forthcoming issue of the *International Journal of Biomedical Nanoscience and Nanotechnology*, researchers have compared existing laboratory and experimental animal studies pertaining to the toxicity of nanoparticles most likely to be intentionally or accidentally ingested. Based on their review, the researchers determined ingestion of nanoparticles at likely exposure levels is unlikely to cause health problems, at least with respect to acute toxicity. Furthermore, in vitro laboratory testing, which often shows toxicity at a cellular level, does not correspond well with in vivo testing, which tends to show less adverse effects.

Ingrid Bergin in the Unit for Laboratory Animal Medicine, at the University of Michigan in Ann Arbor and Frank Witzmann in the Department of Cellular and Integrative Physiology, at Indiana University School of Medicine, in Indianapolis, explain that the use of particles that are in the nano size range (from 1 billionth to 100 billionths of a meter in diameter, 1-100 nm,

other thereabouts) are finding applications in consumer products and medicine. These include particles such as nano-silver, which is increasingly used in consumer products and dietary supplements for its purported antimicrobial properties. Nanoparticles can have some intriguing and useful properties because they do not necessarily behave in the same chemical and physical ways as non-nanoparticle versions of the same material.

Nanoparticles are now used as natural flavor enhancers in the form of liposomes and related materials, food pigments and in some so-called "health supplements." They are also used in antibacterial toothbrushes coated with silver nanoparticles, for instance in food and drink containers and in hygienic infant feeding equipment. They are also used to carry pharmaceuticals to specific disease sites in the body to reduce side effects. Nanoparticles actually encompass a very wide range of materials from pure metals and alloys, to metal oxide nanoparticles, and carbon-based and plastic nanoparticles. Because of their increasing utilization in consumer products, there has been concern over whether these small scale materials could have unique toxicity effects when compared to more traditional versions of the same materials.

Difficulties in assessing the health risks of nanoparticles include the fact that particles of differing materials and shapes can have different properties. Furthermore, the route of exposure (e.g. ingestion vs. inhalation) affects the likelihood of toxicity. The U.S. researchers evaluated the current literature specifically with respect to toxicity of ingested nanoparticles. They point out that, in addition to intentional ingestion as with dietary supplements, unintentional ingestion can occur due to nanoparticle presence in water or as a breakdown product from coated consumer goods. Inhaled nanoparticles also represent an ingestion hazard since they are coughed up, swallowed, and eliminated through the intestinal tract.

Based on their review, the team concludes that, "Ingested nanoparticles appear unlikely to have acute or severe toxic effects at typical levels of exposure." Nevertheless, they add that the current literature is inadequate to assess whether nanoparticles can accumulate in tissues and have long-term effects or whether they might cause subtle alterations in gut microbial populations. The researchers stress that better methods are needed for correlating particle concentrations used for cell-based assessment of toxicity with the actual likely exposure levels to body cells. Such methods may lead to better predictive value for laboratory in vitro testing, which currently over-predicts toxicity of ingested nanoparticles as compared to in vivo testing.

Genetically modified rice as cure for rotavirus diarrhoea

Rotaviruses are one of the leading causes of severe diarrhoea in children across the world. According to WHO estimates, 527,000 children under five, most of them from low-income countries, die of rotavirus infections annually. At present, live vaccines are available to combat the virus. However, there have been some reports of infections induced from vaccines.

Researchers have tweaked the genes of a rice variety to make it produce antibodies against rotavirus. The antibody is found naturally in llamas, which are resistant to rotavirus. Researchers engineered the rice , dubbed as MucoRice ARP1, by introducing rotavirus antibody gene from llamas in rice genome. They tested their newly-developed rice variety on both normal and immune deficient mice. "It markedly decreased the viral load in immunocompetent and immunodeficient mice," the report says.

The antibody was found to work fine even after year-long storage and heat treatment at 94°C for 30 minutes.

The researchers say the present study markedly extends the potential of rice plants into an antibody production system and can form the basis for orally administered medicine against rotavirus infections. "MucoRice-ARP1 rice powder or rice water offer what we believe are novel approaches to the prevention and treatment of rotavirusinduced diarrhoea. It may be used to reduce the medical and economic burden in both developed and developing countries," the study notes.

The researchers observe that vaccines have poor effect on immunocompromised individuals and usage of live vaccines could sometimes backfire.

Hence they regard passive immunotherapy (antibodies) as the only available intervention that can offer protection. Though oral administration of antibodies works well as both prevention and therapy in individuals with rotavirus induced diarrhoea, the production and purification of antibodies is a costly proposition, say the researchers.

P Suresh Kumar, senior scientist at the National Institute of Abiotic Stress Management in Pune says, "Rice being the major staple crop among Indians, the result is highly relevant and encouraging for scientists and policy makers to develop rice strains that bear rotavirus antibody to act against diarrhoea."

"The important aspect of plant based antibody system is that large amounts of antibodies can be produced at a low cost. In contrast with previous systems, there is no need for purification for this transgenic rice," says Kumar. "As MucoRice-ARP1 originates from edible rice seeds, the obtained rice powder can be directly used as an ingredient in a broad range of nutraceuticals."

Kumar informs that unlike antibody producing tobacco leaves and tomatoes, which require storage under low temperature, antibody-producing cereals such as rice and wheat as well as pea seeds can be stored at room temperature.

It remains to be seen if the genetically modified rice is safe or not.

Infant formula feed potentially harmful

It is common knowledge that breast milk is the best diet for newborns. Several studies have even linked infant formula with chronic diseases such as obesity and type II diabetes in adulthood. The basis of this link has, however, been unclear. Researchers have found that feeding formula causes metabolic stress in infants and this causes complications later in life.

The researchers used rhesus monkey infants as human stand-ins for the study. Two groups of five monkeys each were given two different dietary treatments. One group was fed standard infant formula and other breast milk since birth. All the monkeys had same weight at birth but after three months it was found that formula-fed infants had grown faster than the ones fed with breast milk. The study explains that a higher rate of growth at this stage leads to adult obesity.

Formula feeding may lead to other complications as well. The study notes that higher growth rate in infants has also been linked with insulin resistance in adults. The results confirmed higher insulin levels in serum of formula-fed individuals, which could set stage for insulin resistance. Formula-fed infants also showed pro-inflammatory responses that are immune

system's reaction to injury or pathogens. This supports the hypothesis that formula feeding affects the immune system of infants, too.

Lactose level in excreta of formula-fed infants was also found to be higher than that of breast-fed ones. This, the study explains, could be indicative of damage to the intestinal lining.

BPA and BSP and human health

A study has shown that a mixture of BPA, Bisphenol S (BPS) and nylophenol (NP) can incur much greater damage than what these known hormone-disruptors can cause in isolation. What is worse, such chemical mixtures are fairly common in our environment.

Estrogens are key hormones in humans. Though produced in minute quantities, they regulate important reproductive functions in both males and females. Alarmingly, today's man-altered world consists of several compounds that can mimic these hormones, interfering significantly with the bodily functions in the long run. BPA is the most common of such estrogen-mimics. In commercial use since 1957, the hormone-disruptor is commonly found in plastic goods, inner lining of metal food cans and drums and thermal-paper used in receipts.

As more and more people became aware, and wary, of the ill-effects of BPA in the past few years, BPS was introduced as a safer alternative. But studies have shown that pre-release tests with BPS missed some key facts—recent in vitro tests have revealed that BPS also acts as an estrogen-mimic even at very low concentrations. So next time you see BPA-free written on your water bottle, be aware that it has got BPS instead, and that is not a safe option either. NP, a surfactant commonly used in industrial applications and for cleaning oil spills, is another estrogen-mimic.

Cheryl S Watson and Rene Vinas of department of biochemistry and molecular biology at the University of Texas Medical Branch in Galveston, US, have been studying BPA, BPS and NP for a long time. One fact that bothered them was that these estrogen-mimics are never present in the atmosphere in isolation but always as mixtures. How were these mixtures affecting the human body?

"Working with lab-grown rat pituitary cells, we found that mixtures of these environmental estrogens, even at very low concentrations, disrupted hormonal signalling of natural estrogens. This disruption was greater than what single environmental estrogens do," states their paper.

"Environmental estrogens activate or inactivate enzymes in patterns different from normal hormones. They also alter normal cell birth and death and disrupt the secretion of another hormone, prolactin," says Watson. Such disruptions can wreak havoc on vital body functions like reproduction, development, offspring survival and behaviour, among others.

The scientists chose rat pituitary cells for their study because "they are from the "master gland" that controls hormone secretion and responses of many other glands and organs. Therefore, if a disruption occurs in these kinds of cells, it can affect the whole body."

"Plastics are useful and we cannot take drastic measure of eliminating them completely, but we have to be rational in avoiding toxins in plastics and ensure they do not leach out toxic stuff," says Kannan Kurunthachalam, research scientist at Wadsworth Center of the New York State Department of Health. He has done pioneering work on measuring BPA and BPS levels in the urine of western and Asian populations, including Indians. "We can also try to

find a way to use plastics wherein human and environmental exposures can be minimised or eliminated," adds Kurunthachalam.

Copper alloys to reduce bacterial load in hospitals

Copper utensils have been used in Indian households since ages due to the anti-microbial properties of the metal. It has now been found that copper alloys can also help reduce infections in hospitals drastically.

It is estimated that nearly 100,000 billion people die of healthcare-associated infections in the US, while 10-30 per cent patients develop infections in Indian hospitals and nursing homes. Researchers from Medical University of South Carolina, Memorial Sloan-Kettering Cancer Center and Ralph H Johnson Veterans Affairs Medical Center in the US suggest copper could be used to control these infections.

To test the efficacy of the metal, they used copper alloys, registered with the US Environmental Protection Agency, on six frequently touched objects—bed rails, bed tables, intravenous poles, chair arms, call button and monitors—in the Intensive Care Units (ICU) of three hospitals. At the end of the study, it was found that copper fixtures reduced the infections in the three ICUs by more than half. Findings of the study were published in Infection Control and Hospital Epidemiology in May 2013.

"There is enough scientific evidence from clinical trials that evaluate the efficacy of copper alloys in reducing bacterial load," says study co-author, Michael Schmidt of the department of microbiology and immunology at Medical University of South Carolina. M C Yadavannavar, professor of community medicine at Shri B M Patil Medical College, Bijapur, says a few Indian hospitals, like AIIMS in New Delhi and PGI in Chandigarh, are embracing antimicrobial copper in ICU design.

Eritoran, a novel approach to treating Swine flu

MOST bird and swine flu deaths in humans occur due to an inability to breathe. It happens because the body, in its effort to kill the influenza virus, elicits a frenzied immune response which causes severe inflammation in the lungs. This leads to lung damage and hindered breathing and in most cases death. Treating the disease gets difficult day by day as flu viruses evolve rapidly. New viral strains are unaffected by any immunity that a population may have developed against older ones.

Researchers led by Kari Ann Shirey and Stefanie N Vogel of the University of Maryland in the US have now taken a new approach to treat the disease. Instead of the ever-evolving virus they are targeting human body's immune response to the virus to prevent flu-related deaths. And they have found a drug which does just that. Still under pre-clinical trial, eritoran has been found to greatly reduce lung inflammation and deaths in mouse models infected with swine flu viruses currently circulating among humans—H1N1 and H3N2. The treatment also suppressed the genes that cause inflammation.

"Our data suggests that eritoran blocks the cytokine storm induced by influenza by reducing the generation of oxidized phospholipids derived from host cells," says Vogel. The study, published in Nature on May 1, shows eritoran works against flu and other respiratory infections in isolation as well as in combination with existing treatments.

"This pre-clinical study proves that eritoran is effective against influenza in mice. It is different from current anti-influenza therapies and might be very useful because it is still effective when given after six days of infection," says Hongzhou Lu, a professor at the Shanghai Public Health Clinical Center at Fudan University in Shanghai, China. "Although this study showed a positive result, it still needs validation in humans," says Hongzhou.

According to D T Mourya, the director of National Institute of Virology in Pune, different influenza strains can behave differently due to a difference in their ability to cause disease. Thus, the drug needs to be tested against the latest Influenza virus H7N9 also. "People in India are at as much risk as elsewhere due to the newer emerging influenza strains, says Mourya.

Battle against drug resistant malaria

One of the most challenging features of malarial parasite Plasmodium falciparum is its ability to evolve and render anti-malarial drugs ineffective. The emergence of multidrug resistant strains of the parasite in South-East Asia and other tropical countries in recent years is undermining international efforts to eradicate malaria. So much so that in April the WHO announced investing $400 million to combat resistant strains of the debilitating disease.

A recent study by researchers from the Central Drug Research Institute of Council of Scientific and Industrial Research (CSIR-CDRI), in Lucknow, holds out fresh hope for conquering the disease. CSIR-CDRI scientists have found that an antifungal drug can kill multidrug-resistant malaria parasite in mice by enhancing the efficacy of widely used, artimisinin-based anti-malarial drugs artesunate, artemether and arteether.

The scientists had earlier demonstrated that the antifungal drug, ketoconazole, could reverse the resistance of P falciparum to anti-malarial drug mefloquine. Ketoconazole, works by inhibiting the activity of cytochrome P450 3A4 (CYP3A4), an enzyme found in liver. Inhibition of the activity of CYP3A4 slows down the metabolism of mefloquine and thus prolongs its plasma life or the time period for which the drug remains in blood, says one of the authors Renu Tripathi. A prolonged plasma life enhances the anti-malarial activity of mefloquine to the extent that it can act against the resistant P falciparum.

To find out the efficacy of ketoconazole on artimisinin-based anti-malarial drugs, the researchers tested it on mice infected with multi-drug resistant Plasmodium yoelli nigeriensis, which is known to cause malaria in rodents. When ketoconazole was used in combination with artimisinin-based drugs, it cured the infected mice. Analysis of their livers revealed that CYP3A4 enzyme was suppressed by 59 per cent in mice treated with both ketoconazole and artimisinin-based drugs, while the enzyme was not suppressed in mice treated with the drugs alone.

"Inhibition of CYP3A4 enzyme slowed down the conversion of artimisinin into its metabolite, dihydroartemisinin. This increases its anti-malarial activity," says Tripathi. The therapeutic approach can lower the effective dose of artimisinin-based drugs, reducing the cost of malaria treatment, she adds.

Malarial Vaccine

A malaria vaccine has become the first to provide 100% protection against the disease, confounding critics and far surpassing any other experimental malaria vaccine tested. It will now be tested further in clinical trials in Africa.

The results are important because they demonstrate for the first time the concept that a malaria vaccine can provide a high level of protection, says Anthony Fauci, director of the US National Institute of Allergy and Infectious Diseases in Bethesda, Maryland, adding that the findings are cause for "cautious optimism".

No effective malaria vaccine is available at present. The World Health Organization has set a target to develop a malaria vaccine with 80% efficacy by 2025, but until now, says Fauci, "we have not even gotten anywhere near that level of efficacy."

Scientists had previously been sceptical of the vaccine because producing it required overcoming massive logistical hurdles. The vaccine — called PfSPZ because it is made from sporozoites (SPZ), a stage in the life cycle of the malarial parasite *Plasmodium falciparum* (Pf) — uses a weakened form of the whole parasite to invoke an immune response.

In the phase I safety trial, reported today in *Science*, the six subjects given five doses intravenously were 100% protected from later challenge by bites of infectious mosquitoes, whereas five of six unvaccinated controls developed malaria — as did three of nine people given only four doses of the vaccine.

PfSPZ was developed by Sanaria, a company based in Rockville, Maryland, and led by Stephen Hoffman, a veteran malaria researcher who also led the PfSPZ clinical trial. Most malaria-vaccine candidates are recombinant-subunit vaccines containing just a handful of parasite proteins, but Hoffman decided to test the whole-sporozoite vaccine on the basis of past experiments dating back to the 1970s showing that strong and long-lived protection could be obtained by exposing volunteers to thousands of bites from irradiated infected mosquitoes.

That the vaccine works so well is a "pivotal success," says Stefan Kappe, a malaria researcher at the Seattle Biomedical Research Institute in Washington."The trial results constitute the most important advance in malaria vaccine development since the first demonstration of protection with radiation attenuated sporozoite immunization by mosquito bite in the 70s."

Against the odds

But to make PfSPZ was challenging. Sanaria succeeded in raising mosquitoes in sterile conditions on an industrial scale, feeding them blood infected with the malaria parasite and then irradiating them to weaken the parasite so that it can still infect people but not cause disease.

Billions of parasites were then harvested from the mosquitoes' salivary glands, purified and cryopreserved. Many researchers were highly sceptical that sporozoites could be mass-produced in a way that passed the strict quality and safety standards needed for human medicines, notes Fauci. "To my amazement, Hoffman did it," he adds.

Hoffman says that he hopes to have a vaccine licensed within four years. The trial now needs to be repeated and extended in regions where malaria is rampant to test whether it provides protection against different strains of the parasite than that used in the vaccine, and to see

how it performs in different age groups, including young children. The first trials will be carried out at the Ifakara Health Institute in Tanzania.

Piggybacking infrastructure

Even if the vaccine is shown to be highly effective in the field, logistical difficulties might limit its applicability. In mass vaccination campaigns, hundreds of people are vaccinated within minutes, so vaccines are usually given orally or by injection into or just under the skin. Intravenous injection is more cumbersome. "It's very unlikely to be deployable in infants or young children," argues Adrian Hill, a malaria researcher at the Jenner Institute in Oxford, UK.

In 2011, a clinical trial of PfSPZ given under the skin reported disappointing results, protecting only two of 80 subjects. But the need to deliver the vaccine intravenously "is not a show-stopper", says Hoffman, noting that the volume of vaccine — 0.5 millilitres — is tiny and requires a tiny syringe, although the company is exploring ways to improve the intravenous delivery system.

Another logistical hurdle, says Hill, is that the vaccine must be kept frozen in liquid nitrogen vapour phase. Hoffman argues, however, that the vaccine can piggyback on veterinary infrastructure in places that use liquid nitrogen to store and transport veterinary vaccines and semen for artificial insemination of livestock. "If you can carry semen into the deep Saharan belt and remote areas, why can't you do that for a human vaccine?" says Marcel Tanner, director of the Swiss Tropical and Public Health Institute in Basel, Switzerland, which is a sponsor of the trial in Tanzania.

"Which of the logistical challenges can be managed and which will become show-stoppers can be difficult to predict," says David Kaslow, director of the PATH Malaria Vaccine Initiative in Washington, DC, a public–private partnership for malaria-vaccine development.

Hygiene hypothesis

According to the 'hygiene hypothesis', the decreasing incidence of infections in western countries and more recently in developing countries is at the origin of the increasing incidence of both autoimmune and allergic diseases.

The hygiene hypothesis is based upon epidemiological data, particularly migration studies, showing that subjects migrating from a low-incidence to a high-incidence country acquire the immune disorders with a high incidence at the first generation. However, these data and others showing a correlation between high disease incidence and high socio-economic level do not prove a causal link between infections and immune disorders. Proof of principle of the hygiene hypothesis is brought by animal models and to a lesser degree by intervention trials in humans. Underlying mechanisms are multiple and complex. They include decreased consumption of homeostatic factors and immunoregulation. These mechanisms could originate, to some extent, from changes in microbiota caused by changes in lifestyle, particularly in inflammatory bowel diseases. Taken together, these data open new therapeutic perspectives in the prevention of autoimmune and allergic diseases.

Infants whose parents suck on the pacifier to clean it transfer microbes from their saliva to their children.

The human body, particularly the skin and the mouth, is constantly exposed to a variety of bacteria but still maintains a healthy stable state. Skin, the first host tissue to encounter atmospheric bacteria, responds through an elaborate signalling network. It produces antimicrobial peptides (AMPs) and small protein molecules (cytokines) which trigger immune responses. These naturally occurring classes of antimicrobials have novel mechanisms of action, which ensure that microbes have little chance to develop resistance and are effective against a broad spectrum of bugs, including bacteria, fungi and virus. They are, therefore, promising alternatives or augmenters of synthetic antibiotic therapies.

Dermcidin, one of the most important AMPs secreted by sweat glands of the skin, is known to be robustly active against a wide range of disease-causing bacteria such as drug-resistant Staphylococcus aureus and Mycobacterium tuberculosis. A research team led by Chen Song, of Computational Biomolecular Dynamics Group at Max Planck Institute for Biophysical Chemistry in Germany, examined the antimicrobial mechanism of dermcidin. The researchers found that it efficiently damages bacterial cell membrane by producing ion channels across the cellular envelop in the presence of zinc ions. Cell membrane integrity is essential for bacterial cell survival and development of antibiotic resistance. Their X-ray, electrophysiology and simulation data suggests that such channels are highly permeable to water and ions and allow their uncontrolled flow across the membrane, eventually killing harmful microbes. The study also shows that dermcidin can adapt to different types of bacterial membranes. This explains why it is an efficient, broadspectrum antibiotic, which can ward off both bacteria and fungi.

Technological paradigms for food security

Food security involves availability, accessibility and affordability of food. It also includes the ability of the body to absorb the food. All these aspects are profoundly affected by technological progress.

With relation to availability, the most important aspect is increase in the farm productivity. It has been brought about by a combination of myriad technological advances. Probably the single most important factor has been the introduction of hybrid varieties that led to the green revolution across the world. Another important factor has been farm mechanisation. It includes the use of tractors, threshers, etc. It has enabled more productive use of the labour in agriculture.

The introduction of electric pumps and canals that enabled large areas to be brought under irrigation has also contributed immensely. Use of sprinklers and drip irrigation has economised the use of water in agriculture. The use of fertilizers, pesticides and other synthetic chemicals cannot be ignored either. Further, the latest innovation in the form of genetically modified crops promises to usher a new era in agricultural productivity. Soil testing technologies are also important contributors in the march towards sustainable development. The use of biopesticides and biofertilizers are also steps in the same direction. Precision farming and the use of GPS in agriculture also promises to increase productivity. Nanotechnology is also a promising field that is helping increase productivity in farm sector.

Apart from these direct interventions, other important innovations include the use of ICT to help farmers improve the productivity as well as the returns from their produce. The farmers in India also get timely weather updates on through SMS on their mobiles which has also helped increase the productivity.

Further, the productivity from allied activities has also increased thanks to similar factors like hybridisation, mechanisation, etc. These include the fisheries and the dairy sectors.

The accessibility aspect has been answered with the introduction of modern technologies for the safe transfer of food from the farm to the fork. These include good roads, good warehousing facilities and the ubiquitous PDS. The use of technology in the PDS in Tamil Nadu has given fantastic returns in the form of reduction in pilferage and diversion of the PDS foodgrains.

The affordability has been improved thanks to the passing of the NFS Act and promised use of Adhaar to maximise the benefits to the deserving and minimising diversion and corruption. The use of technology has also lead to an improved productivity which has lead to increased purchasing power and hence affordability. Technology being harnessed to improve financial inclusion also improves the affordability and hence food security.

The absorption has improved following use of technology in the form of vaccinations, safe drinking water, tele-medicine, etc. The use of better technology in the health sphere and its reach to the poorest through the NRHM and other health schemes has ensured improved absorption of food by the body.

Hence, technology and food security are intrinsically linked and the future definitely belongs to greater use of technology in ensuring that the world is able to feed its growing population.