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Classroom Study Material

# SCIENCE AND TECHNOLOGY

**October 2016 – June 2017**

***Note: July, August and September material will be updated in September last week.***

Student Notes:

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# 1. BIOTECHNOLOGY

## 1.1. INTRODUCTION

**Biotechnology** is the use of biological processes, organisms, or systems to manufacture products intended **to improve the quality of human life**. The science of biotechnology can be broken down into sub-disciplines called red, white, green, and blue:

- **Red biotechnology** – It involves **medical processes** such as getting organisms to produce new drugs, or using stem cells to regenerate damaged human tissues and perhaps re-grow entire organs.
- **White (also called gray) biotechnology:** It involves **industrial processes** such as the production of new chemicals or the development of new fuels for vehicles.
- **Green biotechnology:** It applies to **agriculture** and involves such processes as the development of pest-resistant crops or the accelerated evolution of disease-resistant animals.
- **Blue biotechnology:** It encompasses processes in **marine and aquatic environments,** such as controlling the proliferation of noxious water-borne organisms.

### 1.1.1. STATUS OF BIOTECHNOLOGY SECTOR IN INDIA

- **Department of Biotechnology** is the nodal agency set up in 1986 under the Ministry of Science and Technology to steer developments and commercialization in the field of biotechnology and modern biology.
- India is among the **top 12** biotech destinations in the world.
- The Indian biotech industry holds about **2 per cent share** of the global biotech industry.
- The Indian Biotech Industry is currently valued at USD 11billion.
- India has emerged as a leading destination for clinical trials, contract research and manufacturing activities owing to the growth in the bioservices sector.
- India has **the second-highest number** of US Food and Drug Administration (USFDA)–**approved plants,** after the USA and is the largest producer of recombinant Hepatitis B vaccine.
- Biotech industry in India is heavily dominated by the pharmaceutical sector, which accounts for more than **60 per cent of revenues.**

### 1.1.2. APPLICATIONS OF BIOTECHNOLOGY

- **GM crops** – Genes of plants/crops have been manipulated using recombinant DNA technology. This helps in:
  - ✓ Making crops resistant to pest attacks (**Bt Cotton** and **Bt Brinjal**).
  - ✓ Making them more tolerant to abiotic stresses (cold, drought, salt, heat).
  - ✓ Reducing post-harvest losses.
  - ✓ Increased efficiency of mineral usage by plants which prevents early exhaustion of fertility of soil.
  - ✓ Enhancing nutritional value of food, e.g., Vitamin 'A' enriched **golden rice**.

Recombinant DNA technology involves joining together of DNA molecules from two different species that are inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture, and industry.

Bt Cotton is genetically modified cotton. This variety of cotton contains cry1Ac gene obtained from Bt (Bacillus thuringiensis) bacteria. This gene incorporation makes the cotton toxic to bollworms. Thus preventing cotton plant damage which leads to greater production.

- ✓ GM techniques have also been used to to increase efficiency of photosynthesis in plants when their leaves go in shade after exposure to bright sunlight.

- **Gene therapy:** It involves correction of a genetic defect through delivery of a normal gene into the individual or embryo to take over the function of and compensate for the non-functional gene. This way hereditary disease such as Parkinson's disease could be treated effectively.
- **Pharmacogenomics**: This technology helps in analyzing how genetic makeup affects an individual's response to drugs.
- **Stem cell therapy:** It is also known as regenerative medicine which promotes the reparative response of diseased, dysfunctional or injured tissue using stem cells or their derivatives.
- **Bioremediation**: It is a waste management technique in which microorganisms (e.g., bacteria, fungi), plants (termed phytoremediation), or biological enzymes are used to consume and break down environmental pollutants, in order to clean a polluted site. Example: oil zappers.
- **Bio-fuels**: These are kind of fuels that are derived from living organisms such as plants and their by-products, microbes or animal waste. Two most common bio-fuels are bio-ethanol produced by fermentation of sugars and bio-diesel obtained from trans-esterification of oil obtained from plants like jatropha, rapeseed, mustard, sunflower, soy, etc.
- **Biofortification:** Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices. Biofortification differs from conventional fortification in that biofortification aims to increase nutrient levels in crops during plant growth rather than through manual means during processing of the crops.

### 1.1.3. CHALLENGES IN BIOTECH SECTOR

- **Biotechnology Regulatory Authority of India Bill** which envisions creating a regulatory body for uses of biotechnology products including genetically modified organisms is pending in the parliament since 2008.
- Also the task to carry out **scientific risk assessment** of every biotech products – be in the field of agriculture, health or environment, or to supervise field trials of GM crops and to regulate the lucrative sector, would be difficult because of a lack of regulator for the sunrise sector.
- The number and quality of jobs offered by this sector is presently lesser than the work force supply available. This is making students less interested in this sector.
- There is **lack of early stage funding** for biotech industries.
- India has created little knowledge capability of its own and has mostly followed the path created by the US.
- **Lack of public awareness** of the modern tools of biotechnology and how it could improve our well-being, offer food and energy securities and helps in preserving our environment.
- India is **fast losing to competition** created by China and Korea due to regulatory and infrastructure challenges.

## 1.2. NATIONAL BIOTECHNOLOGY DEVELOPMENT STRATEGY (NBDS) 2015-2020

**Objectives**

- The idea is to make India a **world class bio-manufacturing hub**.
- NBDS intends to launch a major mission under the Make in India programme backed with significant investments for the creation of new biotech products.
- It also seeks to create a strong **infrastructure** for Research and Development and commercialization and also **empower** India's human resources scientifically and technologically.

Student Notes:

**Strategy**

- To build a skilled workforce and improve research facilities in basic, disciplinary and inter-disciplinary streams of scientific studies.
- Nurturing innovation, translational capacity and entrepreneurship.
- Ensuring a transparent, efficient and globally best Regulatory system and communication strategy.
- Creating a technology development and translation network across the country with global partnership.
- Making India ready to meet the challenge of achieving US$100bn by 2025.
- Launching Four Major Missions – Healthcare, Food and Nutrition, Clean Energy and Education.
- Strategic and focused investment in building the human capital by creating a Life Sciences and Biotechnology Education Council.

**Conclusion**

- NBDS is a major step towards a new era of **science-driven, society relevant innovation and entrepreneurship.**
- NBDS provides the impetus for building indigenous capabilities in health, food and environment. It also lays the foundation for offering research support to biotech industries through launching of major PPP programs and spearheaded new frontiers of biotech research.
- There is a need to enhance our own capacity to comply with our commitments and to enable our flow of resources. Investments need to be strengthened to promote innovation and R&D for development of affordable products for Indian and global market.
- However challenges need to be overcome to reap the benefits of biotechnology and make it play a crucial role in India's sustainable and inclusive development story.

## 1.3. DRAFT GUIDELINES FOR STEM CELL RESEARCH

**Why in News?**

- The **Indian Council of Medical Research (ICMR)** in association with the **Department of Biotechnology recently released the revised Draft Guidelines for Stem Cell Research, 2017** for comments.
- The new guidelines prohibit stem cell research in several areas.

**What Does The Guidelines Prohibit?**

- The prohibited areas for stem cell research include **human germ line gene therapy and reproductive cloning;**
- **in vitro culture of intact human embryos,** regardless of the method of their derivation, beyond 14 days of fertilization or formation of primitive streak, whichever is earlier;

**Germline Editing**

- "Germ line" refers to the egg and sperm, which combine to form an embryo.
- Germline editing is a genome- editing technology that can, in principle, be developed to make specific and targeted genetic alterations in embryos, which will be carried by all the cells of a resulting child and passed on to his/her offspring, a part of the human gene pool.
- By editing the DNA of egg and sperm or the embryo itself, it could be possible to correct disease genes and pass those genetic fixes on to future generations.
- There are various ethical and technical issues involved with germline editing.
- It can create unforeseen changes in the genome which are undesirable.
- It has also been ethically questioned whether editing gene to create babies that parents desires would make them more like commodities.

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- Clinical trials involving transfer of xenogeneic cells into a human host; a
- Any clinical research on Xenogeneic-Human hybrids;
- Use of genome modified human embryos, germ-line stem cells or gametes for developmental propagation;
- Research involving implantation of human embryos (generated by any means) after in vitro manipulation, at any stage of development, into uterus in humans or primates;
- And breeding of animals in which any type of human stem cells have been introduced at any stage of development, and are likely to contribute to chimeric gonadal cells.

**Stem Cell Research Guidelines 2013**

- It **prohibits stem cell therapy** and considers its use for any other purpose outside the domain of clinical trial unethical in the country and hence not permissible.
- All stem cell therapy other than **hematopoietic stem cell transplantation (HSCT) for hematological disorders shall be treated as investigational and conducted only in the form of a clinical trial** after obtaining necessary regulatory approvals.

**Significance**

- The revised guidelines are in line with the advancements in the stem cell research.
- These guidelines also address the concerns related to use of embryos for creating human embryonic stem cells lines as these may lead to commoditization of human cells and tissues.
- The guidelines set out suitable procedures for handling of pluripotent cells which are now easily available for clinical trials.

## 1.4. MITOCHONDRIAL GENE THERAPY

**Why in news?**

- **Human Fertilization and Embryology Authority (HFEA**) of United Kingdom has allowed the first mitochondrial replacement therapy (MRT) by allowing creation of a "three-parent baby" — a child in which the vast majority of DNA comes from the mother and father and a small amount of DNA comes from a female donor.
- The procedure was done through the Pronuclear transfer technique.

**Significance and types of the MRT**

- The benefit of MRT is that it helps in preventing mitochondrial diseases which can be passed on from the affected mother to the offspring.
- The process can be done by two methods - the infographic 1 shows the **Pronuclear transfer** and the infographic 2 shows the **Spindle transfer.**
- Pronuclear transfer has a couple of drawbacks -
  - **Ethical grounds** because it is seen as destroying two embryos
  - Scientists worry because a bit of cytoplasm is usually transferred along with the pronuclei. That means that unacceptably high numbers of disease carrying mitochondria may also get transferred.
- To remove the above drawbacks spindle transfer technique is used as shown in figure 2.

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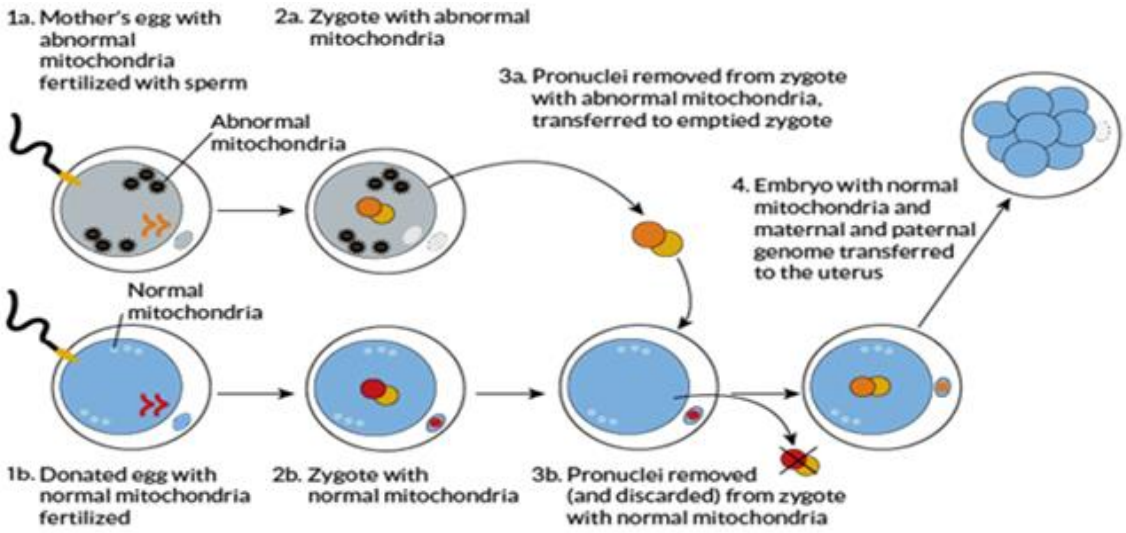



**FIG 1 Pronuclear Transfer**

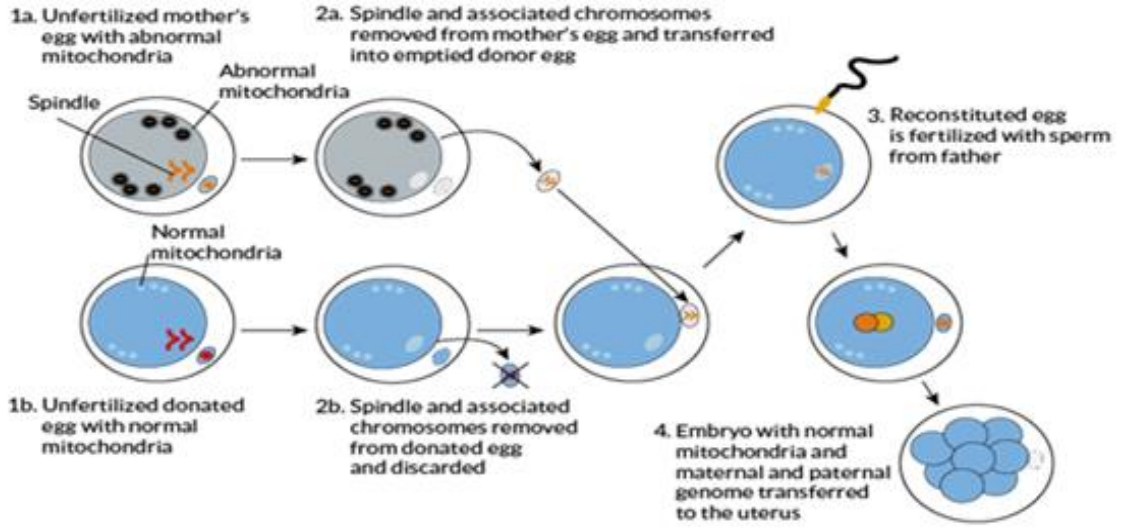



**FIG 2 - Spindle Transfer**

**Pros and Cons of the therapy**

**Pros:**

- It will help in preventing lethal diseases arising out of maternal faulty mitochondrial DNA.
- It cannot be misused as HEFA will act as a fertility regulator. Similar regulators can be established by other countries looking for adopting this technique.

**Cons:**

- There are no clinical trials still to conclusively prove its efficacy.
- It could mark the push to create "Designer babies" which may commoditize mankind etc.

**Way forward**

- Countries like India, USA etc. still have a ban on this technique. Proper Clinical trials is the need of the hour for data to be collected on the safety and efficacy of the technique being used. Also awareness programmes are the solution to remove the unnecessary superstitions prevalent in the common populace.

## 1.5. DNA-TAGGING OF CONVICTS

**Why in news?**

Andhra Pradesh is drafting a legislation that will enable collection and storage of genetic fingerprints in a centralized database to track offenders.

**Benefits of DNA Fingerprinting**

- **Accuracy**- in majority of cases where DNA of more than one person are found, DNA fingerprinting can identify the criminals from other people.
- **Reliability-** is more reliable than Narco analysis which is subjective and also DNA fingerprinting cannot be faked.

**Challenges**

- DNA testing as evidence is not provided under Indian Evidence Act 1872 and Criminal Procedure Code 1973.
- The Union had created similar draft in 2012 which ran into controversy due to concerns around violation of privacy rights.
- **Unscientific investigation:** In India, instead of forensic investigators and scientists, an untrained constable goes to crime scene first, who does not know how to scientifically collect evidences and in the process destroys vital DNA evidence.

DNA fingerprinting relies on sequencing the genome of an individual, which comprises three billion pairs of molecules called nucleotides.

Around 99.9% of all human genomes are similar but the 0.01% stands for three million pairs of nucleotides. Among these three million, there are certain pairs of nucleotides that repeat themselves in the genome.

The sequence of this repetition is unique to each individual. So the presence of DNA samples at, say, a crime scene containing a particular sequence of repetition can be used as a proxy for their owner's involvement in the scene with high certainty.

## 1.6. GENOME SEQUENCING

**What is it?**

- Genome Sequencing refers to the method through which the order of DNA nucleotides, or bases, in a genome—the order of As, Cs, Gs, and Ts that make up an organism's DNA are figured.
- The human genome is made up of over 3 billion of these genetic letters.

**Importance**

- Genome sequence can help scientist one particular gene quickly and easily or at the very least give them an idea of where it is.

**Human Genome Project**

- It was a large multi-institutional effort that took 13 years (1990-2003) to produce a blueprint of the sequence of genes and spaces between genes that make up a typical human genome.
- The first HGP was called HGP-read while the second was called HGP-write.
- The former aimed to read the human genome while scientists believed that it was necessary to write the DNA sequence in order to understand it and hence HGP-write.

**Applications of Genome Sequencing**

- **Forensics –** Genome sequencing or DNA sequencing has been used to identify individuals especially criminals as every individual has a different genome sequence.
- **Medicine** – It is being used to identify the particular gene related with some acquired or hereditary disease.
- **Agriculture –** The mapping and sequencing of whole genome of microorganism have enabled the researchers to make it useful for food crops and plants.

Student Notes:

## 1.7. YAMANAKA GENES

**Why in news?**

- Recently, scientists have found a 'stress factor,' a pro-inflammatory molecule called interleukin-6 (IL6) that may be responsible for reducing the efficiency of the Yamanaka genes.
- With this finding the Yamanaka genes may finally result in practical therapy.

**About Yamanaka Genes**

- They are the four essential genes that can reprogramme the cells in our body and can be used to regenerate old cells or grow new organs.
- Collectively known as OSKM (for the initials of the genes, Oct4, Sox2, Klf4 and Myc), these Yamanaka genes are named after Japanese scientist Shinya Yamanaka.

**Significance of Yamanaka genes**

- The introduction of these genes can convert adult cells into pluripotent stem cells.
- Can be used for RBC generation as type O red blood cells are synthesized from iPSC developed with Yamanaka genes.
- A big revolution as they can use for investigation of diseases and drugs.
- Can be used to synthesise new from stem cells.
- Can also be used to grow & repair tissues & vascular vessels.

**Stem Cells:** Stem cells are a class of undifferentiated cells that are able to differentiate into specialized cell types.

Commonly, stem cells come from two main sources: Embryos (embryonic stem cells) and Adult tissue (adult stem cells). Both are generally characterized by their potency, or potential to differentiate into different cell types. For eg: Pluripotent stem cells have the ability to differentiate into almost all cell types.

**Induced pluripotent stem (iPS) cells**: iPSCs are body (somatic) cells which have been reprogrammed to function like embryonic stem cells, thereby sidestepping the controversial use of killing the embryos while harvesting the stem cells.

They are capable of forming any cell types of the body.

**Importance of Stem Cell Therapy**

- Stem cells offer new potentials for treating diseases such as diabetes, and heart disease.
- To screen new drugs and to develop model systems to study normal growth and identify causes of birth defects.
- Study how an organism develops from a single cell and how healthy cells replace damaged cells in adult organisms.

**Challenges**

- The genes are not very efficient at reversing cell-ageing.
- There is a risk of incomplete programming.
- They may also induce a particular type of tumour (known as teratoma) that makes cell reprogramming incompatible with its potential clinical use.

But the supplies of autologous cells is unlimited & bypass the need for embryos, better understanding of these genes may lead to greatest achievements in medical treatments & research.

## 1.8. SYNTHETIC BIOLOGY

**Why in news?**

- India is set to frame a policy on synthetic biology.
- The Environment Ministry is set to form a group of experts on biotechnology and biodiversity in order to assess synthetic biology worked pursue in Indian labs.

**What is Synthetic Biology?**

- It is an interdisciplinary field that involves the application of engineering to biology.
- It helps in the design and construction of new biological entities such as enzymes, genetic circuits, and cells or the redesign of existing biological systems.

**Applications of Synthetic Biology**

- Synthetic biology in microbial systems holds promise for production of drugs, vaccines, fuel components and other chemicals. A popular example is the production of artemisinin, a powerful anti-malarial drug, in yeast, at a commercial level.
- Microorganisms have also been constructed to act as sensors that can detect a toxin in vitro (outside a living organism) or in vivo (inside a living organism).
- It can also be used in the manufacture of improved biochemicals. One such example is polylactic acid which is a promising alternative to oil-based plastics.
- Can be used for Optimization of genes, microorganisms & plants for efficient conversion of feedstock into biofuels.

## 1.9. BIOFUEL FROM AQUATIC WEEDS

**Why in News?**

- Scientists at IIT Kharagpur found a way to ramp up yields of biofuel sourced from commonly found aquatic weeds such as water hyacinths.

**What is Aquatic Weed?**

- Aquatic weeds are those unabated plants which grow and complete their life cycle in water and cause harm to aquatic environment directly.
- Some limitations of Aquatic weed are that it reduces water storage capacity in reservoirs, tanks, ponds. It also impedes flow and amount of water in canals and drainage systems.
- It also reduces fish production by lowering oxygen levels and promoting nutrient assimilation. It also interferes with navigation and aesthetic value of water body. It also promotes habitat for mosquitoes.

**What is Biofuel?**

- A **biofuel** is defined as any fuel whose energy is obtained through a process of biological carbon fixation. Biofuel can be characterized on the basis of their source biomass.

Should the farmland for food crops be diverted to produce bio-fuel crops such as jatropha?

- **For fuel:**
  - ✓ Bio-fuels are promising alternative to fossil fuels and can help achieve our energy requirements.
  - ✓ Bio-fuels are more environment friendly causing less pollution. This feature raises their value especially in this era of global warming and climate change.
  - ✓ These alternative fuel sources could help stabilize oil prices apart from providing employment to millions.
- **Against fuel:**
  - ✓ Growing crops capable of producing bio-fuels requires large tracts of land. This means lesser land remains to grow food crops to meet food security situation.
  - ✓ Also lesser land will remain available for grazing animals.
  - ✓ Bio-fuel crops requires relatively large amount of water for irrigation apart from causing greater risk of soil erosion.
- **For Food:**
  - ✓ Food safety and security could be better tackled.
  - ✓ Situation of hunger and mal-nutrition could also be better managed.
  - ✓ More food crops production would mean less price and this would benefit poor the most.
- **Against Food:**
  - ✓ Growing bio-fuels is more profitable and thus could help small and marginalized farmers.
  - ✓ Bio-fuels could act as an alternative to surplus food grains crop production.

**Conclusion**

The debate should not be “either” or “or” but how a balance could be achieved in meeting both of our needs. We need to increase our food crops productivity and spend more on R&D so that better solutions could be found. One such example could be culturing bacterium capable of producing ethanol. Also in the short run, waste land could be turned to produce bio-fuel based crops.

**National Biofuels Policy**

- Recently, the National Policy on Biofuels was launched by the Ministry of New and Renewable Energy in 2015. However, recently, the government authorized the Ministry of Petroleum and Natural Gas to carry forward all work related tro biofuels.

**The salient features of the National Policy on Bio-fuels are:-**

- Bio-diesel production will be taken up from non-edible oil seeds in waste /degraded / marginal lands.
- An indicative target of 20% blending of bio-fuels, both for bio-diesel and bio-ethanol, by 2017 has been proposed.
- Minimum Support Price (MSP) for non-edible oil seeds would be announced with periodic revision to provide fair price to the growers.
- Minimum Purchase Price (MPP) for purchase of bio-ethanol and bio-diesel would be announced with periodic revision.
- Major thrust will be given to research, development and demonstration with focus on plantations, processing and production of bio-fuels, including Second Generation Bio-fuels.
- Financial incentives, including subsidies and grants, may be considered for second generation bio-fuels. If it becomes necessary, a National Bio-fuel Fund could be considered.
- A National Biofuel Coordination Committee, headed by the Prime Minister, will be set up to provide policy guidance and coordination.
- A Biofuel Steering Committee, chaired by Cabinet Secretary, will be set up to oversee implementation of the Policy.

Student Notes:

# 2. NANOTECHNOLOGY

## 2.1. INTRODUCTION

Nano science is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, in order to understand and exploit properties that differ significantly from those on a larger scale.

Nanotechnologies are the design, characterisation, production and application of structures, devices and systems by controlling shape and size on a nanometre scale. At this scale, the general physical, chemical, electrical, biological and optical properties of a material start behaving in a unique and peculiar way, i.e. the follow the laws of quantum physics which is very different from the laws of Newtonian physics we see and feel. This uniqueness and peculiarity opens up new vistas for enquiry and applications.

### 2.1.1. APPLICATIONS

**Medical field**

- **Disease Diagnosis:** Nano medicine has resulted in formation of Nano scale diagnostic device which are more efficient & able to detect cancer, bacterial, viral infection. When blood or any tissue sample made to pass through it one such device is known as lab-on-a-chip, Biochip, DNAchip etc.
- **Drug Delivery:** Nanotechnology can be used in the formation of Nano size drug which will help in lower overall drug consumption & side effect by depositing active agent at specific places in body.
- **Cancer Diagnosis and Treatment:** Nanotechnology can locate & eliminate cancer cell using gold Nano cells. Nano cells are targeted to cancer cell by tagging or attaching antibodies to Nano cell surface.
- **Tissue Engineering:** Nanotechnology can help to repair damage tissue through tissue engineering, making use of biodegradable polymer such as polycaprolactone coated with collagen to promote cell to cell attachment or the wound healing process.
- **Medical Nanorobot:** Nanorobotics is a technique of creating machine or robot close to microscopic scale, nanometre. These Nano size robot can navigate the human body, transport important molecule, manipulate microscopic object and communicate with physician by way of miniature sensor .These computer controlled nanorobot can be used in cancer detection & treatment.
- **Superbugs and anti-microbial resistance:** Nanotechnology holds the key to stopping antibiotic-resistant bacteria and the deadly infections they cause.

**Defence**

- Use in intelligence gathering through difficult to detect sensors/cameras/recording devices.
- Possible supplement to traditional weaponry for close combat situations.
- Precision guiding tools for snipers/others who use fire motor shells.

**Agriculture**

- Food processing industry can get better packaging, presentation with least waste and minimum moisture flow and growth of bacteria. This industry provides backward linkages with agriculture.
- In mechanization of agriculture, nano engineered material in automotive products.
- Soil health can be maintained by neutralizing harmful chemical or biological agents. Bio indicators can be used to detect the bio magnification of pesticides and fertilizers.

- Anti-bacterial products such as **nanosilver** when used as a materials preserver maintain its ability to reduce odour-causing bacteria longer and require smaller quantities than other silver preservatives.
- Insect pests management through the formulations of nanomaterials-based pesticides and insecticides
- Enhancement of agricultural productivity using bio-conjugated nanoparticles (encapsulation) for slow release of nutrients and water
- Nanoparticle-mediated gene or DNA transfer in plants for the development of insect pest-resistant varieties
- Use of nanomaterials for preparation of different kind of biosensors, which would be useful in remote sensing devices required for precision farming.
- For controlling pests state-of-the-art nanotechnology has evolved to hassle-free gel-based carriers for pheromones called **nanogels.**




| Agriculture | Food Processing | Food Packaging | Supplements |
|---|---|---|---|
| • Single molecule detection to determine enzyme/ substrate interactions<br>• Nanocapsules for delivery of pesticides, fertilizers and other agrichemicals more efficiently<br>• Delivery of growth hormones in a controlled fashion<br>• Nanosensors for monitoring soil conditions and crop growth<br>• Nanochips for identity preservation and tracking<br>• Nanosensors for detection of animal and plant pathogens<br>• Nanocapsules to deliver vaccines<br>• Nanoparticles to deliver DNA to plants (targeted genetic engineering) | • Nanocapsules to improve bioavailability of neutraceuticals in standard ingredients such as cooking oils<br>• Nanoencapsulated flavor enhancers<br>• Nanotubes and nanoparticles as gelation and viscosifying agents<br>• Nanocapsule infusion of plant based steroids to replace a meat's cholesterol<br>• Nanoparticles to selectively bind and remove chemicals or pathogens from food<br>• Nanoemulsions and –particles for better availability and dispersion of nutrients | • Antibodies attached to fluorescent nanoparticles to detect chemicals or foodborne pathogens<br>• Biodegradable nanosensors for temperature, moisture and time monitoring<br>• Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption<br>• Electrochemical nano-sensors to detect ethylene<br>• Antimicrobial and antifungal surface coatings with nanoparticles (silver, magnesium, zinc)<br>• Lighter, stronger and more heat-resistant films with silicate nanoparticles<br>• Modified permeation behavior of foils | • Nanosize powders to increase absorption of nutrients<br>• Cellulose nanocrystal composites as drug carrier<br>• Nanoencapsulation of neutraceuticals for better absorption, better stability or targeted delivery<br>• Nanocochleates (coiled nanoparticles) to deliver nutrients more efficiently to cells without affecting color or taste of food<br>• Vitamin sprays dispersing active molecules into nanodroplets for better absorption |

**Water treatment and remediation**

- Nanomembranes for water purification, desalination, and detoxification
- Nanosensors for the detection of contaminants and pathogens
- Nanoporous zeolites, nanoporous polymers, and attapulgite clays for water purification
- Magnetic nanoparticles for water treatment and remediation
- TiO2 nanoparticles for the catalytic degradation of water pollutants

**Construction**

- Nanomolecular structures to make asphalt and concrete more robust to water seepage.
- Heat-resistant nanomaterials to block ultraviolet and infrared radiation.
- Nanomaterials for cheaper and durable housing, surfaces, coatings, glues, concrete, and heat and light exclusion.
- Self-cleaning surfaces (e.g., windows, mirrors, toilets) with bioactive coatings.

**Energy**

- Novel hydrogen storage systems based on carbon nanotubes and other lightweight nanomaterials
- Photovoltaic cells and organic light-emitting devices based on quantum dots.
- Carbon nanotubes in composite film coatings for solar cells.
- Nanocatalysts for hydrogen generation.

## 2.1.2. CURRENT ISSUES WITH NANOTECHNOLOGY

**Governance issues**

The boundary-crossing nature of nanotechnology has given rise to several issues. Because materials at the nano-scale are not confined to one particular scientific field or industrial sector, nanotechnology is expected to have an impact that crosses many existing disciplinary and institutional boundaries. Thus, the question here is how particular countries, groups, or actors can facilitate the responsible development of nanotechnology.

**Health and environmental issues**

Another major challenge that nanotechnology has raised across the world is the potential risk of nanotechnology to human health and the environment due to the size of the nano particles.

**Ethical consequences**

For instance nanotechnology may be used in warfare, may invade people's privacy, or may impinge on the relationship between human beings and technology.

**Effect on developing and underdeveloped countries**

Reverse effects of nanotechnology developments on material demands and consequently on developing countries' export of raw materials. Properties at the nano-scale may be used to imitate the properties of rare minerals, thus affecting the export rates of their main producers.

**Human Resource issues**

A developing country such as India may struggle to find quality human resource, esp. in an emerging field which requires cutting edge research.

## 2.1.3. EVOLUTION

The **9th Five-Year Plan (1998-2002**) had mentioned for the first time that national facilities and core groups were set up to promote research in frontier areas of S&T which included superconductivity, robotics, neurosciences and carbon and nano materials.

However, the thrust came with the launch of "**Programme on Nanomaterials: Science and Devices**" in 2000 by the Department of Science and Technology.

Subsequently, the **National Nanoscience and Nanotechnology Initiative (NSTI)** was launched in October, 2001 under the aegis of the Department of Science and Technology of the Ministry of Science. The motive of launching NSTI in 2001 was to create research infrastructure and promote basic research in nanoscience and nanotechnology.

The **Eleventh Five-Year Plan (2007-2012**) categorically mentioned projects to create high value and large impact on socio-economic delivery involving nano material and nano devices in health and disease. The generous Eleventh Five Year Plan Budget allocation of Rs. 1000 crore was earmarked for the Nano Mission when it was launched in 2007/

Accordingly, on 3 May 2007, a **Mission on Nano Science and Technology (Nano Mission)** was launched by the DST to foster, promote and develop all aspects of nanoscience and nanotechnology which have the potential to benefit the country.

**12th FYP**

The Union Cabinet gave its clearance for the continuation of the NSTM in its second phase in the 12th plan period at a cost of Rs. 650 crores. Announcing the Cabinet decision, an official statement noted that as a result of the efforts led by the mission, India has moved from the fourth to the **third position in the world** in terms of scientific publications in nano-science and technology.

The Nano mission, in this new phase, will make greater effort to promote application-oriented R&D so that some useful products, processes and technologies also emerge. It will be steered by a 'Nano Mission Council' chaired by an eminent scientist.

## 2.1.4. MAJOR STAKEHOLDERS

**Department of Science and Technology (DST)**: DST is the nodal agency in the Indian nanotechnology innovation system. It has since 1980s launched may programmes/schemes to foster R&D on miniature-scale and on nano-scale.

**Department of Biotechnology (DBT)**: The DBT is basically active in the area of nano biotechnology R&D. In the period around 2007, the Department of Biotechnology (DBT) initiated a programme on Nano biotechnology.

**Department of Electronics and Information Technology (DeITy)**: The DeITy has established Centre for Materials for Electronics Technology (C-MET) at Pune, Hyderabad and Trissur. These centres are involved in nanotechnology R&D activities, particularly in nanomaterials.

**Department of Industrial Policy and Promotion (DIPP)**: DIPP established a Nano-Manufacturing Technology Centre (NMTC) and Academy of Excellence for Advanced Manufacturing Technology (AEAMT) at the Central Manufacturing Technology Institute (CMTI) in Bangalore.

## 2.1.5. Draft Guidelines for Safe Handling of Nanomaterials

- The Nano Mission under the Department of Science and Technology has come out with the draft "Guidelines and Best Practices for Safe Handling of Nanomaterials in Research Laboratories and Industries
- The guidelines, intended as standard operating procedure (SOP) for handling nanomaterials in research laboratories and industries, prescribe a combination of engineering controls, work practices and personal protective equipment as part of a robust exposure control strategy.
- These lay down the process for identifying hazards, taking note of the specific effect of surface chemistry, shape, size and morphology on toxicity caused to various organs.
- The guidelines also lay down set of best practices related to the making and handling of Nanopowders and use of products relating to food and healthcare.
- **Objectives of these draft guidelines**
- **Identifying hazards**: Nanomaterials are no monolith and thus they pose hazards of different degrees. The draft policy has separately outlines the involved hazards.
- **Best practices for handling nano particles:** The guidelines have clearly intended to make the Nano tech lab a safer place. With the provision for locating emergency equipment, hygiene standards, labelling and signage and cleaning procedures and spill, it can be concluded that Nano tech just like other tech has to be dealt with a word of caution.

- **Safety practices:** Explosion safety, access control, transportation of nano materials is specifically mentioned that again aims at making nano lab a very safe place.

**Way forward**

Nano science has its own risks and the real issue is no clear definition on them. Thus these draft lines has taken baby steps and wait for further studies over it. It is important to address potential risks from emerging technologies like nanotechnology, while promoting their development. Thus the government should be taking on board different stakeholders including the public and incorporating societal concerns. Government has to celebrate the potentialities yet simultaneously acknowledging the vulnerabilities of nano tech.

## 2.2. CARBON NANOTUBES

**What is it?**

- Carbon nanotubes (CNTs) are an allotrope of carbon- they are cylindrical hollow fibers, comprised of a single sheet of pure graphite (a hexagonal lattice of carbon), having a diameter of 0.7 to 50 nanometers with lengths generally in the range of 10's of microns.
- Being a hollow tube comprised entirely of carbon, they are also extremely light weight.
- They have novel properties that make them potentially useful in a wide variety of applications in nanotechnology, electronics, optics and other fields of materials science.

**Difference with Carbon fibres**

- Carbon fibers are fibers about 5–10 micrometres in diameter and composed mostly of carbon atoms. Some important properties of carbon fiber are- high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. These make them very popular in aerospace, civil engineering, military and sports.
- Carbon nanotubes, being at the nano scale have enhanced all these properties of carbon fiber. They are used as additives in various structural materials, often mixed with carbon fiber to improve these properties. They are used in golf clubs, car accessories, aerospace vehicles, etc.
- Structural composites made of carbon fiber (or glass fiber) and a thermoset (e.g.epoxide) have been improved quite substantially by the introduction of carbon nanotubes.

**Uses of Carbon Nanotubes**

- Stiffness and strength of materials used in load bearing applications is key as they reduce the mass and dimensions of the materials..
- CNTs are dispersed homogenously through the metal, with strong interfacial adhesion between the CNTs and the metallic matrix.
- CNT metal matrix composites have excellent electrical properties and are used as reinforcement to metals in order to enhance their electrical properties.
- Carbon nanotubes have extremely high thermal conductivity that allows metal matrix carbon nanotubes to be used for thermal management.
- The thermal properties of CNT metal matrix composites can be improved based on the distribution and bonding of CNTs with the matrix.
- CNT metal matrix composites production is economically viable
- Composite coatings have an increase in their corrosion resistance when CNT is added to them
- Metal matrix composites have high thermal conductivity and low coefficient of thermal expansion.

The applications of CNT metal matrix composites in different manufacturing industries are listed below:

- Electronic packaging industry: Solders and heat sinks for thermal management
- Automobile industry: gears, break shoes, piston rings and cylinder liners
- Sports industry: badminton and tennis rackets and light weight bicycles
- Space applications: structural radiators and high gain antenna boom
- Aerospace industry: landing gears and aircraft brakes

MEMS and sensors battery and energy storage: hydrogen storage materials, micro-beams and micro-gears, anodes and anode coatings.

## 2.3. GRAPHENE

**Why in news?**

- Researchers from the Indian Institute of Science (IISc), Bengaluru have experimentally produced a new type of electrical conductor that was theoretically predicted 20 years ago.
- Scientists have also used soybean to make the world's strongest material graphene commercially more viable.

**Graphene**

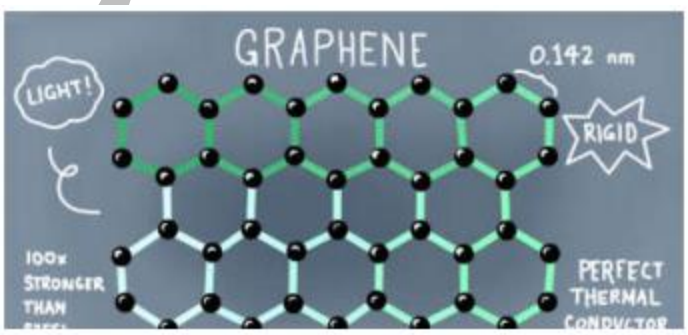
- It is extracted from graphite.
- Graphene form of carbon allotrope consisting of planar sheets (2D structure) which are one atom thick, with the atoms arranged in a honeycomb-shaped lattice. It is composed of carbon atoms linked in a hexagonal lattice.

**Important properties**

- Very good conductor of electricity and heat
- 200 times stronger than steel
- Very light
- Perfectly transparent
- Impermeable to gases

**Applications** of Graphene includes Paints and coatings, lubricants, oils and functional fluids, capacitors and batteries, thermal management applications, display materials and packaging, solar cells, inks and 3D-printers' materials and films.

**About the Novel Electrical Conductor**




- A single or a few layer thick graphene had shown high electrical conductivity at room temperature. The electric current path is along the zig-zag edge(edge of **honey comb lattice** structure of graphene) of the graphene layer.
- Many groups over the world have been trying to access these edges since the emergence of graphene in 2004, but have been largely unsuccessful because when current flows, it flows through both the edge as well as the bulk.

## 2.4. RECENT DEVELOPMENTS

**Nanoceramic Material for Safer, Cheaper Nuclear Reactors**

- Scientists have created a nanoceramic material, which may be used in next-generation nuclear reactors that will operate at higher temperatures and radiation fields, producing energy more efficiently and economically.
- It is better than both water and liquid metals such as sodium and lead. It can withstand both high temperatures and is also not prone to corrosion due to radiation.

**Nanomaterial for Crop Protection**

- Scientists at the **Institute of Nanoscience and Technology** have developed a nanomaterial that delivers pesticide in a targeted manner to control crop insects.
- This new technology can help prevent polluction due to pesticides and will also increase agricultural productivity in the long run.

**Nanogenerator**

- Pune based Indian Institute of Science Education and Research (IISER) and the National Chemical Laboratory have developed a nanogenerator that could produce up to 14 volts of electric power when thumb pressure is applied.
- **Piezoelectricity** is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and proteins) in response to mechanical stress. It refers to electricity resulting from pressure.

# 3. IT AND COMPUTERS

## 3.1. NET NEUTRALITY

**What is Net Neutrality?**

Net Neutrality or Network neutrality is the idea that Internet service providers (ISPs) should treat all data that travels over their networks fairly, without improper discrimination in favour of particular apps, sites or services.

It is a principle that must be upheld to protect the future of our open Internet. However, the principle had faced many threats over the years, such as ISPs forging packets to tamper with certain kinds of traffic or slowing down or even outright blocking protocols or applications.

**Argument in Favour of Net Neutrality**

- **Economic Growth:** Internet should be considered as an essential public services acted as an engine for economic growth, for instance, mobile app of new start-up company would hamper in absence of discriminatory practices.
- **Digital Rights and Freedom:** It ensures that the Internet remains a free and open technology, fostering democratic communication.
- **Boost competition:** allowing cable companies the right to demand a toll to guarantee quality or premium delivery would create an exploitative business model based on the ISPs position. Contrary to this free flow of data would boost the completion and innovation for more bandwidth capacity.

**Stakeholders in the internet space**

1. The consumers of any internet service,
2. The Telecom Service Providers (TSPs) or Internet Service Providers (ISPs),
3. The over-the-top (OTT) service providers (those who provide internet access services such as websites and applications),
4. The government may regulate and define relationships between these players. TRAI is an independent regulator in the telecom sector, which mainly regulates TSPs and their licensing conditions, etc.

**Argument against the Net Neutrality**

- **Innovation:** Allowing ISPs to charge more will result in faster internet and more innovation. Service Providers argue that they should be incentivized to continue investing in high speed internet infrastructure.
- **Overregulation:** Net Neutrality paves the way for government regulation which is detrimental to the free market of internet service provider.
- **Prevent Overuse of Bandwidth:** Popularity of some content lead to overuse of bandwidth with in particular spectrum.

**Recent Initiatives by Government of India**

- Government in 2015 setup **A.K. Bhargava committee on Net Neutrality** in response to Airtel Zero and Internet.org controversy.
- Telecom Regulatory Authority of India (TRAI) recently released a consultation paper on Net neutrality (NN) for comments.

**Issues Involved**

- At present there is **no single standard accepted definition of** Net neutrality.
- **Unclear regulatory structure on** net neutrality - In India, issues of licensing and spectrum allocation are dealt by DoT while regulatory aspects are dealt by TRAI.
- There is a need for **preserving customer privacy and national security** along with regulating net neutrality.

**Provisions of the paper related to Net Neutrality**

- **On Internet Traffic Management Practices (TMPs)** -
  - It recognizes a need for a balance between **non-discriminatory TMP** by the service providers (SPs) and **independence to manage traffic to them**.
  - It recommends two policy approaches to manage Internet traffic:
    - ✓ **Broad approach** - Defining what would constitute "reasonable" TMPs.
    - ✓ **Narrow approach** - Define a negative list of non-reasonable TMPs.
  - Reasons for which TMP can be deployed include **traffic congestion, network security and integrity, latency senstitive traffic like VoIP.**
  - It also recognizes certain exceptions needed for **prioritizing emergency services or complying with directions regarding unlawful content**. Eg. Government Notified content.
  - It also examines whether certain services like Internet of Things (IOT), Virtual Private Network (VPN) etc. should be treated under the scope of TMPs or not.
- **On Core principles of Net Neutrality –**
  - It examines whether specific practices like preferential treatment of content be dealt under the NN framework.
  - It recommends following aspects to define NN's core principles –
    - ✓ **User Rights –** Non-discriminatory access to internet and Fundamental Right to expression.
    - ✓ **Content –** Right to create content and access it without restrictions
    - ✓ **Devices –** Freedom to connect non-harmful devices to the network.
    - ✓ **Harmful practices –** Practices like blocking, throttling (traffic manipulation) and paid prioritizing may not be permitted.
  - It also recognizes difference in quality of internet that may be experienced by a user due to factors such as the **type of device**, **browser**, **and operating system** being used.
- On the **need of transparency with consumers** related to the type of TMP used by the Service provider.
  - It wants **disclosures of pricing Information, performance characteristics, specialized services** etc. by the SPs.
  - Most stakeholders have supported a certain level of transparency for TMPs, however, on scope of disclosure, stakeholders have submitted several alternative frameworks.
  - On the way of disclosures, two approaches are recommended:
    - ✓ **Direct approach** – Disclosures directly to the consumers
    - ✓ **Indirect approach** – Disclosures to third parties like regulators linking the end users.
- **On Regulatory approach and monitoring mechanism needed:**
  - The paper analyzes the present approaches that are being used to regulate NN:
    - ✓ **Cautious Observation –** No specific measure to address NN

**Timeline of Net neutrality (NN) in India**


DoT – Department of Telecommunications

- ✓ **Tentative Refinement –** A light handed approach where the countries refine their existing regulatory regime on communication services and do not prohibit certain behaviours.
- ✓ **Active reforms –** Passing legislations, guidelines and regulations to regulate NN. Eg TRAI's **Prohibition of Discriminatory Tariffs for Data Services Regulations** 2016

- The paper suggests various options for the regulation of NN –
  - ✓ Wait and Watch approach as being done by many countries.
  - ✓ Self-regulation through the formation of voluntary mechanism.
  - ✓ Responsibility to regulate lies with the TRAI and government agencies or a participatory model with various stakeholders.
- The Paper also asks suggestions on the mechanism for most effective legal/policy initiative
  - ✓ Monitoring and supervisory body for NN
  - ✓ Actions in cases of any detected violation
  - ✓ Scope of QoS regulation if opted by the authority

**Significance of the paper**

- The users are free to give their opinions to the paper. Hence, it is a **participatory approach in policy making**.
- It is a step towards promoting equality among consumers.

**Challenges**

- **Crony capitalism** may undermine the concepts of NN.
- A **great amount of political will** is needed to finalize the intricate aspects of NN.
- Independence of regulation by TRAI without any interference is a sin qua non for having NN.

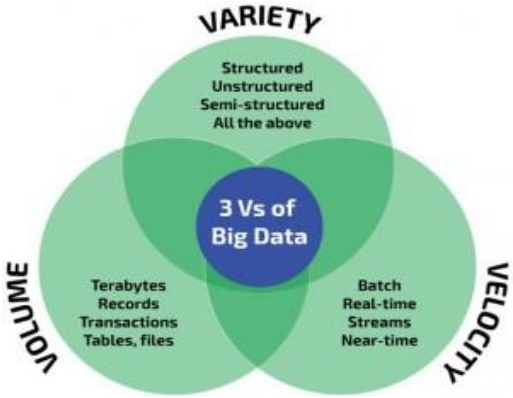
**Way Forward**

- TRAI's consultation paper is a welcome step towards deciding the NN framework in India. The success of the paper will depend on the future planning and implementation framework set by the government.

## 3.2. BIG DATA

**Why in news?**

- Big data is being increasingly used by the government in policy formation. It has been effectively used to estimate inter-state trade and labour migration.




**What is Big Data?**

- Big data is a term that describes the large volume of data – both structured and unstructured beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time.
- It's what organizations do with the data that matters. Big data can be analyzed for insights that lead to better decisions and strategic business moves.

**Applications of Big Data**

- Companies use big data to better understand and target customers by bringing together data from their own transactions as well as social media data and even weather predictions.

- Businesses optimize their processes by tracking and analyzing their supply chain delivery routes and combine that data this with live traffic updates. Others use machine data to optimize the service cycles of their equipment and predict potential faults.
- Big Data is used in healthcare to find new cures for cancer, to optimize treatment and even predict diseases before any physical symptoms appear.

**Data Protection Committee**

- The government had constituted a 10-member committee to identify "key data protection issues" and recommend a framework for data protection law in the country under the former Supreme Court judge Justice B.N. Srikrishna
- The committee is expected to submit its report by the end of 2017.

- Big Data is used to analyze and improve the performance of individuals (at sports, at home or work) where data from sensors in equipment and wearable devices can be combined with video analytics to get insights that traditionally where impossible to see.
- Police forces and security agencies use big data to prevent cyber-attacks, detect credit card fraud, foil terrorism and even predict criminal activity.
- Big Data is used to improve our homes, cities and countries by e.g. optimizing the heating or lighting in our homes, the traffic flow in our cities, or the energy grit across the country.

**Big Data Management Policy, 2016**

- It was launched by Comptroller and Auditor General. It paved the wave for Data Analytics Centre (first of its kind in the country)

**National Data Sharing and Accessibility Policy – 2012**

- India joined the **Open Government Data Movement** through this policy. Consequently, a website was launched by the **National Informatics Centre (NIC)** to share the data of various ministries with citizens.

**Big Data in India**

- With a population of 1.2 billion, the relevance of Big Data becomes all the more pronounced for India.
- It is not only being used by private players but also government agencies for policymaking.
- Recently, NITI Aayog also echoed the idea of **evidence-based policymaking** guided by Big Data.
- **Use of Big Data in policymaking**: Discoms in India are using data from last mile sensors to implement measures of cutting down aggregated technical and commercial losses.
- According to first volume of Economic Survey 2017, economists in the Finance Ministry used monthly data on unreserved railway passenger travel over five years as a proxy for migration in search of work.

**Challenges for Big Data in India**

- **Inefficient infrastructure** (data management centers) for data collection and management.
- **Constant evaluation of feedback generated from new data required:** To use Big Data effectively for policymaking, the government must adopt a dynamic approach and be willing to be flexible regarding its policy structure and processes.
- **Anonymization of data or invasion of privacy**.
- **Data security**: Lack of proper virtual safety raise grave concerns as most of Data today is generated online.

**Way Forward**

- In order to effectively analyze the large chunk of data available, government must establish well equipped data centres. It is essential to segregate the relevant data from the irrelevant.

- It must strengthen its cyber security in order to make the large pool of data available virtually safe.
- It must also address the ethical issues regarding big data analytics and formulate a policy regarding data privacy.

## 3.3. CRYPTOCURRENCY

**Why in News?**

- Poland based Bitcoin exchange platform Bitbay is soon going to open trading in india. The company allows trading in multiple cryptocurrency.
- China, South Korea and Japan have adopted use of bitcoins with regulations.

**What are Cryptocurrencies**?

- A cryptocurrency is a digital or virtual currency (computer generated currency). It is based on the principle of cryptography.
- The first cryptocurrency to capture the public imagination was Bitcoin, which was launched in 2009 by an individual or group known under the pseudonym Satoshi Nakamoto.
- Bitcoin's success has spawned a number of competing cryptocurrencies, such as Litecoin, Namecoin and PPCoin.

**How Do Cryptocurrencies work?**

- Let us take the example of Bitcoin. To start dealing in bitcoin, one needs acquire a bitcoin wallet and then transfer funds (from bank) into that wallet to buy bitcoins.
- Bitcoins can be used to buy products and services from various websites.
- Bitcoins are created through a process known as **mining. New coins are created when an individual solves a complex algorithm.**

**Blockchain**

A blockchain is the electronic ledger which maintains record of all the transactions from the time the first unit of the cryptocurrency – the seed - was mined.

Blockchain can validate the integrity of all the units of currency at any given point of time. As a protocol, each new block contains the hash of the preceding blocks, and this phenomenon links the previous blocks to the new block, thus forming a chain of blocks.

**Why blockchain could be the next big thing for India?**

**Asset database:** In simple terms, blockchain as a distributed ledger is an asset database that can be shared across geographies. The assets can be financial, legal, physical or electronic. The technology can be used in many industries like real estate, insurance, brokerage etc. to store information such as identity, stocks, land or commodity in an encrypted format.

**No Counterfeit:** Therefore, blockchain is considered as a breakthrough in innovation against cyber fraud as all financial transactions can be verified electronically over a network of computers.

**Cost benefits:** Blockchain eases the cost and complexity involved in recording transactions of financial companies. The transactions are immutable and they do not have to worry about its security. Hence, they have the opportunity to save billions of dollars.

RBI praised the intrinsic potential of blockchain technology to help check counterfeiting and bring a major transformation in financial infrastructure, collateral identification and payments system.

RBI's research wing, Institute for Development and Research in Banking Technology (IDRBT) completed the first ever end-to-end test of the blockchain technology. The project was tested in a trade finance with banks and National Payments Corporation of India (NPCI).

**Regulation of Bitcoins**

- Bitcoin startups Zebpay, Unocoin, Coinsecure and Searchtrade, have come together to form **Digital Assets and Blockchain Foundation of India (DABFI)**, an independent regulatory authority for the orderly and transparent growth of the currency.

- The newly created bitcoins are added to **a public ledger known as blockchain**. **All the transactions since the beginning of the cryptocurrency are stored in this ledger.**

**Factors responsible for growth of cryptocurrencies**

- The rise of computational power that allows algorithms to programmatically issue currencies
- Distrust towards governments that can idiosyncratically debase currency or even demonetise at will
- Scarcity of safe assets to store wealth over the long term.

**Benefits of cryptocurrency:**

1. **Privacy Protection:** The use of pseudonyms conceals the identities, information and details of the parties to the transaction.
2. **Cost-effectiveness:** Electronic transactions attract fees and charges, which is on the higher side when the transactions are transnational and undergo currency conversion, or attract processing fee levied by the banks, third party clearing houses or gateways. Cryptocurrencies solve this problem, as they have single valuation globally, and the transaction fee is extremely low, being as low as 1% of the transaction amount. Cryptocurrencies eliminate third party clearing houses or gateways, cutting down the costs and time delay.
3. **Lower Entry Barriers:** Possessing a bank account or a debit/credit card for international usage requires documented proofs for income, address or identification. Cryptocurrencies lower these entry barriers, they are free to join, high on usability and the users do not require any disclosure or proof for income, address or identity.
4. **Alternative to Banking Systems and Fiat Currencies:** Governments have a tight control and regulation over banking systems, international money transfers and their national currencies or monetary policies. Cryptocurrencies offer the user a reliable and secure means of exchange of money outside the direct control of national or private banking systems.
5. **Open Source Methodology and Public Participation:** They have their own consensus based decision making, built-in quality control and self-policing mechanisms for building frameworks, practices, protocols and processes.
6. **Immunity to Government led Financial Retribution:** Governments have the authority and means to freeze or seize a bank account, but it is infeasible to do so in the case of cryptocurrencies. For citizens in repressive countries, where governments can easily freeze or seize the bank accounts, cryptocurrencies are immune to any such seizure by the state.

**Risks involved in cryptocurrencies:**

1. **Key/Wallet/Exchange Security:** In the entire chain of security, wallets and exchanges are found to be the weakest link, and that is where the attacks are commonly aimed at. In 2014, hackers stole about 480 million USD in Bitcoins from Tokyo's Mt. Gox exchange
2. **Hijacking/Routing Attacks/Distributed Denial of Service (DDoS) attacks on Cryptocurrency System:** Cryptocurrency systems are open and are vulnerable to hijacking or Internet routing attacks to which cryptocurrency systems19 are vulnerable to. Additionally, cryptocurrency platforms have also been found to be prone to DDoS attacks, targeted at the exchanges might slow down services or render the platform completely inaccessible. Indian exchange Coinsecure had faced DDoS attacks in 2016,
3. **Uncertain Regulatory Environment:** The future and further success of cryptocurrencies depends upon the way regulatory frameworks are devised. Different countries have

approached this innovation in different ways, and therefore the regulatory environment remains uncertain.

4. **Lack of Liquidity and Lower Acceptability:** Cryptocurrencies function outside banking systems, beyond the regulations or controls of the regulatory agencies. Although online exchanges facilitate exchange of cryptocurrencies with fiat currencies, but generally, this is restricted to the more popular cryptocurrencies only.
5. **Price Volatility:** Cryptocurrencies are known to be extremely prone to price fluctuations. Cryptocurrencies do not yet have an accepted vulnerability index, which other financial instruments such as fiat currencies and gold have
6. **Uncertainty over Consumer Protection and Dispute Settlement Mechanisms:** Cryptocurrencies are decentralised, that means, there is no single authority for mediation or dispute redressal. The miners are not responsible for any arbitration of disputes between the parties. The transactions are also irreversible.
7. **Potential use for Illicit Trade and Criminal Activities**: Between 2011 and 2013, the value of Bitcoins surged as criminals were purchasing Bitcoins in large volumes. In late 2015 and early 2016, Dutch police unearthed two small groups that indulged in Bitcoin-related money laundering. Cryptocurrencies are also emerging as a new funding stream for terrorist outfits. Islamic State of Iraq and Syria (ISIS) had proposed using Bitcoins to raise funds
8. **Potential for Tax Evasion**: Cryptocurrencies are not regulated or controlled by governments, making them a lucrative option for tax evasion. Sales made or salaries paid in the form of cryptocurrencies could be used to avoid income tax liability.

**India's stand:**

- RBI, in 2013, had issued a warning to individuals dealing with virtual currencies in India on the financial, legal, operational and security-related risks
- It further reiterated this stand in 2017, again cautioning users, holders and traders of Virtual Currencies about the potential financial, operational, legal, customer protection and security related risks Over the years, India had ignored cryptocurrencies.
- Government of India has set up a committee chaired by the Special Secretary (Economic Affairs) to take stock of the present status of Virtual Currencies both in India and globally; examine the existing global regulatory and legal structures; and suggest measures (related to consumer protection, money laundering, etc).

**Conclusion**

- For developing countries like India, disruptive technologies like cryptocurrencies bring their own set of benefits and risks.
- At one end, traditional banking systems have their constraints regarding reach and innovation, where private enterprises fill this space up with novel ideas and innovative business solutions.
- At the other end, developing countries are at the lower end of technology adoption life cycle, as far as design, development or entrepreneurship in disruptive technologies is concerned.
- Cryptocurrencies could be a great value proposition in this regard for India, but the prominent security threats, in form of terrorism and left wing extremism, might bring in some hesitation in the early phase of adoption or integration of this technology with the financial system.
- In terms of benefits, this could be a force multiplier in India's quest for financial inclusion, parallel to the electronic payment modalities such a digital wallets and Adhaar Enabled Payment System.

- It could further reduce the cost associated with remittances, which brings annual earnings of close to 62 billion USD to India.
- It would also attract future business entrepreneurs, leading to innovation, generation of job and wealth creation in the due process of payments processing, e-commerce and taxation.

## 3.4. CYBER PHYSICAL SYSTEMS

DST has recently launched a new programme "Interdisciplinary Cyber Physical Systems (ICPS)" to foster and promote R&D in this emerging field of research.

**What are Cyber Physical Systems?**

- Cyber-Physical Systems (CPSs) are the integrations of computation, networking, and physical processes. It has seamless integration of algorithms and physical components.
- In these systems, embedded computers monitor and control the physical processes such as natural and man-made systems governed by laws of physics.
- The CPSs have feedback loops where physical processes affect computations and vice versa.

**Fields of applications:** Medical devices and systems, aerospace systems, transportation vehicles and intelligent highways, defence system, robotics system, process control, factory automation, building and environmental control and smart spaces like Smart Cities, Smart Grids, Smart Factories, Smart Buildings, Smart Houses and Smart Cars where every object is connected to every other object.

**Relevance for India:** Being a developing country, India can be one of the best laboratory for research in CPS. By ensuring that future workforce is skilled in robotics, artificial intelligence, digital manufacturing, big data analysis, deep learning, quantum communication and Internet-of-Things, CPS could be turned into a huge opportunity.

Some of the areas of research in CPS that are specifically relevant to India are:

- **Smart city**: CPS will integrate all physical systems with each other and connected to network.
- **Agriculture:** Will increase efficiency throughout value chain, improving environmental footprint and creating employment opportunities.

**Internet of Things**

- The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items-embedded with electronics, software, sensors, and network connectivity that enable these objects to collect and exchange data.
- Thus IoT creates opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefits.
- IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems. It can also be used to improve crop yield to help feed the world's growing population.

**Draft IoT Policy**

The Policy framework of the IoT Policy has been proposed to be implemented via a multi-pillar approach.

The approach comprises of five vertical pillars (Demonstration Centres, Capacity Building & Incubation, R&D and Innovation, Incentives and Engagements, Human Resource Development) and 2 horizontal supports (Standards & Governance structure).

It focuses on following objectives:

- To create an IoT industry in India of USD 15 billion by 2020. It has been assumed that India would have a share of 5-6% of global IoT industry.
- To undertake capacity development (Human & Technology) for IoT specific skill-sets for domestic and international markets.
- To undertake Research & development for all the assisting technologies.
- To develop IoT products specific to Indian needs in all possible domains.

- **Infrastructure Management**: To provide technology for condition monitoring and predictive maintenance of infrastructure.
- **Internal & External security**: Expedite design and delivery of trustworthy, adaptable and affordable systems, operations in cyberspace and autonomous systems to augment security operations.
- **Disaster Management**: CPS technologies including next generation public safety communications, sensor networks, and response robotics which can increase situational awareness of emergency responders and enable optimized response through all phases of disasters and facilitate resilience, robustness and flexibility.
- **Energy**: Integration of intermittent and uncertain wind and solar sources and plug-in devices necessitates not only new sensors, switches and meters, but also a smart infrastructure for realizing a smart grid..
- **Healthcare**: Ever growing population combined with opportunities provided by inexpensive sensing, communication and computation and demand for 24/7 care needs CPS.
- **Manufacturing and Industry**: Increase competitiveness in manufacturing, enables predictive maintenance models, convergence of global industrial system with power of advanced computing, analytics, low-cost sensing, and new levels of connectivity and new paradigm called Industrial Internet.
- **Transportation**: Eliminate accidents caused by human error, congestion control, traffic based grid jams including road, air and highway networks.

## 3.5. AUGMENTED REALITY

**Why in news?**

- India's first augmented reality (AR) education and training institute will be set in Varanasi.
- The institution will be established by the central government in partnership with Eon Reality, an augmented reality company based in the US.
- While the company will invest two-thirds of the initial expense, the central government will bring in the rest.

**What is Augmented Reality?**

- Augmented reality is a computer technology that functions on computer vision-based recognition algorithms to augment sound, video, graphics and other sensor based inputs on real world objects, using your device's camera.
- It layers digital enhancements to enrich an existing real life setting by appealing to the senses.
- Augmented 3D information helps workers on assembly lines, or during maintenance work and repair to carry out required tasks.

**Difference between Augmented Reality and Virtual Reality**

- AR enhances the real-life experiences while VR recreates a real-life like experience.
- Virtual reality (VR) is an artificial, computer-generated simulation. It makes the user feels that they are experiencing the simulated reality firsthand.
- It is mainly achieved with a headset device like Facebook's Occulus.

**Significance**

- Augmented reality is seen as the next big thing in the Internet revolution especially in learning and practical training space
- It will allow students from various ranges like skill schools, engineering, research, etc. to experience a different kind of learning before entering the real-world workplace.
- It will be a virtual manufacturing shop floor that will provide students from diploma to research level **"hands-on training"** on high value machines that are beyond the budgets of institutions.

- The institutions and the software deployed will be able to create virtual machines of many sectors-from car design to the assembly line of an automobile firm, from textiles to heavy engineering machines.
- The idea goes well with the Skills India and Digital India initiative of the government.

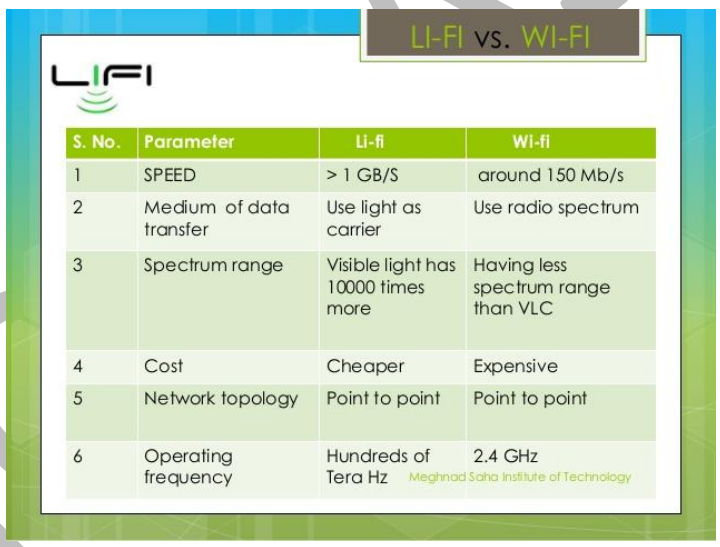
## 3.6. LI-FI

**What is Li-Fi?**

- Li-Fi or Light Fidelity, also known as **visible light communications** (VLC) is a super-quick alternative to Wi-Fi.
- Li-Fi u**tilizes visible light in place of radio waves** to bar data through the air.
- Li-Fi innovation began in 2011 by Professor Harald Haas of the University of Edinburgh, who showed that glimmering light from a solitary LED could transmit a larger number of information than a cellular tower.

**Potential of Li-Fi in India**

- **Connecting rural communities to internet**: It uses solar cells as receivers that could deliver communications and access to the world wide web in a way that the current free space optical (FSO) systems on their own cannot do.
- It has enormous potentials in **robotics and instrumentation**.
- It can be used in **aircraft cabins, hospitals and nuclear power plants** without causing electromagnetic interference as it uses visible light.
- Li-Fi may prove useful in harnessing the power of the Internet for giving more **citizen-centric governance.**




| S. No. | Parameter | Li-fi | Wi-fi |
|---|---|---|---|
| 1 | SPEED | > 1 GB/S | around 150 Mb/s |
| 2 | Medium of data transfer | Use light as carrier | Use radio spectrum |
| 3 | Spectrum range | Visible light has 10000 times more | Having less spectrum range than VLC |
| 4 | Cost | Cheaper | Expensive |
| 5 | Network topology | Point to point | Point to point |
| 6 | Operating frequency | Hundreds of Tera Hz | 2.4 GHz |

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## 3.7. Electromagnetic Field Radiations

**Why in News?**

- The **Telecom Department** launched a portal – Tarang Sanchar Portal, that will allow people to track radiation emitted from mobile towers within a locality.
- The portal will empower consumers to know about the towers working in a particular area and whether they are compliant to the Electromagnetic field (EMF) emission norms defined by the government.

**What is it?**

- **Electric and magnetic fields (EMFs)** are invisible areas of energy (radiation) that are either associated with the use of electrical power or various forms of natural and man-made lighting. EMFs are typically characterized by wavelength or frequency into the following two radioactive categories:

| Radiation Type | Definition | Forms of Radiation | Source Examples |
|---|---|---|---|
| Non-Ionizing | Low to mid-frequency radiation which is generally perceived as harmless due to its lack of potency. | • Extremely Low Frequency (ELF)<br>• Radiofrequency (RF)<br>• Microwaves<br>• Visual Light | • Microwave ovens<br>• Computers<br>• House energy smart meters<br>• Wireless (wifi) networks<br>• Cell Phones<br>• Bluetooth devices<br>• Power lines<br>• MRIs |
| Ionizing | Mid to high-frequency radiation which can, under certain circumstances, lead to cellular and or DNA damage with prolonged exposure. | • Ultraviolet (UV)<br>• X-Rays<br>• Gamma | • Ultraviolet light<br>• X-Rays ranging from 30 * $10^{16}$ Hz to 30 * $10^{19}$ Hz<br>• Some gamma rays |

**Issue**

- The debate that mobile tower radiations affect the health of those residing nearby has been in the spotlight for the past few years.
- However, the government maintains that several WHO studies conducted over past 30 years in different have found that low level electromagnetic radiation are not harmful.

**Guidelines for EMF Radiations in India**

- The **Department of Telecommunications (DoT),** in the year 2008, adopted the **International Commission on Non Ionizing Radiation Protection (ICNIRP)** guidelines that are recommended by World Health Organization (WHO) for basic restriction and limiting reference levels of electromagnetic radiation from mobile towers.
- Based on the Recommendations of an Inter Ministerial Committee constituted by DoT in the year 2010**, limiting reference levels of Electromagnetic Radiation from Mobile towers is reduced to 1/10th of the limit prescribed by the ICNIRP**.
- Specific Absorption Rate was adopted from 2012. At present limit/level of **Specific Absorption Rate (SAR) for Mobile Handsets in India is ais 1.6 Watt per Kg averaged over a mass of one-gram human tissue**, at par with USA, Canada and Australia. The global standards prescribed by ICNIRP of 2 W/kg averaged over a mass of 10 gm tissue.
- It has been made mandatory for manufacturers to display the SAR level on each mobile handset like IMEI (International Mobile Equipment Identity).

| Frequency | ICNIRP Radiation Norms | Revised DoT Norms effective from 01.09.2012 |
|---|---|---|
| 900 MHz | 4.5 Watt/ Sqm | 0.45 Watt/ Sqm |
| 1800 MHz | 9.0 Watt/ Sqm | 0.90 Watt/ Sqm |
| 2100 MHz | 10.5 Watt/ Sqm | 1.05 Watt/ Sqm |

**Other Government Initiatives**

- Stringent Norms for EMF Radiation from Base Stations and Mobile phones.
- **TERM (Telecom Enforcement & Resource Monitoring )** Cells, field units of DoT, carry out the EMR compliance monitoring.

- SAR Lab established to measure SAR levels from mobile phones at TEC (Telecommunication Engineering Centre), DoT.
- Setting up of EMF portal : a website mapping all the cellular base stations in the country and their compliance to EMR regulations
- Enhancing public awareness.
- Guidelines for EMR compliance.
- Mobile phones to compulsorily display SAR values on them.
- Deployment of Public complaint handling system for EMR.

## 3.7.1. RADIO FREQUENCY IDENTIFICATION DEVICE (RFID)

**What is RFID?**

- **RFID (radio-frequency identification)** refers to a technology whereby digital data encoded in RFID tags or smart labels are captured by a reader via radio waves.
- It digitizes the barcode concept and help the save the data captured by the tag/label into a database.

**Advantages**

- Uniquely identify an particular item beyond just its product type
- Identify items even in indirect line-of-sight
- Identify many items (up to 1,000s) at the same time
- Identify items from a few centimeters upto several meters
- RFID can identify 1000s of individual items per second

**Applications of RFID**

- **Infrastructure: Energy, Logistics, Roads and Railways**
  - ✓ RFID technology was adopted by the Ministry of Road Transport and Highways, Government of India for implementing Electronic Tolling systems for national highways.
  - ✓ Recently, the Prime Minister inaugurated RFID based control systems at Cochin sea ports.
- **Industrial and Retail**
  - ✓ Helps automate inventory and asset tracking as well as prevent us of counterfeit products in supply chain.
  - ✓ The government also offers subsidy / financial assistance for using RFID based bar coding on goods produced by MSEs under the ambit of Marketing Assistance schemes floated by the **Ministry of Micro, Small and Medium Enterprises (Min of MSME), Government of India.**
- **Healthcare**
  - ✓ It can help identify tainted or expired drugs thereby ensuring that patients get genuine drugs.
  - ✓ It can also help achieve delivery of medicine, healthcare system and machines to the concerned person.

**Eartagging of Cattles**

- Eartagging of cattles refers to using a radio frequency identification device (RFID) technology which will contain the breed and age of the cattle, as well as information about the owner, location and also details about its vaccination.
- These are polyurethane tags with a unique identification number sequence.
- A committee was setup at the Centre to look into the matter. The committee recommended ear tagging of cattles to prevent smuggling of livestock as well as to keep track of their population and vaccination details.
- The matter is pending for approval in the Supreme Court.

Student Notes:

## 3.8. SWITCH TO DIGITAL TERRESTRIAL TRANSMISSION BY 2023

**Why in news?**

- The broadcast regulator, Telecom Regulatory Authority of India (TRAI), has recommended introduction of digital terrestrial transmission for broadcast services in a **phased manner** and complete shutdown of analog transmission by end of 2023.
- TRAI has recommended that DTT should be deployed in **metros by December 2019 in phase 1**, cities having more than 10 lakh population as per Census 2011 should be covered by December 2021 and **rest of India by December 2023.**

**Background**

- At present, **terrestrial TV broadcasting** in India is under the **exclusive domain of Doordarshan** (Prasar Bharati), the Public Service Broadcaster and it is predominantly analog.
- The existing terrestrial TV platform **provides only a few channels** which do not offer a value proposition to the viewers.

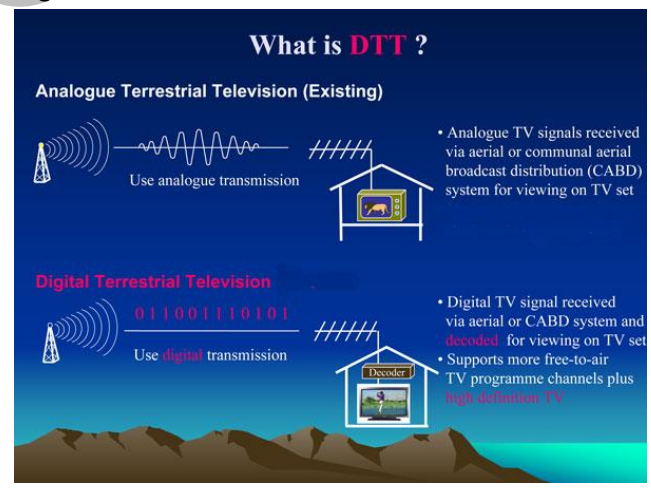
**Basic facts about DTT**

**Terrestrial transmission** is a type of broadcasting in which signals are transmitted by radio wave from a terrestrial transmitter. It is of two type:

- **Analog terrestrial transmission(ATT**)
  In analogue terrestrial television broadcasting **only one signal** is transmitted on a given frequency channel.
- **Digital terrestrial transmission (DTT)** Digital Terrestrial Transmission (DTT) broadcasting allows the transmission of about **10 or more digital services in a single frequency channel**, depending on the technical parameters used and the quality of services desired.

**Consumer advantages of DTT**

- Crystal clear pictures and high quality audio through digital reception.
- Better overall reception, particularly if signal is weak.
- Access to new free and Pay TV channels.
- Lower power requirements hence signals can be used by mobile devices.
- Can provide a rich bouquet of SDTV, HDTV, UHTV, mobile TV channels, radio service and other value added services**.**




**Government advantages of DTT**

- Possibility to cost-effectively implement social programs in fields such as health and education.
- Gives access to additional frequencies that may be used for essential services.
- The spectrum used to transmit data over the air is scarce. To ensure optimum utilization of this valuable resource, over 156 countries signed an **ITU agreement** in 2006, to switch from analogue to digital transmission. By adopting digital transmission India can join the league of countries having DTT such as Luxembourg.
- Adoption of DTT will add to **DIGITAL INDIA program** and enable digital access in rural areas.

## 3.9. PROJECT LOON

**Why in News?**

- By using machine learning algorithms, Google may be able to predict weather through its Project Loon.

**What is Project Loon?**

- **Project Loon** is a network of balloons travelling on the edge of space, designed to extend internet connectivity to rural and remote areas worldwide.
- **It has been developed by X (formerly Google X).**
- **They are tennis-court size balloons that float in the Stratosphere.**
- The balloons communicate with each other and with ground-based networking equipment and mobile devices to get people on the ground connected.
- This technology has been tested in New Zealand, US and Brazil.

**Project Loon in India**

- Project Loon was first proposed to be tested in India in 2015 itself. However, due to objections to the spectrum band proposed, it is yet to be made a reality.
- Google proposed the used of 700-900 MHz frequency for the pilot test. This frequency band is used by cellular operators and a pilot test can affect cellular transmission.
- Recently, the Government has asked Google to come forward with a fresh proposal for Pilot test.

## 3.10. GEO-TAGGING AND GEO-MAPPING

**What is Geo-Tagging?**

- It is the process of adding geographical identification like latitude and longitude to various media such as a photo or video.
- Geotagging can help users find a wide variety of location-specific information from a device.
- It provides users the location of the content of a given picture.
- **Geo-tagging is an efficient way of monitoring of assets such as** infrastructure/assets in agriculture and allied sectors such as soil testing labs, pesticide testing labs and more.

**Geo-Mapping:** a visual representation of the geographical location of geotagged assets layered on top of map or satellite imagery.

**Application of Geotagging**

- **BHUVAN-RUSA App:** Bhuvan RUSA App is a user-friendly mobile application which enables to collect and report geo-tagged information on various parameters such as new construction, up-gradation work and equipment in state higher educational institutions.
- Geotagging is also being extensively used for the assets created under **RKVY (Rashtriya Krishi Vikas Yojana)**

## 3.11. OPTICAL FIBRE

**What is it?**

- Optical fibre is made up of semiconducting materials and usually has a cylindrical structure. In inner core there is material of higher refractive index than in outer core resulting in Total Internal Reflection (TIR).
- Thus signal keeps moving along the axis and never passes out from curved surface while there is almost no loss of energy during transmission.

Student Notes:

**Importance of Optical Fibre**

- Optical fibre are roots of Digital India as they provide end connectivity to users in the remotest part of the country and establish G2C and C2C interface at all levels and almost all spheres of life. Government is moving towards total e-governance and digital infrastructure is vital to realize such goals.
- National Optical Fibre Network (NOFN), also known as Bharatnet, is a project to provide broadband connectivity to 2.5 lakh gram panchayats across the country.

**Challenges**

Laying down optical fibre has multiple challenges:

- Bharatnet or NOFN is to be executed based on PPP model where a SPV, Bharat Broadband Network Ltd (BBNL) has been constituted. However, the evolution of viable PPP models in various regions is a problem.
- Problem of autonomy, flexibility and quick decision making of BBNL has been reported.
- Land acquisition and construction on private lands and populated areas is an issue.
- **Right of Way (RoW)** has not been sorted out yet. Some states are charging exorbitant charges while some are demanding free bandwidth for government establishments. Indian Telegraph Act, 1885 does not notify the rules on Right of Way which is a sensitive area involving centre-state jurisdiction. As per the act, only the Centre can legislate over such subjects, but provides for reasonable conditions that local authorities can impose while granting Right of Way permissions.

# 4. SPACE

## 4.1. WEAPONIZATION OF SPACE

**Why in news?**

- With China and US at loggerheads, a fourth frontier (space) is likely to come about with sophisticated weapons being place in the orbit.

**What is Weaponization of Space?**

- The **weaponization of space** includes placing weapons in outer space or on heavenly bodies as well as creating weapons that will travel from Earth to attack or destroy targets in space.
- Examples include the placing of orbital or suborbital satellites with the intention of attacking enemy satellites, using ground-based direct ascent missiles to attack space assets, jamming signals sent from enemy satellites, using lasers to incapacitate enemy satellites, plasma attacks, orbital ballistic missiles, and satellite attacks on Earth targets.
- Space weapons can be further classified into **direct-energy and kinetic-energy weapons.**
- Waeaponization of space is distinctly different from militarization of Space. While the former entails placing weapons in the space or treating space as a battleground, the latter is simply using space to assist ground based military operations.
- In present day, militaries around the world rely heavily on data generated by the satellites.
- Space warfare can basically be studied in three ways:
  - ✓ auxiliary systems, which can assist in warfare on other terrains;
  - ✓ defensive systems, which are required to protect these space assets;
  - ✓ weaponized systems – which are purely offensive in nature.

**Background**

- The history of space weaponization goes back to the 1960s when the Soviets first tested the "hunter killer" low orbit satellite system.
- However, it remained under wraps as countries around the world lobbied for no weapons policy.
- It has now again come to the foray with China pursuing ambitious space weaponization programs that poses serious threats to military giants like the US
- Chinese efforts of space weaponization are in sharp contrast to its efforts to push for **Prevention of an Arms Race in Outer Space (PAROS) treaty.** It has even submitted a draft treaty to the UN along with Russia.
- A PAROS treaty would complement and reaffirm the importance of the **1967 Outer Space Treaty**, which aims to preserve space for peaceful uses by prohibiting the use of space weapons, the development of space-weapon technology, and technology related to "missile defense." The treaty would prevent any nation from gaining a military advantage in outer space.

**China's Space Weaponization Efforts**

- China has been making impressive advancements in its ICBM (Intercontinental Ballistic Missile) program.
- In 2007, it successfully tested it first **ASAT (Anti-satellite)** missile when it destroyed obsolete satellite at an altitude of 865 km from Earth.
- According to a 2015 report prepared by US Department of Defense, China has invested in advanced space capabilities, with particular emphasis on "satellite communication (SATCOM), intelligence, surveillance, and reconnaissance (ISR), satellite navigation

(SATNAV), and meteorology, as well as manned, unmanned, and interplanetary space exploration.

- China's space weaponization aspirations pose the biggest threat to the US as it can be used to deny its enemies use of strategic information about troop and ship movements, incoming missiles, navigation, communication, etc, along with depriving its opponents the use of C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) systems.
- China recently tested its DN-2 and DN-3 missiles which are believed to have the ability to ram into satellites and destroy them.
- China has been developing co-orbital anti-satellite systems. Additionally, it is also developing soft kill methods such as jammers that can incapacitate a satellite's communication system.

**Integrated Space Cell**

- It was established in 2009 to oversee India's space based military and hardware systems.
- It is managed by Indian Armed Forces, DRDO and ISRO.

**How is India Keeping Up?**

- India has made impressive developments with its **Agni–V Inter-Continental Ballistic Missile. DRDO (Defense Research and Development Organization)** believes that it can harness this technology to develop ASAT weaponry.
- ISRO recent success with PSLV and GSLV-D5 launch vehicles has made equipped enough to undertake space weaponization activities.
- India recently launched GSAT-7 for the Indian Navy. This is being viewed as the beginning of a long line of defense satellites that it will pursue.

**Impacts of Space Weaponization**

- Space Weaponization by any country may result in an arms race in outer space.
- Creation of space debris: When China tested its ASAT missile in 2007 destroying one of its own weather satellites, it created close to 2500 pieces of space debris.
- In 2013, a Russian Satellite was destroyed by one such piece. Therefore, space weaponization has increased the risk for satellites in Low Earth Orbits (LEO).

**Steps to be taken**

- A stringent "**no space weaponization"** policy needs to formulated and adhered to by all countries in order to protect the interest of all.
- **Ban should be extended on production, testing and deployment of weapons in space**.
- A monitoring system must be established so as to catch violators.
- Rules must be formulated for satellite based military assistance.
- The UN Outer Space Treaty only talks about using the space about **peaceful purposes**. Issues like militarization and weaponization must be worded out.

## 4.2. NEED FOR SPACE POLICY

ISRO has achieved worldwide recognition with its numerous achievements such as launching of 104 satellites at one go and a successful Mission on Mars (MoM) in its first attempt, among others. ISRO's missions have far-reaching impacts from a commercial as well as national security perspective. Commercially, ISRO's missions are increasing India's attractiveness in the satellite launching area due to its low cost and higher efficiency. They also strengthen India's credentials in the global governance of space.

However, despite the successes, there are certain areas in India's space programme that needs attention such as:

- **Satellite Launch Vehicles**: There is an over-reliance on the Polar Satellite Launch Vehicle, which has become ISRO's backbone for important missions, including the MoM. GSLV technology that is needed to send heavier satellites into higher orbits is still in developmental stage.
- The focus of ISRO has been largely as a civil space agency, while ignoring national security domain.
- The **role of private sector** in space sector of India needs to be increased as ISRO alone cannot deliver on the multitude of national and global requirements.
- **Outer space activities** such as space debris, weaponisation of space, anti-satellite (Asat) weapons are becoming major challenges.

**Need of Space Policy**

To comprehensively address these concerns, there is a need for a holistic space policy in India.

- The policy should provide for alternative launch vehicles, heavy rocket launchers, more launch facilities and address bureaucratic delays
- The policy must outline an all-encompassing role of ISRO in both civilian and national security domain. While using space assets for economic and developmental applications, security-related needs cannot be ignored against the backdrop of regional and global developments.
- Currently, there is no concrete space policy and clarity regarding India's long-term projects. In the absence of clarity, the scientific and technical bureaucracy will develop a perspective that is almost entirely technology-driven, minus a strategic interface. Also, outer space has been the domain of scientific bureaucracy and due to this a strategic national perspective is not prioritized.
- The policy should provide framework to bring in India's sizeable and talented private sector to maximize the capacity to manufacture as well as launch satellites.
- The outer space activities are pushing states to write new rules and develop global norms. As India contemplates its space policy, it needs to consider them and India, being an established space player, should play an active role in shaping these.
- Lastly, there should be parity between research and development on remote sensing, meteorological satellites, navigation satellites and telecommunications satellites and not just commercial space projects. This is vital as ISRO has emerged as one of the pillars of development in India and the mentioned satellites have applications in various fields such as agriculture, national security, communications etc.4.2 Important Achievement of ISRO

## 4.2.1. GSAT 18 SATELLITE LAUNCHED

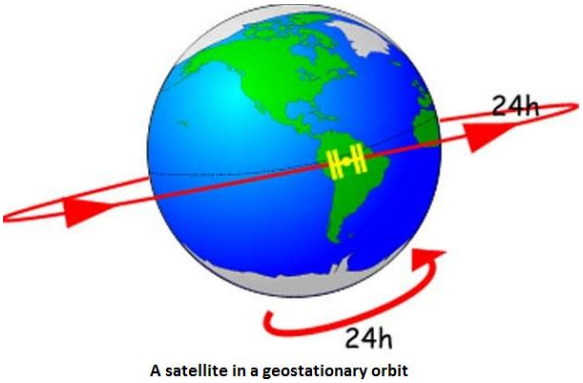
**Why in News?**

- India's latest communication satellite**, GSAT 18** was successfully launched from the spaceport of Kourou in French Guiana, South America.
- It is been built by ISRO and ISRO's Master Control Facility at Hassan, Karnataka is controlling the satellite.
- The Master Facility will also perform the initial raising manoeuvres using the Liquid Apogee Motor (LAM) of the satellite, placing it in a circular Geostationary Orbit.

**What is GSAT?**

- A GSAT is a series of **geosynchronous satellite** placed in geosynchronous orbit, with an orbital period the same as the Earth's rotation period.
- Such a satellite returns to the same position in the sky after each day.
- A special case of geosynchronous satellite is the **geostationary satellite**, which has a geostationary orbit – a circular orbit directly above the Earth's equator.

- Geosynchronous satellites have the advantage of remaining permanently in the same area of the sky, as viewed from a particular location on Earth
- Geostationary satellites have the special property of remaining permanently fixed in exactly the same position in the sky, meaning that ground-based antennas do not need to track them but can remain fixed in one direction. Such satellites are often used for communication purposes.



A satellite in a geostationary orbit

**Challenges**

India does not have any launcher capable of carrying heavier satellites like GSAT-18. However, Indian scientists are developing GSLV –III to overcome the challenge.

## 4.2.2. REMOTE SENSING SATELLITE RESOURCESAT-2A

**Why in News?**

- In its 38th flight PSLV-C36 successfully launched **RESOURCESAT-2A** satellite from Satish Dhawan Space Center in Sriharikota.
- This is the thirty-seventh consecutive successful mission of PSLV.

**More About RESOURCESAT-2A**

- It is a remote sensing satellite which will provide information on water bodies, farm lands, crop extent, forests, mineral deposits, coasts, rural and urban spreads for the next five years.
- The satellite was launched into the Sun Synchronous Orbit at 825 km height.
- Much like its predecessors RESOURCESAT 1 and 2, RESOURCESAT-2A also has a three tier imaging system.
- It is equipped with an Advanced White Field Sensor (AWiFS) that provides images of 56 metre resolution, (LISS-3) Linear Imaging Self-scanning Sensor and LISS-4 provides image of 23.5m and 5.6m resolution respectively.

**Significance of the Launch**

- RESOURCESAT-2A will be useful in crop area and production estimation, drought monitoring, soil mapping, cropping system analysis and farm advisories generation.
- For the first time ISRO used cameras on-board that showed the separation stages during the flight and the deployment of solar panels of the satellite.

## 4.2.3. CARTOSAT 2 SERIES SATELLITE

**Why in news?**

ISRO has successfully launched its sixth CartoSat-2 series satellite. This is the second highest no of satellites (31 in total) launched by ISRO using a single rocket.

**Cartosat satellites:** The Cartosat series are earth-observation satellites in a sun-synchronous orbit. The imagery sent by satellite are useful for cartographic applications, coastal land use and regulation, utility management like road network monitoring, water distribution, land use maps, change detection to bring out geographical and manmade features and other Land Information System (LIS) and Geographical Information System (GIS) applications.

**Nanosatellites** or **nanosats** weigh between 1 kg and 10 kg

**Details**

- There are 30 other nano-satellites: 29 foreign and one Indian. With this launch, the number of foreign satellites launched by India has crossed 300.

- The Indian nano satellite, NIUSAT, belongs to Tamil Nadu's Nooral Islam University. It will provide multi-spectral imagery for agricultural crop monitoring and disaster management support applications.
- Prior to this, **PSLV-37, ISRO's Polar Satellite Launch Vehicle has successfully launched the 714 kg Cartosat-2 Series Satellite along with 103 co-passenger satellites**.
- **India broke the world record of most satellites launches with this launch and strengthened India's Space abilities in front of giants like Russia and USA**.

**Importance**

- The Cartosat-2 series satellites are extremely "agile". They can be programmed to take very specific pictures of very specific designated areas.
- This will give India's defence surveillance a major boost as the satellite can spot terrorist camps and even the bunkers in them.
- The launch will help India grab a slice of the global market for nano and micro-satellites, which is set to grow close to $3 billion in the next three years.

**PSLV**

The PSLV is one of world's most reliable launch vehicles consisting of four stages.

It has been in service for over twenty years and has launched historic missions like Chandrayaan-1, Mars Orbiter Mission, IRNSS etc.

It can take up to 1,750 kg of payload to Sun-Synchronous Polar Orbits of 600 km altitude and payload of 1,425 kg to Geosynchronous and Geostationary orbits.

## 4.2.4. ISRO SET TO LAUNCH BACK-UP SATELLITE

**Background**

To keep India's regional navigation satellite system fully operational, the Indian Space Research Organisation (ISRO) is preparing to launch a back-up for IRNSS-1A that has been hobbled by the failure of the atomic clocks on board.

**Navigation Indian Constellation (NavIC)**

- It is an independent Indian Satellite based positioning system for critical National applications. The main objective is to provide Reliable Position, Navigation and Timing services over India and its neighbourhood, to provide fairly good accuracy to the user.
- The IRNSS will provide basically two types of services:
  - Standard Positioning Service (SPS)
  - Restricted Service (RS)
- It consists of seven satellites, three satellites in GEO stationary orbit (GEO) and four satellites in Geo Synchronous Orbit (GSO) orbit with inclination of 29° to the equatorial plane, namely, IRNSS-1A, 1B, 1C, ID,1E, 1F and 1G.

An **atomic clock** is a clock device that uses an electronic transition frequency of the electromagnetic spectrum of atoms as a frequency standard for its timekeeping element.

Atomic clocks are the most accurate time and frequency standards known, and are used as primary standards for international time distribution services, to control the wave frequency of television broadcasts, and in global navigation satellite systems such as GPS.

A **rubidium atomic clock** is a frequency standard in which a specified hyperfine transition of electrons in rubidium-87 atoms is used to control the output frequency. It is the most inexpensive, compact, and widely used type of atomic clock.

**Benefits of NaVIC:**

- NAVIC's operational launch can result in healthy competition between various navigation services, and potentially significant revenues for the country.
- India can combine NAVIC with GAGAN—its indigenous augmentation system—to service users on differential rates depending on the navigational precision they seek.

- Global navigation system bolsters the ability of a nation to serve as a net security provider, especially through the guarantee of such assurance policies. The US equivalent, Global Positioning System (GPS), played a significant role in relief efforts post disasters such as the tsunami in the Indian Ocean region in 2004 and the Pakistan-India earthquake in 2005.
- Through land-area mapping, yield monitoring and precision-planting of crops, NAVIC allows for the development of civic capabilities in food and livelihood security.
- NAVIC should also propel technological innovations and spin-offs that render India progressively less reliant on technological imports from the West and elsewhere.

## 4.2.5. GSLV MK III

**Why in News?**

- Recently, **GSLV MK III D1 rocket (GSAT 19)** was launched successfully from Satish Dhawan Space Centre, Sriharikota, Andhra Pradesh.


**Need**

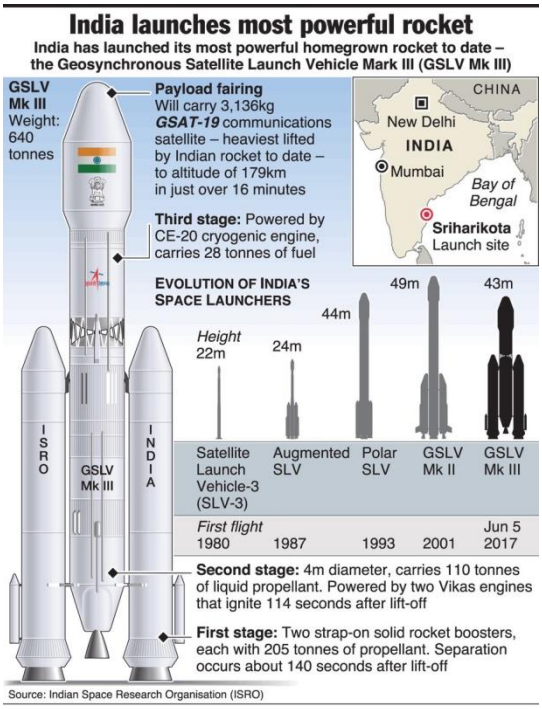
- Currently ISRO's geosynchronous satellite (GSLV MK II) can carry satellites weighing only two tonnes.

**Background**

- The first experimental flight of LVM3, the **LVM3-X/CARE mission** lifted off from Sriharikota in 2014 and successfully tested the atmospheric phase of flight. Crew module Atmospheric Reentry Experiment was also carried out in this flight. This was the first testing of the indigenous cryogenic engine.

**Features**

- It is the **heaviest rocket** to be launched from India till now. It can lift payloads of up to 4000 kg to Geosynchronous Transfer



Orbit and 10000 kg into the Low Earth Orbit.

- It is a three stage vehicle with an **indigenous cryogenic upper stage engine (C25)**. It has been designed to carry heavier communication satellites into the Geosynchronous Transfer Orbit.
- Apart from the upper cryogenic stage, the vehicle has **two solid strap-on motors (S200) and a core liquid booster (L110)**.
- For the first time there will be **no transponders on the satellite**. It will be using a new way beaming data down **using multiple frequency beams**. It is therefore called "**a high through put satellite**".
- For the first time, it would have **indigenously made Lithium ion batteries**.
- This spacecraft would have advanced technologies including miniaturized heat pipe, fibre optic gyro, Micro Electro-Mechanical Systems (MEMS) accelerometer.

**Significance**

- **It would boost India's communication resources** given the fact that there has been a boom of the communication industry in India and there is a high demand for transponders in space related to it.
- It would **also save foreign exchange reserves** of the government provided that presently the heavier Indian communication satellites are launched from the French Guinea.
- It would also act as a carrier to **travel people/astronauts into space**.
- The indigenous components of the rocket would help India to become **self-reliant** in terms of technology. The indigenous batteries developed can also be used to **power electric vehicles in India**.
- It would also be a foreign exchange earner with foreign customers using the services of GSLV MK III provided by ISRO.
- The cost of launches would also be reduced because of introduction of the cryogenic engine.

**Way forward**

- Indigenous cryogenic engine is the first step to expand the capacity of the communication systems of India. Now India should focus on expanding the technology to carry out a payload of about 6-7 tonnes (many developed countries have this capacity). This would help in improving the telecommunication density in India with the rising aspirations of the population of the country.

## 4.3. SPACE DEBRIS

**Why in News?**

- In April 2017, various space agencies such as NASA, European Space Agency in Washington raised the concern regarding increasing space debris.

**What is Space Debris/Orbital Debris?**

- Space debris encompasses both natural (meteoroid) and artificial (man-made) particles. Meteoroids are in orbit about the sun, while most artificial debris is in orbit about the Earth. Hence, the latter is more commonly referred to as orbital debris.

**Kessler syndrome**

- The term is associated with Space Debris, which used to describe a self-sustaining cascading collision of space debris in LEO (Low Earth Orbit).

**More on the issue**

- Space junk travels at speeds up to 30,000 km an hour, which turns tiny pieces of orbital debris into deadly shrapnel that can damage satellites, space shuttles, space stations and spacecraft with humans aboard.

- Various space agencies have to manoeuvre their space programme in light of increasing space debris thus adding to extra economic and human resource on space programme.
- International guidelines suggest removing space crafts from low-Earth orbit within 25 years of the end of their mission. However, only 60 percent of missions follows the guidelines.
- Moreover, space-scientists concern about the inexpensive, tiny satellites called CubeSats which are going to add space junk around 15% in next 10 years.
- Japan has recently launched a cargo ship which will use a half mile long tether to remove some of the debris from Earth's orbit. The tether, made of aluminium strands and steel wire, is designed to slow the debris, pulling it out of orbit.
- **Committee on the Peaceful Uses of Outer Space**, and Inter-Agency Space Debris Coordination Committee (IADC) advocates Global mitigation measures takes many forms ; including preventing the creation of new debris, designing satellites to withstand impacts by small debris, and improving operational procedures such as using orbital regimes with less debris, and predicting and avoiding collisions.

**Committee on the peaceful uses of Outer space**

- It is **an ad-hoc committee under United Nation** set up by the General Assembly in 1959 to govern the exploration and use of space for the benefit of all humanity: for peace, security and development.
- The committee encouraging space research programmes, and studying legal problems arising from the exploration of outer space

**International Space debris Committee**

- It is an international governmental forum for the worldwide coordination of activities related to the issues of man-made and natural debris in space to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options.

## 4.4. GRAPES-3 EXPERIMENT

**Why in News?**

- The GRAPES-3 experiment is being upgraded to get precise information about the propagation of solar storms.

**What is solar Storm?**

- It is an eruption of mass and energy from the solar surface mainly in the form of magnetic plasma and hot gases of electrically charged particles; and in addition, more dangerous gamma, ultraviolet and X rays, out into space.
- Solar Flaries, Cronal Mass ejection, and sunspot activities are the indicators of solar storm.
- Solar storms can happen at any time but tend to become more severe and more frequent in roughly 11-year cycles.

**How does Solar Storm affect the Earth?**

- The collision of charged particles of solar storm with earth's magnetospheres generates the shimmering Northern Lights, the aurora borealis, and aurora australis in southern hemisphere.
- Some charged particles can modify the Earth's magnetic field and affect compass readings.
- The changing magnetic fields can also induce electricity in long pipelines, or produce electrical surges in our power grids leading to brown outs and black outs.
- It can affect the space programme, trade communications (stock-exchange), broadcast communications, airlines and navigation.

**What is GRAPES-3?**

- GRAPES-3 (Gamma Ray Astronomy PeV Energies Phase-3) is a muon telescope observation unit, located in Oat (Nilgiri ,Tamilnadu).
- The first cosmic ray experiment was started in 1955 as GRAPES-1 by Tata Institute of Fundamental Research (TIFR), which was upgraded in various stages to GRAPES-2, before the new experiment GRAPES-3 was established.

- GRAPES-3 has been established with the collaboration of the Tata Institute of Fundamental Research, Mumbai, India and the Osaka City University, Osaka, Japan.

**What are the functions of GRAPES-3?**

- To study cosmic rays, air shower detectors and muon detectors from galaxy.
- To study the sun and its accelerator of energetic particles and its effects on the Earth.
- It studies our galaxy through nuclear composition of cosmic rays and diffusion of γ-ray (gamma rays)

**Why needed up-gradation?**

- It will act as an early warning system and will measure the intensity of coronal mass ejection.
- The upgrade will provide precise information about the propagation of storms in the last million miles.
- It would increase the chances of spotting solar storms by observing the large extent of sky and improving the direction of incident rays.
- It would **discern the direction of detected particles** of solar storm such as plasma thereby, making it unique among all the other cosmic ray detectors in the world.

Student Notes:

# 5. IPR

## 5.1. WHAT IS IPR?

- Intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an **exclusive right over the use** of his/her creation for a certain period of time.
- IPRs in India are administered by the **Department of Industrial Policy and Promotion** under the Ministry of Commerce & Industry.

### 5.1.1. TYPES OF IPR

- Patent
  - ✓ A patent is granted for an **invention** which is a **new product or process** that meets conditions of **novelty, non-obviousness** and **industrial use.**
  - ✓ Novelty means inventive step is the feature(s) of the invention that involves technical advance as compared to existing knowledge.
  - ✓ Non-obviousness means the invention is not obvious to a person skilled in the art.
  - ✓ Industrial use means that the invention is capable of being made or used in an industry.
  - ✓ Patents in India are governed by **"The patent Act 1970"** which was amended in 2005 to make it compliant with TRIPS.
- Trademark
  - ✓ A trademark means a **mark** capable of being represented **graphically** and which is capable of **distinguishing the goods or services** of one undertaking from those of other undertakings.
  - ✓ A Trade Mark can be a device, brand, heading, label ticket name, packaging, sign, word, letter, number, drawing, picture, emblem, colour or combination of colours, shape of goods, signature or a combination thereof.
  - ✓ Trade marks in India are governed by **Trade Marks Act 1999** which was amended in 2010.
- Geographical Indications
  - ✓ It is a sign used on **agricultural** or **natural** or **manufactured goods** as originating or manufactured in a particular region of a country. It denotes its origin where a **specific quality, characteristic or reputation** of the product is essentially attributable to that origin.
  - ✓ Geographical Indicators in India are governed by **"The Geographical Indications of Goods (Registration & Protection) Act, 1999".**
- Copyright
  - ✓ Copyright is a right given by the law to creators of **literary, dramatic, musical and artistic works and producers of cinematograph films and sound recordings.**

**Delhi High court on copyrights:**

- Delhi high court has held that reproducing books and distributing copies thereof for the purpose of education is not copyright infringement.
- Though, this judgment upholds the interests of students and their rights and ability to access education, the publishers claimed that photocopies hurt their sales.
- The copyright law rests on a delicate balance between the interests of copyright owners and copyright users. The law is designed to encourage the creation of works and simultaneously, to permit the users to enjoy the works and promote arts and knowledge.
- In the Indian Copyright Act, 1957, section 52 lists a number of scenarios which do not constitute infringement, including a fair dealing provision. The section is the bulwark for public enjoyment of copyrighted work – it allows largely purposive acts, including fair dealing, copying in research, educational institutions etc.

- ✓ This right allows its creator the rights of reproduction, communication to the public, adaptation and translation of the work.
- ✓ Copyrights in India are governed by **"The Copyright Act, 1957".**

- Design
  - ✓ An industrial design consists of the creation of a shape, configuration or composition of pattern or color, or combination of pattern and color in three-dimensional form containing aesthetic value.
  - ✓ An industrial design can be a two- or three-dimensional pattern used to produce a product, industrial commodity or handicraft.
  - ✓ Designs in India are governed by "**The Designs Act 2000**".
- Plant Variety Protection
  - ✓ It refers to the protection granted for plant varieties. These rights are given to the farmers and plant breeders to encourage the development of new varieties of plants.
  - ✓ Plant variety protection in India is governed by "**The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001**".

## 5.2. NATIONAL IPR POLICY 2016

- The National IPR Policy 2016 is completely compliant with the World Trade Organisation's agreement on Trade Related aspects of IPRs (TRIPS).
- The policy has a **special thrust on**
  - ✓ Awareness generation at school/college level,
  - ✓ Effective enforcement of IPRs and
  - ✓ Encouragement of IP commercialisation through various incentives
- The policy retains the provisions on **Compulsory Licencing** (CL) (in the National Manufacturing Policy and Section 84 of India's Patents Act) as well as Section 3(d) of India's Patents Act (**preventing ever-greening of drug patents**) in spite of the EU and US objections terming CL as inconsistent with WTO's TRIPS agreement.
- According to Section 3(d), besides novelty and inventive step, improvement in **therapeutic efficacy** is a must for grant of patents when it comes to incremental inventions.
- The policy will also suggest incentives such as **tax benefits and fee waivers to encourage R&D and IP creation** to strengthen the Make In India/Start-up/Digital India initiatives.
- To protect 'small inventions' developed especially in the **informal / unorganised sectors**, policy will promote '**utility patents**' (with lower compliance burden and shorter period of protection, when compared to the normal patents) only for mechanical innovations.

**Seven objectives**

- IPR Awareness - To create public awareness about the economic, social and cultural benefts of IPRs among all sections of society.
- Generation of IPRs - To stimulate the generation of IPRs.
- Legal and Legislative Framework - To have strong and effective IPR laws, which balance the interests of rights owners with larger public interest.
- Administration and Management - To modernize and strengthen service oriented IPR administration.
- Commercialization of IPR - Get value for IPRs through commercialization.
- Enforcement and Adjudication - To strengthen the enforcement and adjudicatory mechanisms for combating IPR infringements.
- Human Capital Development - To strengthen and expand human resources, institutions and capacities for teaching, training, research and skill building in IPRs.

**Key features**

- Department of industrial policy and promotion (DIPP) will be the nodal agency for all IPR issues.
- Films, music, industrial drawings will also come under the ambit of copyright.
- Existing IPR laws will be reviewed to remove any inconsistencies and make them in accordance with present time and future needs.
- Less empowered groups of IP owners such as artisans, weavers and farmers will be provided financial support by offering them IP friendly loans.
- Trademark offices to be modernised, and the aim is to reduce the time taken for examination and registration to just 1 month by 2017.
- It proposes to establish IP Promotion and Development Council which will oversee opening of IP Promotion and Development Units in all states in order to create a single window system for promotion, awareness and utilization of IP in the country.
- 1st time patent fee waiver and a support system for MSMEs. This will boost innovation in the sector. Also an effective loan guarantee scheme to be created to encourage start-ups.
- The policy to be reviewed every 5 years in consultation with all the stakeholders.

**Limitations**

- The policy is based on the premise that more IPRs mean more innovation. However there is little research that backs this assumption.
- Openness, sharing and access to knowledge have been given back seat in the policy document.
- Policy suggests researchers in public funded research organizations to mandatorily convert all research into IP. However it is best left at the discretion of the inventor.
- Criminalizing the civil wrong of unauthorized copying such as movies and literature is prone to misuse.
- To create an atmosphere of creativity and innovation, a holistic approach is required and not just IPR protection.

**Conclusion and way forward**

- The Policy aims to push IPRs as a marketable financial asset, promote innovation and entrepreneurship, while protecting public interest including ensuring the availability of essential and life-saving drugs at affordable prices.
- The new IPR policy introduced with a slogan of "Creative India, Innovative India" is largely a step in the right direction. However to obtain the best outcome the challenges and limitations needs to be suitable addressed.

## 5.3. TRADE MARK RULES

**Why in News?**

- The Trade Mark Rules, 2017 have been notified recently by the Ministry of Commerce and Industry.

**What is a Trademark?**

- It is **a sign capable of distinguishing the goods or services** of one enterprise from those of other enterprises.
- It is **protected by Trademarks Act 1999**.
- **Trademarks registry** established in India in 1940, presently administers the Trademarks Act. It is also a resource centre for trademarks.

**Need**

- It would replace the previous Trade Mark Rules 2002, and therefore would **streamline and simplify the processing of Trade Mark applications**.

**Rules**

- **Ease of filing Trademarks:**
  - **Trade Mark Forms** have been reduced from 74 to 8.
  - **Expedited processing of a registration application** has been extended up to registration stage which till now existed only up to examination stage.
  - Servicing of documents to Trade Mark Registry has been eased.
- **Trademark Fees**:
  - All fees related to trademark have been rationalized.
  - Online filing fees have been made 10% lower than physical filing fees to promote e-filing of trademark.
  - Fees for Individuals, Start-ups and Small Enterprises have been reduced to only Rs 4,500.
- For the first time, **modalities for determining well-known trademarks** have been introduced.
- Hearing of disputes has been introduced through video conferencing.
- Adjournments in opposition proceedings have been restricted to a maximum of two to avoid pendency.

**Significance**

- Presently, examination time for a Trademarks application has already been brought down from 13 months to just 1 month in January 2017 despite a 35% jump in filings in 2015-16.The new Rules should give a **boost to the Intellectual Property Regime in India**.
- By rationalizing the fee structure, this step may also be a right **step to promote entrepreneurship** in India.
- New rules would also give a **time-bound resolution of disputes** besides lowering the burden on tribunals and courts.
- It is a step towards **ease of doing business** and would eventually increase India's position as a good investment decision with protection of intellectual property rights.

**Way Forward**

- The Trademark rules have been changed at a timely moment when India stands at having a third largest startup ecosystem in the world. There should also be a commensurate capacity building needed to implement the changed rules.

## 5.4. DATA EXCLUSIVITY

**What is it?**

- This refers to exclusive rights, granted over the pharmaceutical test data submitted by companies to drug regulatory authorities for obtain market authorisation. It means that information concerning a drug's safety and efficacy is kept confidential for a period of, say, five or ten years.
- It is a form of legal monopoly protection for a drug, over and above the patent protections. This is given expressly to compensate for the investment made during clinical trials. It implied that regulators cannot approve a similar drug with similar

**TRIPS plus measures**

It means going beyond the TRIPS provisions. TRIPS plus provisions are frequently pushed as a part of free trade agreements between developed and developing countries. Some such provisions are:

- Data exclusivity - one of the most worrying demands in RCEP negotiations (covered in detail in subsequent subsection)
- Patent term extensions are given to compensate the company for delays in processing patent applications. A patent term extension will give another five-year monopoly to the innovator company.

Many developed countries have even signed Anti-Counterfeiting Trade Agreement (ACTA) which establishes international standards for IPR enforcement outside WTO and WIPO.

data for the next five years.

**Arguments in favor**

- It will incentivize the efforts to bring new drugs in market as their costs incurred in expensive and time consuming preclinical and clinical trials will be recovered.

**Arguments against it**

- It is beyond the mandate of TRIPS agreement and would prevent drug regulators to use the data, submitted by Originator Company, for approving bioequivalent versions of the same drug, which would prevent generics from entering into market.
- It would prolong monopoly even after expiry of 20-year period and will lead to evergreening of patents negating the impact of Section 3(d) of patent act and blocking of compulsory licensing.
- Even for establishing bioequivalence, clinical trials would be repeated on human subjects which is immoral and unethical.
- Giving exclusivity just on the basis of money spent would set bad precedent for other industries which may now claim IP-like rights.

**Way forward**

The government should held firm its stand on "TRIPS plus" and not succumb to the pressure which may lead to evergreening of patents and blocking of compulsory licenses and severely undermine public interest.

## 5.5. GENERIC MEDICINES

**Why in news?**

- Recently, the Prime Minister has urged doctors to prescribe only generic medicines to patients.

**What are Generic Medicines?**

- It is a low-cost version of a formulation that is equivalent to branded product in quality, dosage, strength, route of administration and efficacy.
- Due to patency issues generic drugs are not sold in the market unless the patent of the branded drug expires.
- Even after the patency generic drugs are available under brands and are called Branded generics.

Export of Generic Version of Patented Drugs

- Bayer had moved the Delhi high court to **restrain** two Indian pharmaceutical companies **from exporting generic versions** of drugs abroad-
  - ✓ Against Natco Pharma from selling invention Sorafenib, used in treatment of kidney cancer
  - ✓ Against Alembic from selling Rivaroxaban, which is a blood thinner.
- Bayer's argument was that **the compulsory licenses** granted for production of these two drugs were for sale within India only and not abroad.
- The Delhi High court allowed generic drug manufacturers to export patented drugs for the purposes of development, clinical trials and regulatory clearances.

**Current regulation regarding Generic Drugs in India**

- The **Medical Council of India's ethics code for doctors made generic prescription mandatory** in October 2016, though it was not enforced.
- **Health Ministry has proposed changes in the Drugs and Cosmetics Act** to ensure the generic names is printed in bigger fonts than the brand names.
- Drug Controller of India has directed states to order the approval of drugs based on generic names only.

Student Notes:

- Department of Pharmaceuticals has given in-principle approval for **a Uniform code for pharmaceutical marketing practices**, which legally binds all stakeholders like doctors, pharmacists etc. to promote generics. Any violations would attract penalty. This has also not been enforced.
- Under the **Pradhan Mantri Bhartiya Janaushadhi Pariyaojana**, 861 centres have been established in 28 states to supply generic drugs. 99 private companies certified by the **WHO** have also been inducted to manufacture generic drugs for PMBJP.

**Compulsory licensing of pharmaceuticals and TRIPS**

- Compulsory licensing is when a government allows someone else to produce the patented product or process without the consent of the patent owner. It is one of the flexibilities on patent protection included in the WTO's agreement on intellectual property — the TRIPS (Trade-Related Aspects of Intellectual Property Rights) Agreement.
- The TRIPS Agreement does not specifically list the reasons that might be used to justify compulsory licensing. However, the countries are free to determine the grounds for granting compulsory licences.
- Under Section 84 (1) of the Indian Patent Act, any person may request a compulsory license if, after three years from the date of the grant of a patent, the needs of the public to be covered by the invention have not been satisfied; the invention is not available to the public at an affordable price; or the patented invention is not "worked in," or manufactured in the country, to the fullest extent possible.

**Challenges for Generic Drugs in India**

- One of the biggest concerns raised by the doctors is that switching to generic drugs for chronic illness patients may risk the patient of not getting full benefit of the drug.
- Drug inspection department in the country is **highly understaffed** and hardly one percent of the drugs in the country are tested for quality.
- Most generic medicines too are sold under brand names. Therefore, the chemist would have the discretion to sell a particular brand (mostly likely the one where he has the highest margin)
- **Unawareness** among the people about generic drugs. Generic drugs being cheaper are considered to be of inferior quality by the public at large.
- It might **reduce the entry of big pharmaceutical majors** in the Indian market thus creating a dearth of investment in Indian pharmaceutical market.
- There is still a **shortage of supply of generic medicines** and needs to be addressed first before prescribing the generic medicines. Also the **quality of the generic drugs is not uniform**.
- Health is a state subject and Centre-State coordination would be much needed to counter this problem.

**Way Forward**

- A legal framework must be adopted for **"quality testing"** of generic drugs.
- The government must also clarify that how a patient would get the appropriate drug when a doctor just writes the salt names on the prescription and not fall prey to the Chemist personal gains.
- Adequate no. of drug inspectors must be hired for regular field inspections.
- Public should be made aware on how generic drugs are at par with branded ones
- Stockpiling of drugs in order to ensure constant supply
- Doctors should also be given a window to take the call of prescribing branded drugs in cases deemed necessary.

## 5.6. BIOPROSPECTING AND BIOPIRACY

**Introduction**

- Bioprospecting refers to **biodiversity prospecting**. It is the process of **discovery and commercialization** of new products based on biological resources.
- These biological resources may include chemical compounds, genes, micro-organisms, macro-organisms, and other valuable products from nature.

**Analysis**

> **Biopiracy** is the practice of commercially exploiting naturally occurring biochemical or genetic material, especially by obtaining patents that restrict its future use, while failing to pay fair compensation to the community from which it originates.

- Pros:
  - ✓ Bioprospecting, if well managed, can generate **income for developing countries and its indigenous community.**
  - ✓ It can provide incentives for the conservation of biological resources and biodiversity.
  - ✓ It can lead to **discovery of new drugs**.
- Cons:
  - ✓ If not well managed, bioprospecting may lead to environmental problems related to **unauthorized (over-) exploitation.**
  - ✓ Social and economic problems related to unfair sharing of benefits -or the total absence of benefit sharing- and to **disrespect for the rights, knowledge and dignity of local communities.**
- Thus bioprospecting in itself is not bad. However it is its misuse (leading to biopiracy) that creates problem for nature and human kind.

**Steps taken to prevent biopiracy**

- India is a member of **CBD (Convention on Biodiversity)** and as a mark of its ratification, India enacted the **Biodiversity Act of 2002**.
- Autonomous bodies such as National biodiversity authority, state biodiversity boards and biodiversity management committees have been constituted to regulate access to biological resources and associated traditional knowledge to ensure **equitable sharing of benefits** arising out of their use.
- **Traditional knowledge digital library:** It is a database that documents traditional knowledge and makes it available in the public domain.

**Way forward**

- It is evident that India is on the right path when it comes to protecting its national interest in its biodiversity and traditional knowledge, while granting access on a case-by-case basis.
- The issue of benefit sharing is tantamount, and India must now adopt a balanced approach to safeguard its genetic resources while promoting much needed growth in the biotechnology sector.
- This could be achieved by formulating a comprehensive **National Bioprospecting Policy** which suitably addresses issues related to intellectual property rights, tenure of land and natural resources, R&D, conservation and protection of biodiversity.

# 6. CONTRIBUTION OF INDIANS AND INDIGENIZATION OF TECHNOLOGY

## 6.1. IMPORTANT ACHIEVEMENTS OF INDIANS IN THE FIELD OF MODERN SCIENCE AND TECHNOLOGY

**PHYSICS:**

- **CV RAMAN:** He won Nobel Prize of Physics in 1930 for his discovery of Raman Effect which says that when light traverses a transparent medium a small part of the scattered light changes wavelength. It has applications in drug discovery, mineralogy, life sciences, semiconductors production etc.
- **Jagdish Chandra Bose:** He is a noted scientist who invented microwave components like waveguides, horn antennas etc.
- **S Chandrashekhar:** He was awarded the 1983 Nobel Prize for Physics for his mathematical theory of black holes and on the basis of this Chandrashekhar Limit was defined.
- **S.N Bose:** His work on 'Bosons' have helped revolutionize formation of Standard model of physics. He also partnered with Einstein to for Bose-Einstein statistics that has applications in information retrieval in present times.
- **Tessy Thomas:** She is also called the missile woman of India who spearheaded the programme on the Agni IV missile.

**CHEMISTRY:**

- Praffula Chandra Ray - He was a noted chemist who set up the first chemical factory of India - Bengal Chemical and Pharmaceutical Works Ltd.in 1901
- Har Gobind Khurana - He was an Indian American who shared the Nobel Prize of Medicine of 1968 for the research on cell's synthesis of proteins.

**MATHS:**

- **S. Ramanujam:** Without formal training, he was the second Indian to become Fellow of Royal Society of London. December 22 is celebrated as National Mathematics Day after him.

**NUCLEAR SCIENCES:**

- **Homi J. Bhabha:** He was the first person to become the Chairman of the Atomic Energy Commission of India and was the brain behind our three stage nuclear programme.

**SPACE SCIENCES:**

- **Meghnad Saha:** Saha Equation. This equation is one of the basic tools for interpretation of the spectra of stars in astrophysics and space sciences.
- **Vikram Sarabhai:** He was instrumental in setting up of ISRO. Apart from that he also helped set up IIMs. For his contribution he was also given Padma Vibhushan.

## 6.2. INDIA SHOWS SECOND HIGHEST GROWTH IN SCIENCE RESEARCH

**Why in News?**

- According to Nature Index 2016 Rising Stars report, India ranks second position, only behind China, among countries with the highest increase in their contribution to high-quality scientific research.

Student Notes:

- The Indian institutions that made to the top 100 highest performers across the globe include Council for Scientific and Industrial Research (CSIR), Indian Institute of Science Education and Research (IISER), Tata Institute of Fundamental Research (TIFR), Indian Institute of Science (IISc) and Indian Institute of Technology (IITs).

**Significance**

- The report reflects India's emergence as one of the world's largest economies.
- The report shows that India is moving in the right direction and hopefully, it will stimulate not only the government and individual scientists, but also young people in schools to take science more seriously.

**Hurdles to Scientific Research in India**

- The academic ambience in many universities does not encourage the research pursuits of faculties. Research management is another very serious problem.
- Students drifting to other job-oriented courses after graduation in science are prevalent in India owing to the widespread impression among them that unlike professional courses, a career in basic science is not lucrative.
- Lack of investment: India currently spends around one per cent of its GDP on research and development. In contrast, China spent about $209 billion on research and development in 2015, or 2.1 per cent of its GDP.

**Initiatives to Promote scientific research**

- The govt. of India recently launched **VAJRA (Visiting Advanced Joint Research) faculty scheme** to enable NRI and overseas scientists community to participate and carry out R&D in the country. The **Science and Engineering Research Board (SERB**), a Statutory body of the Department will implement the Scheme.
- **Jigyasa:** a student- scientist connect programme which focuses on connecting school students and scientists so as to extend student's classroom learning with that of a very well planned research laboratory based learning.
- **IMPacting Research INnovation and Technology (IMPRINT):** the first-of-its-kind Pan-IIT and IISc joint initiative, is a Ministry of Human Resource Development (MHRD) initiative to address major engineering challenges that the country must address and champion to enable, empower and embolden the nation for inclusive growth and self-reliance.
- **Innovations for Development of Efficient and Affordable Systems (IDEAS):** Government will launch a scheme for students from higher educational institutions to volunteer to offer innovative, original and practical solutions to problems facing the country and win Rs 1 Crore.
- **Science Cities Scheme** provides for setting up of **Science Cities** in all the states of the country :
  - ✓ To portray the growth of **science and technology** and their applications in **industry, human welfare** and **environment.**
  - ✓ To promote and enhance **public understanding** of the culture of science and technology.
  - ✓ To inculcate and sustain **Scientific Awareness** & **Scientific Temper.**

**Scientific Social Responsibility**

- Prime Minister advocated **scientific social responsibility (SSR**) on the lines of **corporate social responsibility (CSR)** at the 104th Indian Science Congress.

**What is Scientific Social Responsibility?**

- It is analogous to CSR. CSR includes initiatives that benefit society.
- Similarly, SSR shall include encouraging innovation and applying scientific models for the benefit of society.
- SSR also includes promoting greener options/ climate friendly innovations and research models.
- SSR would promote scientific excellence in all stakeholders including educational institutions.

**Way Forward**

- India needs to grow an attractive environment for research, so that students and academics who leave the country for higher studies and research opportunities have an incentive to return.

## 6.3. WOMEN PARTICIPATION IN SCIENTIFIC RESEARCH

In the last few decades there has been a rise in the enrolment of women in graduate programmes in pure sciences in India, but they are still a minority vis-a-vis men.

Right from school women do take up science, but mostly for the purpose of a degree. Only a few of them go on to pursue scientific careers.

**Reasons for low participation of women**

- The prime reason for this anomaly is not their performance, but the **attitude of our society**. The Indian society sees the default role of a woman as a homemaker. A career of such long gestational period is not perceived to be the primary goal of a woman.
- Women were also shown in **traditional roles** like nursing and mothering, while men were shown as pilots, doctors, etc. **Gender bias** has been observed in this field. Science research is an area considered a man's world.
- **Timing in a scientists' career** is an important factor. The prime time for a scientist in his/her career is also the time when women usually get married or have children. This puts a lag on their career. Even a six months delay in research in science, particularly experimental work, implies that your work gets left behind and your career suffers.
- **Dual responsibility on women** deters her to take up full time responsibility of research work.

These issues can be addressed by the following measures:

- **Return-to-work programmes** for women
- Institutes should provide **crèches** for the children
- Circumstances should be created to **make working easier** for a woman scientist.
- Create gender enabling environment in institutions. Academic spaces need to be **gender-neutral**.
- Female students and women in science need **mentors** that they can identify with, and that too Indian. But there is an absence of **role models**.
- Scientists should be recognized by their work, and not by their gender. There should be **no prejudice**.

**Initiatives taken:**

- **The Science and Technology Policy of the Govt. of India, 2003** enunciates a commitment to promote the empowerment of women in S&T and ensure their full and equal participation. This was further reiterated in 2013 policy.
- **Bio- CARe:** The Department of Biotechnology under the Bio-CARe scheme provides support for women scientists, both employed and unemployed to build capacities so as to help them undertake independent Research and Development (R&D) projects.
- **KIRAN**: Department of science and Technology has restructured all the women specific programmes under one umbrella known as "KIRAN" (Knowledge Involvement in Research Advancement through Nurturing). KIRAN is addressing various issues related with women scientists (e.g. unemployment, relocation etc.) and aimed to provide opportunities in research, technology development/ demonstration, and self-employment etc.
- **Consolidation of University Research for Innovation and Excellence in women universities (CURIE)** is another component of KIRAN that has a focus to develop state-of-the-art infrastructure to help large number of women to enhance their S&T skills and knowledge in order to make a fulfilling career in this domain besides promoting research culture in such institutions.

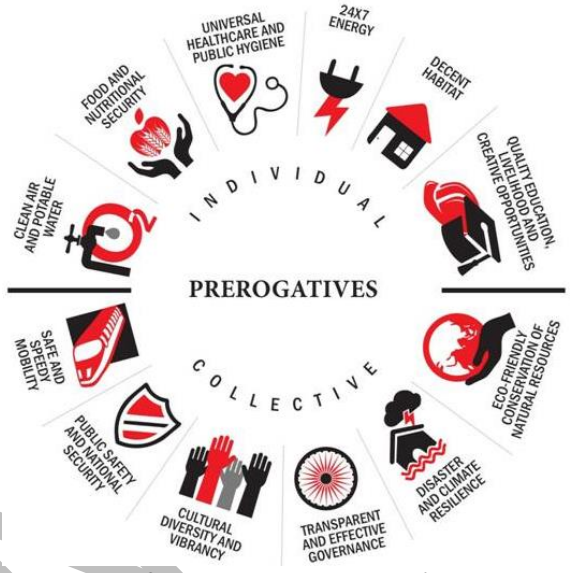
## 6.4. TECHNOLOGY VISION DOCUMENT

The government unveiled the Technology Vision Document 2035 in January 2016. The document foresees the Indians of 2035, and technologies required for fulfilling their needs.

It is not a visualization of technologies that will be available in 2035, but a vision of where our country and its citizens should be in 2035 and how technology should bring this vision to fruition.

Aim of Technology Vision Document 2035:

- The Aim of this 'Technology Vision Document 2035' is to ensure the Security, Enhancing of Prosperity, and Enhancing Identity of every Indian.
- It **identifies 12 sectors** for which *Sectoral Technology roadmaps* will be prepared by Technology Information, Forecasting and Assessment Council, (TIFAC)
  - ✓ Education
  - ✓ Medical Sciences & Healthcare
  - ✓ Food and Agriculture
  - ✓ Water
  - ✓ Energy
  - ✓ Environment
  - ✓ Habitat
  - ✓ Transportation
  - ✓ Infrastructure
  - ✓ Manufacturing
  - ✓ Materials
  - ✓ Information and Communication Technology




- It also identifies **twelve (12) prerogatives**- (six for meeting individual needs and six for the collective needs) that should be available to each and every Indian.
- It categorizes technologies into a six-fold classification from an Indian perspective which is as follows:
  - ✓ **Technology Leadership:** niche technologies in which we have core competencies, skilled manpower, infrastructure and a traditional knowledge base e.g., Nuclear Energy, Space Science.
  - ✓ **Technology Independence:** strategic technologies that we would have to develop on our own as they may not be obtainable from elsewhere e.g. Defence sector.
  - ✓ **Technology Innovation:** linking disparate technologies together or making a breakthrough in one technology and applying it to another e.g. solar cells patterned on chlorophyll based synthetic pathway are a potent future source of renewable energy.
  - ✓ **Technology Adoption:** obtain technologies from elsewhere, modify them according to local needs and reduce dependence on other sources eg., foreign collaboration in the sectors of rainwater harvesting, agri-biotech, desalination, energy efficient buildings.
  - ✓ **Technology Constraints:** areas where technology is threatening and problematic i.e. having a negative social or environmental impact because of serious legal and ethical issues e.g., Genetically Modified (GM) Crops.
- The document dwells upon the grand challenges in the field of Technologies which are:
  - ✓ Guaranteeing nutritional security and eliminating female and child anaemia
  - ✓ Ensuring quantity and quality of water in all rivers and aquatic bodies
  - ✓ Providing learner centric, language neutral and holistic education to all
  - ✓ Developing commercially viable decentralized and distributed energy for all
  - ✓ Making India non-fossil fuel based
  - ✓ Securing critical resources commensurate with the size of our country
  - ✓ Ensuring universal eco-friendly waste management

- ✓ Taking the railway to Leh and Tawang
- ✓ Understanding national climate patterns and adapting to them
- ✓ Ensuring location independent electoral and financial empowerment

- The Vision Document gives a 'Call to Action' to all the key stakeholders. It says for long term sustainability of India's technological prowess, it is important that
  - ✓ *Technical Education Institutions* engage in advanced research on a large scale leading to path-breaking innovations.
  - ✓ *Government* enhances its financial support from the current 1% to the long-envisaged 2% of the GDP.
  - ✓ the number of *full-time equivalent Scientists* in the core research sector should increase.
  - ✓ *Private Sector Participation and Investment* in evolving technologies that is readily deployable and is translatable from lab to field thereby increasing efficiency in terms of technology and economic returns.
  - ✓ *Academia-Intelligentsia-Industry connect* is established via idea exchange, innovative curricula design, based on the needs of the industry, industry-sponsored student internships and research fellowships inter alia.
  - ✓ *Creation of an Research Ecosystem* so as to achieve the translation of research to technology product/process by integrating students, researchers and entrepreneurs.
- The document also identifies three key activities as a part of the 'Call to Action':
  - ✓ The first being *knowledge creation*. It says that India cannot afford not to be in the forefront of the knowledge revolution, either applied or pure.
  - ✓ The second activity that cannot be reflected, it says is *ecosystem design for innovation and development*. The document again interestingly says that the primary responsibility for ecosystem design must necessarily rests with government authorities.
  - ✓ A third key activity that it mentions is *technology deployment* with launching certain national missions involving specific targets, defined timelines requiring only a few carefully defined identified players.

While this Vision document walks towards the future taking into consideration the country as a whole, the technology roadmap of each sector would provide of outlining future technology trends, R&D directives, pointers for research, anticipated challenges and policy imperatives pertaining to each sector.

## 6.5. NITI AAYOG 3 YEAR ACTION AGENDA

**Factors that have held back India's progress in S&T**

- Low public spending and private investment on Research and Development (R&D)
- Inefficient and non-uniform management of S&T initiatives due to bureaucratic hurdles, lack of interdepartmental synergies and a lack of clear prioritization.
- Existing government schemes for innovation suffer from duplication of efforts, long approval times and lack of clear evaluation guidelines.
- Slow technological development in key sectors such as agriculture, energy, waste management etc.
- Lack of a well-functioning national ecosystem having limited number of idea incubators and dedicated technology parks.
- Higher education system has lagged in terms of R&D as well as producing an adequately trained scientific workforce.

Student Notes:

**Funding and Management of Science and Technology**

- **Evaluate existing government schemes** –
  - There is a need to create a comprehensive database of all existing schemes related to S&T across different ministries and departments.
  - Such a database can then be used to evaluate existing schemes using pre-defined criteria including commercial feasibility, risk and timelines.
- **Develop clear guidelines for PPPs in S&T** –
  - Via PPPs, government can facilitate collaboration between academic institutions and industry for ensuring demand-driven and relevant R&D.
  - There is a need to recognize that PPPs in S&T are different than those in infrastructure as R&D projects are associated with higher risk and longer timelines for achieving results.
- **Create a body to coordinate all public S&T efforts and actors** –
  - National Science, Technology & Innovation Foundation should be setup and deliberate national issues, recommend priority interventions in S&T, prepare frameworks for their implementation and monitor progress of public projects.
  - Within the foundation, a multi-disciplinary overall monitoring group consisting of scientists and social scientists can be steup to recommend actions to maximize the societal impact of projects as well as strategies for the deployment of technologies in a timely manner.
- **Rethinking the Teaching-Research-Industry Link**:
  - The objective should be to eventually move research from falling solely under the purview of research institutes and councils to also being encompassed by research universities.
  - Research must be made an integral part of the responsibilities of faculty members along with providing autonomy to attract research staff from abroad or to compete for research projects from industry.
- **Improve the Administration of the Patent Regime**:
  - It is important that National IPR Policy be communicated and disseminated to scientists, engineers and other researchers in the public and private sectors to spur innovation.
  - There is a need to streamline the administration of our patent regime as there are widespread complaints about delays in the grant of patents in India.

**Priority sectors for intervention**

Given the limited funds the government has at its disposal, it may offer well-targeted grants to seek solutions to specific social problems.

- **Water Management** – The government should prioritize the development of cost-effective, implementable, scalable, water sector technologies such as desalination, recycling removing heavy toxic metals from water, and water conservation technologies for realizing the target for Water for All.
- **Agriculture**: The government should encourage innovations in three areas within agriculture:
  - It should seek to develop technologies for rejuvenating soil affected by overdose of pesticides, fertilizers and other toxic chemicals.
  - It should invite research to help develop cost effective technologies for implementing Precision Agriculture (PA) or satellite farming for farming management based on observing, measuring and responding to inter and intra-field variability in crops.
  - It should invite scientists to develop cost-effective technologies for food storage and transportation to minimize post-harvest losses in agriculture.

- **Energy**: The government should encourage the development of clean coal technologies and renewable sources of energy. For example, conversion of coal into Methanol and other non-polluting forms of energy can be explored. The government urgently needs to fund the development of cost-effective technologies for addressing water accumulation in solid, semisolid and liquid forms as well as technologies to convert "waste to energy". Along with private sector, the government should harness new technologies for converting waste into productive materials such as manure and gas.
- **Health**: The government should help develop creative and cost-effective solutions to recurring vector borne diseases such as Chikungunya, dengue and drug resistance malaria. Solutions may take the forms of new vaccines, devices that help detect and kill mosquitos carrying the viruses and creating sanitary conditions that prevent the multiplication of mosquitoes in the first place.

Apart from these, policymakers should also incentivize innovation in crosscutting areas such as:

- **Connectivity**: Government should help develop afforadable technologies for providing nationwide digital connectivity which will form the backbone for e-governance, e-health, communication, rural innovations and entrepreneurship.
- **Security**: It should also encourage the development of technologies such as foliage penetration through wall imaging radars.

## 6.6. INDIGENISATION OF DEFENCE TECHNOLOGY

It is a well-established fact that no nation aspiring to great power status can expect to achieve it without being substantively self-reliant in defence production. To achieve the self-reliance in defence products the government under **Make in India** programme has awarded 56 defence manufacturing permits to private sector entities in the past one year.

**Need for indigenization of Defence Technology:**

- Various studies highlighted that 20-25% reductions in imports could directly create an additional 100,000 to 120,000 highly skilled jobs in India.
- The rise in percentage of domestic procurement from 40% to 70% in the next five years, we would double the output in our defence industry.
- Defence forces are facing the problem to upkeep, repair, overhaul & maintenance of the imported equipment due to low availability of spares and assemblies.
- For nearly all equipment and weapon platforms, the vendor offers all possible spares and assemblies in the form of MRLS (Manufacturers Recommended List of Spares) which leads to mismatch in demand and supply of defence equipment.
- Defence procurement had remained mired in disadvantageous buyer-seller, patron-client relationships like that with the erstwhile Soviet Union and now Russia.
- Defence Technology and production capability of Defence Public Sector Undertakings (DPSUs) and Ordnance Factories (OFs) are based on 'Incremental and backup support' and not on 'transformative' thus, not able to meet the contracted time lines for supply of munitions and weapon systems.

**Way Forward**

- **Consortium Approach:** There is a need to adopt consortium approach on the lines of Brahmos Aerospace. We need to capitalize maximum on the ability of numerous companies, bring them under one umbrella and push ahead for successful culmination of our Design and Development projects.
- **Upgrade Production Capacities.** There is a need for immediate review and up-gradation of the existing production capacities. Once the DPSUs and OFs are able to meet demands of

own Armed Forces, then, we can certainly expect exports of sizeable number of weapons, equipment and ammunition to friendly foreign countries.

- **Human Capital**. The Indian universities, both public and private, need to focus on creating a rich pool of talent for the industry to absorb for progress in defence R&D. Our curriculum has to be inclined more towards practical and research oriented studies rather than theory.
- **Funds for Capital Acquisition.** Larger proportion of funds should be earmarked for capital acquisition. Very little amount of money is left for modernisation after taking out committed liabilities. Currently, only 42% of budget is available under capital head. The revenue expenditure is approximately 58%. This proportion needs significant alteration.

**The Defence Production Policy (DPP)**

- It aims to achieving substantive self-reliance in the design, development and production of equipment, weapon systems.
- Creating conditions conducive through ease of doing business for the private industry to take an active role in this endeavour.
- Enhancing potential of SMEs (Small and Micro Enterprises) in indigenisation and broadening the defence R&D base of the country.
- DPP has been supplement by various other initiatives such as:
- Preference to 'Buy (Indian)', 'Buy and Make (Indian)' & 'Make' categories of capital acquisition over 'Buy & Make (Global)' or 'Buy (Global)' categories in Defence Procurement Procedure.
- Foreign Direct Investment (FDI) Policy under which Foreign Investment Cap upto 49% is allowed through automatic route and above 49% under Government route on case-to-case basis.
- The initial validity of Industrial Licence has been increased from 3 years to 15 years with a provision to further extend it by 3 years on a case to case basis.
- Most of the components, parts, sub-systems have been taken out from the list of defence products requiring Industrial License.

## 6.7. RECENT ACHIVEMENTS OF DRDO

### 6.7.1. INDIA'S INTERCEPTOR MISSILE

**Why in news?**

- DRDO has come up with a new indigenously produced **Advanced Air Defence (AAD)** interceptor missile, **Ashwin**.
- The missile was tested on the newly named Abdul Kalam Island located in the Balashore district off the Odisha coast.
- The test involved the launch of the single-stage Ashvin Advanced Defense interceptor missile from a mobile launcher and the successful destruction of an incoming target.

**Salient Features**

- 7.5-metre-long, single stage solid rocket propelled, guided, supersonic missile.
- It is capable of destroying any incoming hostile ballistic missile.
- The missile comes with an inbuilt navigator, an advanced computer and an electro-mechanical activator.
- The technology in the missile is encrypted using a secure data link independent tracking and homing capabilities and sophisticated radars.
- After the successful test, India became the fourth country in the world to have full-fledged multi-layer Ballistic Missile Defence system. Only United States, Russia and Israel are in the same league.

- The new supersonic missile interceptor will soon become a part of the Indian Army's arsenal.

**About India's BMD**

- India began developing a multi-tiered Ballistic Missile Defense (BMD) system in 1999, after the end of the Kargil War in reaction to Pakistan's growing missile arsenal.
- A consortium of 40 Indian companies were involved in the development of the missile defense shield.
- India's BMD shield is a two-tiered defense system
  - ✓ Prithvi Air Defense (PAD) / Pradyumna Ballistic Missile Interceptor destroying missiles at exo-atmospheric altitudes of 50–80 kilometers (31–50 miles),
  - ✓ Advanced Air Defense (AAD)/ Ashvin Advanced Defense interceptor missile endo-atmosphere at altitudes of 20-40 kilometers (12-24 miles).
- In addition to the indigenously developed BMD system, India has procured six regiments of Russian S-300 air defense systems and is negotiating for five regiments of more advanced S-400 systems with Russia.

## 6.7.2. AGNI-V AND NAG MISSILES

**Why in News?**

- India successfully conducted the final test of its indigenous ICBM, Agni-V from Wheeler Island off Odisha coast and has successfully test fired the **anti-tank missile "Nag"** in Rajasthan.

**About AGNI V**

- The nuclear-capable missile has a strike range of over 5,000-km.
- It has been developed by DRDO
- It can be transported and swiftly launched from anywhere on land. It can even be launched from canisters.
- It is a surface-to-surface missile having new technologies incorporated than previous Agni counterparts in terms of navigation and guidance, warhead and engine.
- It is one of the most accurate ballistic missile in the world and therefore has high kill efficiency.

**Integrated Guided Missile Development Programme**

- It was conceived by Dr. APJ Abdul Kalam for self-sufficiency in missile technology in 1983
- DRDO is its implementing agency
- It has a time bound objective to develop the following missiles -
  - ✓ Short range surface to surface ballistic missile - **PRITHVI**
  - ✓ Intermediate range surface to surface ballistic missile - **AGNI**
  - ✓ Short Range low level surface to air missile - **TRISHUL**
  - ✓ Medium range surface to air missile - **AKASH**
  - ✓ Third generation anti tank missile - **NAG**
- In 1990s the programme was expanded to include Sagarika (ballistic missile), Dhanush (naval version of Prithvi) and Surya missiles
- In 2008 DRDO announced the successful completion of the program

**Significance of the launch**

- Its range extends to entire Pakistan and also northernmost parts of China thus adding to our defence preparedness. This is especially relevant in times of strengthening China-pak axis and aggressive geopolitics in the region.

- It will promote our policy of deterrence and promote the regional balance of power in the Indian subcontinent.

**Future plans**

- India has also started working on Agni-VI. It will be capable of being launched from submarines as well as from land, and will have a strike-range of 8,000-10,000 km.

### 6.7.3. HIGH NITROGEN STEEL

**Why in news?**

The Defence Research and Development Organisation (DRDO) has signed a technology transfer agreement with Jindal Stainless (Hisar) Limited (JSHL) for manufacturing High Nitrogen Steel (HNS).

**About High nitrogen steel (HNS)**

- High nitrogen steels are a new class of high alloy martensitic, austenitic or duplex grades with up to 0.9 mass% of N in solid solution.

**Significance**

- The alloy has significant applications in the defence sector due to its **much higher ballistic strength** than normal steel, but currently the country is largely dependent on imports.
- In addition to being **non-magnetic and corrosion-resistant**, the HNS **cost is about 40% less** compared to Rolled Homogenous Armour Steel (RHA)
- The HNS technology would further the Army's quest for **lighter and high-performance armouring material** compared to materials currently in use.
- will pave the way for further **acceleration of locally developed technology**,

**Applications of NHS**

- The potential applications of HNS include combat platforms like futuristic infantry combat vehicles, mine-protected vehicles, army bridges and army corridors.

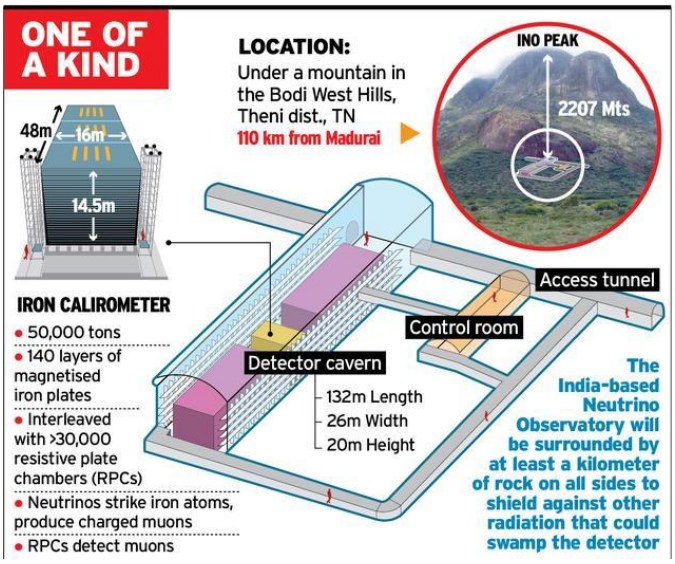
## 6.8. INDIA-BASED NEUTRINO OBSERVATORY (INO)

**Why in news?**

The National Green Tribunal recently suspended the Environmental Clearance (EC) granted to the India-based Neutrino Observatory (INO) and asked the project proponent to make a fresh application.

**More on news**

- The MoEF had categorised it a Category 'B' project, for which an Environmental Impact Assessment is not necessary, however the Madhikettan Shola National Park in Idukki district of Kerala was just about 4.9 km from the proposed project site and the Tamil Nadu-Kerala border was just a kilometre away, making it a Category 'A' project.



**India-based Neutrino Observatory (INO) Project**

- The India-based Neutrino Observatory (INO) Project is a multi-institutional effort aimed at building a world-class underground laboratory with a rock cover of approx.1200 m for non-accelerator based high energy and nuclear physics research in India.
- The INO is set to come up on the hills near Thevaram in Theni district and will have a 50,000-tonne magnetic detector to study neutrinos that are significant in particle physics.
- In the 1960s, India had a neutrino observatory located at the Kolar Gold Fields in Karnataka. However, the laboratory was shut in the 1990s because the mines were being closed.
- **Need:** Determination of neutrino masses is the most significant open problem in particle physics today and is the key goal of the INO project.

**Benefits**

- According to government INO will be the agent of transforming physics of this kind in India and will make a global impact. The outcome of this investment will be extraordinary and long term.
- Understanding the particle will help scientists pick the correct theory beyond the standard model of particle physics and address the problem of matter-antimatter asymmetry of the universe.
- Research on neutrino particle would be path breaking in the field of science and will help in knowing more about the universe.
- An important outcome of the project will be training young researchers in large-scale experimental science.
  - ✓ It can play a role in nuclear non-proliferation through the remote monitoring of nuclear reactors. Using Neutrino detectors, the plutonium content can be monitored remotely and can be used to detect any pilferage.
  - ✓ Study of Geoneutrinos might help creating an earthquake warning system. This field of science is called Neutrino Tomography.

## 6.9. DEEP OCEAN MISSION

**Why in news?**

- **Ministry of Earth Sciences** is set to launch 10,000 crore **"Deep Ocean Mission"** to study and harness the mineral resources beneath the ocean floor by January 2017.

**Polymetallic Nodules**

- Also known as **manganese nodules**, they are largely porous nodules found in abundance carpeting the sea floor of world oceans in deep sea.
- Besides **manganese and iron**, they contain **nickel, copper, cobalt, lead, molybdenum, cadmium, vanadium, titanium**, of which nickel, cobalt and copper are considered to be of economic and strategic importance.

**Background**

- India boasts of 7500 km of coastline and 2.4 million square km of exclusive economic zone.
- The program on **Polymetallic nodules** was initiated at CSIR-NIO (National Institute od Oceanography) with the collection of the first nodule sample from Arabian Sea on board the first Research Vessel **Gaveshani on 26 January 1981**.
- India was the **first country in the world to have been given the Pioneer Area for exploration of deep-sea mineral viz. Polymetallic nodules** in the Central Indian Ocean Basin in 1987 under the **UN Law of the Sea**.

**About Deep Ocean Mission**

- It will also involve the **Department of Science and Technology and the Department of Biotechnology.**

- Major components of the project are deep **ocean energy, desalination plant along the Chennai coast, deep sea science and fisheries, minerals and polymetallic nodules.**
- The exclusive economic zone allotted to India will be covered under the mission.

## 6.10. DISANET-DISASTER COMMUNICATION NETWORK

**Why in news?**

- IIT Madras team is developing a low-cost communication system named **DISANET.**
- It will allow basic services such as voice, text and video communications to be exchanged within its network of rescue workers, Master Operation Centre and the NDMA.

**Why the need?**

- One of the first things to get affected during natural disasters and accidents is the communication network. In a country where over a billion use mobile phones, providing mobile connectivity during a disaster, at least for emergency usage, is a priority.
- The plan is also to enable citizens within the reach of this system to communicate essential messages, such as "I am safe" or basic information – name, age, gender, etc, of persons discovered.
- The whole system is compatible with basic model mobile phones, as most users in India do not own smart phones.
- At present, people who are involved in rescue operations, such as police personnel, use walkie/talkie handsets (VHF/UHF) but VHF/UHF handsets are expensive.

**Components of the network**

- The design has four subsystems - WiFi, a satellite link, single-carrier GSM and LTE (Long Term Evolution). Rescue workers with GSM handsets, WiFi cameras and WiFi nodes can spread out over an area of 12-25 square kilometre to form the **primary deployment area**. These workers supply communication between the affected area and the Master Operation Centre (MOC).

**Benefits of the initiative**

- The rescue team will be able to directly communicate with citizens about the arrangements using FM broadcast, which citizens receive on their mobiles.
- This enables the flow of authenticated information from the authorities to the citizens and prevents rumour-mongering during times of disaster.

## 6.11. INDIA JOINS CERN

**Why in news?**

- India recently became an associate member of the European Organisation for Nuclear Research (CERN), the world's largest nuclear and particle physics laboratory.
- India can choose to apply for full membership after two years or continue with this status for five years.

**India's contribution to CERN**

- Many Indians have made contributed to the **construction of the LHC accelerator, ALICE and CMS** experiments at CERN.
- Indian scientist's role in LHC helped in the **discovery of Higgs Boson**.
- In the field of large-scale computing, India has designed, developed and deployed **software for the Worldwide Large Hadron Collider Grid (WLCG).**

Student Notes:

**Other facts about CERN membership**

- India will also have to contribute 11.5 million Swiss francs every year to the capital or to the operating costs of CERN's programmes, which the country did not have to as an observer member.
- Being associate member status Indian industries, now, can bid for tenders and procurements.

**Significance for India**

- Larger role in formulating scientific policy and experiments
- India can take part in meetings of the CERN Council and its committees (Finance Committee and Scientific Policy Committee).
- Indian scientists will become eligible for staff appointments.
- Access to various facilities and industrial participation, commensurate with the financial contribution
- Students pursuing their Masters and PhD can participate in various schools and workshops organised by CERN.
- Post-doctoral positions and staff positions at CERN will also open up.

**About CERN**

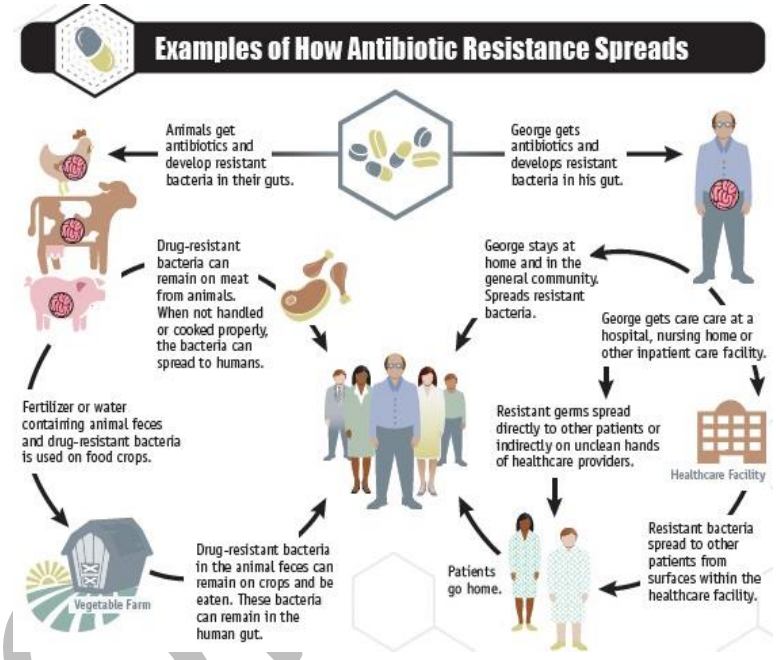
- CERN is based in Geneva on the French-Swiss border.
- It was founded in 1954.
- It has 22 member states and four associate member states and other associate members transitioning to full member status.
- At CERN, scientists and engineers are **probing the fundamental structure of the Universe.**
- India was inducted as an 'Observer' at CERN in 2004.
- Projects at CERN
  - **Large Hadron Collider** - The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator.
    - ✓ It aims to study the fundamentals of universe.
  - **Compact Muon Solenoid (CMS)** - It is a general-purpose detector at the LHC.
    - ✓ Its studies the Standard Model (including the Higgs boson)
    - ✓ It is also searching for extra dimensions and particles that make up dark matter.
  - **ALICE** is the acronym for **A** **L**arge **I**on **C**ollider **E**xperiment.
    - ✓ It researches in the physics of matter at an infinitely small scale. E.g. Research on quarks which make protons and neutrons.

# 7. HEALTH

## 7.1. ANTIMICROBIAL RESISTANCE

**What is Antimicrobial Resistance (AMR)?**

- Antimicrobial resistance is resistance of a microorganism to an antimicrobial drug that was originally effective for treatment of infections caused by it.
- Antibiotic resistance occurs naturally, but misuse of antibiotics in humans and animals is accelerating the process. Poor infection prevention and control further accelerate it.




**Impacts**

- Threats to global health, food security, and development
- A growing number of infections – such as pneumonia, tuberculosis etc– are becoming harder to treat as the antibiotics used to treat them become less effective.
- Longer hospital stays, higher medical costs and increased mortality.
- Superbugs have lately emerged as one of the major pitfalls of antimicrobial resistance.

**What are Superbugs?**

- Microorganisms that has become resistant to battery of antibiotic drugs after their prolonged exposure to antibiotics.
- Hence, the medicines become **ineffective** and infections persist in the body, increasing the risk of spread to others.
- **Overuse** (consuming more antibiotic than prescribed) and **Misuse** (taking prescribed antibiotic incorrectly or taking antibiotic to treat viral infection) of antibiotics are the major reason for formation of Superbugs. **Human consumption** of **antibiotic-treated chicken** and **livestock** further increasing resistance.
- Few prominent superbugs highlighted by WHO are **MRSA** (methicillin-resistant Staphylococcus aureus), **Neisseria gonorrhoeae**, **Klebsiella**, **E. coli.**
- **Klebsiella Bacteria** has recently developed resistance to a powerful class of antibiotics called **carbapenems.**
- **World Health Organization (WHO)** has recently provided a list of twelve **"Superbugs"** which pose an enormous threat to human health.

**Current Situation in India**

- India faces a twin challenge of overconsumption of antibiotics breeding drug-resistant bacteria while ensuring that the poor and vulnerable have easy access.
- Lack of knowledge among medical practitioners as well as general public on rational use of antibiotics aggravates the issue.

- According to WHO, anti-biotic resistance may cause rise in death of Indians to 20 lakhs per year by 2050.
- Scientists have recently isolated resistance causing mcr-1 gene in a strain of E.coli in India. mcr-1 gene. Mcr-1 gene is responsible for resistance against the antibiotic, Colistin- the last mile antibiotic that the human race has currently access to.
- This is an alarming news and ould make India's Battle against MAR all the more difficult.

**Action Taken By WHO**

The WHO released it Global Action Plan on Anti-microbial Resistance, 2015. It has the following five objectives:

- To improve awareness and understanding of antimicrobial resistance.
- To strengthen surveillance and research.
- To reduce the incidence of infection.
- To optimize the use of antimicrobial medicines.
- To ensure sustainable investment in countering antimicrobial resistance
- WHO has revised antibiotics protocol to curb antibiotic resistance. This is the biggest revision of the antibiotics section in the essential medicines list (EML). The new list will help health system planners and doctors ensure that people who need antibiotics have access to them, and they get the right one, so that the problem of resistance doesn't get worse.
- WHO has divided the drugs into three categories — **access, watch and reserve**.
  - ✓ The **'access' category** includes commonly used antibiotics. They will be available at all times as treatment for a wide range of common infections.
  - ✓ The **'watch' group** covers antibiotics that are recommended as first or second choice treatment for a small number of infections. Prescription of these drugs should be reduced to avoid further development of resistance.
  - ✓ The **'reserve' category** includes antibiotics that are considered last-resort options, and used only in the most severe circumstances such as for life-threatening infections due to multidrug-resistant bacteria.

- **Essential medicines** are the medicines that "satisfy the priority health care needs of the population".
- These are the medications to which people should have access at all times in sufficient amounts. The prices should be at generally affordable levels.
- The **WHO** publishes **Model List of Essential Medicines** (**EML**) every two years since 1977. It is used by countries to develop their own local lists of essential medicine.

- Indian Researchers have been able to reverse antibiotic resistance in E. coli (Escherichia coli).
- They have unravelled the mechanism by which hydrogen sulphide (H2S) gas produced by bacteria protects them from antibiotics and plays a key role in helping bacteria develop drug resistance.
- The drug-resistant strains were naturally producing more hydrogen sulphide compared with drug-sensitive E. coli and by blocking/disabling the enzyme that triggers the biosynthesis of hydrogen sulphide in bacteria, the researchers, have been able to reverse antibiotic resistance in E. coli bacteria.

**National Action Plan on Antimicrobial Resistance**

- India recently has launched **National Action Plan on Antimicrobial Resistance on the lines of WHO's global action plan on AMR.**
- Government also signed a **"Delhi Declaration"** to strategize collectively with WHO, FAO (Food and Agriculture Organization) and other UN agencies to implement the national and state action plans on Anti Microbial Resistance.

Student Notes:

**Features**

- **India's action plan has objectives of** –
  - Enhancing **awareness among masses and strict adulteration laws**.
  - Strengthening **surveillance**
    - ✓ Conducting national-level **surveillance of antibiotic resistance** in humans, animal and the environment
    - ✓ **Surveillance of antibiotic use** in humans and animals
    - ✓ **Monitoring antibiotic residues** in food animals and the environment.
  - Improving **rational use of antibiotics** –
    - ✓ Restricting and phase-out of non-therapeutic use of antibiotics in food animals Eg. Phase out growth promoters in animal foods
    - ✓ Restricting and regulating feed and feed premix containing antibiotics.
    - ✓ Eliminating use of critically important antimicrobials for humans in food animals.
    - ✓ Regulating online sale and ensure prescription sale and appropriate labeling.
  - Reducing infections
    - ✓ Reducing environmental spread of AMR through necessary laws and surveillance of waste from animal farms, food processing, pharmaceutical sector and health care facilities.
  - Promoting policies and research in anti microbial resistance.
    - ✓ Introduce programmes to support small and mid-size animal farmers to help them reduce antibiotic use
    - ✓ Issue pond-health cards and install necessary systems to prevent infection, support biosecurity and waste management.
    - ✓ Develop a separate policy for freshwater/inland fisheries
    - ✓ Establish an independent veterinary regulatory authority for drugs.
  - Support neighbouring countries in collective fight against infectious diseases

**Government efforts on AMR**

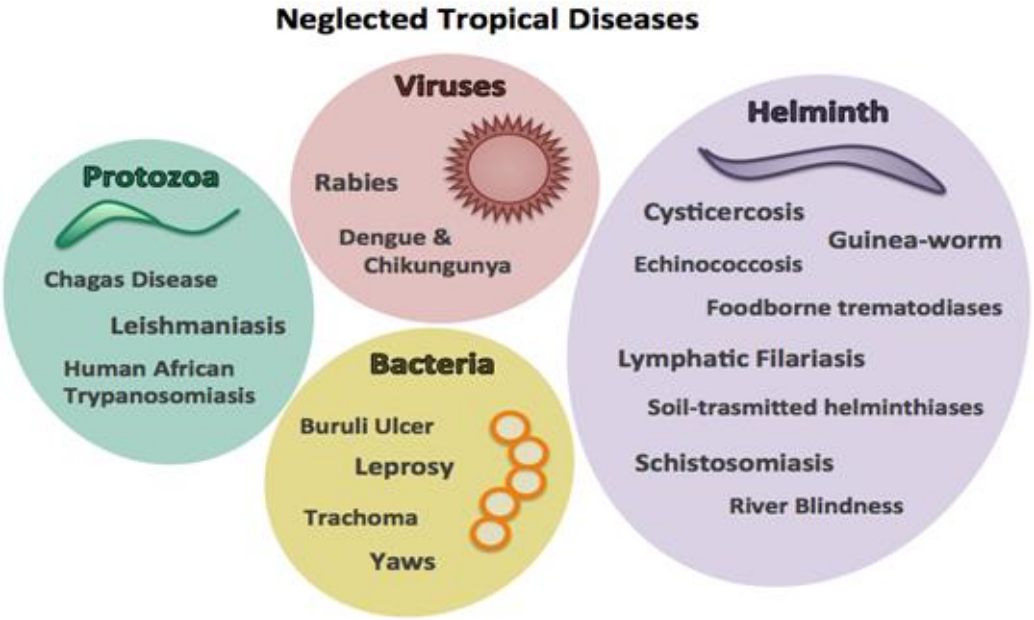
- Government has initiated a series of actions including –
  - To strengthen the surveillance of antimicrobial resistance (AMR) in the country, Indian Council of Medical Research (ICMR) has set up a National Anti-Microbial Resistance Research and Surveillance Network (AMRRSN) to enable compilation of National Data of AMR at different levels of Health Care.
  - The Drugs and Cosmetic Rule, 1945 were amended in 2013 to incorporate a new Schedule H1. These will be sold on prescription only. They are also marked with Red Line (Red Line Campaign).
  - Brought out **National Guidelines for use of antibiotics**.
  - AMR is now being addressed **comprehensively under "One Health Approach"**.

> **One Health** recognizes that the health of humans, animals and ecosystems are interconnected. It involves applying a collaborative, multidisciplinary and cross-sectoral approach to address potential or existing risks that originate at the animal-human-ecosystems interface.

**Challenge**

- Coordination among different ministries and between centre and state governments would be a challenge.
- **Action plan's success would depend on implementation of national-level programmes** to support small-scale animal farms, manage waste from animal farms, animal food processing and pharmaceutical manufacturing sector and health care facilities.

## 7.2. NEGLECTED TROPICAL DISEASES




**What are Neglected Tropical Diseases?**

- WHO defines NTDs as a diverse group of communicable diseases that prevail in tropical and subtropical conditions in 149 countries.
- Populations living in poverty, without adequate sanitation and in close contact with infectious vectors and domestic animals and livestock are those worst affected.
- NTDs also find a mention in SDGs (Sustainable Development Goals 2030).

**Leprosy and its Current Status in India:**

- Bacterial disease caused by Mycobacterium leprae,
- Affects the skin and peripheral nerves.
- Long incubation period generally 5-7 years.
- Timely diagnosis and treatment of cases, before nerve damage has occurred, is the most effective way of preventing disability.
- About 60% of the global leprosy patients live in India and Annual New Case Detection Rate (ANCDR) stands at 9.71 per 1,00,000 population.
- Institute of Immunology has developed Mycobacterium Indicus Pranii (MIP), an indigenous vaccine for leprosy.
- MIP will be administered as prevention for people living in close contact with those infected by the bacteria.
- MIP is now being introduced into the **National Leprosy Elimination Programme (NLEP)**. It will boost the immune system against the bacterial disease.

**Current Status in India**

- India has achieved the target for eliminating visceral leishmaniasis (kala azar), a neglected tropical disease (NTD), in 82 per cent sub-districts, according to the fourth World Health Organization (WHO) report on NTDs released in April, 2017.
- India has set a target of eliminating visceral leishmaniasis by 2017 and lymphatic filariasis in endemic pockets by 2017.
- Another significant achievement by India was the elimination of yaws, a chronic skin disease that mostly affects poor children, in 2015; WHO recognised India as the first member state to "achieve this important milestone".
- India has also progressed in treating lymphatic filariasis (elephantiasis), and has stopped mass drug administration in 72 endemic districts after passing evaluations.
- Apart from this India has also been struggling with vector borne tropical disease such as dengue and Chikungunya.

The following national programmes in relation to tropical diseases are being implemented:

- **National Vector Borne Disease Control Programme (NVBDCP):** for control of Dengue and elimination of Kala-azar and Lymphatic Filariasis.
- **National Leprosy Eradication Programme:** India has achieved the elimination of leprosy at national level in December 2005. Focus is now to achieve elimination of leprosy at district level.
- **National Programme for Control of Blindness:** services are provided for the control of Trachoma.
- **School Health Programme:** services are provided for the prevention of Soil-transmitted Helminthiases.

## 7.2.1. DENGUE, CHIKUNGUNYA ON THE RISE

**Why in News?**

- There has been a sharp increase in the incidence of dengue and chikungunya in the country in 2017 over the previous year.
- Cases have also been reported earlier than usual mainly attributed due to the early arrival of monsoon.
- In 2016, the worst dengue hit states were Delhi, West Bengal and Tamil Nadu. While in case of Chikungunya, Karnataka needs special help, as it has a disproportionately higher incidence compared to other States.

**Causes**

- **Climate change and erratic weather:**
  - ✓ Unseasonal rain prolongs the season for mosquitoes. Climate changes make the environment conducive to mosquito breeding.
  - ✓ Variable and erratic weather coupled with the climate change has become the root cause for the spread of the mosquito borne diseases like dengue and Chikungunya.
- **Causalities due to comorbidity:**
  - ✓ Comorbidity is the presence of one or more additional diseases or disorders co-occurring with (that is, concomitant or concurrent with) a primary disease or disorder.
  - ✓ Casualties this year have mostly been due to co-morbidities of dengue and chikungunya rather than the viral fever itself.
- **Poor urban planning:**
  - ✓ Poor urban planning make people dwell in the slums which are often without basic amenities.
  - ✓ Unhygienic food and lack of proper houses make them more prone to water borne diseases.
- **Poor health infrastructure:**
  - ✓ India's investment in health services remains one of the lowest in the world.
- **Lack of affordable healthcare facilities:**
- Doctor to patient ratio is extremely poor in the villages. Costly healthcare services in cities deter village people from travelling to cities for treatment in initial stages of the diseases

**Solutions**

- **Environmental management:**
  - Environmental management ought to be the mainstay of vector control and involves destroying, altering, removing or recycling non-essential containers that provide egg, larval or pupal habitats.

- Clean environment makes sure that whatever the adverse weather changes, the mosquito does not breed.

- **Improved city infrastructure:**
  - It is important to have urban dwelling with proper waste management facilities.
  - There should be installation of reliable piped water supply to communities dwelling especially in slum areas to reduce the need for storage.
  - Strict legislation and regulation can significantly change planning and construction of buildings.
- **Biological and chemical control:**
  - Biological control is based on the introduction of organisms that prey upon, compete with or reduce populations of the target species.
  - Frequent sprays of chemical to curb such diseases are other way to reduce the cases.
- **Community participation:**
  - Mobilising the community to participate in sanitation campaigns holds the key, although families that live in deprived neighbourhoods will need generous municipal assistance, improved civic facilities and access to free health care.
- **Advance planning**:
  - It is necessary to embark on comprehensive public health initiatives in July, instead of waiting till October and trying to deal with a surge of sick people using a creaking healthcare system.

**Lessons from successful initiatives**

- **India:**
  - Experiments with bio-vector control - in Puducherry and later in Kheda district of Gujarat - showed a dramatic reduction in vector-borne diseases.
  - In these cases, what was done was aggressive cleaning of the environment to make sure there was no stagnant water in drains and use of fish larvae to eradicate the mosquito.
- **Singapore:**
  - Singapore has one of the highest burdens of infections transmitted by Aedes mosquitoes; dengue haemorrhagic fever appeared in the 1960s and became a major cause of child deaths.
  - It achieved significant control through integrated vector management that entailed**: Advocacy, social mobilisation and legislation; collaboration within the health sector and across other sectors; evidence based decision-making and capacity building of providers and communities**.
  - It has come down heavily on the construction sector for not complying with vector control guidelines.
- **Sri Lanka:**
  - There are several aspects to the Sri Lankan experience that could help evaluate the efforts of India's States in their battle to control disease-spreading vectors. Better results were achieved by the island nation through integration of different approaches.
  - This includes **focussing on mosquito control in irrigation and agriculture, introducing new classes of insecticides for residual spraying within houses, and scaling up distribution of insecticide-treated bed nets even in areas caught up in conflict**.
  - Mobile centres for access to diagnostics and treatment also helped halt disease transmission.

## 7.3. COALITION FOR EPIDEMIC PREPAREDNESS & INNOVATIONS

**Why in News?**

- It was officially launched in Jan 2017 at World Economic Forum (WEF) at Davos with an initial investment of $460 million from the **Germany**, **Japan** and **Norway** including **Bill & Melinda Gates Foundation**.
- It will be headquartered in Norwegian Institute for Public Health, in Oslo.
- India has joined CEPI to lead the fight against epidemics.

**What is CEPI?**

- It is a **Global alliance** of governments, intergovernmental institutions like WHO, health specialists, and philanthropists to finance and coordinate the development of new vaccine to prevent and contain infectious disease epidemics.
- CEPI has signed a MoU with WHO. It is using WHO's priority list to choose which diseases to pursue.
- CEPI has finalized three diseases to start developing vaccines for: Middle East Respiratory Syndrome (MERS), Lassa fever and Nipah.
- The steering agencies of the coalition are - Department of Biotechnology, Ministry of Science & Technology, GOI; Government of Norway; Wellcome Trust; Bill & Melinda Gates Foundation; and World Economic Forum.

**Why Need of CEPI?**

- Infectious disease epidemics cost the world $60 billion each year endangering lives, disrupting societies and damaging economies esp. of low and middle income countries.
- Recent cases like **Ebola outbreak** in West Africa and **Zika** in the America have exposed serious flaws in the world's capacity to prepare for and respond to infectious disease outbreaks Recent outbreaks: **SARS, Ebola and Zika** - reveal gaps that partnerships like CEPI should fill.

**Ebola**

- The Ebola virus causes an acute, serious illness which is often fatal if untreated.
- The Ebolavirus belongs to the virus family Filoviridae. Five species of the Ebola virus have been identified till date.
- Formerly known as Ebola haemorrhagic fever, it was first occurred in remote villages in Central Africa, near tropical rainforests in 1976.
- The virus is transmitted to people from wild animals (through close contact with the blood, secretions, organs or other bodily fluids of infected animals such as chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rainforest) and spreads in the human population through human-to-human transmission via direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected people, and with surfaces and materials (e.g. bedding, clothing) contaminated with these fluids.
- Recently a new Ebola vaccine rVSV-ZEBOV has been proved to give 100 percent protections in its final test results.

**Zika Virus**

- Zika virus disease is caused by a virus transmitted primarily by **Aedes mosquitoes**.
- Zika can be passed through sex from a person with Zika to his or her partners.
- People with Zika virus disease can have symptoms including mild fever, skin rash, conjunctivitis, muscle and joint pain, malaise or headache. These symptoms normally last for 2-7 days.
- There is scientific consensus that Zika virus is a cause of microcephaly and Guillain-Barré syndrome.

**India and Zika virus**

- The WHO has placed India as a '**Category-2' country** for Zika risk.
- A Category-2, the second highest on a four-point scale and that also includes 2015 Zika-hotspot Brazil, indicates that the virus is being actively transmitted within the country.
- Until April, India was a Category-4 country.

**Benefits of the Coalition**

- It will provide a **permanent, sustainable model** for epidemic vaccine development through sharing of risk and benefits of vaccine development.
- It will help in building regional capabilities of various stakeholders in the long run. It will also bolster India's status of pharmacy of the world
- It will **shorten the time** it takes to make vaccines to protect against virus epidemics, which can emerge suddenly as global public health threats.
- It will help protect our population and help lower preventable deaths.

**Way forward**

- To be successful the coalition should set up adequate funding mechanisms, regulatory environment and scientific guidelines on the vaccine development. Also disease mapping should be done to properly assess the cause and the solutions of the epidemics.
- The clinical trials of the vaccines developed under the programme would have to be based on highest medical, ethical standards. For this hints can be taken from the recommendations of the Ranjit Roy Chaudhary.

## 7.4. TUBERCULOSIS (TB)

**About the Disease**

- TB is a caused by bacteria (Mycobacterium tuberculosis) that most often affect the lungs.
- It is a communicable disease which is spread from person to person through air.
- According to the WHO, it is one the top 10 leading causes of death worldwide.
- It is curable and preventable however, bacteria have become resiatnt to various strains of antibiotic leading multiple drug resistamnt TB which is difficult to treat.

**Global TB Report**

- WHO has been publishing a global TB report every year since 1997.
- The main aim of the report is to provide a comprehensive and up-to-date assessment of the TB epidemic, and of progress in prevention, diagnosis and treatment of the disease at global, regional and country levels.

**XDR-TB**

XDR-TB is a form of TB which is resistant to at least four of the core anti-TB drugs. XDR-TB involves resistance to the two most powerful anti-TB drugs, isoniazid and rifampicin, also known as multidrug-resistance (MDR-TB), in addition to resistance to any of the fluoroquinolones (such as levofloxacin or moxifloxacin) and to at least one of the three injectable second-line drugs (amikacin, capreomycin or kanamycin).

**Current Situation in India**

- WHO recently released its Global TB Report. According to the report, India has 27 per cent of the global burden of incident tuberculosis and 34 per cent of global TB deaths.
- In 2015, estimate of incidence TB is 2.8 million cases.
- India diagnosed and notified 1.7 million incident TB patients in 2015.
- The estimate of the number of TB deaths is 4,78,000 — making TB one of the leading causes of death in India.
- Further, of the estimated 79,000 cases of multidrug resistant (MDR) TB, about 31,000 were diagnosed.
- The increasing density of population and growing urban environment facilitates the transmission of TB cutting across all economic strata, which is perpetuating the age-old cycle of transmission and risk.
- Joint Management Mission Report of 2015, reported that despite increasing expenditure under Revised National Tuberculosis Control Programme (RNTCP), there was a gap

between the allocation of funds and the minimum investment required to reach the goals of the Plan.

- The existing TB surveillance system lacks the capacity to count the large pool of privately diagnosed and treated TB cases.
- Within the public sector, there is heavy dependence on an insensitive diagnostic test (heavily relied on sputum test) and incompetence to diagnose drug resistance cases.
- There has been limited progress in the form of special action plans for tribal populations.
- In the urban areas, however, there is no established health structure owing to the slow progress of the National Health Mission in the urban areas.

**National Strategic Plan for Tuberculosis Elimination 2017-2025**

- The action plan aims to achieve active case finding of TB to 100% by 2020 and complete elimination of TB by 2025.
- The aim of this Action Plan is to do away with the earlier strategy of self-reporting where few patients get themselves tested; and rather, focus on detecting more cases, both drug-sensitive and drug-resistant, by government itself reaching out to patients.
- The requirements for moving towards TB elimination have been integrated into the four strategic pillars of **"Detect – Treat – Prevent – Build" (DTPB).**
- It is a vision document designed to address co-morbidity of TB with HIV by strengthening care such as joint management of TB/HIV co-infected patients, TB/DM management etc.
- Implementation will be a combined effort of all stakeholders such as NGOs, local - governments, state welfare schemes and machinery working towards the same goals.
- For the first time, the TB control programme talks about having in place patient-friendly systems to provide treatment and **social support**, which would encompass the reducing out of pocket expenditure such as; cost of treatment, cost of travels, cost of diagnosis and wage loss.
- The plan conceives a shift from regulatory approach to partnership approach (Synergy) with the largely unorganized and unregulated private sector.
- It seeks to make the daily regimen universal by moving away from the thrice weekly regimen, followed by RNTCP.

**Synergy with Private Sector Health Care**

- Increase Private Health Provider Engagement.
- Decentralized drug resistant TB services.
- Free drugs and diagnostic tests to TB patients in private sector.
- Increasing support for patients seeking care in the private sector.
- Enhance Surveillance and Quality improvement.
- Expand ICT support and Build management capacity.

**What is Swasth E-Gurukul?**

- Swasth-e-gurukul is an e-learning initiative of World Health Organization.
- It is a single repository for training material for all disease programmes such as TB, AIDS, leprosy, malaria, diabetes etc.
- The Initiative provides information to all health care providers.

**What is NIKSHAY?**

- It is an IT tool which facilitates monitoring of universal access to TB patients database.
- Developed jointly by the Central TB Division of the Ministry of Health and Family Welfare and National Informatics Centre (NIC).
- Implemented at national, state, district and Tuberculosis Unit (TU) levels.
- Utilises SMS technology for communication with TB patients and grassroots level healthcare services providers as well as health and family welfare policy makers.
- Moreover, the tool establishes a correlation between TB & HIV, leading to outcome analysis of treatment.

- Moreover, new **anti-TB drug Bedaquiline** has been introduced under Conditional Access Programme (CAP).
- Under the **'Make in India**' thrust of the Government of India, it is proposed to explore the possibility of developing capacity to produce first-line drugs for RNTCP in the public sector.
- IT based **E-Nikshay platform has** been made user friendly so that Private Doctors find it easy to notify.
- **Swasth E-Gurukul TB** and myriad TB Awareness Media Campaigns would not only focus on awareness but also on fighting stigma and discrimination prevalent against the TB patients.
- The strategic plan envisions a TB Corpus Fund maintained by Bharat Kshay Niyantran Pratishtan' (India TB Control Foundation).
- Furthermore, this document calls for effective linkages between Central Tuberculosis Division, AADHAR, Social Walfare Scheme, Pradhan Mantri Jan Dhan Yojana and Nikshay Platform.

**Way ahead**

- National Strategic Plan for Tuberculosis Elimination 2017-2025, is the need of the hour, when we are racing against time in front of growing bacterium resistance against health problems.
- India has managed to scale up basic TB services in the public health system. However, the rate of decline in TB cases and treatment of more than 10 Million TB patients is too slow to meet the 2030 Sustainable Development Goals (SDG) and World Health Organization's (WHO) End TB Strategy.

## 7.5. HIV/AIDS BILL

**Why in News?**

- Parliament has recently passed HIV and AIDS (Prevention and Control) Bill.

**Facts**

- AIDS is a leading cause of death among **women of reproductive age, adolescents, Sex workers, transgenders** etc.
- Punitive laws, stigma, human rights violations, social exclusion, gender inequality, lack of sexual and reproductive health services and exclusion from decision making process aggravate their vulnerability.
- The **adult HIV prevalence** at national level has steadily declined from 0.34% in 2007 and 0.28% in 2012 to 0.26% in 2015.
- India had 2.1 million people living with HIV at the end of 2016, with new infections falling to 80,000 in 2016 from 150,000 in 2005, shows data from the UNAIDS Ending AIDS Report 2017.
- Of these, 9,100 infected were children under age 15 years.

The Central Drugs Standard Control Organisation (CDSCO) has registered the child-friendly and heat-stable oral pellet formulation of the HIV drug lopinavir/ritonavir (LPV/r).

**Why important?**

- The lack of child-friendly HIV formulations is a major reason for a large treatment gap between adults and children.
- Due to this gap paediatric HIV is considered neglected disease. The registration of the pellets is a positive sign as the needs of children are being addressed.

**Provisions of the Bill**

- **It aims to**:
  - Prevent and control the spread of HIV and AIDS
  - Prohibit discrimination against persons with HIV and AIDS
  - Provide informed consent and confidentiality in treatment

- Place obligations on establishments to safeguard their rights
- Creates mechanisms for redressing their complaints.

- It **lists out various grounds of discrimination** against HIV positive persons like **denial, termination, or unfair treatment** in employment, education, health care, housing, standing for public office, and insurance.
- It **prohibits individuals from publishing information or advocating feelings of hatred** against HIV positive persons and those living with them.
- No HIV test, medical treatment, or research will be conducted without an informed consent. **Only an informed consent or a court order can reveal this information**.
- Establishments keeping records of information of HIV positive persons **shall adopt data protection measures**.
- Central and state governments shall take measures to –
  - Prevent the spread of HIV or AIDS by providing anti-retroviral therapy and infection management
  - Facilitate their access to welfare schemes especially for women and children
  - Formulate HIV or AIDS education communication programmes
  - Lay guidelines for the care and treatment of children with HIV or AIDS.
- An ombudsman shall be appointed by each state to inquire into complaints related to the violation of the Act. It shall submit a report to the state government every six months stating the number and nature of complaints received and the actions taken.
- A person between the age of 12 to 18 years who is mature in managing the affairs of his HIV or AIDS affected family shall be competent to act as a guardian of another sibling below 18 years of age.
- Every HIV infected or affected person below the age of 18 years has the right to reside in a shared household and enjoy the facilities of the household.
- Cases relating to HIV positive persons shall be disposed off by the court on a priority basis. The proceedings be conducted by suppressing the identity of the person and in camera.

**Steps taken by Government of India**

- Government launched a Central Sector Scheme - **National AIDS Control Programme (NACP)**.
- **India has successfully achieved the 6th Millennium Development Goal (MDG 6) of halting and reversing the HIV epidemic.**
- For preventing HIV/AIDS transmission from mother to child,
  - **Prevention from Parent to Child Transmission (PPTCT)** programme have been integrated with the RCH programme.
  - **PALS (PPTCT ART Linkages Software) System has also been launched** to maintain details of all HIV positive pregnant and breast feeding women and their newborn babies.
- Government would be implementing the **90:90:90 strategy as** adopted by UNAIDS.
- **HIV Sensitive social protection portal** has been launched to help officials and counselors.

**90:90:90 Strategy**
**It is a new HIV treatment that lays the groundwork to end the AIDS epidemic.**
- 90% of all people living with HIV will know their HIV status (90% diagnosed)
- 90% of all people with diagnosed HIV infection will receive sustained antiretroviral therapy (90% on HIV treatment)
- 90% of all people receiving antiretroviral therapy will have viral suppression (90% suppressed).

- India has **extended support to the African countries** in their fight against HIV-AID which reflects India's global commitment.

**Challenges in HIV Programme**

- **Capital**: Many developed countries have reduced their financial commitments to developing countries. They argue that with booming growth, India should become a donor itself.
- **Removing Stigma:** needs to be removed by community awareness.
- **Medicine stockpiles:** there have been instances of shortage of medicines related to HIV/AIDS. Eg. Children friendly Lopinavir Syrup production was stopped by CIPLA since government failed to clear its dues.

**Way Forward**

- With dearth of funding, India has started to integrate the HIV/AIDS programs into primary health missions.
  - For instance, 6 components of the NACP III were merged with NRHM in 2010 like Integrated Counselling and Testing Centres; prevention of parent-to-child transmission, Antiretroviral treatment etc.
- India has also started allocating more budgetary capital to fight HIV/AIDS.
- Centre and States would have to cooperate and set targets within specified timelines.
- A focus on injectable drug users also needs to increase to prevent the transmission of HIV/AIDS.

A streamlined process of procurement and storage of medicines related to HIV/AIDS. Eg. Tamil Nadu model of direct procurement from manufacturers prevents any leakages and also reduces drug prices.

## 7.6. TOBACCO FARMING

**Why in news?**

COP7 meet for WHO's Framework Convention on Tobacco Control (FCTC) was held in New Delhi recently, health authorities and Governments across the Southeast Asia region — and the world — explored how best they can support tobacco farmers as demand-targeted initiatives make their mark.

**WHO FRAMEWORK CONVENTION ON TOBACCO CONTROL (FCTC) 2003**

- WHO FCTC is the first global public health treaty in response to the globalization of the tobacco epidemic.
- It is **legally binding** to its members. **India has also ratified it.**
- Its recommends **demand side measures of tobacco control** like
  - ✓ **Price and tax measures** to reduce the demand for tobacco.
  - ✓ **Non-price measures** like Packaging and labelling of tobacco products; public awareness and Tobacco advertising etc.
- It also **gives some supply measures of tobacco control** like preventing illicit tobacco trade; control sales to minors etc.

**Background**

In the backdrop of declining demand for tobacco products among wealthier countries and measures to roll-back tobacco consumption in the developing world supporting the tobacco farmers and finding alternative livelihood has become necessary to secure their future.

**Steps that can be taken by the government and local authorities-**

- Providing training that gives the skills needed for tobacco farmers to diversify their crops and income, while also emphasising tobacco's harmful environmental and health outcomes for consumers and farmers.

- Industry strategies to promote tobacco farming must be identified and regulated and policies should be developed to protect tobacco growers and workers from industry practices that fix prices or create conditions that are disadvantageous.
- Raising awareness among tobacco farmers so that they can increase their autonomy, as well as creating a network of civil society organisations able to monitor industry malpractices.
- Appropriate research on market opportunities

- According to WHO**, tobacco-related diseases kill** about **2,500 Indians daily** and over 10 lakh Indians a year.
- It is estimated that about **5,500 youth and children (as young as eight years old) initiate tobacco**.
- **India has 12 crore tobacco users**, according to the **Global Adult Tobacco Survey**.
- The total direct and indirect cost of diseases attributable to tobacco use was Rs 1.04 lakh crore ($17 billion) in 2011 or 1.16 per cent of India's GDP.
- **India ranks 3rd globally among 205** countries with 85 per cent implementation of pictorial warnings on tobacco products pack.

**About Tobacco Farming in India**

- In India, Tobacco crop is grown in an area of 0.45 M ha (0.27% of the net cultivated area) producing ~ 750 M kg of tobacco leaf. India is the 2nd largest producer and exporter after China and Brazil respectively.
- In the global scenario, Indian tobacco accounts for 10% of the area and 9% of the total production.
- It is grown largely in semi-arid and rain-fed areas where the cultivation of alternative crops is economically unviable.
- The distinctive and positive features of Indian tobacco include the lower levels of heavy metals, very low levels of Tobacco Specific Nitrosamines (TSNAs) and pesticide residues compared to the other tobacco producing countries in the world.
- Further, endowed with varied agro-climatic conditions, India has the capacity to produce different styles of tobacco ranging from coloury neutral filler to flavourful leaf catering to the needs of a wide variety of customers globally.
- In addition, production and processing costs of tobacco are also quite low in India, thus making the Indian tobacco price-competitive and value for money.

## 7.7. E-CIGARETTES

**Why in News?**

- A study by University of California says that E-cigarettes are attracting a new population of adolescents who might not otherwise have smoked tobacco products.

**Background**

- Supreme Court has banned orally ingested tobacco products recently.
- Government has put high taxes on cigarettes.
- The above steps seem to have pushed the sale of e-cigarettes.

E-cigarette is a type of Electronic nicotine delivery systems (ENDS).

- It is a battery-powered device using electricity to vaporise a nicotine containing fluid.
- These do not have tar like conventional cigarettes.
- It resembles a cigarette by having a red LED to simulate the tip of a real cigarette.
- It also produces a bluish vapour that resembles cigarette smoke.
- It can be an **Electronic non-nicotine delivery system (ENNDS) too** where the liquid is not nicotine.
- The liquid here is dissolved into propylene glycol or/and glycerine to create an aerosol.
- WHO has termed both ENDS and ENNDS as **'vaping'** - a 'tobacco-free' version of the cigarette in which a liquid is inhaled through a vaporiser.

**Problems in E-cigarettes**

- There is no convincing evidence proving that e-cigarettes help quit smoking.
- With different flavours, it may promote 'nicotine addiction' by inducing habit of smoking in non-smokers.
- Some aerosols of the E-cigarettes have cancer causing agents like formaldehyde.
- Nicotine is considered to promote cardiovascular diseases. Nicotine may also affect the brain development in foetuses.

**India's Position**

- WHO Global Report 2015 says that number of smokers in India is on the decline.
- As e-cigarettes contain nicotine and not tobacco, these do not fall within the ambit of the COTPA Act 2003.
- Most e-commerce websites sell e-cigarettes as therapeutic products thus increasing appeal.
- A committee in 2014 recommended to ban e-cigarettes having nicotine. Only few states banned it.
- **Lack of a uniform approach enables the sellers to exploit loopholes**. E.g. Punjab has classified nicotine as a poison, while Maharashtra treats it as an unapproved drug.

**What needs to be done?**

- WHO Report on the Regulation on ENDS recommends -
  - ✓ prohibit the addition of flavours to ENDS
  - ✓ ban the use of ENDS indoors and in public places
  - ✓ restrict its advertising, promotion, and sponsorship
  - ✓ Regulations to stop ENDS promotion to non-smokers and protect existing tobacco control efforts.
- An independent scientific research is also needed to assess the benefits and risks of ENDS.

**Way Forward**

We have made remarkable progress in terms of tobacco control, but the increasing popularity of e-cigarettes threatens to undermine years of hard work. There is urgent need therefore to act now, to protect public health.

**Cigarettes and other Tobacco Products Act 2003**

- Section 5 prohibits all forms of advertisements (both direct and indirect) of tobacco products.
- This Act mandates health warnings on the packaging and advertisements of tobacco products.

## 7.8. NATIONAL E-HEALTH AUTHORITY

**Why in News?**

Recently the Government has announced the setting up a National eHealth Authority for the promotion of eHealth standards by the Ministry of Health and Family Welfare.

**A brief Background for setting up NeHA**

- **The National Knowledge Commission (NKC**) had recommended in 2008 formation of National Health Information Authority (NHIA) to support implementation on e-Health.
- **High Level Expert Group (HLEG**) set up by Planning Commission in the context of **12th Five Year (2012-2017)** had recommended HER adoption and setting up of a nationwide network to support the same.
- They had done so as part of recommending Universal Health Coverage.

- **'Digital India' Program** had been announced on August 2014 and a set of on-line Healthcare services are scheduled to be offered.

**About NeHA**

- It will be the **nodal authority** that will be responsible for development of an Integrated Health Information System (including Telemedicine and mHealth) in India.
- It will also be **responsible for enforcing the laws & regulations** relating to the privacy and security of the patients health information & records.
- NeHA will be setup through an appropriate legislation (Act of Parliament)
- The Chairman will be an eminent person in the field of Medicine, Public Health or Judiciary.

**Functions of NeHA**

- **To guide the adoption of e-Health solutions** at various levels and areas in a manner that meaningful aggregation of health and governance data and storage/exchange of electronic health records happens at various levels in a cost-effective manner.
- **To facilitate integration of multiple health** IT systems through health information exchanges.
- **To oversee orderly evolution of state wide** and nationwide Electronic Health Record Store/Exchange System that ensures security, confidentiality and privacy of patient data and continuity of care.
- **To engage with stakeholders** through various means so that eHealth plans are adopted and other policy, regulatory and legal provisions are implemented by both the public & private sector stakeholders
- **To promote setting up of state health records** repositories and health information exchanges.
- **To address the issues relating to privacy & confidentiality** of Patients' EHR in the legislation.

**Benefits by Digitalising Health data by setting up of NeHA**

- **Better manage care for patients by providing accurate**, up-to-date, and complete information about patients at the point of care;
- **Access patient records quickly** for more coordinated, efficient care;
- **Share electronic information securely** with patients and other clinicians;
- **Diagnose patients** more **effectively**, reduce medical errors and provide safer care;
- **Prescribe more reliably** and safer;
- **Improve productivity** and work-life balance; and
- **Reduced cost** through less paperwork, improved safety, reduced duplication of testing, improved health.

**The Way Forward**

- **India spends around 4.1% of GDP on health,** of which only about **1.1% is the contribution of the government.**
- With its rich demographic dividend, the importance of a robust healthcare system increase greatly.
- Initiatives like NeHA in the otherwise problem ridden healthcare sector in India can surely help in refining India's human development indicators.
- The necessary ingredients are all **present**: **A digital health Greenfield, robust telecom infrastructure, unique ID authentication, and a large talented pool of IT professionals. Utilising them may allow India to shape healthcare delivery globally.**

# 7.9. FOOD REGULATIONS

## 7.9.1. DRAFT REGULATIONS ON FORTIFICATION OF FOODS

**Why in News?**

- Food Safety and Standards Authority of India (FSSAI) issued draft regulations to allow food fortification in foods for public health benefit.

**FSSAI**

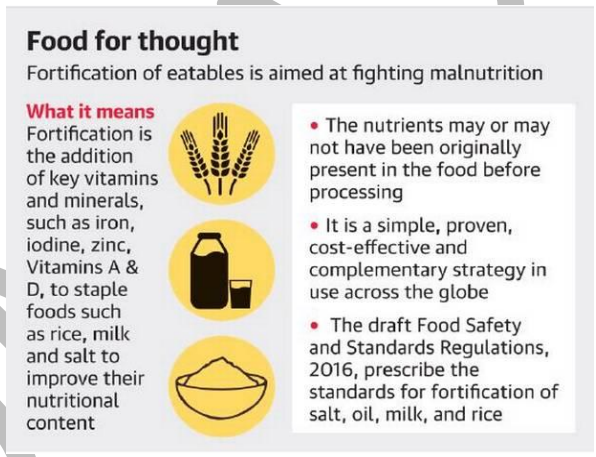
- It is a statutory body as per Food Safety and Standards Act 2006.
- It comes under the Ministry of Health and Family Welfare.
- Its aim is to establish a single reference point for all matters relating to food safety and standards.

**Need of the regulation**

- **Global Nutrition Reports** have repeatedly alarmed India over its stagnant malnutrition problems.
- To avoid malnutrition, one of the viable solutions is food fortification.

**Background**

- In 2016 a **Group of Secretaries on "Education & Health – Universal Access and Quality**" identified food fortification in items like salt, milk etc. with micronutrients to be completed in 3 years to address malnutrition in India.
- **National Summit on Fortification of Food** was held in New Delhi in 2016.
- In 2017, FSSAI also released the comprehensive draft regulations on food fortification.
- Recently the states of Rajasthan, Madhya Pradesh, Haryana and Himachal Pradesh governments have begun using fortified oil for their mid-day meal schemes.




**Issues Involved**

- It is **still not mandatory** to fortify food and is limited to only voluntary initiatives.
- There are **no fortification standards** to enhance the efficacy of the fortified food.

**About the regulation**

- These regulations prescribe standards for fortification of salt, oil, milk, vanaspati, atta, maida and rice.
- FSSAI **may make fortification of food mandatory** on Government of India (GOI) orders based on extent and severity of public health.
- It **defines both the minimum and the maximum threshold** of micronutrients to be added in food.
- **For quality assurance, the following steps are proposed** –
  - ✓ Certification required from a food laboratory notified by FSSAI.
  - ✓ Record keeping including the source of fortificant being procured.
  - ✓ Random testing of fortified food.
  - ✓ Regular audit of the processing stages.
  - ✓ Adoption of Good manufacturing practices as ordered by FSSAI.
- All fortified foods whether mandated or voluntary **should bear the fortification logo** and details of fortificant on its package.
- **FSSAI shall be responsible to encourage** the production, manufacture, distribution, sale and consumption of fortified food in ways like –

- ✓ Advising about fortified food in Government-funded programmes.
- ✓ Organizing public awareness, education and advocacy campaigns on fortified food.
- ✓ Conducting technical assistance programmes for small manufacturers in fortification.
- ✓ Encourage governments to give financial incentives like subsidies and loans for manufacturers and packers for food fortification.

- Provisions of the Infant Milk Substitutes, Feeding Bottles and Infant Foods Act 1992 would not be affected by the regulation.

**Significance of the regulation**

- The regulations provides for **specific role of FSSAI in promotion for food fortification**.
- It **allows mandating of food fortification** based on health severity as per scientific analysis.
- There would be a fortification logo for the first time which will **help raise consumer awareness**.
- It will **help solve the problem of hidden hunger** i.e. the absence of vital micronutrients in human body.
- It shifts focus from only food security towards **attaining a nutritional security**.

**Challenges**

- FSSAI **lacks in 3Fs** – Funds, Functionaries/Manpower and Functions. These loopholes have a potential to make the regulations a non-starter.
- The regulation **does not explicitly give the penalties** on not following its said provisions.
- It will **still not be mandatory for all essential foods** to fortify food.
- There is no mention of **Bio fortification** which has a better reach than conventional food fortification.

**Way Forward**

- A fortification initiative will combat high malnutrition, promote food processing industry and also improve customer satisfaction. Therefore the government must reform its institutional structure and its overall implementation to mainstream this key initiative.

## 7.9.2. FOOD ADULTERATION AND LAW COMMISSION RECOMMENDATIONS

**Ways to reduce adulteration**

**Why in news?**

- The Law Commission of India in its 264th report has recommended life imprisonment for traders, businessmen and shopkeepers found guilty of the death of their customers by intentionally selling them adulterated or "noxious" food and drink.
- A recent study on milk samples in Delhi found wide adulteration. In 2016 too, Union Minister for Science And Technology told the Lok Sabha that 68% of the milk sold did not conform to standards laid down by India's food regulator FSSAI (2012 report).

**Food Adulteration under the IPC**

- Indian Penal Code, 1860 (IPC) under sections 272 and 273 also provides for penal provisions with food adulteration.
- The food act provides for a maximum punishment of life imprisonment.
- In comparison to the Food Act, the IPC prescribes punishment of maximum 6 months of imprisonment or a fine of one thousand rupees or both.
- States like Odisha, Uttar Pradesh and West Bengal have brought in legislations to amend IPC to enhance the punishment to imprisonment for life and also the fine.

**What is Adulterated Food?**

A food item is said to be adulterated if:

- A substance which is added is injurious for human consumption.
- An inferior substance substitutes wholly or partly.

- A valuable ingredient has been abstracted from the food product, wholly or in part.
- Various types of adulterants found in the food products are as follows:

**Adulterants**

- Intentional adulterants; like coloring agents, starch, Pepperoil, injectable dyes and others.
- Incidental adulterants; like pesticide residues, larvae in foods, droppings of rodents.
- Metallic contaminants; like lead, arsenic, effluent from chemical industries etc.

**Why Food Legislation is necessary?**

- Increasing daily need and fast growing lifestyle have led to **ever growing food and food products markets** providing an opportunity for greedy people to make quick money by food adulteration.
- Most of the food adulterants are very harmful and toxic driving the citizens to **health hazards** that ultimately result in various ailments and even premature deaths.
- Food legislations are enacted to ensure that the acceptable minimum level of food safety is ensured; and the standards that secure such safety are strictly enforced.

**Common Milk Adulterants**

Most common harmful adulterants include **starch, chlorine, hydrated lime, sodium carbonate, formalin and ammonium sulphate.**

Milk producers use these to scrimp on milk portions and prepare "**synthetic milk**" by mixing **urea, caustic soda, refined oil and common detergents**.

**Impact of Adulteration**

Adulterated milk is linked to a range of health hazards including **food poisoning, gastrointestinal disorders, kidney failure and skin diseases, eye and heart problems, and cancer.**

Oxytocin used to increase the productivity of cows and buffalos triggers early puberty among girls, male breast etc.

**The Present Legal Framework and its Criticisms**

- Food Safety and Standards Act, 2006 (Food Act) was brought in to consolidate all previous existing food laws thus creating a single reference point for all matters relating to food safety and standards.
- It establishes an independent statutory authority- **Food Safety and Standards Authority** (Food Authority) which **has following functions**-
  - ✓ Laying down scientific standards for articles of food and
  - ✓ Regulating their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.
- The Food Authority along with the State Food Safety Authorities is responsible for monitoring and verifying the relevant requirements under the Act and its enforcement.
- The Act provides for the appointment of a Commissioner of Food Safety at state level and local Food Safety Officers for efficient implementation of food safety and standards under the Food Act.

**Recommendations of Law Commission**

- **Sections 272 and 273** of the IPC should be amended to bring the penal framework in it on par with the existing punishments scheme provided in the Food Act and the State Amendments to the Code.
- **The punishment should be graded with proportion to the harm caused** to the consumer due to consumption of adulterated food and drinks.
- IPC should be amended to **provide for life imprisonment** as maximum punishment in cases where food adulteration leads to death.

**Way Forward**

The IPC should be amended to provide for stricter punishment and increased fines so that it works as a deterrent for anti-social persons who indulge in food adulteration with the greed and profit motive.

## 7.10. NATIONAL VACCINE REGULATORY AUTHORITY

**Why in news?**

- WHO recently declared **Indian National Regulatory Authority** functional and awarded it highest rating 4 which means 100% compliance with the WHO benchmarking , good result with sustained improvement trend and stringent regulator of vaccine as per developed countries and European Union.

**What is NRA?**

- As Specified by WHO, NRAs are national regulatory agencies responsible for ensuring international standards of quality and safety in vaccine production either for export or for public distribution.
- It comprise of **Central drugs standard control organization**, **State Drug Regulatory Authorities, Pharmaco-vigilance Programme of India (PvPI) and Adverse Events Following Immunization (AEFI)** structures at the Central and States levels.

**Significance for India**

- It means that India has been classified as a stringent regulator of vaccines alongside developed countries such as the US, Japan and EU member states.
- It will boost Indian pharmaceutical companies to enter international markets and compete as drugs will be of international standards.
- It will also boost Make in India campaign by influx of investment and technology after improved global confidence in Indian medicinal product.
- India is major supplier of vaccine to UNICEF, the WHO and Pan American Health Organisation which in turn supplies it to more than 100 countries therefore it will open up opportunities to hitherto untapped markets and generate steady forex income.

**eVIN Project**

- eVIN is an indigenously developed technology system in India that digitises vaccine stocks and monitors the temperature of the cold chain through a smartphone application.
- The technological innovation is implemented by the United Nations Development Programme (UNDP).
- By streamlining the vaccine flow network, eVIN is a powerful contribution to strengthening health systems and ensures equity through easy and timely availability of vaccines to all children.

## 7.11. CORONARY STENT PRICE CAPPED

**Why in News?**

- National Pharmaceutical Pricing Authority (NPPA) capped coronary stents prices up to 40 per cent lower than their existing market rates.
- It is valid for all stents sold within India – whether domestic or imported.
- The National Pharmaceutical Pricing Authority has also started work on capping price for orthopaedic implants. As with cardiac stents, implants can have huge margins, ranging from 200% to 500%, making them very expensive for patients and insurers.

Student Notes:

**Background**

- In 2016, Coronary stents were included in the National List of Essential Medicines (2015).
- Later the Department of Pharmaceuticals incorporated coronary stents in Schedule I of the Drug Prices Control Order, 2013 making it a 'scheduled formulation'.

**What is a Stent?**

- It is a tube-shaped device which is inserted into a blocked blood vessel.
- It helps clear the blockage in arteries, sometimes through physical means (Bare Metal stents) and often through the drugs it gives out at a slow rate (Drug eluting stents).
- Thinner the stent, more sophisticated and expensive it is supposed to be.

**Need of price cap**

- Presently nearly **two-thirds of the high out-of-pocket expenditure on health incurred by Indians went towards drugs.**
- Lancent research has shown a rise in **irrational use of medical technologies**, including cardiac stents and knee implants.
- Indian stent market is about $500 million. It is expected to grow further due to rise in incidence of hypertension and diabetes.
- Coronary artery disease is becoming a major health problem in India. Therefore it has become the first medical device to be brought under price control.

**National List of Essential Medicines (NLEM)**

- As per the WHO, Essential Medicines are those that **satisfy the priority health care needs of the population.**
- **NLEM 2015** contains 376 medicines.
- Criteria for inclusion into this list includes public health emergency, cost effective medicine etc.
- Core Committee formed by the Ministry of Health reviews and revises the medicines in the NLEM.

**Significance of the order**

- This order would **reduce the 'unethical markups' in the prices** of the medical devices like stents making healthcare more affordable.
- NPPA report had found out that there **was a 'vulgar profiteering'** by raising the medical device prices in an irrational manner. This order would curb this practice.
- **Quality levels of the stent** may drop if the monitoring is not adequate.

**National Pharmaceutical Pricing Policy 2012**

- The criteria to fix the price ceiling of any commodity is calculated as the **simple average of all brands of that particular product that have a market share of at least 1 per cent.**

**Way Forward**

- There is a need of two pronged strategy to make medicines and medical devices affordable:
  - Government should **monitor expenditures** jointly in partnership with the community,
  - Government should also use regulation where needed, and raise public spending on health.
  - Promote generic medicines.
- Also district hospitals should expand the coverage of cardiac treatments pan India so that the order can benefit maximum population.

**National Pharmaceutical Pricing Authority**

- It is an independent body under Department of Pharmaceuticals under Ministry of Chemicals and Fertilizers.
- Its functions are:
  - To fix/ revise the controlled bulk drugs prices and formulations.
  - To enforce prices and availability of the medicines under the **Drugs (Prices Control) Order, 1995/2013**.
  - To **recover amounts overcharged by manufacturers** for the controlled drugs from the consumers.
  - To **monitor the prices of decontrolled drugs** in order to keep them at reasonable levels.

# 7.12. REGULATION OF DRUG SUPPLY AND PRICING

## 7.12.1. REGULATING ONLINE SALE OF MEDICINES

**Why in News?**

- A sub-committee constituted by Drugs Consultative Committee to examine online drugs sale has recently submitted its report.

**Drugs Consultative Committee**

- It is a statutory body under the Drugs and Cosmetics Act 1940 constituted by the Central government.
- It is advises central, state governments on uniformity of this act throughout India.
- It has representatives from central and state governments.
- It meets when required by the central government.
- It has the power to regulate its own procedure.

**Issues involved**

- Drugs and Cosmetics Act 1940 **lacks any guidelines for e-commerce players in the pharmaceutical industry**. However, 'scheduled' drugs should be sold only by licensed pharmacies against a doctor's prescription.
- **Easy access to online medicines may promote antimicrobial resistance.**
- Online pharmacies cannot be quality assured presently leading to drugs of dubious quality in the market.

**Recommendations of the sub-committee**

- Create a **National Portal** as a nodal platform to transact and monitor online drug sale.
- Evolve a mechanism to register e-pharmacies.
- There needs to be geographical restriction in the operation of e-pharmacies.
- Retail drug sale licenses can also be registered on National Portal to carry online drug sale.
- Certain drugs prone to misuse like Narcotics and Psychotropic drugs, tranquilizers etc. should be excluded from online sale.
- Offline and Online drugs sale will continue to be regulated with Drugs and Cosmetics rules 1945.

**Benefits of e-Pharmacy**

- The e-pharmacy model provides tracking and traceability of medicines.
- Addresses the problem of counterfeit medicines, consumption of drugs without prescription, tax loss.
- Provides value added services for consumer empowerment in healthcare, which are well aligned with the government's Digital India initiative.

**Limitations of online pharmacy**

- Unregulated selling of prescription drugs online promotes self-medication.
- Government revenue is also hit as e-commerce players escape the taxes equivalent to retail pharmacies.

**The Self-regulation Code of Conduct**

The Indian Internet Pharmacy Association under the ambit of FICCI recently announced the launch of self-regulation code of conduct for the e-pharmacy sector.

- E-pharmacy will process scheduled medicines only against a **valid copy of prescription** (physical or scanned) of a registered medical practitioner and ensure that no schedule X and other sensitive habit forming medicines are processed through their platform.

- They must make reasonable effort to ensure that all the pharmacy partners are duly registered under the Drugs and Cosmetics Act/ Rules.
- The player must make suitable arrangements to ensure that the medicines are packed, transported and delivered in such a way that their integrity, quality, and effectiveness are preserved
- e-pharmacy players must partner with government for any **recall of medicines** and collect adverse events of medicines (consumer reports) and comply to submit them to National Centre for Pharmacovigilance.
- The online pharmacy sector must ensure a proper mechanism to address any queries or grievances that the customer may have and an **ombudsman commission** be appointed to address any public grievance.

**Significance of self-regulation code**

- It will help in adhering to the highest professional standards and to have proper safeguards so as to ensure that consumer's health and safety is not compromised.
- By recognising and registering the legitimate e-pharmacies, government can easily address the challenges by maintaining sanctity of both IT Act and Drug and Cosmetic Act bringing effectiveness and efficiency in the entire system.
- Will help in overcoming the challenges of Accessibility, affordability and lack of awareness in e-Pharma sector for last mile access to medicines.

**Way Forward**

- Government has been promoting accessible and affordable generic medicine to prevent self-medication through online mode. It should also frame guidelines regarding the online sale of medicines.
- It should come up with an independent health regulator that has online sales also in its purview. It should also have punitive powers for those breaking the law.

## 7.12.2. ENSURING QUALITY OF DRUGS IN GOVERNMENT SUPPLY CHAIN

**Why in News?**

- According to a drug survey report published by the **Ministry of Health and Family Welfare**, more than 10 percent drugs in the government supply chain are **not of standard quality (NSQ).**

**More on the Survey**

- Survey of the **'Extent of Problems of Spurious and Not of Standard Quality Drugs'** was conducted by **National Institute of Biologicals (NIB), Noida.**
- The design of the survey included 224 drug molecules belonging to 15 different therapeutic categories of National List of Essential Medicines (2011).
- More than 47,000 drug samples were drawn from 36 states and UTs from retail outlets, government sources, airports and seaports.
- The survey found a total of 3.16% NSQ drugs while 0.0245% was found to be spurious in nature.
- The NSQ drugs were found to be higher percentage in drugs drawn from government sources than in retail outlets.

Student Notes:

**Way Forward**

- Stringent guidelines need to be put in place by the government procurement agencies for qualifying manufacturers.
- Each consignment must be checked from (National Accreditation Board for Testing and Calibration Laboratories) accredited laboratories.
- Government warehouses, medical store depots and pharmacies should have adequate storage facilities such as maintenance of required temperature, humidity, air conditioned spaces and refrigerators.
- Strict laws must be put in place to make manufacturers adhere to standard quality.

Student Notes:

# 8. SOME RECENT DEVELOPMENTS IN THE FIELD OF SCIENCE AND TECHNOLOGY

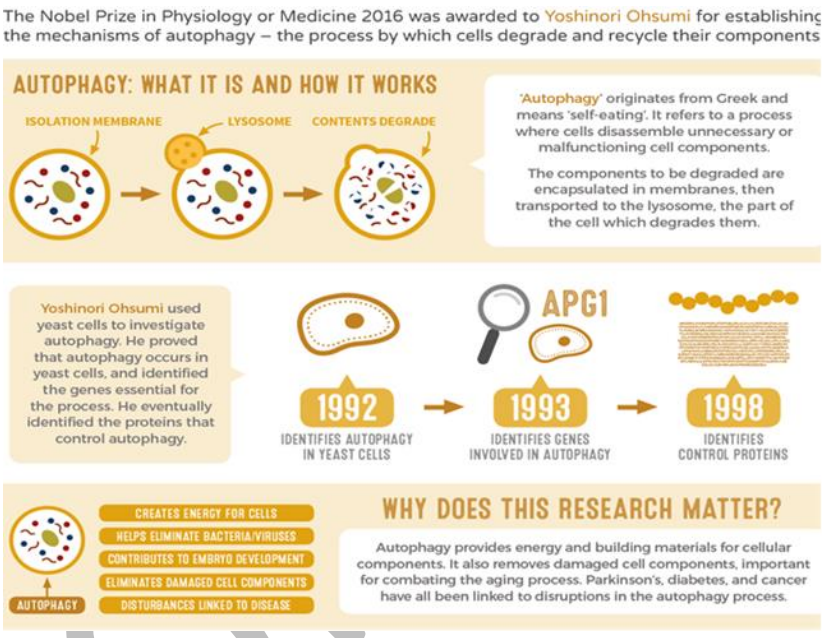
## 8.1. NOBEL PRIZE IN MEDICINE/PHYSIOLOGY

**Why in News?**

Yoshinori Ohsumi, a Japanese cell biologist was awarded the 2016 Nobel Prize in Physiology or Medicine for **"his discoveries of mechanisms for autophagy".**

**About Autophagy**

- Autophagy is a greek term for "self-eating".
- It is a fundamental process for degrading and recycling cellular components.
- This discovery of the mechanism of autophagy will aid in the fight against diseases such as cancer, Parkinson's disease and Alzheimer's.



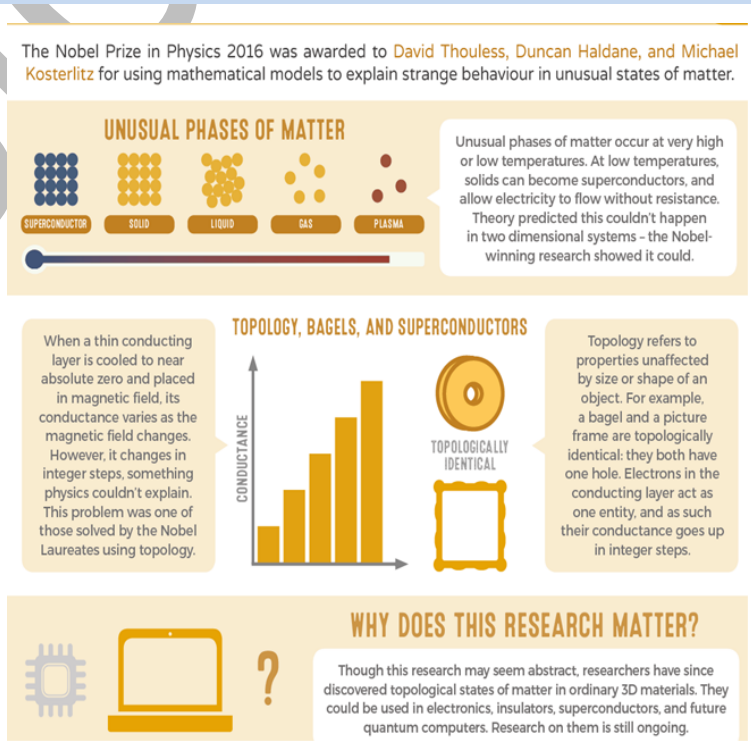

## 8.2. NOBEL PRIZE IN PHYSICS 2016

**Why in News?**

The Nobel Prize 2016 in Physics was awarded to David J. Thouless, F. Duncan M. Haldane and J. Michael Kosterlitz for **"theoretical discoveries of topological phase transitions and topological phases of matter."**

**What is it?**

- Topology refers to the study of geometrical properties and spatial relations unaffected by the continuous change of shape or size of figures.
- It is referred to as the modern version of geometry.



- The scientists studied different phases (such as solid, liquid and gas) of different materials. These phases were characterized using topology.

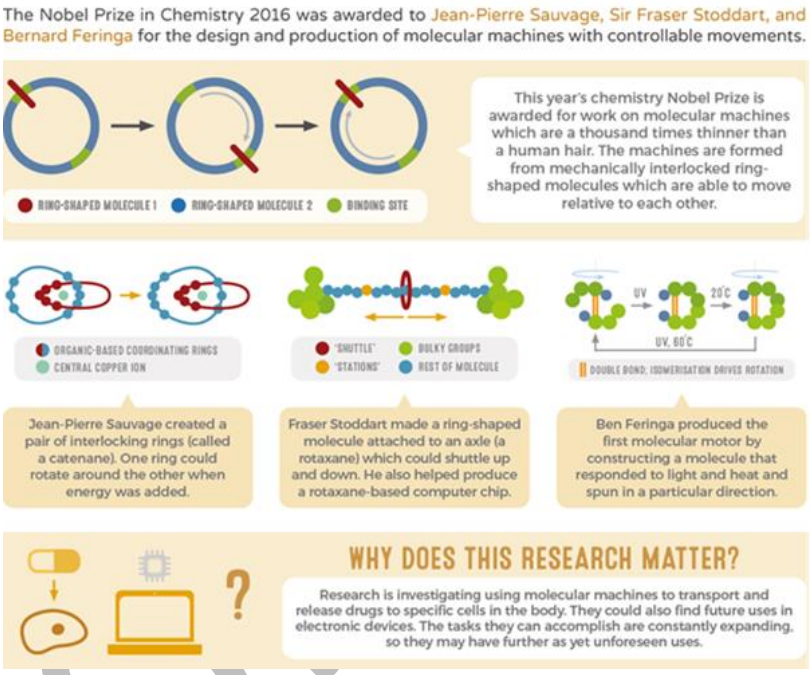
**Significance**

- The study is being applauded as the meeting point of topology and phase transitions.
- It will help make the study of phase transitions easier.

## 8.3. NOBEL PRIZE IN CHEMISTRY 2016

**Why in News?**

- The Nobel Prize in Chemistry 2016 was awarded to Frenchman Jean-Pierre Sauvage, British-born Fraser Stoddart and Dutch scientist Bernard "Ben" Feringa for **"developing miniscule machines at the molecular level."**




**Significance**

- These molecular machines with controllable movements can perform a task when energy is added.
- Machines will eventually prove to be invaluable - doing things no other machines can do.

## 8.4. HYPERLOOP TECHNOLOGY

**Why in News?**

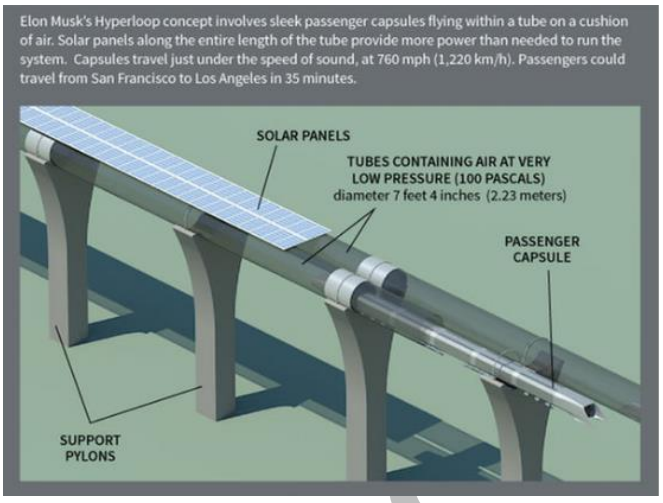
**Hyperloop**
- It was an idea of entrepreneur Elon Musk.
- It is a **system of magnetically levitating capsules** that are sent **at high speeds through low-pressure tubes**.
- It can have speeds even greater than commercial air travel.
- **Linear Induction motors** are used in it and control its speed.

- Recently two companies **Hyperloop Transportation Technologies (HTT) and Hyperloop One (HO)** have evinced interest to develop hyperloop technology in India by 2021.
- Hyperloop One Global Challenge selected 35 semi-finalist cities for developing hyperloop, 5 of them are in India.
- Presently such a system is being developed between Abu Dhabi and Dubai.

**Significance**

- It is a revolutionary mode of transport that has the **potential to reduce transport time of people and goods by more than 80%**.
- It has a **lower right of way problem** thus simplifying the land acquisition for this transport.
- It also has a lower carbon footprint apart from lowering noise pollution of public transport.
- It would also promote **Make in India programme** and manufacturing sector of India with technology transfer related to the hyperloop pods.

**Challenges**




- It requires heavy investments (about $100 million) and therefore private sector partnership is needed. Therefore **effective public and private sector coordination** is a prerequisite.
- It may prove to be **non-inclusive way of transport** as its cost of travel may be prohibitive for the economically marginalized people.
- **High-power consumption, accidents and technical challenges** have hampered its progress.

**Way forward**

- At a time when railway infrastructure is abysmal and the airline industry is priced, hyperloop only perceives to be a futuristic idea.
- Still with India being able to sustain a high growth rate for another decade, hyperloop may be a disruptive technology to promote India's future ambitions.

## 8.5. FAST NEUTRON REACTOR

**Why in News?**

- Russia has invited India to join it in developing the next generation nuclear reactors and to participate in its fast-reactor research project.
- The multipurpose fast reactor project, known by the Russian acronym MBIR, is coming up at the International Research Centre in Dimitrovgrad located in the Ulyanovsk region in Russia.

**What Are Fast Reactors?**

- A fast neutron reactor/fast reactor is a type of reactor in which nuclear fission chain reaction is sustained by fast neutrons.
- Such a reactor does not need any neutron moderator such as water which serves such a purpose in thermal reactors.
- Fast reactors are beneficial in the sense that it can help in the reprocessing and deactivation of radioactive waste material and produce energy as well.
- MBIR, the fast reactor project follows the closed fuel cycle.
- Transitioning to closed fuel cycle which is based on fast neutron reactors can solve five essential problems: safety, competitiveness, shortage of fuel, reprocessing and refabricating the used nuclear fuel and radioactive waste.
- It also addresses the non-proliferation of fission materials and weapon technologies.

**More on MBIR**

- The main purpose of the MBIR is to conduct large no. of reactor studies of Generation-4 nuclear systems.
- MBIR's design includes three independent loops that can be used to test different coolants like gas, lead, molten salt and others.

**Where Does India Stand?**

- The country is currently developing breeder reactors which will be fuelled by the country's vast thorium deposits.

- The Advanced Heavy Water Reactor (AHWR) is the latest Indian design for a next-generation nuclear reactor.
- Russia has also offered India a new breed of reactor units – the VVER-Toi (typical optimised, enhanced information design) for the third and fourth units of Kundakulam project in Tamil Nadu.

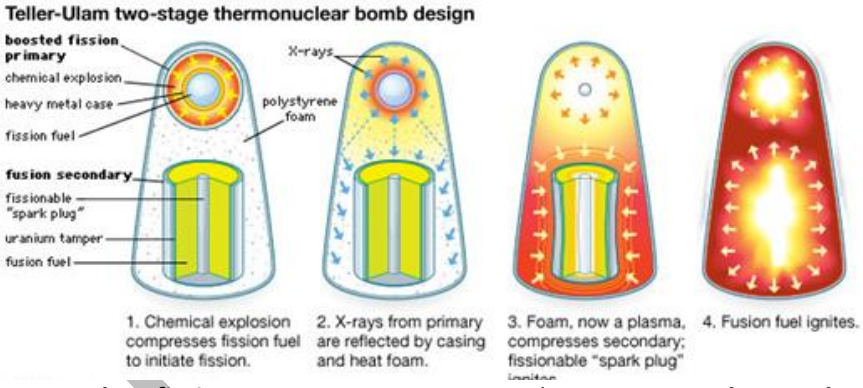
## 8.6. THERMOBARIC BOMB

Recently, the GBU-43 Massive Ordnance Air Blast (MOAB), popularly called the Mother of All Bombs, became the largest non-nuclear bomb ever to be dropped on a battlefield after the United States military used it against an ISIS target in Afghanistan's Nangarhar province.

**How is the MOAB different?**

- One, it packs in 8,000 kg of explosives — in comparison, the average weight of most deployed conventional bombs is roughly 250 kg.
- Two, it is a thermobaric weapon, which uses oxygen from the surrounding air to generate an intense, high-temperature blast wave that packs an incredible amount of energy into a small, localised area.
- In comparison, most conventional bombs consist of a mix of fuel and oxygen-generating substances. Thermobaric weapons consist of almost entirely 100% fuel, and rely on atmospheric oxygen.

**Hydrogen Bombs**




- Hydrogen bombs are thermonuclear weapons.
- A **thermonuclear weapon** is a nuclear weapon that uses the energy from a **primary nuclear fission** reaction to compress and ignite a **secondary nuclear fusion** reaction.
- The result is greatly increased explosive power when compared to single-stage fission weapons.
- It is colloquially referred to as a **hydrogen bomb** or **H-bomb** because it employs fusion of isotopes of hydrogen.

**Salient Features of Hydrogen Bomb:**

- A Hydrogen bomb is a much more powerful atomic weapon.
- The energy released in a Hydrogen bomb is several magnitudes higher than an Atom bomb.
- Hydrogen bombs use the fusion of hydrogen atoms, hence its name.
- A fusion bomb is more sophisticated and difficult to make, since it requires a much higher temperature -- in the order of millions of degrees centigrade. So a fission is carried out first to produce more energy, which is then used to initiate fusion. In a fusion bomb, a fission device has to be triggered first.
- It is easier to make Hydrogen bombs in small size, so it is easier to place them in missiles.
- Hiroshima and Nagasaki both were atomic bombs and till date Hydrogen bombs have never been used in war.

**Atomic Bombs**

- Atomic bombs differ from hydrogen bombs primarily due to the fact they are fission bombs. It develops its energy from the fission of heavy, unstable nuclei.
- Radioactive forms of elements such as plutonium and uranium are especially susceptible to fission.

## 8.7. BHARAT QR CODE

Bharat QR code has been developed jointly by National Payments Corporation of India (NPCI), Visa, MasterCard and American Express under instructions from Reserve Bank of India (RBI).

**QR code (Quick Response code)** is a two-dimensional (matrix) machine-readable bar code made up of black and white square. This code can be read by the camera of a smartphone.

- It is capable of 360 degrees (omni-directional), high speed reading.
- QR Code can store up to 7089 digits as compared to conventional bar codes which can store max 20 digits.
- It carries information both horizontally and vertically. It has error correction capability and data stored in it can be restored even if it is partially damaged or dirty.

It works as common interface for the MasterCard/Visa/ RuPay platforms and also facilitate acceptance of Aadhaar-enabled payments and Unified Payments Interface (UPI).

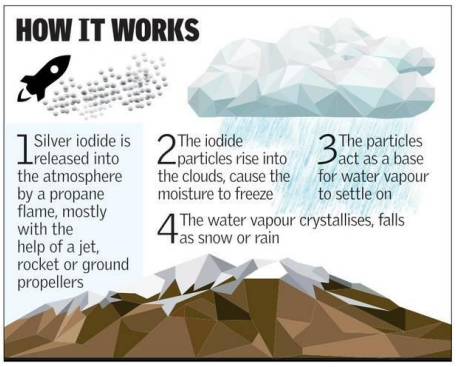
**Advantages**

- It eliminates the need of using card swiping machines for digital payments.
- Interoperability-Using BharatQR code, the merchants will be required to display only one QR code instead of multiple ones.
- It will also eliminate the uncertainty of entering a wrong amount as all a customer would have to do is scan and authenticate

## 8.8. CLOUD SEEDING

**Why in news?**

- Maharashtra government has decided to conduct **cloud seeding experiment** next three year to tackle the problem of frequent droughts in Vidarbha region.
- This programme will be coordinated by the **Indian Institute of Tropical Meteorology** and is part of larger experiment of **Earth Science Ministry** to understand how clouds and aerosols interact and influence climate.
- Karnataka government has also taken up cloud seeding experiment called Project Varshadhari.




**Cloud seeding**

- **Cloud seeding** also known as **weather modification** Technique, is an artificial way to induce moisture in the clouds so as to cause a rainfall. In this process either **silver iodide, potassium iodide** or **dry ice (solid carbon dioxide)** is dumped onto the clouds causing rainfall.

**Application of cloud seeding**

- This method can be used to cause significant amount of rainfall over a specified area especially in location where rain is badly needed.
- It can be developed as an effective tool to safeguard from the effect of vagaries of monsoon on agriculture as it is timely rain, rather than a lot of it, which is more important for crops.

- Timely and ambient rain results in maximum farm yield. Thus it helps in boosting local economy and feeding people.

**Concerns**

- Several experiments have been conducted across India to protect drought affected areas. However they were not very effective and gave mixed results.
- It is not fool proof as different type of clouds may exist over a region and same type of seeding may not be effective for all.
- Moreover seeded clouds may actually travel to another location and do not cause precipitation on the intended location questioning its effectiveness.
- There are environmental consequences like spreading of harmful chemicals in atmosphere.
- If not controlled properly, cloud seeding may result in undesirable weather conditions like flooding, storms, hail, etc.
- Lastly it is very expensive.

## 8.9. FLU GAS TECHNOLOGY

**Why in news?**

- Ministry of Environment Forest and Climate Change **(MoEFCC)** has decided to use **Flu-Gas Desulfurization** to reduce emissions from thermal power plants following new environmental notification.

**About**

- As per new notification by **MoEFC** emissions of pollutants namely Particulate matters need to be reduced by 65%; Oxides of nitrogen (NOx) by 70% and Sulphur dioxide by 85%.

**Flu-Gas Desulfurization (FGD) technology**

- Flue gas desulfurization (FGD) is a **set of technologies** used to remove **sulfur dioxide (SO2)** from exhaust flue gases of fossil-fuel power plants, as well as from the emissions of other sulfur oxide emitting processes.
- Common methods used to remove SO2 are: Wet scrubbing method, Spray-dry scrubbing method, Wet and Dry lime scrubbing method, SNOX method, Dry sorbent injection method, etc.
- For a typical coal-fired power station, **flue-gas desulfurization (FGD)** may remove 90 percent or more of the SO2 in the flue gases.
- Sulfur dioxide emissions are a primary contributor to **acid rain** and have been regulated by every industrialized nation in the world.

| | |
|---|---|
| **Centre for Science and Environment**<br>• It is a public interest research and advocacy organisation based in New Delhi.<br>• It researches into, lobbies for and communicates the urgency of development that is both sustainable and equitable. | **Flue Gases**<br>• It is a **mixture of gases** which is by produce by combustion of fuel and other materials in power stations and various industrial plants and released in the atmosphere via flu (ducts).<br>• It largely contains **oxides of nitrogen** derived from combustion of air, **carbon dioxide**, **carbon monoxide**, **water vapour**, **excess oxygen, sulphur oxides, particulate matter** like soot. |
| **Electrostatic Precipitators:** It is a filtration device that removes fine particles like particulate matter using electrostatic force by ionizing the passing gas.<br>**Retrofit Boiler** | |

## 8.10. AQUAPONIC FARM

**Why in news?**

In the backdrop of a huge demand for organic farming in the country and reports of high level of chemicals and toxic in the vegetables the concept of kitchen gardening has come up. One such initiative is Aquaponic in Gurugram Haryana.

Student Notes:

**What is it?**

Aquaponics, a technique that marries horticulture and aquaculture, helps the farmer raise fishes while he also grows plants.

**How does it work?**

- In aquaponics fish and plants are grown together in a tank. The tank has fishes in it and on the sides of the tank there are beds for plants. The water from the fish tank which is rich in nutrients due to the fish waste goes into the plants.
- The beds for supporting the plants can be made using material such as thermocol sheets or gravel.

**Significance**

- The setup cost of aquaponic farm might be higher than conventional farms, but the operational cost is much less
- There is no need for fertilizers and the water requirement is 90% less than that required in conventional farming.
- Suits greatly to the demand of organic fruits and vegetables
- The yield from aquaponics is two times higher than that of conventional farming.

However, there remains one restriction that fruits and vegetables which grow underground cannot be grown using aquaponics.