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TOPIC/SUMMARY

'Ever Greening' Patents

- What does 'Ever Greening' mean in the context of patents and especially with regard to the pharma industry?

- Well, a company manufactures a product for which it secures a patent. Shortly before the expiration of that patent, the company files a new patent that revises or extends the term of protection. This is what ever greening is all about. Ever greening is a method by which technology producers keep their products updated, with the intent of maintaining patent protection for longer periods of time than would normally be permissible under the low. It refers to increasing the life of the patent or the patent term beyond 20 years to reap the benefits for a much longer period of time.

- The ever-greening process has causes some controversy in the pharmaceutical industry. Ever greening may be used by manufacturers of a particular drug to restrict or prevent competition from manufacturers of generic equivalents to that drug. The process of ever greening may involve specific aspects of patent law and international trade law. The main arguments in favour of governments regulating against ever greening are that rapid entry of multiple generic competitors after patent expiry is likely to lower prices and facilitate competition, and that eventual loss of monopoly was part of the trade-off for the initial award of patent (or intellectual monopoly privilege) protection in the first place.

Green School Revolution

- Environment education is an essential dimension of basic education focused on a sphere of interaction that lies at the root of personal and social development.

- There is an urgent need to create awareness about the significance of carbon footprint among the public, especially among students, through the mass media and also the school curriculum. The concept of Green School Revolution (GSR) could go a long way in this direction in which school children could be expected to venture out and take up tasks that make them aware of the environmental problems of today. Students may also be encouraged to compile information on areas such as water and energy usage. An analysis of such information, apart from giving them an idea of the magnitude of the problems, would also motivate them to

come up with solutions.

- The major thrust areas of Green School Revolution programme are:
  a. Assessment of polluting sources locally.
  b. Development of best and standard practices.
  c. Pupils-cum-youth awareness.
  d. Intensifying public awareness of environment including water, air, soil quality, waste, management, and efficient energy use for the sustainable growth of our country.

Strategies:

- **Water audit:** Fresh water consumption in India is increasing rapidly for industrial and domestic purposes. In this situation, conservation of energy is an important practice that we need to follow in our daily life. Water audit seems important in this context. The basic objective would be to help students understand the monetary costs of water and environmental impact of water.

- **Energy Audit:** Energy conservation is a matter of vital importance to all of us. With rapid industrialization, urbanization and changing life styles our per capita energy consumption is increasing irreversibly. While those with access are enjoying all comforts, there are people at the grassroots to fulfil their basic needs. Energy Audit, therefore, could be a step in the right direction.

- **Land Audit:** The major objective of this task is to familiarize students with land usage, calculation of percentage of green cover in the area, plant and animal species supported by the school ecosystem and the use of pesticides/insecticides to control pests by the school and also to assess open area/field available in the school that can be used for reforestation in the future.

- **Waste Audit:** Most schools face the problem of waste management, which not only affects school health but also affects the school ecosystem in particular and the surrounding environment in general. So assessing the quantity of solid waste (biodegradable/non biodegradable) and e-waste could be of significant importance for the school. It will also encourage schools to come up with their own waste disposal plans.

- Awareness generation: Student awareness and awareness of institutional stakeholders play a crucial role in managing available natural resources. School-based activities like poetry reading/writing, slogan writing, story and essay writing, plays, skits, poster making, interviews and surveys, and integrating radio and TV programmes on environmental issues will act as catalyst for general environmental awareness.

- Eco clubs, DNA clubs, VIPNET clubs are government initiatives for schools.

- The need of the hour is to replicate this movement across the length and breadth of our country to ensure a stronger, bolder and resurgent green India in the 21st century.

Safety of Nuclear Power Plants in India

- Nuclear, in light of the Japanese nuclear accident let us take a look at Indian nuclear power reactors.

- In India, the Nuclear Power Corporation of India Ltd (NPCIL) currently operates 20 nuclear power reactors with an installed capacity of 4780 MW. Of these reactors, two are BWRs (2x160 MW) at TAPs 1 & 2 and others are Pressurized Heavy Water Reactors ((PHWRs). The safety of these BWR plants was reanalyzed a few years ago and reviewed by the Atomic Energy Regulatory Board (AERB). Following this, the two BWRs at TAPS 1 & 2 have been renovated, upgraded and additional safety features provide with latest state of art safety standards. The PHWRs are of different design than that of BWRs and have multiple, redundant and diverse shutdown systems as well as cooling water systems.

- The Indian plants have amply testified to their safety during the severe earthquake of Gujarat on 26 January 2001 when the Kakrapar Atomic Power Station continued to operate safety, supplying much needed power to the region. Similarly, during the tsunami event in Tamil Nadu on 26 December 2004, the Madras Atomic Power Station (MAPS) was safety shutdown without any radiological consequences. The plant was restarted in a matter of days after regulatory review. The KKNPP under construction also remained unaffected by the tsunami due to the higher level chosen in design for locating the plant.

- In-depth review of all such events has been done for all the plants and necessary reinforcement features based on the outcome of these reviews have been incorporated as a laid down procedure. However, the Japan nuclear accident is being reviewed as information becomes available. Resulting out of such a review, any reinforcements needed in Indian reactors will be implemented.

Safety of Nuclear Power Plants in India:

- A study of geographic areas combined with an assessment of historical earthquakes allow geologists to determine seismic risk and to create seismic hazard maps, which show the likely Peak Ground Acceleration (PGA) values to be experienced in region during an earthquake, with a probability of exceedance (PE). Seismic engineers and government departments use these values to determine the appropriate earthquake loading for designing important buildings and structures (such as hospitals, bridges, nuclear power plants etc.) In these zones needing to survive the maximum considered event (MCE).

- The criteria for assessment of siting of a NPP are specified in the siting code AERB/SC/S and related safety guides published by the Atomic Energy Regulatory Board (AERB). The safety guides detail the acceptable procedures for meeting the requirements laid down by the siting code given above.

- To eliminate any risk, in addition to the acceptance criteria, rejection criteria with respect to various hazards for siting of NPPs are also stipulated by the AERB.

- After selection of a nuclear power plant sites as per the above stipulated codes and guides of AERB, design and engineering of all the building structures and equipment are carried out and reviewed by highly specialized engineers and scientists. The final designs are again verified by the AERB.

Kudankulam Nuclear Power Project (KKNPP):

- The Kudankulam Nuclear Power Project (KKNPP) is a twin unit (2*1000 MWe) nuclear power project being built in Kudankulam, Tirunelvelly District of Tamil Nadu (about 25 km from Kanyakumari). The project is being executed under the provisions of the Inter Governmental Agreement signed between the India and the Russian federation.

- These WER-1000 reactors belong to the family of Pressurized Water Research (PWRs), which are the predominant type in operation the world over. This type of reactor uses light water as coolant and moderator and enriched uranium (up to 4.4%) as fuel. Reactors have various state-of-art reactor protection and safety system to handle all design basis and beyond design basis events. Some of the very interesting safety features of these reactors are passive systems (that work without any electrical power) for decay heat removal, core cooling in case of loss of coolant, quick boron injection to shut down the reactor, hydrogen recombiners, and melt fuel catcher.

Nuclear Science: Back to the Basics

- **Critical mass:** A critical mass is the smallest amount of fissile material needed for a sustained nuclear chain reaction. The critical mass of a fissionable material depends upon its nuclear properties (e.g. the nuclear fission cross-section), its density, its shapes, its enrichment, its purity, its temperature and its surroundings.

- **Nuclear Fission and Chain reactions:** In a thermal Nuclear Power Plant, when a U-235 atom splits, along with the released energy it also ejects three neutrons. These neutrons in turn trigger more fission reactions. But this is not the case, as these stray neutrons don't always hit a U-235 atom, them usually miss and just go shooting off. The more dense the lump of U-235 is, the closer together the atoms are, and the more likely it is for an ejected neutron to bump into one of the atoms.

- If the odds of a neutron available for hitting a U-235 atom are on an average less than 1, then the mass is subcritical. Some energy will be released, but the reaction will rapidly peter out with run out of neutrons. If the odds of a neutron hitting a U-235 atom are exactly 1, i.e. on an average, each time an atom splits and ejects three neutrons an average of one of them connects, then we say the mass is critical. Fairly constant release of energy until all of the fuel is used up. This is how a nuclear reactor works.

- If the odds of a neutron hitting a U-235 atom are more than 1, i.e. on an average each split atom causes more than one other atom to split, then the mass is called supercritical. Fission will continue in a chain reaction, releasing energy faster and faster, until a mind-numbingly large explosion is met.

- **Inherent safety:** Just being supercritical isn't enough. Because as soon as the very slight supercritical is there, either enough uranium is burnt up and there isn't super critically anymore, or with the excessive heat the density would go down enough to take out the super-critically.

- Fuel used in commercial nuclear reactors is enriched to contain only about 3-5% U-235, the purity requirement for a bomb is around 90%. The fuel of a nuclear power plant is not even

close to the critical mass required for exploding. Even if somehow (which it wouldn't) the fuel got compressed so that it became supercritical, it would rapidly self-correct down to the critical level, by heating, melting or blowing apart. Therefore, there is just no way it could possibly happen by accident, even one couldn't do it on purpose with the fuel used in nuclear power reactors.

- **Nuclear meltdown:** A nuclear meltdown is an informal term for a severe nuclear reactor accident that results in core damage from overheating. The terms is not officially defined by the International Atomic Energy Agency or by the U.S. Nuclear Regulatory Commission. However, it has been define to mean the accidental melting of the core of a nuclear and is in common usage as a reference to the core's either complete or partial collapse. "Core melt accident" and "partial core melt" are the analogous technical terms.

- A core melt accident occurs when the heat generated by a nuclear reactor exceeds the heat removed by the cooling systems to the point where at least one nuclear fuel element exceeds its melting point. This differs from a fuel element failure, which is not caused by high temperatures. A meltdown may be caused by a loss of coolant, loss of coolant temperatures, or low coolant flow rate or be the result of a critically excursion in which the reactor is operated at a power level that exceeds its design limits. A meltdown is considered a serious event because of the potential for release of radioactive material into the environment.

Radiation Alert!

- In a nuclear power plant, nuclear fission/fusion generates a large quantity of heat and ionization. The heat needs to be extracted by the cooling water to keep the temperature of different components of the reactor under control to escape a probable meltdown due to high temperature. Since the central core of the reactor under concern is mode of Uranium dioxide (UO2), it is continuously disintegrating (radioactive) releasing large quantity to that. This process of radioactive disintegration cannot be slowed down. It takes place with pre-set half-life of disintegration.

- If pumping of cooling water is stopped, the available water gets heated and evaporated leading to further depletion of water. The temperature of the vessel rises raising the pressure beyond the capacity of the vessel. The process of gas and steam build-up starts and radiation leakage to the atmosphere follows. In the worst-case scenario, the plant explodes.

- It is really difficult to understand the consequences because not only operational fuel rods (core), but spent fuel rods also nee cooling provisions; otherwise radioactive substances into the atmosphere, if kept dry. Before understanding the various effects of radiation, let us get to understand the language of radiation.

Units of Radiation:

- One has to fathom through a sea of units. Take, for instance, the unit called Roentgen (R), which is defined as amount of radiation produced in 1 cm3 of dry air at 00C and 760 mm Hg pressure erg/g and is a measure of exposure. An alternate SI unit for exposure is Coulumb per kilogram (C/kg = 3876 R). Yet another unit called rad (= 100 erg/g) was also devised, which is a

unit of absorbed dose.

- However, the International Committee for Radiological Protection (ICRP) set up in 1928 took several measures to standardize and unify the radiation dose and dose rate. In 1975, it commended a new series of units in the SI system for dose measurement. A unit of absorbed dose is defined as Gray (Gy) and one Roentgen is equal to 8.732 x 10-3 Gy. One gray is equal to 100 rads or 1 J/kg. Another term called kerma (kinetic energy released in media) is also used to indicate absorbed dose. Another unit called rem (roentgen-equivalent-man) is a complicated unit, which considers the effect of ionizing radiation on human body. Such unit of dose equivalent is named Sievert (Sv) and 1 Sievert is equal to 100 rem.

Effects of Radiation:

- Radiation in the form of electromagnetic radiation is present everywhere. However, the most disastrous effects are seen with ionizing radiations, which are released from disintegration of certain radioactive materials. When they irradiate living tissue, cells are damaged or destroyed. The ultimate effect may be burns, dermatitis, cancer induction and blood changes. Reproduction may also be affected as chromosomes are damaged by the ionizing radiations. This genetic damage could be passed on to future generations as well.

- The biological effects of ionizing radiation may be in terms of deposited energy in the tissue and organs. This may aggravate damage. Depending on the level of exposure, many biological effects of ionizing radiations are possible:

1. **Stopping of cell division:** The epidermis of our skin forms new cells in the bottom layer, which move towards the top, where dead cells are accumulated. Each second 10,000,000 cells die and are replaced in the human body. If cell creation by cell division is stopped, the effect will be catastrophic.

2. **Introducing defects in chromosomes:** Breaking of chromosomes by ionizing radiation may result in non-transfer of all the genetic materials from one generation to the other.

3. **Gene mutation:** The DNA structure alters completely and new species may be formed. Exposure to ionizing radiation can lead to such process.

4. **Sterility:** The genetic effects can appear as sterility, as genetic organs are affected by radiation more readily than other parts of the body. Temporary sterility is caused in men and women by exposure to a level of 0.25 Sv and 1.6Sv respectively.

5. **Temporary useasiness:** Nausea, vomiting and diarrhea (NVD) are stated to occur if humans are exposed to more than the recommended dose of radiation.

6. **Chronic disease:** On exposure to radiation, chances of cancer, leukemia, cataract and hereditary effects rise. Local exposure of 8 Sv in the eyes may cause cataract after 5-10 years.

7. **Cell death:** This property of ionizing radiation is already used in treatment of cancer, but if excessive dose is administered, healthy cells with start dying, leading to change in or death

of physical properties of vital cell structures.

- The most disturbing part of these ionizing radiations is their integrating nature. Once exposed to certain radiation level, further exposure adds up to the already received exposure. There is very little effect of time on such accumulated radiation dose in a body.

- Earlier the tolerance dose was thought to be 1 R per week and that there was no measurable biological effect if exposure was less than this. The ICRP replaced this tolerance dose with the Maximum Permissible Dose (MPD) in 1954 and in 1958 MPD was fixed as 0.3 rem per week (3 mGy per week), for critical human organs. In 1977, the concept of ALARA (As Low As Reasonably Achievable) was introduced. Based on natural background dose-level, the whole body does per year is defined or different types of workers.

  Radiation worker: 50 mSv per year (5 rem per year)
  General public: 5 mSv per year (0.5 rem per year)

- For radiation worker, 50 mSv per year is equivalent to around 1 mSv per ween (52 week per year) or 25 mSv per hour (working hours: 8 hours per day). To be on the safer side generally 7.5 mSv per hour is considered as the average dose rate over a period.

Radiation Safety:

- To safeguard against ionizing radiations, three factors are to be considered – distances, time and shielding. The radiation intensity follows the inverse square law—if distance from the source is doubled, the intensity of radiation will reduce four times.

- For safety against ionizing radiation, the best strategy is to remain as far away as possible from the source. Another is time of exposure. Since ionizing radiations are of integration type, it is better to reduce the time of exposure to accumulate fewer doses and remain within the safe permitted limit. The third strategy is to adopt shielding by high-density materials. Every material has a certain shielding capability for ionizing radiations. Generally concrete, lead, iron, barium-concrete etc are used as shielding materials to protect against ionizing radiation. With a combination of these three safety parameters, the exposure to radiation can be controlled to a great extent.

- The International Nuclear and Radiological Event Scale (INES) was introduced in 1990 by the International Atomic Energy Agency (IAEA) in order to enable prompt communication of safety significance information in case of nuclear accidents. Because of the difficulty of interpretation, the INES level of an incident is assigned well after the incident occurs and, therefore, has a very logarithmic and the assignment of level is carried out after considering various pros and cost of the nuclear emergency.

- No doubt nuclear energy is a boon in terms of cheap, eco-friendly and large power availability, but it can get converted into a bane with a little twist of nature. Therefore, radiation effects, hazards and safety concerns must be considered while exploiting nuclear energy or peaceful alternate endeavours

Safeguarding Traditional Knowledge

- The global fight against bio-piracy and preservation of intellectual property rights of the people took a major step forward recently when about 35 countries came together at an international conference to explore options of replicating India's TKDL or Traditional Knowledge Digital Library to protect their traditional knowledge. The International Conference on Utilization of the Traditional Knowledge Digital Library (TKDL) as a Model for Protection of Traditional Knowledge held in New Delhi from 22-24 March 2011 demonstrated in ample measure TKDL's immense value in safeguarding national TK.

- It was organized by the Council of Scientific and Industrial Research (CSIR) in association with the World Intellectual Property Organization (WIPO).

- The TKDL documents traditional knowledge available in public domain in the form of existing literature related to Ayurveda, Unani Siddha and Yoga, and presents it in searchable and digitized format in English, German, French, Japanese and Spanish. The information is structured to assist patent examiners in their search for existing evidence of previously known/documented knowledge or prior art.

- More than 150 experts in traditional medicine, law and computer science spent almost ten years accessing and classifying information codified in authoritative textbooks on Ayurvedic, Unani and Siddha medicines and documenting postures in Yoga. They collated scattered data published in ancient languages and transformed it into a systematic, proprietary database. The TKDL digitized available information in five languages and in format that allowed patent examiners to retrieve the information in the way they needed.

- As it stands today, the TKDL has documented 85,500 Ayurvedic formulations, 1,20,200 Unadi formulations, 13,470 Siddha formulations and 1098 Yoga postures. TKDL safeguards 0.226 million medicinal formulations as these are used in Ayurveda, Unadi and Siddha. The TKDL database size runs to 34 million A4 size pages.

- The USP of TKDL is that is operates within the established rules and laws of the recognized patent system and does so in a manner that cannot be challenged in any way. TKDL established prior art and does so in an internationally acceptable manner despite the fact that the source of the prior at goes back thousands of years and was originally written in a language few today use regularly. By empowering patent examiners, TKDL is instrumental in preventing the grant of wrong patents.

- For instance, a patent that earlier took at least a decade of enormously expensive intensive litigation to be revoked is now being routinely refused in a matter of weeks at no cost (since the patent application is rejected and no rights have been granted that need to be revoked). A new and welcome trend is that many applicants are unilaterally withdrawing their applications can being faced with TKDL–their actions tacit acknowledgement of a misappropriation attempt.

- The Conference proved that the TKDL story is not just one of significance from the context of national pride but is one of inspirational leadership than can serve as a beacon illuminating the way forward in the global fight against bio-piracy and preservation of IP rights of the people.

Gagan: A New Dimension in Aircraft Navigation

- With the satellite-based navigation system, the pilot is provided with on-board position for precision and non-precision landing approaches as well as for en route applications. This will result in the opening up of air connections to a large number of small Airports that lack the conventional full-fledged navigational facilities.

- The basic requirement for a satellite-based navigation system is a constellation of satellites with known orbits, which can be used as reference. Satellite-based navigation system is not new. The US government launched a satellite constellation known as Global Positioning System (GPS) in the 1980s for use by the military. It is also available for civilian use. World over, rail, road and ocean traffic and even individuals have been using it to know their exact position anywhere on the globe and also to chart out the route for their destination.

- The International Civil Aviation Organization (ICAO) has endorsed GPS as the care satellite constellation to provide worldwide seamless navigation for civil aviation.

What is GPS?

- GPS consists of three main segments: 1) the satellite constellation, 2) the ground control network and 3) the use equipment.

- The satellite constellation is made up of 30 solar-powered satellites, which revolve around the earth in six orbital planes at a radius of about 26,600 km from the center of the earth. Their main function is to continually broadcast ranging and navigational signals. There are in the form of pseudo random codes (PRC), transmitted as low power radio waves in the L band carrying information on their position in space and time. Each satellite is identified with a unique PRN code and equipped with an atomic clock for precise timing.

- The ground control network consists of six stations across the globe. They constantly monitor the satellites for their health and fine-tune their orbital data, which is transmitted back to them.

- The user equipment is a GPS receiver. It captures the ranging and navigational signals from the satellites in view and computers the user's position (latitude, longitude and attitude), velocity and time (PVT). Any one with a suitable GPS receiver—an individual hiker, a vehicle and road, a ship or an aircraft—can receive the signals for navigation purposes.

- The position accuracy of the GPS is about 20 and 30 meters in the horizontal and vertical directions respectively. Though this may be adequate for ocean and road transport navigation, aircraft navigation requires much greater accuracy.

Gagan:

- The ISRO and the AAI signed a MoU to install a space-based augmentation system (SBAS) to render the GPS signal suitable for civil aviation over the Indian airspace. An interesting aspect of the project is the name chosen for this system, which is the same chosen for this system, which is strikingly Indian. IT is called GAGAN (GPS Aided GEO Augmented Navigation).

- As with GPS, SBAS also consists of three segments: the space segments, the ground segment and the user segment.

- The space segment of GAGAN consists of three geosynchronous communication satellites. The first one, GSAT-8, was launched by ISRO on 21 May 2011 from Kourou, French Guiana. The satellite, weighing about 3100 kg, has been positioned in a geostationary orbit at 55-degree east longitude on the Indian Ocean. It carries a dual frequency L1 and L5 navigation payload compatible with the GPS. Since a minimum of three satellites will be added in due course.

- The ground segment consists of 15 Indian Reference Stations (INRESs), an Indian Master Control Center (INMCC) and an Indian Navigation Land Uplink Station (INLUS), all suitably augmented. In the Final Operational Phase, which is currently being carried out, the Reference Stations are located at Ahmedabad, Bangalore, Thiruvananthapuram, Port Blair, Delhi, Kolkata, Guwahati, Jammu, Dibrugarh, Patna, Bhubaneshwar, Nagpur, Goa, Porbandar and Jaisalmer. They are connected to the INMCC at Bangalore. Each station is provided with a minimum of two identical GPs receivers/antennae subsystems to receive GPS signals.

- The INMCC processes the data received from all the 15 INRESs. It will also estimate the integrity and the availability of the GPS satellite and transmits the corrections and confidence parameters to the INLUS.

- The INLUS, also located at Bangalore, format these message consisting of ionospheric, ephemeris and clock drift correction and transmits them to the satellites' navigation payland for broadcasting to the use segment.

- The user segment is a modified GPS receiver installed in the aircraft. It receives these signals and determines the aircraft's exact location in the sky. The pilot can use this information for the navigation en route and for lending. The pilot can also broadcast this information, along with other aircraft-specific data to other planes and to the air traffic control facilities to obtain seamless navigation service for all phases of flight from takeoff to landing over the Indian airspace.

- GAGAN is capable of better than 7.6 meters accuracy in both vertical and horizontal, and time to alert better than 6.2 seconds, meeting the ICAO standards.

- GAGAN, although being built primarily for civil aviation, can cater to other applications. All the GPS applications could advantageously use the GAGAN signal that will ensure not only accuracy but also integrity. Such applications in future may include Railways and Maritime vessels.

- Individual users in our country can also benefit from GAGAN since the higher positional accuracy through the narrow lanes in both urban and rural areas which otherwise will be difficult.

- GAGAN service is free of charge. Anybody in the coverage area and possessing the commercially available special GPS receivers can get the benefits of GAGAN.

- The experience gained during GAGAN implementation will lead us to the successful completion of the task related to the establishment of the indigenous Indian Regional Navigation Satellite System (IRNSS). When that happens in a couple of years, our country will have firmly established itself in the field of satellite navigation.

TRIPS: Fifteen Years and After:

- Fifteen years after signing of the Trade Related intellectual Property Rights (TRIPS) agreement, experts from developing countries are trying to find ways to guard against rising cost of technology and healthcare due to it.
- THIPS agreement signed in 1994 required developing countries to bring about significant changes in their Intellectual Property (IP) laws to raise their standards of intellectual rights protection, As a result, costs of technologies like climate change related and healthcare related ones increased significantly.

TRIPS—What for Developing Countries?

- The TRIPS agreement that was conceived to expand and strengthen intellectual property rights has not been able to deliver the benefits promised to developing countries at the time of its signing—namely transfer of technology, stimulation of local innovation and increase of foreign direct investment.
- Developed countries prompted the negotiation of the TRIPS agreement on the argument that an expanded and strengthened protection of intellectual Property Rights (IPRs) would bring about increased flows of foreign direct investment (FDI) and technology transfer to developing countries and those changes in IPRs would also stimulate local innovation.

TRIPS-plus Looms Large:

- Now there are efforts to push the standards even higher. Developed countries are forcing developing countries to comply with more stringent IP laws through TRIPS-plus provisions that the latter have been coaxed to sign in lieu of bilateral free trade agreements. TRIPS-plus makes the IP protection requirements more stringent than TRIPS.
- Under TRIPS agreement, patents must last for 20 years from the date of application. TRIPS-plus provisions extend the period beyond 20 years (usually indefinitely) with the excuse that need to obtain marketing approvals for new chemicals takes time and reduces the effective term of patent protection and possibility of recovering research and development funds.

Solution in South-South Technological Co-operation:

- Government representatives and civil society groups from developing countries believe that developing countries could share the technological resource base that exists with them and establish their own intellectual property regime to keep the cost of technologies like climate and health care related ones law.
- "Closer ties and stronger co-operation among developing countries could help developing countries establish their own IP provisions and stop being dictated by the UP regime

established by the developed world".

TRIPS Flexibilities:

- The TRIPS agreement also provides for some flexibility that developing countries can use to address the economic and social concern of these countries. While the bilateral agreements or free trade agreements try to nullify many of these flexibilities, the challenge before developing countries is to make most efficient use of these flexibilities.

The Flexibilities under TRIPS:

- **Compulsory licenses:** Mechanism used by public authorities to authorize use of a patient-protected invention by the government or third parties without the consent of the patent-holder. Countries can decide on the grounds on which it is granted and are usually resorted to for public health emergencies. Patent-holders receive compensation, usually in the form of a royalty.

- **Parallel imports:** Companies often charge lower prices for a medicine in one country than in another, taking into account a range of market factors. Many countries' patent laws determine that once a patent owner sells its goods in any country, it has no right to control the resale of those goods. This means that a country with limited resources can sometimes afford more of a patented medicine by purchasing it abroad at a lower prices and importing it, rather than buying it directly in its domestic market at the higher place.

- **Bolar Provision/regular exception:** This permits the use of a patented invention without authorization from the patent owner in order to obtain marketing approval of a generic product before the patent expires allowing a generic product to enter the market more quickly after patent expiry, which in turn facilitates access to cheaper medicines.

- Exemptions for least developed countries: In November 2005, before the WTO Hong Kong Ministerial Conference, the WTO TRIPS Council extended the transition period for least developed countries from mandatory compliance with the TRIPS agreement until July 2013. With specific reference to pharmaceutical products, the Doha Declaration, as implemented by a TRIPS Council Decision of June 2002, exempts least developed countries from having to grant patents and from providing for the protection of undisclosed information 1 January 2016. These transition periods are subject to further extension upon duly motivated request.

Tags for Living Beings

The Saga of DNA Barcode

What's the Barcode?

- DNA sequence analysis of a uniform target gene (genetic marker) in an organism's mitochondrial DNA to enable species identification is called DNA barcoding.

Ten Reasons for Barcoding Life:

1. **Works with Fragments.** Barcoding can identity a species from bits and pieces, including undesirable animal or plant material in processed foodstuffs and morphologically unrecognizable products derived from protected or regulated species.
2. **Works for all stage of life.** Barcoding can identity a species in its many forms, from eggs and seed, through many forms, from eggs and seed, through larvae and seedlings, to adult sand flowers.
3. **Unmasks look-alikes.** Barcoding can distinguish among species that look alike, uncovering dangerous organisms masquerading as harmless ones and enabling a more accurate view of biodiversity.
4. **Reduces ambiguity.** A barcode provides on unambiguous digital identifying feature for identification of species, supplementing the more analog gradations of words, shapes and colors.
5. **Makes expertise go further.** Scientists can equip themselves with barcoding to speed identification of known organisms and facilitate rapid recognition of new species.
6. **Democratizes access.** A standardized library of barcodes will empower many more people to call any name the species around them.
7. **Opens the way for an electronic handheld field guide.** Barcoding links biological identification to advancing frontiers in DNA sequencing, electronics, and information science, paving the way for handheld devices or species identification.
8. **Sprouts new leaves on the tree of life.** Barcoding the similarities and differences among the estimated 10 million species of animals and plants will help show where their leaves belong on the tree of life.
9. **Demonstrates value of collections.** Compiling the library of barcodes begins with the multimillions of specimens in museums, herbaria, zoos, and gardens, and other biological repositories, thus highlights their ongoing efforts to preserve and understand Earth's biodiversity.
10. **Speeds writing the encyclopedia of life.** A library of barcodes linked to named specimens will enhance public access to biological knowledge, helping to create on on-line encyclopedia of life on Earth.

Criticism:

- The greater applications of DNA barcoding in biological studies notwithstanding, this cannot be projected as the final word for species identification. There are many grey areas as well. In

organisms where mtDNA genes are maternally inherited, one species with more than one mtDNA sequence, in cases of hybridisation, male-killing microorganisms, cytoplasmic incompatibility-including symbionts, horizontal gene transfer, etc there are chances of errors.

- The fact is that both traditional taxonomy and molecular taxonomy using DNA barcodes are complementary, and each one could be used for strengthening the other! DNA barcodes should make species recognition in the field much easier and relatively error-free, especially where traditional methods are not practical. In addition, species identification should become more reliable, particularly for non-experts.

Promising Future:

- Initially referred to as DNA typing or profiling, the DNA barcoding initiate has taken this step forward, and several taxa have now been surveyed in their natural habitats using this technique. A complete DNA-based inventory of the Earth's present biota using large-scale high-throughput DNA barcoding is an ambitious proposal rivalling even the Human Genome Project.
- Barcode of Life initiative (BoLI) is an international movement of researchers, research organizations, and users who are dedicated to developing DNA barcoding as a global standard for species identification.
- DNA barcoding is an accurate, rapid, cost-effective, and universally accessible DNA-based system for species identification. DNA barcodes can help expand our knowledge by exploring many more species rapidly and inexpensively. Once widespread, this system will revolutionize access to biological information and affect research, policy, pest and disease control, food safety, resource management, conservation, education, recreation, and many other areas in which societies interact with biodiversity.

Biodiversity Informatics

Digitizing the Web of Life:

Biodiversity Informatics vs. Bioinformatics:

- Biodiversity informatics includes application of information technologies to the management, algorithm exploration, analysis and interpretation of primary data regarding life particularly the species level organization while Bioinformatics is the use of computer technologies for mining, capture, storage, search, retrieval, modelling, and analysis of genomic and proteomic data.

Benefits of Biodiversity Informatics:

- Permits mining, capture, storage, search, retrieval, visualization, mapping, modeling, analysis and publication of data.
- Networking of database between different institutions, laboratories, universities, and research organizations that will help scientists and research scholars carry out research on different aspects of biodiversity conservation.
- Access to useful data at little or no cost with interactive and user-defined readability.
- Improved education and training process a teacher can obtain real data sets for various student exercises.

- Significant role in policy and decision-making processes that directly or indirectly affect billions of lives.
- Information and data gaps are more apparent, and these gaps will encourage scientists to carry out research on the neglected, unexplored and much awaited themes and issues.
- Increased public confidence and participation in more transparent and accessible science.

Biodiversity Information Management

Legal Aspects:

- Natural resources routinely inventoried and monitored include those with direct economic significance, such as minerals, timber, land and soil, agriculture production and water resources. Biological and genetic resources are increasingly viewed as natural resources with potential economic value. In addition, such resources play a key role in providing ecosystem services – maintaining the air, water, soil climate and other environmental conditions essential to human survival.
- A wide variety of resources are required for the objective assessment of the extent of biodiversity and the realization of its potential both to benefit humankind and to contribute to the well being of the planet. Biodiversity information refers to global biodiversity data that have been organized, integrated and to some extent analyzed. The development and use of biodiversity information has not been a priority of government and most efforts in this area have been undertaken by the scientific research community or to a lesser degree, by the non-governmental sector. Broadening the use of biodiversity information from these to other sections of society is a principal challenge.
- Use of biodiversity information generally depends upon specific motivations. These principle categories of motivations include:

    1. **Public Policy motivations:** These motivations primarily involve compliance with laws, rules, regulations or treaties. They derive from all levels of human activities, from village-established rules, through sate- or national-level laws and policies to international treaties.
    2. **Private Sector motivations:** These motivations relate to the need for biodiversity information to advance commercial interests. Companies involved in plant breeding, ecotourism, technology or natural resource management may have a vested economic interest in receiving and applying such information. In addition, the private sector is increasingly seeking biodiversity information to avoid potential environmental problems or to develop contingency plans.
    3. **Public interest and cultural motivations:** These include efforts by both governmental and non-governmental institutions, as well as individuals, to apply biodiversity information in ways that advance the conservation and sustainable development of natural resources. Public interest incentives act as primary motivators for biodiversity information management, which takes the form of encouraging proactive efforts of encouraging proactive efforts for environmental protection, such as establishment and management of protected areas. Access to environmental information has also proved to be a powerful force for empowering local people to take an interest in and feel responsible for their biodiversity resources. Cultural motivations including scholarly pursuits and incentives help to document knowledge about local plant and animal species and are responsible for the

vast amount of biodiversity information. In addition to being the major source for exploration and information generation, these academic and scholarly endeavours also constitute a major incentive for the use of existing information.

- A substantial part of the biodiversity in India exists in the "Protected Areas" declared under the Wild Life (Protection) Act, 1972, or in the Reserved and Protected Forests under the Indian Forests Act, 1927. The jurisdiction over these areas vests with the State Forest Department.

- The proposed low relating to biodiversity drafted by the Ministry of Environment and Forests works on CBD's premise that the state has the sovereign right over its genetic resources. The law proposes to establish authorities at the national, state and local levels to deal with the issues of access to genetic resources. However, the issues with regard to 'ownership', jurisdiction, and inter-play with existing laws are yet to be addressed and resolved.

- While access to information is generally important to biodiversity conservation and management, there must be some restrictions and the information may be governed by statute. The breadth of information needed for biodiversity conservation and management means that privacy conflicts are bound to arise. Many corporations and individuals may resist the collection of information by outsiders on private land, yet collecting such information may be essential to the effective management of biodiversity found there and therefore be required by law.

- The goal of biodiversity information management is to strike optimal balance in conserving the diversity of nature and advancing human sustainable development, governments, citizens, international organizations and businesses will have to co-operate in finding ways to support the essential processes of the planet, on effort that depends on maintaining biological diversity.

Solar Homes:

- In recent times, efforts have been underway to design buildings in line with the concept of building-integrated photovoltaic (BIPV) to minimize energy requirements. However, this is still in the concept stage and is yet to prove its sustainability over a period of time.

- India's first green housing project facilitated with building-integrated solar power has been developed in Kolkata.

Building Integrated Photovoltaic (BIPV):

- The idea is to harness India's geographical advantage, its latitude, to get more sun hour by using solar energy through Building Integrated Photovoltaic (BIPV) and wind energy in case of Building Integrated Wind Turbines (BIWT), thus coming up with what could be partially sustainable or green buildings.

- To reduce energy requirement, conventional building materials are replaced by photovoltaic materials are replaced by photovoltaic materials in part of the building envelope such as the roof, skylights, or facades. The transparent and opaque photovoltaic modules are integrated with other facade for sunlight, air and an aesthetic look inside the building. They are increasingly being incorporated into the constitution of new building as a principal of ancillary source of electrical power, although existing buildings may be retrofitted with BIPV modules as well.

- The advantage of integrated photovoltaic over more common non-integrated systems is that the initial cost can be offset by reducing the amount spent on building materials and labor that would normally be used to construct the part of the building that the BIPV modules replace. In

addition, since BIPV are an integral part of the design, they generally blend in better and are more aesthetically appealing than other solar options. These advantages make BIPV one of the fastest growing segments of the photovoltaic industry.

Building code and legal framework: The basic considerations in a BIPV system are:

1. Mechanical resistance and stability
2. Safety in case of fire
3. Hygiene, health and environment
4. Safety in use
5. Protection against noise
6. Energy, economy and heat retention

- The country's leading building companies have shown considerable interest in setting up mega-scale projects using roof-integrated solar PV as an integral component. Although BIPV homes are energy efficient with better aesthetic and environment concern, yet their initial cost is quite high. However, a long-term analysis of the cost of energy makes the technology sustainable.

Fuel from water and Carbon Dioxide using Sunlight

- Scientists from the California Institute of Technology (CalTech), based at Pasadena, California, USA have come up with a way to convert water and carbon dioxide into fuel using sunlight and an oxide of a naturally occurring rare earth metal–cerium–as a catalyst.
- The device uses the Sun's rays and cerium oxide to break down carbon dioxide and water in the air into a gas mixture of carbon monoxide and hydrogen gases known as "synthesis gas," or "syngas," as it is also commonly called. It can then be converted into liquid fuels through well-established processes.
- The development of the device is significant because while hydrogen is particularly viable as an alternative transport fuel, its production by currently used technology is inefficient.

Nanotechnology

What is Nanotechnology?

- Definitions of nanotechnology are as diverse as its applications. Basically, it is the ability to design and control the structure of an object at all length scales from the atom up to the macro scale.
- One nanometer is one-billionth of a meter, roughly the width of three of four atoms.
- Materials reduced to the nanoscale can suddenly show very different properties compared to what they exhibit on a macroscale, enabling unique applications.
- For instance, opaque substances like copper become transparent, inert materials like platinum become catalysts, stable materials like aluminium turn combustible, solids like gold turn into liquids at room temperature and even loses conductivity, and insulators such as silicon become conductors. Much of the fascination with nanotechnology stems from these unique quantum and surface phenomena that matter exhibits at the nanoscale.

Building Blocks of Nanotechnology:

- Particles that show the wonders at the nanoscale are known as nanoparticles. The transition from microparticles to nanoparticles can lead to a number of changes in physical properties. Two of the major factors in this are the increase in the ratio of surface area to volume, and the size of the particle moving in to the realm where quantum effects predominate.
- High surface area is a critical factor in the performance of catalysis and structures such as electrodes, allowing improvement in performance of such technologies such as fuel cells and batteries.

Application of Nanotech:

Health and Medicine:

- Medical science will be able to create devices small enough to enter the body's bloodstream to repair damage and treat diseases at the cellular level.
- Nanotechnology can help to reproduce or repaid damaged tissue. This so-called "tissue engineering" might replace today's conventional treatments, e.g. transplantation of organs or artificial implants.
- To get rid of wound infections there is an antimicrobial dressing covered with nanocrystalline silver. The nanocrystalline coating of silver rapidly kills a broad spectrum of bacteria in as little as 30 minutes.

Wastewater Treatment:

- Nanotechnology has strong influence on wastewater treatment and is currently utilized in many parts of the world. Magnetic nanoparticles offer an effective and reliable method to remove heavy metal contaminants from wastewater by making use of magnetic separation techniques. Using nanoscale particles increases the efficiency to absorb the contaminants and is comparatively inexpensive compared to traditional precipitation and filtration methods.

Energy and Environmental Crisis:

- A reduction of energy consumption can be reached by better insulation systems, by the use of more efficient lighting of combustion systems, and by use of lighter and stronger materials in the transportation sector. Currently used light bulbs only convert approximately 5% of the electrical energy into light. Nanotechnological approaches like light-emitting diodes (LEDs) or Quantum Coged Atoms (QCAs) could lead to a strong reduction of energy consumption for illumination.

Computing and Data Storage:

- In the coming decades we'll have to build molecular computers to keep the computer hardware revolution on track. Nanotechnology will let us build computers that are incredibly powerful. The critical length scale of integrated circuits is already at the nanoscale (50 mm and below) regarding the gate length of transistors in CPUs of DRAM devices.

Information and Communication:

- The production of displays with low energy consumption could be accomplished using carbon nanotubes. Carbon nanotubes can be electrically conductive and due to their small diameter to several nanometers, they can be used as field emitters with extremely high efficiency for field emission displays (FED).
- Nanocrystals are ideal light harvesters in photovoltaic devices. They absorb sunlight more strongly than dye molecules or bulk semiconductor materials; therefore, high optical densities can be achieved while maintaining the requirement of thin films.

Food Production and Distribution:

- Nanotechnology also has applications in the food sector. Many vitamins and their precursors, such as carotenoids, are insoluble in water. However, when skilfully produced and formulated as nanoparticles, these substances can easily be mixed with cold water, and their bioavailability in the human body also increases.
- Nanotechnology can be applied in the production, processing, safety and packaging of food. A nanocomposite coating process could improve food packaging by placing anti-microbial agents directly on the surface of the coated film.

Space Mission:

- By application of nanotechnology a new era of robotic exploration of the solar system is in the coming among other technologies through the development of small economical spacecrafts with high autonomy and improved capabilities. Furthermore, nanotechnological diagnostics and therapy procedures will improve life support systems and an autonomous medical supply of astronauts, which will pave the way for long-term and more complex manned space missions.
- Momentum toward this nanotechnology future is building as researchers, private companies and government agencies all over the world rush to be the leaders in this very exciting race.
- The future is small, but it promises to benefit us all.

Nanotechnology in Medicine:

- Bioavailability refers to the presence of drug molecules where they are needed in the body and where they will do the most good. Targeted drug delivery results in maximizing bioavailability to concerous tissues in the body as well as prolonged over a period of time.

Nanodevices:

Nanodevices that have already been proved are:

1. **Cantilevers:** These are tiny levers anchored at one end. They can be designed such that they bind to molecules that represent a deviation from normally, such as altered DNA sequences or proteins present in infected cell. When these molecules bind to the cantilevers, surface tension changes causing the cantilever to bend. By monitoring this bending, scientists can identify the type of molecule that has caused the bending. This may help in identifying infecting cells even if they are present in very low concentrations.
2. **Nanopores:** These are tiny holes that allow the DNA molecule to pass through one strand at a

time. By monitoring the shape and electrical properties or each base or letter on the strand of DNA, scientists can decipher the encoded information on DNA. This is possible because shape and electrical properties are unique for each of the four bases that make up the genetic code. Errors in the genetic code associated with a particular disease can also be located.

3. **Nanotubes:** Carbon rods, about half the diameter of a molecule of DNA, can detect the presence of altered genes and also pinpoint the exact location of those changes (mutations).

4. **Quantum Dots:** Nanoparticles of cadmium selenide (quantum dots) glow when exposed to ultraviolet light. The wavelength or the colour of the light depends on the size of the dot. When injected, they seep into cancer tomours. The surgeon can see the glowing tumour, and use it as a guide for more precise cutting of tomours.

   Quantum dots demonstrate the nanoscale property that colour is size-dependent. By combining different sized quantum dots within a single bead, scientists can create probes that release distinct colours and intensities of light. When the crystals are hit by UV light, each latex bead emits light that serves as a sort of spectral bar code, identifying a particular region of DNA, which is associated with a particular type of cancer. We know that most cancers arise from multiple mutations within DNA. Thus several quantum dots can be designed to show several cancer-associated regions of DNA simultaneously. This can potentially eliminate the need for surgical biopsy (removal of tissue for histopathological examination under microscope).

5. **Nanoshells:** These are miniscule beads coated with gold that absorb specific wavelengths of light. These shells then get heated up and kill the surrounding cell. By engineering the nanoshells to selectively link with the antibodies associated with a diseased cell, we can ensure that the nanoshells seep only into the tumour and destroy if, leaving the neighbouring normal cell intact. This has already been done using near-infrared light on animal cancer cell line cultures.

6. **Dendrimer:** This molecule has over a hundred hooks on it that provide a large surface area and hence allow it to teach to cells in the body for a variety of purposes like identification, diagnosis or therapy. For example, scientists have attached folic-acid to a few of the hooks (folic-acid being a vitamin is received by cells in the body). Cancer cells have more vitamin receptors than normal cells, so these vitamin-laden dendrimers were absorbed by the cancer cell. To the rest of the hooks on the dendrimer, anti-cancer drugs were placed and these were absorbed with the dendrimer into the cancer cell, thereby delivering the cancer drug to the cancer cell and nowhere else.

7. **BioMEMS (Biological Micro-Electro-Mechanical Systems):** These are tiny working machines that usually consists of several microsensors coupled with a microprocessor, the processing unit of the device. BioMEMS can be used in the detection of DNA, viruses, proteins and other biologically derived molecules.

- Nanomedicine has already crossed the threshold of laboratory animals and entered the portals of clinical practice. The coming decade will establish the existing nanotechnology devices and discover new ones, which may take us from blunderbuss treatment to target-specific and efficient therapy of incurable cancers and life-threatening multi drug-resistant bacterial infections.

Spectrum:

A New Natural Resource?

- The word 'natural resource' brings to our mind environmental elements like water, land, minerals and petroleum products. One may stretch it to clear air. But no one so far even thought that an intangible and abstract entity called spectrum could be a natural resource. And that too with an adjective 'scarce', like any other resource.

- Since the last four or five years a realization has come about the spectrum being scarce and insufficient for our ever expanding needs and hence precious.

What is Spectrum?

- Spectrum is a distribution of frequencies in a wave or a ray. The most popular example of a spectrum is the rainbow. The visible light from the sunrays is comprised of seven colour from violet to red in the famous sequence VIBGYOR.

Radio Waves:

- A significant part of the EM Spectrum is occupied by radio ways. They are a versatile tool and can perform very wide nature of duties for man. Different types of radio broadcasts – medium wave, short wave, FM and satellite radio, radars for traffic control and weather prediction, wireless communication for police and armed forces, conventional television, Cable TV, radio operated toys, robotics, microwave cooking and cordless phones are the traditional applications of these waves.

- They are expanding but at a moderate rate. But applications like mobile phones, Global Positioning systems (GPS), satellite TV, Bluetooth etc are newer applications and are expanding at a fast pace.

- Which frequency is suitable for a particular application, depends upon the nature of application, its sensitivity to directionally, the distance between the instrument and the source etc. These waves have four different categories of penetration. Upto 2 Giga Hertz we have radio waves that can go through building structures/walls and television, which are to be used indoors, obvious contenders for a place in this segment are mobile phones.

- The second category is semi-penetrating, which can manage some penetration but not through heavy structures or dense objects. They also do not need to have direct line-of-sight access. Here a narrow band around 2.4 GHz is used for domestic services like cooking, cardless phones, Bluetooth etc.

Shortage of Frequency:

- Mobile telephony is allotted a nominally wide band of frequencies at two or three sports on the spots on the spectrum, viz at 400 MHz, 800 MHz and at 1900 MHz.

- After voice, we needed to send written texts (as SMS); later, even more – photographs and songs too! Now this requires higher speed of data transfer, otherwise the song will shutter and pictures will appear in jerks. While 16 kbps (kilo bytes per second) speed is all right for voice

content, songs need 128 kpbs and data (like picture) may require even 1000kbps i.e. 1 Mbps. If you want to see a picture moving, the demand can be even higher.

- Faster data transfer needs a wider frequency band, that is, a broader slice on the spectrum line.
- Unfortunately, this spectrum is not like currency notes than can be printed as done during deficit financing.
- There are two solutions to this scarcity – administrative and technical. As part of the administrative solution the government has requested the defence ministry to vacate some frequencies that were earlier allotted to them. They can move over to other frequencies or change the technology itself – by using fibre optic cable networks. Such cables are delicate to handle in addition to the cost factor.
- The technical solution to use the spectrum more efficiently by sending more information using the same width of the frequency band. That is what 3G technology is all about.

2G and 3G:

- There is no part of the spectrum that can be called 2G or 3G. Thus, strictly speaking, the word '2G Spectrum' is a misnomer. These letters denote the generations of the cell phone technology. Similar usage exists in computer technology where 1G, 2G and 3G indicate progressively advanced generations of technology of the equipment/process.
- In the first generation telephony we hand analog exchanges. In the 3G or second generation the voice was transmitted in digital form, it is called duplex system because the line on which two persons are taking gets dedicated to that pair of talkers. To use the line more efficiently, more people should be able to use the same line simultaneously. Around the turn of this millennium, 3G technology came that permits this, among other things.
- Compared to voice, the data comes in a more interrupted manner. It comes in bursts. There can be gaps between bursts. 3G uses this gap to push data from the other users. For this, the data is broken down into small packets and sent. At the destination these packets from respective users are joined appropriately to mad a complete message (which can be a song, a picture or just a voice talk.)
- Of course better results require better frequency bandwidth. Against a 2G line needing 30 to 200 kHz, a 3G requires to 20 MHz of bandwidth. But it carries more traffic too. Some of the other issues like incompatiblility between various techniques and standards in 2G technology are also addressed in 3G.

Sustainability:

- For all natural resources that are limited in supply, the issue of use within the sustainability boundaries always exists. The radio frequency spectrum too has this issue thought it is not a consumable item. Demand for the bandwidths for various applications is increasing and mobile telephony is the leading consumer.

Fuel Cells

- The search for alternative fuels for a sustainable economy and conservation of the environment has brought fuel cell technology to the forefront. A fuel cell creates electric energy by converting a fuel into a negative charge on one terminal and a positive charge on the other terminal. It converts chemical energy of a fuel into electrical energy without the internal combustion steps of a heat engine.

- Such conversions are possible because the combustion reactions are also redox reactions in nature. That is why a fuel cell uses lightweight but active oxidants and reductants as its fuel. It creates electric energy from a fuel (input on anode side) and an oxidant (input on cathode side) in the presence of an electrolyte. While the electrolyte remains permanently inside the cell, the reactants flow in and byproducts flow out.

- When a load is connected across a fuel cell the current flows. When it powers a load like car, bus, autorickshaw etc. the fuel is slowly consumed. It works continuously as long as the oxidizing and reducing agents are supplied at the electrodes.

- A fuel cell does not come under the category of either primary of secondary cell. It differs from a secondary cell in that it cannot be charged in the conventional manner, it is also different from a primary cell in that it consumes reactants that must be replenished continuously and not prepacked.

- The materials used in fuel cells differ by type because many combinations of fuel and oxidants are possible. The most commonly used fuel cell is the hydrogen cell that uses hydrogen as fuel and oxygen as oxidants. However, a fuel cell does not create any pollution and so can play a leading role in meeting the national goals of clean air, climate protection and energy security.

History of Fuel Cells:

- The principle of the fuel cell was discovered by German scientist Christian Friedrich Schonbein in 1838. He found that a phenomenon opposite to electrolysis of water could create electric energy.

- The first fuel cell based on this principle was built in 1845 by Welsh scientist Sir William Grove.

Fuel Cell System:

- The hydrogen-oxygen (H2–O2) fuel cell has been by far the most successful research in this field. It works on the principle of catalysis, separating the electrons and protons of the reactant fuel at one electrode, and forcing the electrons to travel through a circuit, converting them to electric power. Another catalytic process takes the electrons back to another electrode, combining them with the protons and oxidants to form waste products.

Fuel Cell Design Issues:

- There are several issues related to design of fuel cells that need to be taken care and managed effectively.

  a) **Temperature management:** In H2–O2 fuel cell temperature management is particularly challenging as 2 H2 + O2 = 2 H2O reaction is highly exothermic, so a large quantity of heat is generated within the fuel cell. In order to prevent damage to the cell due to thermal loading the same temperature must be maintained throughout the fuel cell.

  b) **Water and air management:** In proton exchange membrane fuel cell, the membrane must be hydrated, requiring water to be evaporated at precisely the same rate that it is produced. If the water is evaporated too quickly, the membrane dries, resistance across it increases and eventually will crack, creating a gas short circuit, where hydrogen and oxygen combine directly, generating heat that will damage fuel cell. On the otherhand if water evaporates to slowly, the electrodes will flood, preventing the reactants from reaching the catalyst and stopping the reaction. The management of water in cells is being developed like electroosmotic pumps (osmosis in presence of electric field) focusing on the flow control. Like a combustion engine, a steady ratio between the reactants and oxygen (air) is necessary to keep the fuel cell operating properly.

  c) **Activation loss management:** In fuel cell, voltage decreases as current increases due to several activation factors. Due to resistance of the cell components and interconnects ohmic loss occurs and voltage drops. Hence, resistance of the fuel cell components needs to be maintained for a steady voltage. Moreover, the depletion of reactants at catalyst sites under high load causes rapid loss of voltage. This is called mass transport loss.

Benefits and Drawbacks:

- Fuel cells are the only technology that can provide pollution free energy for both transportation and electric utilities. Fuel cells are reliable, easy to maintain and safe. They can be fabricated in a wide range of sizes without sacrificing either efficiency or environmental performance. The flexibility allows fuel cells to generate power in efficient manner for automobiles, utilities and buildings.
- Fuel cells are used as power sources in remote locations, such as spacecraft, remote weather stations, large parks, rural locations and in certain military applications. A fuel cell system running on hydrogen can be compact and lightweight and has no major moving parts.
- However, there are certain drawbacks as well. For instance, a single fuel cell only produces approximately 0.7 volts. In order to produce large quantities of electricity, we require many cells. When combined in series if yields higher voltage and when combined in parallel if allows a stronger current to be drawn – such a design is called a “fuel cell stock”. Besides, it is difficult to use hydrogen as fuel due to difficulties of storage and distribution.
- In India several industries and research organizations are involved in the development of fuel cell. The Defence Research and Development Organization (DRDO) and Reva electric car company jointly displayed the first fuel cell car of India in 2007 and expect the car to reach the mass market soon. The development of Direct Methanol Fuel Cell (DMFC) is also under way at IISc, Bangalore.

Green Chemistry

- Green or sustainable chemistry can help us achieve sustainability in three key areas that could form the basis to protect our environment without harming growth and development. These areas include the role of chemists in a) improving process of converting solar energy into chemical and electrical energy, b) obtaining the reagents or chemicals used in the chemical industry from renewable resources, instead of obtaining them from oil and petroleum – a fast depleting natural resource, and c) replacing polluting technologies with suitable non polluting ones.

12 Principles of Green Chemistry:

- Paul Anastas and John Warner introduced the twelve principles of green chemistry in 1998. These are asset of guidelines for putting green chemistry into practice. With the aim of understanding green chemistry in various processes from research lab, house hold, general life to bulk production these principles will be discussed in detail with suitable examples from each wherever applicable and the reader may be able to get a vivid image of the source of the problem and the green solution to it, so that in future even readers of this article may be able to contribute their share in sustainability.

1. **Pollution Prevention:** By minimizing the waste produced or by using methods that can avoid waste generation pollution prevention can be attained. This could be different for different people. For instance, you could take public transport instead of own vehicle, thereby minimizing the CO_2 emission, use recyclable paper in order to minimize the burden on natural resource and also to lessen the amount of toxic products coming out after bleach during paper production. For a chemist this could be achieved at the molecular level, which on converting into bulk process helps in minimizing tons of waste. An interesting example for this would be to develop efficient methods of converting solar energy into chemical energy and electrical energy. This would help avoid the necessity of generating power from nuclear plants, which produce a lot of waste in terms of radioactive substances, gaseous emissions and chemical pollutants.

2. **Atom Economy:** In the process of making one chemical from another, a part of the starting chemical is lost, which comes out as waste. In atom economy, methods have to be designed such that the entire chemical converts into the other without losing any part of it. It should be just like cooking, put all the ingredients in and the food is cooked, without any waste being produced. Few examples from organic chemistry include the famous Grignard reaction and Diels-Alder reaction with atom economy (AE) of 44.2% and 100% (AE is defined as measure of molecular weight of product over molecular weight of reactant). It is a theoretical value used to calculate how atom efficient a chemical reaction will be.

3. **Less Hazardous Chemical Synthesis:** Synthetic methodologies must be designed such that the chemicals used and by-products, if generated, are not or less harmful to human health and the environment. A better example is the formation of alkenes through more safe Grubbs catalyst in comparison with the Witting reaction. It is worth noting that the Grubb reaction though safe is a finding at recent years whereas the Witting reaction is an age-old method that has helped in a large number of synthesis reactions. This example can serve as a better understanding of how a very important method of the past can be suitably substituted with a less hazardous modern method. In this case, the reaction based on Grubb catalyst produces very less waste compared to the Witting reaction.

4. **Designing Safer Chemicals:** Chemical substances (molecules) may process a variety of properties that define their commercial value like their polymerizing tendency, ability to form coatings etc. In the same way, they also exhibit biological activities that may group them into beneficial drug-like compounds or if they are biologically harmful, they may be classified as toxic. In a true sense, all the molecules of our interest that are used as drugs, plastics, paints etc almost always have some toxicity. It is desired that chemists focus on designing safer chemicals, with some previous understanding. Much work has been done in recording structures of molecules and their toxicity data, which could be used to develop molecules with low toxicity.

5. **Safer Solvents and Auxiliaries:** Solvents are substances (generally liquids) that can dissolve a variety of solids and later can be evaporated easily. Solvents have a variety of applications, like dissolving solids for chemical reactions, dissolving paints which after applying on doors evaporate leaving a coat of paint, decaffeinating coffee, separating organic compounds from mixtures etc. It is hard and impractical to think of not using solvents at all which are largely a produce of petrol and oil industry, a non-renewable resource. Solvents also account for the huge quantity of waste generated in synthesis and processes. After evaporating they also contribute to air pollution, along with water and soil pollution as well.

   Recovery and reuse is a good option, but demand distillation, which in itself is a power consuming process. Hence, the only option left is to find substitutes for solvents. A few options found and applied in the past include reactions in water, reactions in solid phase, supercritical fluids as solvents and ionic liquids (solvent-like inorganic substances with low evaporation) as solvents. This field is the most actively pursued and may contribute largely to the green aspect of chemistry.

6. **Design for Energy Efficiency:** Rising consumption and heavy future demand on energy that is primarily generated from petroleum and depleting resources has raised serious concerns in the international community. The solution would not lie in digging in more deeper to use up all the available resource, instead it lies in designing energy efficient processes and generating alternative sources of energy production.

   In line with this, chemists can design reactions that could take place at moderate temperature using catalysts or other methods, thereby reducing more demand on energy. Common man can also contribute to this by using public transportation and more fuel economy vehicles, thereby reducing demand on petroleum and also by allowing fewer amounts of pollutants to enter the atmosphere. On the other hand, there is a lot of ongoing research in developing alternate methods of producing energy from non-depleting resources, like solar energy, bio fuels, wind power, geothermal energy, Hydrogen cells and Proton exchange membrane cells. The best studied among these are the solar cells for converting sun light into electrical energy using organic molecules.

7. **Use of Renewable Feedstocks:** This is another field of interest in research as well as in serious practice these days. Efforts are being out in to produce organic chemicals and related products to be obtained from natural resources other than petroleum and depleting resources. This is not a very novel field to mankind, because since long ethanol has been produced from a variety of sources like sugarcane, beet root, grape etc. So, other

products or chemicals can be produced from natural resources.

The best substitute for this is the biomass material available from living organisms, like wood, crops, agricultural residues, food etc. Renewable materials that can be obtained from nature include lignin, suberin, cellulose, polyhydroxyalkanoates, lactic acid, chitin, starch, oil glycerol etc. These can be used ultimately to produce chemicals of our interest, like lignin (which can be further used for production of vanillin, DMSO and humic acid), chitin (used to produce chitosan which is later used in water purification, biomedical applications etc). Interestingly, these renewable stocks are mostly leftover waster of other processes like farming, agriculture etc and hence are the cheapest alternatives.

8. **Reduce Derivatives:** This is more applicable to organic chemists working on synthesis of compounds in multi-step synthesis. It is desired that the routes to synthesize a compound be as short as possible utilizing less number of protection and deprotection of sensitive functional groups. It might be a bit challenging to seek better methods of synthesis but in the long run during the course of performing the same reaction of a large scale, the waste minimized by eliminating protection and deprotection may amount to some tons of material thereby contributing hugely to the success of green chemistry.

   One such process designed in the industry is in Polaroid films, where researchers sought to release hydroquinones at elevated pH, which being highly basic tends to cleave covalent protecting group in the form of a co-crystal was developed. This approach was successful for their purpose but interestingly minimized a lot of waste thus making the process green.

9. **Catalysis:** This can contribute to green chemistry at least in three ways: by lowering the activation energy of a process, by allowing unfavourable reactions to happen, and through bio-catalysis attaining high levels of selectivity at minimal waste, most of which is fast biodegradable and non-polluting. Catalytic reagents also eliminate the need of stoichiometric amounts of it in the reaction. An example of this includes use of nayori hydrogenation in place of DIBAL-H. In another case, Grubbs catalysis was used successfully in olefin metathesis proving unfavourable reactions also happen at ambient conditions and with less waste. Enzymes and whole cell biotranformaton are now taking the stage in selective (regioselective, enantioselective and chemo selective) reactions, with advantage of replacing highly toxic and polluting metal complexes, giving high yields, biodegradable, ambient condition reactions, produced from microorganism or animals, giving no waste and biodegradable when discarded.

10. **Design for Degradation:** Most household and routinely used substances are under the scanner in this category and are being worked out rigorously. They include detergents, plastics (poly ethylene bags), paints etc. Some general alternatives are possible in this case, like use of natural cloth or fibre bags instead of plastic bags, using degradable plastic bags, recycling the non-degradable waste bags and plastics etc. An interesting case of pollution and hazard from detergents happened in 1950s when water coming from taps was also foaming due to the presence of tetrapropylene alkylbenzene sulonate (TPPS) accumulated due to an incomplete degradation. It was addressed by making changes in the structure of the molecule (linear alkylbenzene sulfonate, LAS) with retention of surfactant property but easily biodegradable. It is desired that the chemists be able to understand these aspects before hand while designing and synthesizing such compounds, even though it is not a simple task. Trends have now emerged following decades of data collection, which low allow chemists to predict to properties of such compounds beforehand.

11. **Real-time Analysis for Pollution Prevention:** Real time analysis for a chemist is monitoring the progress of a reaction as it happens to find a better point to stop the reaction in order to avoid formation of by-products. By finding the right time to stop, a lot of energy can also be saved which would have been wasted unnecessarily in continuing the reaction beyond the required point. The importance of this concept can be realized only when one imagines a reaction happening at a scale of tons, where saving even a few minutes of electricity would mean a lot. Similarly, by avoiding the formation of by-product, a lot of solvent can also be saved in the process of purification. The other aspect of real time analysis involves analysis a reaction whose sample needs to be run on HPLC, where method optimization to consume minimum amount of solvent and power need to be designed.

12. **Inherently Safer Chemistry for Accident Prevention:** The Bhopal gas incident is the worst reminder of an industrial tragedy. Accidents do keep happening in industries with damage both to human life and environment apart from the monetary loss. It is necessary that the hazard data (toxicity, physical hazards such as explosive or flammability) and global hazards be addressed in the design of chemicals and processes in order to prevent such accidents.

Achievements and Barriers:

- Since its inception, the concept of green chemistry had much impact on design and implementation of new processes. A few examples of drastic changes brought about include large reduction in lead pollution because of replacement of lead in points and batteries with better friendly alternatives, replacement of chlorine with chlorine dioxide leading to significant reduction in endocrine disrupting chemicals such as polychlorobiphenyls etc.

- Howsoever beneficent green chemistry principles might be to sustainability, the practical implementation in large production plants is a daunting task, as it demands a huge change in industrial setup, machinery and pilot plants. In the presence of laws, suitable incentives and necessary financial support to bring in major changes, the industry may be able to turn their processes green but this could take time.

- Awareness of a problem and initiating action towards controlling it is in itself the big leap required in implementing new policies. Green chemistry is also one such step taken towards sustainability and wellbeing of the human race. Only very recently has the science succeeded in stabilizing itself in many fields, but it still emerges in new fields.

- Under these circumstances there is a need to maintain balance between supporting new developments in chemistry and bringing the previously established chemical process under greener and sustainable purview. But this is a slow process requiring considerable efforts. It is hoped that very soon a trend may get firmly established wherein most of the existing chemical processes could become greener and sustainable.

Electrically Conducting Polymers (ECPs)

- Organic polymers have always been believed to be insulators of heat and electricity and that is why their use in making switch boards, MCBs, thermal insulations, handles of utensils etc. A key discovery in the development of conducting polymers was the discovery in 1973 that the inorganic polymer, polysulfur nitride (SN)x, is a metal. Below a critical temperature of about 0.3 K, (SN)x, becomes a superconductor.

- The first major breakthrough in the field of electricity conducting polymers occurred in 1977.

- For the first time it was demonstrated that polyacetylene (PA), an intrinsically insulating polymer, could become highly conducting on treatment with oxidizing (electron-accepting) or reducing (electron-donating) agents. This process was called doping.

- Another major advancement happened in 1980, when poly (p-phenylene) (PPP) was doped to conductivity level quite comparable to that of PA. This polymer was the first example of the non-acetylenic hydrocarbon polymer that could be doped with an electron-acceptor or an electron-donor to give polymers with conducting properties. This discovery paved the way for a number of new conducting polymers.

Applications of Electrically Conducting Polymers:

- These polymers are extremely promising and find tremendous use in our day-to-day life with a wide range of products extending from the most common consumer goods like rechargeable batteries and microelectronic goods to highly specialized applications in space, aeronautics and electronics.

- Around the 1990s, the field received a major boost when it was first discovered that polymers such as poly (phenylenevinylene) (PPV) luminesce when a voltage is applied to a thin film between two metallic electrodes. This led to the first polymer light-emitting diode.

- These devices can emit light in a variety of colours. Emissive displays fabricated from polymer LEDs were introduced as products in cell phones and personal digital assistants (PDAs) in 2003.

- Polyaniline (PANI) has turned out to be one of the most extensively commercialized electronic polymers, often blended or chemically combined with other industrial plastics to obtain the most desirable features. It is used, for example, in electromagnetic shielding, and when dispersed in paint as an anti-rust agent. PANI is also belied to play a major role in the emerging area of nanoscience.

- **Sensors:** A sensor is a device that measures a physical quantity and converts it into a signal that can be read by an observer or by an instrument. The ability of PANI to change the electrical conductivity and colour upon exposure to acidic, basic and some neutral vapours or liquids finds its usefulness in the field of sensors, detectors and indicators. PANI has been used to fabricate sensors for liquefied petroleum gas, hydrogen peroxide, humidity, mercuric ion, pH, and biosensor.

Lightweight and rechargeable batteries: This is one of the most publicized and promising applications of ECPs.

- The polymer electrodes of these batteries have a longer shelf life than the metal electrodes of any ordinary battery.
- Another advantage of polymer electrode batteries is the absence of toxic materials in them and therefore disposal problems are minimized.
- **Artificial nerves:** electrical fields can stimulate the healing of bone, cartilage, skin, spinal and peripheral nerves and the connective tissues. As a result, researchers have sought to incorporate electrical signals directly to biomaterials. Due to biocompatibility of some conducting polymers, they may be used to transport small electrical signals through the body, i.e. they act as artificial nerves.
- Conducting polymers are promising materials of the future and will continue to have an impact on the progress of science and technology.

Stainless Steel:

- If you find the words 'green allay' a bit mystifying, well stainless steel is one of the very few alloys that are 100% recyclable, it can, therefore, be melted time and time again and reformed into a new product.
- An average stainless steel object is composed of about 60% recycled material (25% coming from end-of-life products and 35% from manufacturing process scraps). If you wonder why the recycled content is not even higher, here's the reasons. There are simply not enough end-of-life stainless steel scraps around because 20 to 30 years ago much less stainless was produced.
- Actually, stainless steel is not consumed, it remains as a part of the sustainable closed loop system. Also, the manufacture and processing of stainless steel do not cause adverse effects on the health of workers. Plastic, on the other hand, is a major pollutant when manufactured or disposed of. Plastic items that clutter landfills may leach out dangerous chemicals. As you can see, environmental credentials of stainless steel are impeccable. It is indeed a green are impeccable. It is indeed a green allow!

Applications:

- Stainless steel is a very versatile and useful material. Because of its unique combination of properties that offers attractive benefits, stainless steel is used in a wide variety of products, ranging from the mundane kitchen sink to the sophisticated nuclear reactor. It has revolutionized most modern industries, including construction, transportation, food pharmaceuticals, health-care and power.
- Stainless steel has one of the most hygienic surfaces that are very easy to clean, as the surface has no pores or cracks to harbour bacteria, dirt or grime. It will not affect the flavour, as it does not react with food. Even acidic foods like tomatoes and vinegar can be safely cooked in it. These features have mode stainless steel indispensable for the preparation, delivery and storage of food.

Islands in danger

- The world's first underwater cabinet meeting organised by the Maldivian president on 17 October 2009 was a symbolic cry for help over rising sea levels that threaten the tropical archipelago's existence. This island archipelago nation off the tip of India, best known for its mesmerising beauty and sparkling beaches, represented by 1,200 atolls, 80% of which are no more than a metre above sea level, is among the most threatened by rising seas.

- In 2007, the United Nation's Intergovernmental Panel on Climate Change (IPCC) warned that a rise in sea levels of between 18 and 59 centimetres by 2100 would be enough to make the Maldives virtually uninhabitable. The economy of this Indian Ocean island nation is supported by climate-sensitive activities like fishing and tourism. Global warming and sea level rise, if continued unabated, would affect the very existence of the nations and therefore the nation's government is developing a plan to evacuate the entire country to new homes in Sri Lanka, India or Australia in case of need!

- The Alarm bell is ticking not just for the Maldives but also for many islands across the globe. The New Moore Island of India in the Sunderbans has been consumed recently by the rising sea—even as Bangladesh was also claiming its right over it! The New Moore is not the first island to be submerged in the Sunderbans. The first inhabited island to have been submerged by the rising sea level was Lohachara. Once home to about 10,000 people, the island was submerged under the sea in 1996. The submerging of islands also results in migration of people making them "environmental refugees."

- The first uninhabited island to vanish from the map due to sea level rise was the Pacific atoll nation of Kiribati. The people of low-lying islands in Vanuatu, also in the Pacific, have been evacuated as a precaution, though the island still remains above the sea.

- The islands are much more vulnerable to the impacts of climate change and subsequent sea level rise.

Defining Islands:

- An islands, strictly speaking, is a piece of land surrounded by water. The Millennium Ecosystem Assessment (MA), a research programme supported by the United Nations, defines islands as "lands isolated by surrounding water and with a high proportion of coast to hinterland". This definition stipulates that they must be populated, separated from the mainland by a distance of at least two kilometres, and measure between 0.15 square kilometres and the size of Greenland (2.2 million square kilometres).

- By a combination of the size of the land area, and political and demographic criteria, islands are grouped into the Small Island Developing States. Countries known collectively as Small Island Developing States (SIDS) have in common their smallness and insularity that often also indicates their vulnerability. These small island and low-lying coastal countries are subject to structural vulnerability that affects their productivity, development and cooperation policies. Since SIDS were identified as a special group during the 1992 Earth Summit, a number of internationally agreed development goals have been formulated to address SIDS vulnerabilities and to build

resistance and sustainability. Currently 52 states in the Caribbean, the Pacific, and Africa, Indian Ocean, Mediterranean and South China Sea are included in this category.

- An **archipelago** is a chain or cluster of islands that are formed tectonically. It is now used to generally refer to any island group or, sometimes, to a sea containing a large number of scattered islands. Archipelagos are usually found isolated in bodies of water; less commonly, a large land mass may neighbour them. The five largest modern countries that are mainly archipelagos are Japan, the Philippines, New Zealand, the United Kingdom and Indonesia. The largest archipelago in the world, by size, is Indonesia. Australia is geographically considered a continent, not an island, although in the past it was considered an island country for tourism purposes. It is sometimes still considered an island country.

Importance of Islands:

- Islands encompass a diverse range of territories, differing in landform, climate and biogeography. Nearly one fourth of the world's countries are islands! With the legacy of a unique evolutionary history, islands are treasure troves of biodiversity. The species may become island dwellers either by drifting or by dispersal. Once they reach the islands, they are confined to small, isolated pockets, much away from the mainland. The formation of new islands and their isolation from the mainland provides many unoccupied riches for species to adapt to.

- In the absence of many predators and competitors, the newly arrived species may easily get established in the new niches available. As the chances of breeding with mainland species are limited, through isolation (and with restricted gene pool), they develop into distinct species, some with highly specialized characteristics. This results in a high rate of endemism, with species restricting their distribution to localized areas.

- Compared to the mainland, islands have a disproportionately high number of endemic species.

- Islands are rich in ecosystem diversity too, as within islands we may come across mountain forests to coastal wetlands. These ecosystems provide food, fresh water, wood, fibre, medicines, fuel, tools and other important raw materials, in addition to aesthetic, spiritual, educational and recreational values. In fact, the livelihood and economic stability of the islands depend on its biodiversity.

- Think about corals and mangroves that border island ecosystems. These unique ecosystems provide a wide array of ecosystem services, including defence against natural disasters, support to recycling of nutrients, and regulation of microclimate. They also act as homes and nursery grounds of hundreds of marine species. Above all, biodiversity of islands not only supports the economy and food security of the islands but also determines the livelihood and cultural identity of 600 million island-dwelling people across the world.

- Coral reefs provide an estimated US$ 375 billion per year in goods and services to the world. This includes support for marine fisheries, which provide the principal protein source for many island populations. The Lakshadweep is a coral island. Coral reef ecosystems around Indian islands are home to hundreds of marine ornamental fishes.

Vulnerability of Islands:

- Each island ecosystem is unique in its biological character and therefore even slight changes in environmental conditions may drastically impact biodiversity and life of human species inhabiting there. These ecosystems are fragile, often comprising species that have evolved in the absence of aggressive competitors, diseases or predators. Though they are more biodiverse than mainland regions and the degree of endemism is high, the small size of populations and separation restricts movement and gene flow, limiting the ability for recolonization following catastrophic events. Many of the islands are thickly populated and there are pressures from human developmental activities, including tourism.

- The impacts of climate change and related events are much more effervescent in islands than any other ecosystem in the world. The most significant impacts of climate change are sea level and sea-surface temperature (SST) rise. Because most small islands are low lying and have a large exposure of coasts in relation to landmass, as well as a high concentration population in coastal zones, islands are extremely vulnerable to sea-level rise.

- Sea-level rise will also cause increased salinity due to encroachment of the sea and saltwater intrusion into freshwater lenses, contributing to an increasing shortage of water supply and loss of agricultural land. Water stresses caused by climate change will have terrific impacts on poor rural people reliant on water resources for their livelihoods. Ocean warming, frequent tropical cyclones, flash floods and droughts are likely to have dramatic impact on food production system in islands.
- As fishing is the major occupation of many island people, the socio-economic implications of fisheries loos would be severe and this may trigger other anthropogenic stresses such as over-fishing. Not all effects of climate change on agriculture are expected to be negative. For example, increased temperatures in high-latitude islands are likely to make conditions more suitable for agriculture and provide opportunities to enhance resilience of local food systems.

- The rise in sea temperature causes coral bleaching, which negatively affects fishes, sponges, giant clams, molluscs and other sea creatures, whose survival depends on reefs. The coral bleaching events are now frequently reported from seas around Lakshadweep as well as Andaman and Nicobar islands due to increase in SST. The food security of the Lakshadweep islands is not hit because of this phenomenon primarily due to dependence of people on tuna, a pelagic fish caught abundantly in waters around the islands.

- A report issued by the World Worldwide Fund for Nature (WWF) argues that Australia's Great Barrier Reef, the largest of its kind in the world, could lose 95% of its living coral by 2050 should ocean temperatures increase by the 1.5 degrees Celsius projected by climate scientists. This is due to the phenomena of coral bleaching and ocean acidification. As oceans absorb more amount of carbon dioxide, more carbonic acid is formed, resulting in ocean acidification.

- The majority of the world's turtles have environmental sex determination, which means the sex of sea turtle hatchlings is temperature dependent. Warmer temperatures increase the number of female sea turtles at the expense of males.

- Some scientists are now suggesting that global climate change has to potential to eliminate the production of male turtle offspring if mean global temperatures increase by 4oC, and increases of less than 2oC may dramatically skew the male-female sex ratios. Global warming, therefore, will have impacts on sea turtle populations, majority of which prefer calm and pristine beaches

around islands to nest.

- The islands are also well known for their human diversity and cultural diversity. For example, the Andaman group of islands are inhabited by four Negrito tribes, viz., the Great Andamanese, Onge, Jarawa and Sentinalese and the Nicobar group of islands by two Mongoloid tribes, viz., Nicobarese and Shompens. Recent molecular genetic studies revealed the presence of these tribes in India around 60,000 years ago! As life of these island people depends fully on the health of the forest ecosystems and fishing, climate change events could make their lives more miserable.

Coral Bleaching

- Corals are marine animals included in class Anthozoa and phylum Cnidaria. These organisms, producing hard exoskeleton of calcium carbonate, are represented by a colony of genetically similar flower-like structures called polyps. Over many generations the colony secretes a skeleton that is characteristic of the species. Huge deposits of these skeletons over long periods of history may give rise to coral reefs. Each polyp is typically only a few millimetres in diameter and has skeleton cup, tentacles with stinging cells, a mount and a stomach. The tiny tentacles snatch at passing plankton for food.

- Many corals form a symbiotic relationship with a class of algae, zooxanthellae, of the genus Symbiodinium. Typically a polyp harbours one species of algae. Via photosynthesis, these provide energy for the coral, and aid in calcification. The algae benefit from a safe environment, and consume the carbon dioxide and nitrogenous waste produced by the polyp. Due to the strain the algae can put on the polyp, stress on the coral often drives the coral to eject the algae. Mass ejections are known as coral bleaching, because the algae contribute to coral's brown colouration; other colours, however, are due to host coral pigments, such as green fluorescent protein (GFP).

- Rising water temperatures block the photosynthetic reaction that convents carbon dioxide into sugar. This results in a build up of products that poison the zooxanthellae. To save itself, the coral spits out the zooxanthellae and some of its own tissue, leaving the coral a bleached white. This phenomenon is often referred to as coral bleaching.

Holography

Principle of Holography:

- Holography is actually a two-step process that involves recording of the hologram and reconstruction of the image from the hologram. For recording the hologram, a highly coherent laser beam is divided by a beam splitter into two beams. One of these beams, known as the reference beam, hits the photographic plate directly. The other beam illuminates the object whose hologram is to be recorded. The reflected beam, called the object beam, falls on the photographic plate. The object beam and the reference beam are made to mix with each other to form the interference pattern on the photographic plate. The resulting interference pattern forms the hologram.

- However, unlike a photograph, a hologram is quite unintelligible and gives no idea about the image embedded in it. But, it contains information not only about the amplitude but also about the phase of the object wave. It has, therefore, all the information about the object.

- For viewing the image, the hologram is illuminated with another beam, called the read-out or reconstruction beam. In most cases, this beam is identical with the reference beam used during the formation of hologram. This process is termed as reconstruction.

Applications of Holography:

- Holography finds application in many diverse fields.

- **Data Storage:** An important application of holography is in the field of information or data storage. The ability to store large amounts of information in some kind of media is of great importance as many electronic products incorporate storage devices. The advantage of holographic data storage is that the entire volume of recoding media is used instead of just the surface. In 2005, holographic versatile disk (HVD), a 120 mm disk that used a holographic layer to store data, was produced by some companies. This had the potential or storing 3.9 TB (terabyte) data. Further developments in the field are going on and it is expected that holographic data storage would become the next generation of popular storage media.

- **Security:** Another major application of holography is in the coding of information for security purposes and in preventing counterfeiting. Such holograms, called security holograms, are replicated from a master hologram that requires very expensive, specialized and technologically advanced equipment, such as electron-beam lithography system. This kind of technique allows creation of surface holograms with a resolution of up to 0.1 micrometre.

- The security holograms are widely used in many currency notes. Security holograms in multiple-colour are created with several layers. They are used in the form of stickers on credit and bankcards, books, DVDs, mobile phone batteries, sports equipments, branded merchandise etc.

- **Cryptography:** Holographic methods may also be used in cryptography for secret communication of information. This is done by recording the holograms of secret communication of information. This is done by recording the holograms of secret documents, maps and objects. The images can be reconstructed at the receiver end.

- **Holographic Microscopy:** Holographic microscopy is yet another potential application of holography. A conventional microscope has a small depth of field (the range of depth over which an object is in focus at any microscopic setting). Biological specimen, generally suspended in a fluid, move about making them sometimes in and sometimes out of focus of the microscope. However, this motion can be “freezed” in a hologram taken through a microscope. The reconstructed 3-D image can then be studied at leisure.

- **Holographic Interferometry:** One of the most promising applications of holography lies in the field of interferometry. They can be used for testing stresses, strains and deformations of objects under the effect of mechanical stress or thermal gradient.

- Holographic interferometry can also be used for studying vibrations in objects. This has been used to study the vibration modes of both string and percussion musical instruments. The technique

can also be applied for non-destructive testing of materials, to detect cracks, disorders, voids and residual stresses in a test sample without destruction of the sample. Holographic interferometry can be used for testing automobile engines, aircraft tyres, artificial bones and joints.

Medical Applications:

- Some of the prominent fields of medical science in which holographic technique is used include endoscopy, dentistry, urology, ophthalmology, otology, orthopaedics and pathology.

- In the field of ophthalmology any retinal detachment or intraocular foreign body can easily be detected. In corneal surgery, holographic technique can be used for measurement of elastic expansion of the cornea, which is a very vital information for the surgery. Holographic lenses can make one lens provide several different functions, such as correcting regular vision and also acting as magnifiers for reading, all in the same lens and throughout the entire lens at the same time.

- Endoscopic holography, which combines the features of holography and endoscopy, provides a powerful tool for non-contact high-resolution 3-D imaging and non-destructive measurements for natural cavities found inside the human body or any difficult-to-access environment.

- In otology, different parts of the human peripheral hearing organs are studied using double exposure and time-average holographic interferometric techniques.

- In urology, holographic techniques can be used for detecting kidney stones and for the diagnosis of other urinary problems e.g. tumors in the urinary bladder.

- For applications of holography in dentistry both continuous wave and pulse laser holography have been used. Besides other applications in dentistry, holograms can be employed as training aids in the disciplines of dental anatomy and operative dentistry.

Ocean Technology

- Scientific exploration of the oceans is necessary for effective utilisation of our planet earth. To view the ocean from the human frame of reference is always a challenging objective and a herculean task to execute. To succeed such ambitious task and carry out highly advanced research, we need state-of-the-art equipped ocean research vessels such as Sagar Nidhi.

- The vessel is capable of carrying out Geo-scientific, Biological, Chemical, Meteorological and Oceanographic research activities. Right from the design phase she was planned to support research in the Indian Ocean and Antarctic waters and built accordingly. Sagar Nidhi is operated by the National Institute of Ocean Technology, an Autonomous institute under the Ministry of Earth Sciences, Govt. of India.

- Sagar Nidhi is also being utilized for ocean engineering purposes. Two-third of the earth's distinctive feature is occupied by oceans that possess economically valuable mineral wealth such as oil and natural gas, gas hydrates, manganese nodules, submarine hydrothermal sulphides, manganese crust, phosphorites, placers, calcareous sands and lime mud. To exploit these resources, technology is being developed at NIOT such as Deep Sea Mining systems, ROV's, AUV's, manned/unmanned submersibles, auto Coring System and exploration of Gas Hydrates.

These technologies are demonstrated in deep seas on board Sagar Nidhi.

Fusion: A Limitless Source of Energy

- There are two types of fusion—uncontrolled and controlled. In uncontrolled nuclear fusion, vast amount of energy in uncontrolled manner is released causing destruction only—the hydrogen bomb is an example. Thus uncontrolled nuclear fusion is not of use for constructive purpose. In controlled nuclear fusion, the vast energy is released steadily so it can be used for peaceful purposes, say, the nuclear fusion reactors.

- Hydrogen constitutes about 70% mass of the sun and other stars. The three isotopes of hydrogen (protium- $_1H^1$, deuterium- $_1H^2$, and tritium- $_1H^3$) and light isotope of helium ($_2He^3$) constitute the fuel of the nuclear fusion process.

- Among all fuels, deuterium is the ideal and principal raw material for fusion reactors because:

  - Deuterium is non-radioactive, and inert and denser than hydrogen. So it is relatively easy and safe to produce, handle and store deuterium gas. Further, the by-products like oxygen formed during production of deuterium can be used in the medical field, sea diving, welding, etc. Tritium is radioactive so its production and storage involves radiation hazards.\

  - Deuterium is a renewable fuel as it is obtainable from water. This way, deuterium is as close as the nearest body of water. The ocean and other water bodies contain more than 25 million tons of deuterium. Thus, water bodies provide inexhaustible amount of deuterium as source of energy.

  - Burning of one deuterium nuclei through fusion produces about 7.2 MeV energy (when deuterium alone is used as fuel). So 18 g of water produces sufficient amount of heavy water and in turn sufficient deuterium to produce about 10^{22} MeV energy. If fusion reactors operate at 50% efficiency then 18 g ordinary water has capacity to produce about 222 KWH power sufficient to operate one cooler, one TV, one refrigerator, tube lights and electric bulbs for one month for a family.

Products of Nuclear Fusion:

- The products of nuclear fusion are vast amount of energy and some particles with by-product helium—an inert, non-polluting, non-radioactive and non-greenhouse gas. Helium finds many uses:
  a) As cryogenic rocket fuel;

  b) In superconductivity as mercury on cooling by liquid helium becomes superconductive at 4 K;

  c) For filling tyres of airships and balloons for meteorological observations as it is non-inflammable with lifting power being equal to 92% of that of hydrogen gas;

  d) Mixture of helium with oxygen is used for sea-divers for respiration, and in treatment of certain respiratory diseases like asthma;

e) For providing inert atmosphere in the welding of metals or alloys that are easily oxidized.

Hurdles in Nuclear Fusion:

- The energy intensity of renewable sources like wind, ocean, etc. is very low. So, fusion is a renewable, clean commercial and limitless source of energy capable of meeting industrial and household power needs.

- But then what is stopping us from using nuclear fusion as an energy source? Fusion involves some inherent problems like creation of plasma state, and fusion of positive charged nuclei against extremely high repulsion between them. To get the plasma state and to overcome nuclear repulsion during nuclear fusion, nuclei must be brought very close together not only by high pressure but also with high kinetic energies as required activation energy for fusion is very high. For this, a temperature about 108 K is required.

- Nuclear fusion is possible in stars as temperature about 108 K is available in stars. On earth, it may be obtained by exploding a fission bomb as in hydrogen bomb. But, this way of fusion is an uncontrolled process that release uncontrolled energy leading to destruction.

- For peaceful use of fusion energy, the nuclear fusion process has to be controlled. Till now, there is no available method of controlling the release of fusion energy. A controlled release of fusion energy is possible in a fusion reactor but its construction is problematic.

- The main problem is the manufacturing of a container capable of containing hot plasma state under the required conditions of high temperature and high pressure. So far, there is no manufacturing material that can withstand 108 K temperature.

Developments in Fusion Technology:

- Considerable efforts have been made to accomplish controlled fusion. Scientists have been working for production of temperature of the order of 108 K and hot plasma without destroying the container itself and without letting the plasma to cool on touching the wall of the container.
- The production of high temperature is based on electromagnetic and laser devices. In electromagnetic devices, the container is surrounded by strong and circular magnetic fields that repel the plasma and force and compress it away from the sides into center of the container. Further, the extremely dense flow of current within the plasma heats it up to enormously high temperature.

- The high pressure and high temperature developed in the plasma state of fuel forces plasma particles to fuse together to produce helium nuclei and enormous energy in the form of heat. This is known as the 'Pinch Effect'. On the basis of this effect, in experimental reactors, fusion has been observed for a fraction of a second. Three types of experimental reactors, namely – magnetic bottle, tokamak and stellarator have been tried on the same principle i.e. magnetic containment and compression of plasma.

- A major step taken towards imitation of stellar energy was the launch of International Thermonuclear Experimental Reactor (ITER) project at Cadarache in France. ITER will be designed for fusion of about 0.5 g of deuterium-tritium mixture in its approximate 840 sq m fusion reactor chamber to produce approximate 500 MW power sustained for up to 400 seconds. ITER is based

around a hydrogen plasma torus operating at over 100 millions Kelvin temperature.

- The project is anticipated to last for thirty years – 10 years for construction, and 20 years for operation. The first plasma operation is expected in 2016, and a commercial fusion reactor is expected in 2050.

India and Fusion Technology:

- Several Indian research institutions are engaged in different components of fusion research. Some such institutions are the Bhabha Atomic Research Center (BARC), Indira Gandhi Centre for Atomic Research (IGCAR), Center for Advanced Technology (CAT), Institute for Plasma Research (IPR) and Physical Research Laboratory (PRL).

- In 1989, India's indigenous tokamak named 'Aditya' was installed at IPR, Gandhinagar. In Aditya, plasta at about 5 million K can be generated, which however is not sufficient to trigger fusion.

- India's electricity generation capacity would need to go up six to seven fold from the current installed capacity of around 1.15 lakh MW to between 7.8-9.6 lakh MW by 2031-32 (end of XV plan period). To meet this requirement, India is trying to tap non-conventional energy resources including fusion reactor technology.

Infecting Mosquitoes to Curb Dengue

- Australian scientists claim to have found a new way to control dengue fever, a painful and debilitating disease that kills more than 40,000 people worldwide and afflicts 50 million more every year. As of now, there is no vaccine or cure for dengue fever.

- A team of scientists from the University of Queensland found that the lifespan of the mosquitoes that transmit dengue fever could be shortened by infecting them with a bacterium known as Walbachia. Walbachia bacteria are rampant in nature, where they are estimated to infect 60% of all insect species. The researchers found the mosquitoes infected with Wolbachia bacteria proved resistant to dengue fever and Chikungunya, which usually is not as fatal as dengue but can cause symptoms similar to it. The infected mosquitoes also became poor hosts for a form of malaria parasites that infect birds.

Himalayan Red Berry–Wonder Heart Tonic

- Himalayan Red Berry (Crataegus crenulata (D. Don) M. Roemer, Fam. Rasaceae) is endemic to Himalayan hills ranging from 900 to 2400 m altitude. Locally known as "Ghingaroo", this dense bushy shrub grows widely in abundance in barren, rocky and dry grasslands. This perennial, deciduous and thorny shrub is commonly known as Indian hawthorn.

- Presence of bioflavanoids in several species of Crataegus is useful in the treatment of disorders of the heart and circulation system especially in case of angina. The fruits of Crataegus also have antispasmodic, diuretic, sedative, and vasodilatation properties. The fruits and flowers have hypotensive properties and hence are useful in cases of high blood pressure.

- Owing to its nutraceutical, pharmaceutical, biotechnological and environmental usage, the Defence Institute of Bio-Energy Research (DIBER), Haldwani has made a successful attempt in exploitation of this plant species.

- Modern scientific research has shown that this shrub has potential application for treatment of hypertension patients. Clinical trials on heart patients with hypertension have shown that total flavanoids of Crataegus reduce cholesterol level and improve cardiac functions. Crataegus leaves are also found useful for antioxidant, immunomodulatory and anti-inflammatory activities.

- Antioxidants present in berries of hawthorn reduce damage from free radicals.

- Crataegus is identified for environmental benefits as well including soil and water conservation, desertification control and land reclamation in fragile mountain ecosystems. The shrub develops an extensive root system, which holds the soil and helps in reducing soil erosion and landslides.

- The Discovery of a unique copper-repressing protein in the tuberculosis causing bacterium may pave the way toward new strategies to prevent tuberculosis infection. Earlier, scientists did not know exactly how invading bacterium protect themselves from copper ions used by the body as a defense against infection. Now they can pursue ways to deactivate the repressor protein, so that tuberculosis can be prevented.

- A Cloudburst leads to the exact phenomenon one would expect if cloud burst—copious and intense rainfall over a small area. It is sometimes also called Rain Gush or Rain Gust. In scientific parlance, cloudbursts are described as "devastating convective phenomena producing sudden high-intensity rainfall (<"10 cm per hour) over a small area."

Superbug NMD-1

- Of late, in the Indian sub-continent, Gram-negative Enterobacteriaceae stains, resistant to the powerful antibiotic carbapenem, are becoming more widespread, especially in India and Pakistan, Incidentally, the antibiotic carbapenem is considered to be the last line of treatment for infections caused by Gram-negative bacteria. How does the resistance arise?

- The resistance arises on account of a new gene that is responsible for production of the metallo-beta-lactamase enzyme that makes the antibiotic carbapenem ineffective. This drug-resistance bacterial gene, the so-called superbug, was named New Delhi Metallo-beta-lactamase-1 (NDM-1) in 2009 when it was first identified in a Swedish national admitted to a hospital in New Delhi.

- The potential of NDM-1 to be a worldwide public health problem is great, and co-ordinated international surveillance is needed.

- Resistance to extended-spectrum beta-lactamase (ESBL) drugs like third-generation cephalosporins is less than 15% in developed countries. While in India, it is between 60 and 70%! For treatment of ESBL infections, carbapenem a reserved antibiotic and the last line of treatment – is the drug of choice as it has the lowest resistance rates and the broadest action against Gram-negative infections. However, its indiscriminate use has played a major role in the development of the carbapenem-resistant gene, including the new NDM-1 strain.

- NDM-1 was unknown until a few years ago, but has begun to show up in the last three years. NDM-1 is, in all probability, still a hospital-acquired infection. Drug-resistant NDM-1 strains are a cause for worry because very few drugs are available to treat Gram-negative infections.

The Cloudbursts

- Most Cloudbursts occur in association with thunderstorms. In such type of storms there are strong uprushes of air. These updrafts are filled with turbulent wind pockets that shove the small raindrops around leading to collisions between raindrops. The collisions lead to conglomerations and large-sized drops are formed. The forceful upward rush of air also prevents the condensing raindrops from falling downwards. So instead of falling down to Earth the water droplets are pushed upwards till a large amount of water accumulates at a high level. Eventually all updrafts become weak and collapse. With nothing to push it up, the entire water falls down almost all at once.

- The mechanical action of rain is greatly increased by the force and amount of rainfall. So a single Cloudburst can do far more damage than the same volume of rain falling as a gentle shower. The perilous nature of Cloudbursts is therefore because of these large raindrops falling as a torrent, at great speed over a small area.

- Cloudbursts cause flash floods. Flash floods in turn, uproot trees, trigger soil erosion, landslides and landslips leading to habitat destruction, and massive loss of property. Downstream, the floodwaters show down and deposit large amounts of silt that may choke the mouth of water bodies and/or raise the riverbed. Other things being equal, the rapidity with which the rain sweeps away the soil depends upon the steepness of the slope. On hillsides, flash floods can be devastating.

- India is no stranger to this calamity. There have been many major Cloudbursts that have caused untold loss in recent times.

- And the latest in line was one that led to untold devastation in Leh recently.

The Cumulonimbus:

- The Cumulonimbus is a tall cloud that contains very high, unpredictable winds. Such clouds are associated with thunderstorms. Typically these are the clouds that are usually responsible for Cloudbursts.

Nobel Prizes-2010

Physiology or Medicine:
(Robert G. Edwards)

- This year's Nobel Prize for Medicine or Physiology has been awarded to Dr. Robert Edwards, Professor Emeritus at the University of Cambridge, UK for developing in vitro fertilization, considered as a "breakthrough that has helped millions of infertile couples world wide to have children". In vitro fertilization (IVF) is a process in which an egg cell is removed, fertilized out side the female body by adding sperm cells and returned to the female for conceptions.

Test Tube Baby:

- As a result of their sustained efforts over more than a decade under such demanding conditions, on 25 July 1978 Louise Brown was born in Britain as the world's first IVF baby, heralding a revolution in infertility treatment.

- Meanwhile, IVF has become the final solution, not only for women with fallopian tube problems such as endometriosis, scarring, blockages, etc which cannot be set right by surgical procedures, but also for male infertility caused by low sperm count or poor sperm quality. In such cases in single sperm cell may be selected for quality and transferred into an egg by a technique known as intracytoplasmic sperm injection.

- Even with healthy couples with a family history of inherited disease and so at high risk of passing on to their offspring. IVF has served as a useful tool since the 1990s. In such cases the embryo can be screened for genetic defects before transfer.

- India's and Asia's first and world's only second test tube baby was born in Kolkata on 3 October 1978. Her name is Durga or Kanupriya Agarwal. The man behind this pioneering efforts was Dr. Subhas Mukherjee, Professor of Physiology, Bankura Sammilani Medical College, Kolkata.

Physics:

- The 2010 Nobel Prize in Physics was awarded to Andre Geim and Konstantin Novoselov, both belonging to the University of Manchester, UK for discovering a two-dimensional allotrope of Carbon, which is now called Graphene.
- The Nobel laureates have also shown that carbon in such a flat form has exceptional properties that can be predicated from the remarkable edifice of quantum physics. As a material it is completely new – not only the thinnest ever but also the strongest.

- Graphene is almost completely transparent, yet so dense that not even helium, the smallest gas atom, can pass through it. Its honeycomb crystal lattice gives the material especially unique electrical properties. The great mobility of electrons in grapheme allows for the creation of ultra-fast electronic devices. This property is thought to be a result of graphene's a near-perfect atomic structure.

- In addition to ultra-fast electronics, other potential applications include grapheme transistors, integrated circuits, transparent conducting electrodes, and many more yet to be explored. Graphene-based computers will sooner or later replace the silicon-based computers. Since it is practically transparent and a good conductor, graphene is suitable for producing transparent touch screens, light panels, LCD displays and maybe even highly efficient solar cells that can power small cars.

Chemistry:

- This year's Nobel Prize in Chemistry has been awarded to Richard F. Heck, Ei-ichi-Negishi and Akira Suzuki for the development of 'palladium-catalysed cross-coupling in organic synthesis', a technique that achieves carbon-carbon, or C-C bonds, highly selectively and under relatively gentle conditions.

- Carbon has only four electrons in its outermost layer and, therefore, it strives to attach to other atoms so that electrons can be shared between atoms in a molecule through chemical bonds. Methane, the simplest organic molecule, has a carbon atom sharing electrons with four hydrogen atoms, thus making the outer layer (orbital) full. To build complex organic molecules, chemists start with pre-existing smaller molecules; this is where the problem arises because in such molecules the carbon atoms are in stable configuration and, therefore, have little reactivity with other molecules. The question is how to make carbon atoms more reactive so that they combine with other carbon atoms.

- The palladium-catalysed C-C bond forming reactions of Heck, Negishi and Suzuki have had a large impact in synthetic organic chemistry and have found many applications in target-oriented synthesis. A spectacular example of the use of palladium-catalysed cross-coupling reaction is in the test-tube creation of palytoxin – a gigantic molecule in the chemical world. It is a naturally occurring poison that was first isolated from a coral in Hawaii in 1971.

- These cross-coupling reactions have been applied in the synthesis of a large number of natural products and biologically active compounds with complex structures. They have also found applications in fine chemical and pharmaceutical industries.