



SCIENCE & TECHNOLOGY

Classroom Study Material

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SCIENCE AND TECHNOLOGY

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1. BIOTECHNOLOGY

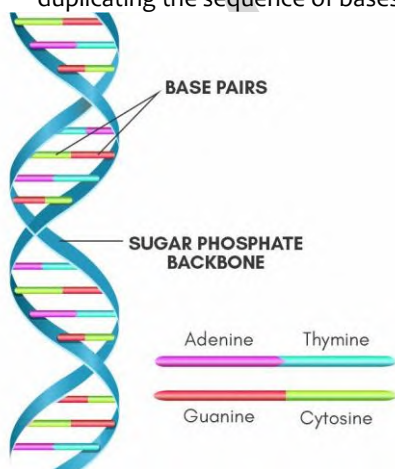
1.1. DNA TECHNOLOGY (USE & APPLICATION) REGULATION BILL

Why in news?

Recently, the **DNA Technology (Use and Application) Regulation Bill, 2019** was introduced in the Lok Sabha, which provides for the regulation of use of DNA technology for establishing the identity of certain persons.

What is DNA?

- DNA stands for **Deoxyribonucleic Acid**, a hereditary material in human and almost all the other organisms.
- Most DNA is located in the cell nucleus (called nuclear DNA) but some small amount of DNA can be found in Mitochondria (called mitochondrion DNA).
- It is composed of two chains, which coil around each other to form a **double helix** carrying the genetic instructions used in the growth.
- It is made up of **23 pairs of chromosomes** and provides instructions for building an entire organism and the proteins.
- The information in DNA is stored as a code made up of **four chemical bases**: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA consists of about 3 billion bases, and more than 99 percent of those bases are the same in all people.
- An important property of DNA is that **it can replicate**, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases.



Key Provisions of the Bill

- **Use of DNA Data:** DNA testing is allowed only in respect of matters listed in the Schedule to the Bill, such as-
 - Offences under the Indian Penal Code, 1860.
 - for civil matters such as paternity suits.

- for matters related to establishment of individual identity.
- **Collection of DNA:** the investigating authorities may collect bodily substances of persons.
 - **Requirement of consent for collection** in certain situations. For instance,
 - ✓ For arrested persons- Requirement of **written consent** if the offence carries a punishment of up to **seven years**. If the offence carries more than seven years of imprisonment or death, **consent is not required**.
- **DNA Data Bank- A National DNA Databank and regional DNA Databanks** will store DNA Profiles in a specified format.
- **Removal of DNA profiles:**
 - The Bill provides for removal of the DNA profiles of the following persons:
 - ✓ of a suspect if a police report is filed or court order given,
 - ✓ of an undertrial if a court order is given, and
 - ✓ on written request, for persons who are not a suspect, offender or undertrial, from the crime scene or missing persons' index.
- **Establishment of DNA Regulatory Board:** which will supervise the DNA Data Banks and DNA laboratories.
- **Penalties for various offences,** including disclosure of DNA information or using DNA sample without authorization have been provided.

1.2. NATIONAL GUIDELINES FOR GENE THERAPY

Why in News?

Indian Council of Medical Research (ICMR) published "**National Guidelines for Gene Therapy-Product Development and Clinical Trials**".

Gene Therapy Product (GTP)

- It is defined as any **biological entity, having the required gene, that could introduce modifications** in the genome for therapeutic benefit.
- GTPs work by **repairing, replacing or deactivating** dysfunctional disease-causing genes aiming to restore normal function.
- GTPs include:
 - **Recombinant viral vectors:** adenovirus, retrovirus
 - **Non-viral vectors:** naked DNA transfection



- **Microbial/bacterial vectors** (Salmonella, E. coli): recombinant bacteria derived vehicles
- Modifications resulting from the use of **CRISPR** and other similar technologies
- **ex vivo genetically modified cells**: gene modified/ augmented stem cells, iPS (induced pluripotent stem) cells, CAR-T cells etc.
- **Soluble/particulate/emulsion/Nano based interventions** containing any form of genetic material/ nucleic acid for the purpose of clinical gene therapy
- **DNA vaccines** where the final product is nucleic acid and is administered for vaccination/ therapy.

As per the New Drugs and Clinical trial Rules (2019) the GTPs falls under 'new drug' and shall always be deemed to be 'new drug'.

About Gene Therapy

- It refers to the process of **introduction, removal or change** in content of an individual's genetic material with the goal of treating the disease and a possibility of achieving long term cure.
- It is classified into 2 types:
 - **Germ-line gene therapy**: The concept of germ-line gene therapy is to introduce gene modified cells into the germline, that can be **transmitted vertically across generations**. Germline gene therapy is prohibited in India, due to ethical and social considerations.
 - **Somatic cell gene therapy**: It affects the **targeted cells/tissue/organs in the patient**, and is not passed on to subsequent generations. It is legal in India. This also includes genome modification as done in CRISPR-related and other technologies. It has two categories:
 - ✓ **ex vivo**- cells obtained from an individual are genetically **modified/corrected outside the body** followed by transplantation into the same or a different individual.
 - ✓ **in vivo**- the gene of interest is delivered directly to target cells/ tissues/organs (like liver, pancreas, muscle, heart etc.) in the patients. Gene delivery can be carried out by viral or non- viral vector systems.
- Due to complexity and unpredictability of human diseases and need for ethical framework to prevent the misuse of gene therapy these **Guidelines becomes necessary**.
 - Around **70 million Indians** are estimated to suffer from **inherited genetic diseases**. These include blood disorders such as

haemophilia, thalassemia, sickle-cell anaemia etc.

Key guidelines

- **Applicability**: The guidelines apply to **all stakeholders** in the field of gene therapy including researchers, clinicians, regulatory committees, industry, patient support groups etc.
- **General Principles**: Clinical trials on human participants involving GTPs must safeguard **human rights, safety and dignity**. Various principles like Principle of Essentiality, Voluntariness, Non-exploitation, Risk Minimization etc. need to be followed.
- **Mechanism for Review and Oversight**:
 - Proposed establishment of **Gene Therapy Advisory and Evaluation Committee (GTAEC)**- an independent body with experts from diverse areas of biomedical research, government agencies and other stakeholders.
 - It is mandatory for all institutions and entities engaged in development of GTPs to establish an **Institutional Bio-safety committee (IBSC)**.
 - Research involving development of new GTPs needs to obtain approvals from IBSC and Ethics Committee (EC). Biological material from humans can be procured only from clinics/hospitals that have an **Ethics Committee**.
 - All clinical trials are mandated to be registered with **Clinical Trials Registry-India (CTRI)**. It is an online public record system for registration of clinical trials being conducted in India.
- **Responsibilities of various stakeholders**
 - Investigators should treat the biological material with **utmost respect and adequate care** to avoid its misuse.
 - Storage and disposal of the GTPs or its components should be as per the Regulations and Guidelines on **Bio-safety of Recombinant DNA Research and Bio-containment 2017**.
 - Any GTP of foreign origin or its modified variants that will be first in human use is not permissible for direct first in human trials in India.
 - Investigators should demonstrate **respect for autonomy and privacy of patients**.
- **Good Manufacturing Practice (GMP) Guidelines**:
 - It includes Personnel Training, establishment of quality control processes.



- Waste materials and by-products of the GTP manufacturing process must be securely decontaminated and transported as per appropriate biohazard disposal protocol.

Some important terms

- **Gene:** It is a sequence of nucleotides in DNA or RNA. Some genes act as instructions to make products like RNA or proteins.
- **Genome:** It is the entire DNA, or sequence of genes, in a cell. Simply put, the genome is divided into chromosomes, chromosomes contain genes, and genes are made of DNA.
 - Each genome has approximately 3.2 billion DNA base pairs.
- **Germline:** Inherited genetic material that comes from the eggs or sperm and is passed on to offspring.
- **Genome mapping/sequencing:** It means deciphering the exact order of base pairs in an individual. The way these base pairs are arranged, or variations and mutations in their pattern, can provide clues about the individual's health or ill health, inherited or acquired.
 - It figures out the **order of DNA nucleotides, or bases**, in a genome, i.e. the order of Adenine, Cytosine, Guanines, and Thymine that make up an organism's DNA.
- **Genotype:** Pattern of genes in an organism's DNA that is responsible for a particular trait
- **Phenotype:** It refers to the observable physical properties of an organism. These include the organism's appearance, development, and behaviour.
- **Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR):** It is the DNA-targeting part of the system which consists of an RNA molecule, or 'guide', designed to bind to specific DNA bases through complementary base-pairing.
 - CRISPR-associated nucleases (Cas9) is the nuclease part that cuts the DNA.
 - **Lulu and Nana** are the world's first gene-edited human babies using CRISPR gene editing.
- **Stem cells:** They are special human cells that have the ability to develop into many different cell types, from muscle cells to brain cells.
- **Somatic cells:** They are any body cells that are not involved in reproduction. Most cells in body are somatic cells. They include skin cells, bone cells, red blood cells, and many more.
- **Germ cells:** They are cells that create reproductive cells called **gametes**. They are found only in the **reproductive glands (ovaries in females and testes in males.)**
- **Retrovirus:** It is family of viruses with RNA as genetic material that can integrate their genome into the DNA of host cells, they invade.
- **Transgene:** It is a genetic material that is artificially introduced into the genome of another organism.

Next Generation Sequencing (NSG) facility

- Recently, govt inaugurated the NSG facility at the Centre for Cellular and Molecular Biology in Hyderabad.

- NGS technologies are different from the Sanger method (Whole Genome Sequencing) in that they **provide massively parallel analysis**, extremely high-throughput from multiple samples at much reduced cost

- The NSG would help **prenatal genetic screening and counselling**, thereby generating large scale genomic data critical for diagnosis and therapy.

Recreated Escherichia coli (E coli)

- Scientists have created **the world's first living organism that has a fully synthetic and radically altered DNA code** by replacing the genes of E. coli bacteria with genomes synthesized in the lab.
 - E coli is a strain of bacteria which is normally found in soil and the human gut and it survives on a smaller set of genetic instructions.

1.3. MANAV: HUMAN ATLAS INITIATIVE

Why in news?

Department of Biotechnology (DBT) recently launched **MANAV: Human Atlas Initiative**.

Details

- **MANAV Project** aims to create an open and interactive atlas of human biology, compiling, curating and synthesizing data at the molecular, cellular, tissue and organismic level from scientific literature and public databases.
- For the first time, Indian scientists will be **mapping every single tissue** of the human body to have deeper understanding of the roles of tissues and cells linked to various diseases.
- **Participating institutes** include National Centre for Cell Science (NCCS) and Indian Institute of Science, Education and Research (IISER), Pune. Besides, Persistent Systems Limited has co-funded the project (alongwith DBT) and is developing the platform.
- The project can be signed up by **students** who are in their **final year graduation and above**. Even participants having a science background but not necessarily involved in active scientific research can be part of this network.
- It will be helpful in Physiological and molecular mapping, Drug discovery, customise and personalize medicine, Skill development of student community and Future research.
 - It will help to understand and capture the human physiology in two stages – in a **normal stage and while in a disease stage**. Such a database on individual tissues will be helpful in tracing the causes of a disease, understanding specific pathways etc.

Related News

UMMID (Unique Methods of Management and treatment of Inherited Disorders)

- Recently, Government launched **UMMID initiative**.
- It aims to **create awareness about genetic disorders amongst clinicians and establish molecular diagnostics in hospitals** so that the benefits of developments in medical genetics could reach patients.
- It is supported by **Department of Biotechnology**
- Three components of UMMID initiative
 - To **establish NIDAN (National Inherited Diseases Administration) Kendras** (Diagnostic Centre)-provide counselling, prenatal testing and diagnosis, management, and multidisciplinary care in Government Hospital.
 - To produce **skilled clinicians** in Human Genetics, and
 - To undertake **screening of pregnant women and new born babies** for inherited genetic diseases in hospitals at aspirational districts.

1.4. GENOME INDIA PROJECT

Why in news?

Union government has given clearance to an ambitious gene mapping project known as the **Genome India Project** with an estimated worth of Rs 238 crores.

About the project

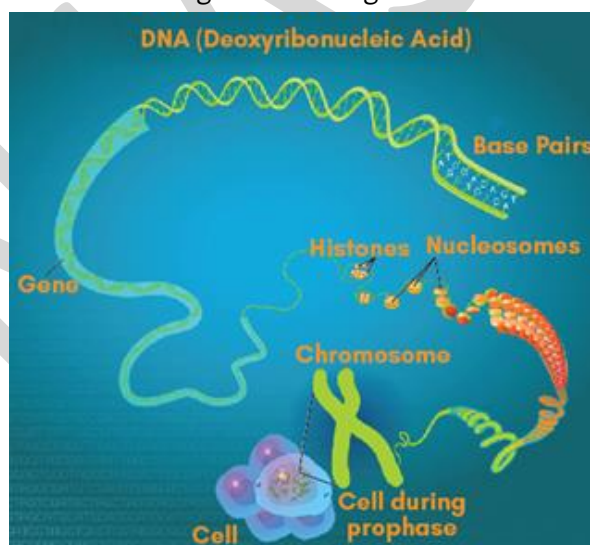
- The project has been cleared by **Department of Biotechnology** (under the Ministry of Science and Technology).
- It is in line with Budget Speech which proposed to initiate two new national level Science Schemes to map India's genetic landscape to create a comprehensive database.
- It involves **20 leading institutions including the Indian Institute of Science** in Bengaluru and a few IITs.
- The **Centre for Brain Research**, an autonomous institute of **IISc, Bengaluru** will serve as the nodal point of the project.
- The first stage of the project will look at samples of **10,000 persons from all over the country to form a grid** that will enable the development of a Reference Genome.
- As a precursor to this project, **Council of Scientific and Industrial Research (CSIR)** last year concluded a six-month exercise of conducting a "whole-genome sequence" of a **1,008 Indians under "IndiGen" programme**.

Significance of the project

- Existing global genetic studies of the **Human Genome Project** are based mainly on **Caucasian**; urban middle class samples (95%),

which are not considered representative of all humans.

- The project will help **India develop indigenous capacity to generate, maintain, analyze**, utilize and communicate large-scale genome data, in a scalable manner.
- This will help to **understand the type and nature of diseases** and traits that comprise the diverse Indian population and will help to develop precision medicine.
- It would **further improve scientific understanding of evolution** both from a biological (intra- and inter-species interaction, species-ecology interactions, etc.) and sociological (migration patterns, rituals, etc.) point of view
- **Predictive and Preventive Healthcare**- The outcomes of the project will help in faster and efficient diagnosis of rare genetic diseases.



1.5. GM CROPS

Why in News?

Recently, Genetic Engineering Appraisal Committee (GEAC) asked Maharashtra Government to initiate action to stop cultivation of illegal Herbicide-Tolerant variety of Bt Cotton (Ht-bt cotton).

About GM crops

- A **GM crop** has a gene artificially inserted into it from another species to give it some desired properties like – pest resistance, herbicide-tolerance, drought resistance etc.
- **Currently, only GM crop permitted for cultivation in India is Bt Cotton**. But several cases of **cultivation of illegal GM crops (Brinjal, Soyabean etc)** have been reported from across states in the last few months.



- There is a well established **regulatory framework** for approval of GM Crops as per “Rules for the Manufacture/Use/Import/Export and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells, 1989” under the **Environment (Protection) Act, 1986**.
- **Ht-bt cotton**
 - Currently, only GM cotton permitted to be grown in India are hybrids/varieties that contain ‘**cry1Ac**’ and ‘**cry2Ab**’ genes, isolated from the soil bacterium **Bacillus thuringiensis (Bt)** and coding for proteins **toxic to bollworm insect** pests.
 - **Ht-Bt Cotton/ BG Cotton – III**, involves the addition of another gene, ‘**Cp4-Epsps**’ from another soil bacterium, **Agrobacterium tumefaciens**.
 - Ht-Bt cotton can tolerate Glyphosate, a herbicide variety, whose action **kill only the weeds (Pink Bollworm)**, not the crop.
 - In India, Glyphosate is registered for use on tea and non-crop area.

About Genetic Engineering Appraisal Committee (GEAC)

- GEAC established under Ministry of Environment, Forest and Climate Change is the apex body for **approval of activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production from the environmental angle**.
- The GEAC is also responsible for **approval of proposals relating to release of genetically engineered organisms** and products into the environment including experimental field trials.

1.5.1. GOLDEN RICE

Why in news?

The International Rice Research Institute along with its partners has successfully cultivated Golden Rice in a controlled environment on IRRI campus.

Vitamin A deficiency

- Vitamin A deficiency generally occurs due to an imbalanced diet including limited access to fresh fruit, vegetables and animal products.
- Persistent deficiency in this vital nutrient can result in blindness, illness and even death.
- Vitamin A deficiency also compromises the immune system, which means children die from common diseases including diarrhea, respiratory tract infections and measles.

What is golden rice?

- Golden rice is the collective name of **rice varieties that are genetically modified to counter vitamin A deficiency** in developing countries.
- European scientists developed the first strain of Golden Rice towards the end of the 1990s.
- Golden rice differs from standard rice in that it contains **extra genes one from maize and one from bacterial origin** together responsible for the **production of provitamin A (beta-carotene)** in the rice grain.
 - Provitamin A colors the grains yellow-orange, hence the name ‘Golden Rice’.
 - Once absorbed into the body, provitamin A is converted into vitamin A.
 - Provitamin A is found in many fruits and vegetables; it is also what makes carrots orange, for example.
- Research has indicated that one cup of Golden Rice can provide up to 50 per cent of the daily requirement of an adult for vitamin A.
- The Golden Rice can be grown just the same way we grow normal rice. There is no change in cost of cultivation.
- It reduces water use by up to 30 per cent without any yield loss.
- It **should not be stored for more than three months**. It may lose its nutrients after that.

International Rice Research Institute

- It is an independent, nonprofit, research and educational institute, founded in 1960 by the Ford and Rockefeller foundations with support from the Philippine government.
- The institute, headquartered in Los Baños, Philippines, has offices in 17 rice-growing countries in Asia and Africa. Its regional centre was opened recently in Vanarasi.
- It is dedicated to reducing poverty and hunger through rice science; improving the health and welfare of rice farmers and consumers; and protecting the rice-growing environment for future generations.
- IRRI is a member of the CGIAR Consortium, a global research partnership committed to a food-secure future

Related information

Muktoshri (IET 21845)

- It is a **commercialised rice variety** that is resistant to arsenic.
- It was developed jointly by West Bengal’s Agriculture Department and National Botanical Research Institute, Lucknow.

2. SPACE TECHNOLOGY

2.1. ISRO

2.1.1. GAGANYAAN

Why in News?

Recently, **Gaganyaan National Advisory Council** has been created with members from different institutions and industries.

About Gaganyaan Advisory Council

- It comprises of multiple senior officials like Secretaries of Department of Space & Department of Science and Technology, Principal Scientific Advisor to PM, Former Chairman of ISRO, Directors of Premier Academic and Research Institutions, Heads of various Indian Industries etc.
- It discusses **overall project status of Gaganyaan**, covering technical details as well as collaboration with various national stake holders.
- It stresses **the need for setting priorities at various National Institutions including Industries to accomplish Gaganyaan.**

Background

- An Indian manned mission to space was **first mooted in 2004**.
- The Gaganyaan programme, an indigenous mission that would take Indian astronauts to space, was **announced in 2018**.
- Over the years, the **Indian Space Research Organisation** has developed and tested a number of technologies that are critical to a human space flight. These include a **Space Capsule Recovery Experiment (SRE-2007)**, **Crew module Atmospheric Reentry Experiment (CARE-2014)**, **GSLV Mk-III (2014)**, **Reusable Launch Vehicle- Technology Demonstrator (RLV-TD)**, **Crew Escape System and Pad Abort Test**. ISRO also recently unveiled a space capsule (crew module) and Space suit prototype.
- ISRO has signed a pact with the **Russian firm Glavkosmos** to select and train astronauts for the country's Gaganyaan project.
- ISRO will receive assistance from the **French space agency CNES**, in terms of expertise various fields including space medicine, astronaut health monitoring, radiation protection and life support.

About Gaganyaan Mission

- It is a **crewed orbital spacecraft** which is expected to carry three people into the space for seven days.

- With this, India could potentially **become the fourth country to send a man to space**, after the erstwhile USSR, the US and China.
- The total programme is **expected to be complete before 2022**.
- ISRO also plans **two unmanned Gaganyaan flights** — by December 2020 and in July 2021 — before undertaking the manned mission by December 2021.
- **GSLV Mk III**, the three-stage heavy lift launch vehicle, will be **used to launch Gaganyaan** as it has the necessary payload capability.
- The spacecraft is expected to be placed in a **low earth orbit of 300-400 km**. Within 16 minutes of taking off, the crew will be in space, where they will **remain for five-seven days**. The return journey is expected to take 36 minutes.
- Gaganyaan would be **smaller in size** than the current Russian Soyuz, Chinese Shenzhou, NASA's planned Orion spacecraft
- While formal agreements are not yet in place, **ISRO will collaborate with the Indian Air Force** and its Institute of Aerospace Medicine, Bengaluru, to train astronauts.
 - The astronauts on the human space mission 'Gaganyaan' are **IAF pilots whose training is going in Russia**.
- This project will help in
 - **Enhancement of science and technology levels in the country and space diplomacy**
 - **Contribution to economy and Inspiring youth**
 - **Development of technology for social benefits**

Related News

Vyomamitra

- ISRO will send **Vyomamitra** in the unmanned Gaganyaan spacecraft.
- **Vyomamitra** (vyoma-space, mitra-friend) is an artificial intelligence-based robotic system (half-humanoid) to mimic crew activity inside the crew module of Gaganyaan.
- It has been developed by **scientists at IISc in collaboration with ISRO**.

Human Space Flight Centre (HSFC)

- It was inaugurated in January 2019 under ISRO to coordinate Indian Human Spaceflight Programme (HSP) and will be **responsible for the implementation of Gaganyaan project**.
- It will be involved in all the end-to-end mission planning, development of engineering systems for crew survival in space, crew selection and training and also pursue activities for sustained human space flight missions.



- HSFC will take support of the existing ISRO Centres to implement the first development flight of Gaganyaan under HSP.
- Currently, HSP work is split across various centres such as the **Vikram Sarabhai Space Centre** in Thiruvananthapuram and the **U.R. Rao Satellite Centre** in Bengaluru.
- Recently, ISRO has proposed a **consolidated HSFC**, which will be established at **Challakere, Karnataka**. It will help India in the long run as currently India has to pay large sums of money for training and using such facilities in foreign countries.

Satellite-Launch Vehicles Developed By ISRO Polar Satellite Launch Vehicle (PSLV)

- It is designed mainly to deliver the “**earth-observation**” or “**remote sensing**” satellites with lift-off mass of up to about 1750 Kg to Sun-Synchronous circular polar orbits of 600-900 Km altitude.
- PSLV is a **four-staged launch vehicle** with alternating solid and liquid stages.
- It is the **third generation launch vehicle of India** and the first Indian launch vehicle to be equipped with liquid stages.

Geosynchronous Satellite Launch Vehicle (GSLV)

- GSLV is designed mainly to **deliver the communication satellites** to the highly elliptical (typically 250 x 36000 Km) Geosynchronous Transfer Orbit (GTO).
- Two versions of the GSLV:
 - **GSLV Mk-II:** It is a three stage vehicle with four liquid strap-ons. First stage using solid rocket motor, second stage using Liquid fuel and Cryogenic Upper Stage (CUS) forms the third stage of GSLV Mk II. It has the capability to launch satellites of lift-off mass of up to **2,500 kg to the GTO and satellites of up to 5,000 kg** lift-off mass to the LEO (low earth orbit).
 - **GSLV MK-III:** It is a three stage vehicle with an **indigenous cryogenic upper stage engine (C25)** with two solid fuel strap-on engines in the first stage, a liquid propellant core as second stage. It has been designed to carry heavier communication satellites weighing up to **4000 kg into the Geosynchronous Transfer Orbit** or satellites weighing about 10,000 kg to a Low Earth Orbit (LEO).
 - ✓ The indigenous cryogenic C25 engine helps to keep fuel loads on the rocket relatively low.
 - ✓ India is among six nations — apart from the US, Russia, France, Japan and China — to possess cryogenic engine technology.

Small Satellite Launch Vehicle (SSLV)

- It is a launch vehicle developed by ISRO with payload capacity of **500 kg to Low Earth orbit or**

300 kg to Sun synchronous orbit for launching small satellites.

- It was developed with the aim of launching small satellites commercially at drastically reduced price and higher launch rate as compared to PSLV.
- Designed by **ISRO’s Vikram Sarabhai Space Centre**, it can accommodate multiple satellites, albeit smaller ones.
- Unlike the PSLV and GSLV, the **SSLV can be assembled both vertically and horizontally**.
- The first three stages of the vehicle will use solid propellant, with a fourth stage being a **velocity-trimming module**.

2.1.2. CHANDRAYAAN 2

Why in news?

ISRO launched Chandrayaan-2 mission to the Moon in July, but its lander failed to reach the lunar surface.

About mission

- Chandrayaan-2, a completely indigenous mission, is India’s **second lunar exploration mission** which the following basic components-
 - **Orbiter-** will observe the lunar surface and relay communication between Earth and Chandrayaan 2’s Lander.
 - **Lander (called Vikram)-** designed to execute India’s first soft landing on the lunar surface.
 - **Rover (called Pragyan)-** a 6-wheeled, AI-powered vehicle, which will move on the lunar surface and perform on-site chemical analysis.
- **Launcher-** It was launched by Geosynchronous Satellite Launch Vehicle GSLV MkIII-M1. It is India’s most powerful launcher to date, and has been completely designed and fabricated from within the country.
- **Some notable features of Chandrayaan 2 Mission-**
 - 1st space mission to conduct a soft landing on the **Moon’s south polar region**.
 - 1st Indian expedition to attempt a soft landing on the lunar surface with home-grown technology.
 - 1st Indian mission to explore the lunar terrain with home-grown technology.
 - 4th country ever to soft land on the lunar surface after the United States, the U.S.S.R. and China.
- **Primary Objective:** To demonstrate the ability to soft-land on the lunar surface and operate a robotic rover on the surface. It seeks to
 - foster a new age of discovery,

- increase our understanding of space,
- stimulate the advancement of technology,
- promote global alliances,
- inspire a future generation of explorers and scientists.

Scientific Objectives of Chandrayaan 2

- Moon provides the **best linkage to Earth's early history**.
 - It offers an undisturbed historical record of the inner Solar system environment.
- Evidence for water molecules discovered by Chandrayaan-1, **requires further studies** on the extent of water molecule distribution on the Moon.
- It will also **study new rock types** with unique chemical composition.

Why explore the Lunar South Pole?

- The lunar surface area remains in shadow, which is much larger than that at the North Pole. There is a possibility of the presence of water in permanently shadowed areas around it.
- In addition, South Pole region has **craters that are cold traps and contain a fossil record** of the early Solar System.
- Its **regolith has traces** of hydrogen, ammonia, methane, sodium, mercury and silver- making it an untapped source of essential resources.
- Its elemental and positional advantages make it a suitable pit stop for future space exploration.

Related News

Chandrayan-1

- Chandrayan-1 was launched by India in October, 2009 using PSLV-C11.
- **Primary Objective:** To prepare a three-dimensional atlas of both near and far side of the moon and chemical, mineralogical and photo-geological mapping of moon.
- **Findings of Chandrayan-1**
 - **Detection of Water** – Major finding was the detection of Water (H₂O) and Hydroxyl (OH) on the surface of the moon. The data revealed its presence in abundance around the polar region.
 - **Magma Ocean Hypothesis** – It confirmed the Ocean Magma Hypothesis i.e. the moon was once completely in molten state.
 - **New Spinel-rich Rock** – Data from Chandrayaan-1 have led to detection of new spinel-rich rock type on lunar far-side.
 - **X-Ray signals detected**– It detected x-ray signals during weak solar flares thus indicating presence of magnesium, aluminium, silicon and calcium on lunar surface.

Chandrayaan-3

- **Chandrayaan-3**, the country's third lunar mission, has been approved.
- It will have a **lander, rover, and a propulsion module** and will likely attempt another soft-landing on the lunar surface.
- The mission, which will cost around Rs 600 crore, will also try to land **in the lunar south pole** like Chandrayaan-2.

Spectroscopy

- Recently, Indian Space Research Organisation (ISRO) released an image from Chandrayaan-2 showing measurements from the Moon, carried out by the instrument **Imaging Infrared Spectrometer (IIRS)**.
- **Spectroscopy** is the technique of splitting light (or more precisely electromagnetic radiation) into its constituent wavelengths (a spectrum). For instance, splitting of white light into its constituent colours by prism.
- A **spectrometer** is the instrument used to separate and measure spectral components of a physical phenomenon.
- From the reflected solar spectrum, scientists will look for signatures, including of minerals. This will help map the lunar surface composition, which in turn will help **us understand the Moon's origin and evolution in a geologic context**.

Mission Payloads

Orbiter payloads-

- Terrain Mapping Camera-2 (TMC-2),
- Chandrayaan-2 Large Area Soft X-ray Spectrometer (CLASS),
- Solar X-ray monitor (XSM),
- Orbiter High Resolution camera (OHRC)
- Dual Frequency L and S band Synthetic Aperture Radar (DFSAR),
- Imaging IR Spectrometer (IIRS),
- Chandrayaan-2 Atmospheric Compositional Explorer 2 (ChACE-2),
- Dual Frequency Radio Science (DFRS) experiment.

Vikram payloads

- Radio Anatomy of Moon Bound Hypersensitive Ionosphere and Atmosphere (RAMBHA),
- Chandra's Surface Thermo-physical Experiment (ChaSTE),
- Instrument for Lunar Seismic Activity (ILSA)

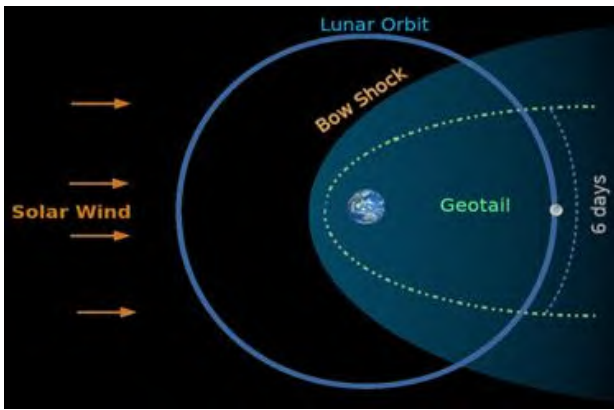
Pragyan payloads

- Alpha Particle Induced X-ray Spectroscope (APXS),
- Laser induced Breakdown Spectroscope (LIBS)
- **Passive Experiment-** Laser Retroreflector array (LRA)

2.1.3. GEOTAIL

Why in news?

Recently Chandrayaan-2 had detected charged particles in Moon's soil during the orbiter's passage through the "geotail".



More on news

- CLASS (Chandrayaan 2 Large Area Soft X-ray Spectrometer), is an instrument on Chandrayaan-2, designed to detect signatures of elements in the Moon's soil.
- The Moon's soil can be best observed when a solar flare provides a rich source of X-rays to illuminate the surface. This happens when Moon traverses through geotail.
- Once every 29 days, the Moon traverses the geotail for about six days.

What is geotail and how is it formed?

- The Sun emits the solar wind, which is a continuous stream of charged particles (like electrons, protons, alpha particles etc). These particles are present in the upper atmosphere of the Sun, called the Corona.
- Since the Earth has a magnetic field, it obstructs this solar wind plasma.
- This interaction results in the formation of a magnetic envelope around Earth called magnetosphere. (see figure).
- On the Earth side facing the Sun, this magnetosphere is compressed into a region that is approximately three to four times the Earth radius.
- On the opposite side, the envelope is stretched into a long tail, which extends beyond the orbit of the Moon. It is this that is called the geotail.

2.1.4. NAVIC

Why in news?

Global standards body 3GPP, which develops protocols for mobile telephony, has approved India's regional navigation system NavIC.

Details

- The specification approval will boost commercial use of NavIC by international and domestic mobile device makers.

- The manufacturers can now mass-produce navigation devices compatible with NavIC so that users of these devices can easily access NavIC signals.
- Acceptance of NavIC by 3GPP would also bring NavIC technology to the commercial market for its use in 4G, 5G and Internet of Things (IOT).
- Indian Companies and Startups will have an opportunity to develop Integrated circuits and products based on NavIC.

IRNSS

INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM

IRNSS (NavIC) is designed to provide accurate real-time positioning and timing services to users in India as well as region extending up to 1,500 km from its boundary

NAVIGATION CONSTELLATION CONSISTS OF SEVEN SATELLITES:

3 in geostationary earth orbit (GEO) and **4** in geosynchronous orbit (GSO) inclined at 29 degrees to equator
Each sat has three rubidium atomic clocks, which provide accurate locational data

IT WILL PROVIDE TWO TYPES OF SERVICES

- 1 Standard positioning service** | Meant for all users
- 2 Restricted service** | Encrypted service provided only to authorised users (military and security agencies)

Applications of IRNSS are: Terrestrial, area and marine navigation; disaster management; vehicle tracking and fleet management; precise timing mapping and geodetic data capture; terrestrial navigation aid for hikers and travellers; visual and voice navigation for drivers

While American GPS has 24 satellites in orbit, the number of sats visible to ground receiver is limited. In IRNSS, four satellites are always in geosynchronous orbits, hence always visible to receiver in a region 1,500 km around India

About 3rd Generation Partnership Project (3GPP)

- The 3rd Generation Partnership Project (3GPP) unites 7 telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).
- The project covers cellular telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system description for mobile telecommunications.

- 3GPP currently has global navigation satellite system support from BDS (Chinese), Galileo (European), GLONASS (Russia) and GPS (USA) for cellular positioning systems.

Related News

NAVIC as allied system of US

- Recently, the US congress has agreed to designate India's NavIC as its allied navigational satellite system **along with Galileo of European Union and QZSS of Japan.**
- Also, US **designated Russia's GLONASS and Chinese Beidou as a "non-allied system"**. It means that US satellite navigation system will not co-operate or exchange data with these satellite navigation systems.
- The designation of India's NAVIC as an "allied system" is part of the American effort to develop a **prototype program for Multi-Global Navigation Satellite System (GNSS) receiver development.**
 - A Multi-GNSS receiver is the system able to calculate position, velocity and time by receiving the satellite signals broadcasted from multiple navigation satellite systems.
 - It helps to achieve high position accuracy with increased number of satellites compared to GPS-only positioning.

2.1.5. GSAT-30

Why in News?

Recently, GSAT 30 was launched successfully

Details

- India's **telecommunication satellite GSAT-30**, weighing 3357 kg, was successfully launched into a Geosynchronous Transfer Orbit (GTO) from Kourou launch base, French Guiana **by launch vehicle Ariane-5 VA-251.**
 - ISRO hired a **foreign launcher as it plans to save GSLV-Mk III** (with capacity of 4000Kg) for its upcoming first human space flight Gaganyaan and two preceding crew-less trials.
- GSAT-30 is to serve as **replacement to INSAT-4A services with enhanced coverage.**
 - **INSAT-4A** was launched in 2005 which is used by cable operators to broadcast their programmes abroad.
- The satellite provides Indian mainland and islands coverage in Ku-band and extended coverage in C-band covering Gulf countries, a large number of Asian countries and Australia.
- **It will provide** DTH Television Services, Digital Satellite News Gathering (DSNG), e-governance applications, etc.

- The satellite will also be used for bulk data transfer for a host of emerging telecommunication applications.
- India's communication satellites system includes Indian National Satellite (INSAT) series (e.g. INSAT-4B, INSAT-4CR etc.) and GSAT series (e.g. GSAT-6,7, 8 etc.).

2.1.6. GEMINI

Why in news?

Recently, the Government of India has launched the **Gagan Enabled Mariner's Instrument for Navigation and Information (GEMINI)** device, a satellite-based advisory service for deep-sea fishermen.

GAGAN

- It stands for GPS Aided GEO Augmented Navigation.
- **Developed by-** Airports Authority of India (AAI) and Indian Space Research Organization (ISRO).
- It is a system to improve the accuracy of a global navigation satellite system (GNSS) receiver by providing reference signals.
- It is the first in the world, which has been certified for approach with vertical guidance operating in the equatorial ionospheric region.
- It consists of **three geosynchronous satellites** (GSAT-8, GSAT-10 and GSAT-15), and covers the entire Indian Ocean round the clock. It covers the entire area from **Australia to Africa.**
- Recently, Real-time Train Information System (RTIS) has been developed by the Centre for Railway Information Systems (CIRE) which helps to monitor precise speeds and movement throughout the journey and uses GAGAN to transmit signal.

More about GEMINI

- It has been developed to **disseminate seamless and effective emergency information and communication on disaster warnings**, Potential Fishing Zones (PFZ) and Ocean States Forecasts (OSF) to fishermen.
- It has been developed by the **Indian National Centre for Ocean Information Services (INCOIS)**, an autonomous body under the Ministry of Earth Sciences (MoES) and **Airports Authority of India (AAI).**
- This device receives and transfers the data received from GAGAN satellites to a mobile through bluetooth communication.
- This is in consonance with an effort to achieve **Blue Revolution.** The **Meena Kumari Committee** had recommended optimum utilization of the Exclusive Economic Zone (EEZ)— sea between 22 and 370 km from the coast.

Related Information

- The government of India has also launched **PFZ forecasts**, newly developed by INCOIS, which will provide advisories on Potential Fishing Zones to fishermen **3 days in advance**.
- Currently, satellite based potential fishing zone advisories are made available by Indian National Centre for Ocean Information Services (INCOIS) on daily basis in local language to the fishing community.
- The PFZ advisories help in increased fish catch (2-5 times) and reducing searching time (about 30-70%), which leads to savings towards cost of fuel.

2.1.7. INDIAN DATA RELAY SATELLITE SYSTEM (IDRSS)**Why in News?**

India plans for its own **space-to-space tracking and communication** of its space assets this year by putting up a new satellite series called **Indian Data Relay Satellite System (IDRSS)**.

About IDRSS

- A **set of 2 IDRSS satellites** will be placed in **geostationary orbit**, enabling satellite to satellite communication and transfer of data.
- It will track, send and receive real-time information from other Indian satellites, in particular those in low-earth orbits (LEO) which have limited coverage of earth.
- It **will also be useful in monitoring launches** and benefitting **crew members of the Gaganyaan mission** ensuring mission control throughout their travel.
- It is also significant for space docking, space station, as well as distant expeditions to moon, Mars and Venus.
- It will also **reduce the dependence on the ground stations** in tracking satellites.
- First satellite will be launched by 2020 end and second one by 2021.
- India will join US, China, Japan and Europe who already have such DRS systems.

2.1.8. CARTOSAT-3**Why in news?**

ISRO successfully launched **Cartosat-3 and 13 commercial nanosatellites** from Satish Dhawan Space Centre (SDSC), Sriharikota.

About Cartosat 3

- Cartosat-3 satellite is a third-generation agile advanced satellite having high resolution imaging capability.
- The mission life of the Cartosat-3 is 5 years.

- It will be followed by additional satellites of the same design, namely Cartosat-3A and 3B, next year.
- **Orbit Type:** Sun synchronous polar orbit (SSPO) at altitude of 509 km.
 - **SSPO** are polar orbits which are synchronous with the Sun i.e. in these orbits, Earth's surface is always illuminated by the Sun at the same angle when viewed from the satellite.
- Launch Vehicle: **PSLV-C47**
- It was navigated for the first time using the indigenous **Vikram processor** designed by the ISRO and fabricated within the country.
 - The Vikram Processor is to be used for rocket's navigation, guidance and control and also for general processing applications.

Applications

- It will address the increased user's demands for large scale urban planning, rural resource and infrastructure development, coastal land use and land cover etc.
- It also has uses in **Disaster Management Support Programmes** like Cyclone and Floods Mapping & Monitoring, Landslide Mapping & Monitoring, Agricultural Drought, Forest Fire, Earthquakes etc.
- It is expected to help in **military reconnaissance** and mapping.

Related Information**Cartosat satellites**

- Cartosat satellites are **earth observation satellites**, used mainly for large-scale mapping of the Earth through **high-resolution cameras**.
- They help to detect changes in natural geographical or man-made features.

Previous launches in Cartosat series

- **CARTOSAT-1**, launched in 2005, was the first Indian Remote Sensing Satellite capable of providing in-orbit stereo images.
- **Cartosat-2** was launched in 2007, and increases the imaging resolution to one meter.
- It was followed by six more spacecraft designated **Cartosat-2A to 2F**, which are believed to be primarily used for military reconnaissance.

Other satellites launched alongside Cartosat - 3

- 13 Commercial Nanosatellites from USA were also successfully injected into designated orbit.
- These include 12 SuperDove earth observation satellites named "**Flock-4P**", and a communication test bed satellite called "**MESHBED**".
- These satellites were launched under commercial arrangement with **NewSpace India Limited (NSIL)**, the commercial arm of Indian Space Research Organisation (ISRO).

2.1.9. RISAT-2BR1

Why in News?

Polar Satellite Launch Vehicle (PSLV) marked its **'Golden Jubilee' launch** by injecting India's advanced radar imaging satellite RISAT-2BR1 and 9 other customer satellites into their intended orbits on board **PLSV-C48** from Sriharikota.

About RISAT-2BR1

- RISAT-2BR1 is the **second radar imaging satellite** in the **RISAT-2B series** and along with the **CARTOSAT-3** is part of a group of satellites that will **boost India's earth imaging capabilities from space**.
- RISAT-2BR1 has a **powerful resolution** allowing two objects separated by **35-centimetre distance** to be distinctly identified and will cover a swathe of **5 to 10 kilometres**.
- The RISAT satellites are equipped with a **Synthetic Aperture Radar (SAR)** that can take pictures of the earth during day and night and also under cloudy conditions.
- The satellite will help in agriculture, mining, forestry and coastal management, soil monitoring, disaster management support and **round the clock border surveillance**.
- The satellite has a **mission life** of five years.
- In the past decade, ISRO has launched two satellites in the **RISAT series**, beginning in 2009 with the Israeli-built **RISAT 2**, and the second one, **RISAT 1**, in 2012. The RISAT 1 is no longer operational.
 - Risat-2 is a military satellite which was fast tracked after the Mumbai terrorist incident to boost surveillance capabilities of security forces.

2.1.10. NEWSPACE INDIA

- Recently, the Indian Space Research Organisation (ISRO), inaugurated its commercial arm **NewSpace India Limited (NSIL), in Bengaluru**.
- It was incorporated for **commercially utilising research and development activities** carried out by ISRO with an authorised share capital of Rs 100 crore and initial paid up capital of Rs 10 crore.
- Main objectives of NSIL:**
 - To scale up industry participation in Indian space programmes as it will act as an aggregator for all space related activities in industry and develop private entrepreneurship in space related technologies.
 - Manufacturing and production of **Small Satellite Launch Vehicle (SSLV)** and **Polar Satellite Launch Vehicle (PSLV)** through technology transfer mechanisms.
 - Cater to emerging global commercial SSLV market demand by providing satellite building and satellite-based services, including **supply of sub-systems** for various domestic and international application needs.

Related information

Antrix

- Antrix is the commercial arm of ISRO headquartered in Bangalore. It promotes and commercially markets the products and services emanating from the Indian Space Programme.
- In the year 2008, the Company was awarded 'MINIRATNA' status

2.1.11. OTHER ISRO MISSIONS

Aditya-L1 mission	<ul style="list-style-type: none"> Aditya-L1 is an important mission planned for 2021, to study the solar corona. The spacecraft will be placed in a halo orbit around the Sun-Earth Lagrangian point (L1), about 1.5 million km from the Earth. It is ISRO's first scientific expedition to study Sun to be launched early next year. It is a 400 kg-class satellite, that will be launched using the Polar Satellite Launch Vehicle. It will have 7 payloads on board to study Sun's corona, solar emissions, solar winds and flares, and Coronal Mass Ejections, and will carry out round-the-clock imaging of Sun.
Astrosat	<ul style="list-style-type: none"> Astrosat, the first Indian multi-wavelength space observatory which completed four years in orbit in Sept 2019. It enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite. It is seen as a smaller version of NASA's Hubble Space Telescope. It has 5 payloads which includes: <ul style="list-style-type: none"> Ultraviolet Imaging Telescope (UVIT) Large Area X-ray Proportional Counter (LAXPC) Soft X-ray Telescope (SXT) Cadmium Zinc Telluride Imager (CZTI)

	<ul style="list-style-type: none"> ○ Scanning Sky Monitor (SSM)
Geo Imaging Satellite (GISAT-1)	<ul style="list-style-type: none"> ● It is planned Indian earth observing satellite to facilitate continuous observation of Indian sub-continent, quick monitoring of natural hazards and disaster. ● It will be the first of two planned Indian Earth Observatory spacecraft to be placed in a geostationary orbit of around 36,000 km.
XPoSat	<ul style="list-style-type: none"> ● X-ray Polarimeter Satellite, is a planned dedicated mission to study polarisation. ● The spacecraft will carry Polarimeter Instrument in X-rays (POLIX) payload which will study the degree and angle of polarisation of bright X-ray sources in the energy range 5-30 keV. ● The satellite has a mission life of five years and will be placed in circular 500-700km orbit ● It will study neutron stars, supernova remnants, pulsars and regions around black holes.
Other planetary missions	<ul style="list-style-type: none"> ● Shukrayaan 1 is venusian mission is a planned orbiter to Venus to study the surface and atmosphere of the Venus. ● Mangalyaan-2 is India's 2nd interplanetary mission planned for launch to Mars.
NISAR	<ul style="list-style-type: none"> ● NASA-ISRO Synthetic Aperture Radar (Nisar) is a joint project between NASA & ISRO. ● It is the 1st dual band radar imaging satellite. ● NISAR will provide a means of resolving highly spatial and temporally complex processes ranging from ecosystem disturbances, to ice sheet collapse and natural hazards including earthquakes, tsunamis, volcanoes, and landslides. ● NISAR is a dual frequency L-band and S- band radar mission, that will map Earth every 12 days from two directions.
UNISPACE Nanosatellite Assembly & Training (UNNATI) programme	<ul style="list-style-type: none"> ● ISRO launched a capacity building programme on Nanosatellite development named UNNATI. ● It is an initiative to commemorate the 50th anniversary of the first United Nations conference on the exploration and peaceful uses of outer space (UNISPACE+50). ● It would provide opportunities to the participating developing countries to strengthen in assembling, integrating and testing of Nanosatellite.
Space Technology Cells (STCs)	<ul style="list-style-type: none"> ● ISRO has set up 5 Space Technology Cells (STCs) at Indian Institute of Technologies (IITs) - Bombay, Kanpur, Kharagpur & Madras; Indian Institute of Science (IISc), Bengaluru and Joint Research Programme with Savitribai Phule Pune University (SPPU, Pune) to carry out research activities in the areas of space technology and applications. ● IIT Delhi is also going to set up an STC in collaboration with ISRO. ● ISRO desires development of high- end technology in collaboration with IITs in the areas of Space Science, Space Technology and Space Applications. ISRO would fund the identified projects.

2.2. NASA

InSight mission	<ul style="list-style-type: none"> ● Recently, NASA InSight mission detected quakes and magnetic pulses on the planet Mars. ● Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight), is the first mission dedicated to looking deep beneath the Martian surface. ● It is part of NASA's Discovery Program. ● It is embedded with seismometer for detecting quakes, sensors for gauging wind and air pressure, magnetometer and heat flow probe designed to take the planet's temperature. ● Recent finding <ul style="list-style-type: none"> ○ Mars does not have tectonic plates like Earth, but it does have volcanically active regions, one of which is Cerberus Fossae, that can cause rumbles.
Voyager-2	<ul style="list-style-type: none"> ● Recently, the NASA fixed a glitch in its Voyager-2 probe. ● Like Voyager 1, Voyager 2 was designed to find and study the edge of our solar system. ● It is the only spacecraft to study all four of the solar system's giant planets- Jupiter, Saturn, Uranus and Neptune at close range. ● Voyager 2 is 11.5 billion miles from the Earth and, at that distance, light takes 17 hours to reach it or for messages from it to reach mission control on Earth. ● Voyager gets its power from a radioisotope thermoelectric generator (RTG) which turns heat from the decay of a radioactive material into electricity. ● It officially entered 'interstellar space' in November 2018. It joined its twin—Voyager 1—as the only human-made objects to enter the space between the stars. <ul style="list-style-type: none"> ○ This space between the stars is dominated by the plasma that was ejected by the death of nearby giant stars millions of years ago. ○ The sun sends out a constant flow of charged particles called the solar wind, which ultimately travels past all the planets to some three times the distance to Pluto before being impeded by the interstellar medium. ○ This forms a giant bubble around the sun and its planets, known as the heliosphere.



	<ul style="list-style-type: none"> It was the first human-made object to fly past Uranus in 1986 and Neptune in 1989, making it the only spacecraft to have had a close look of the icy planets.
Methane on Mars Surface	<ul style="list-style-type: none"> NASA's Curiosity rover recently measured the highest level of methane gas ever found in the atmosphere at Mars's surface. The reading taken at Gale Crater is three times greater than the previous record. Presence of methane on Mars is tracked because its presence could be a sign of life. On Earth, most methane is produced by living things, although the gas can also come from geological sources such as chemical reactions involving rocks.
Dragon Fly Mission	<ul style="list-style-type: none"> NASA has planned a Dragon Fly Mission to Titan, the largest moon of Saturn planet. Dragonfly was selected as part of the agency's New Frontiers program, aimed at understanding how chemistry gave way to biology. <ul style="list-style-type: none"> Program also includes the New Horizons mission to Pluto and the Kuiper Belt, Juno Mission to Jupiter, and OSIRIS-Rex Mission to the asteroid Bennu. About Titan: It's the second-largest moon in the solar system (even larger than mercury). <ul style="list-style-type: none"> Its atmosphere is mostly made of nitrogen, like Earth's. Its landscape is dominated by sand dunes and waterways composed of hydrocarbons – liquid methane and ethane. Its surface is composed of water ice, frozen as hard as rock. Previous Mission to Saturn: Cassini Mission was launched through collaboration between NASA, ESA and the Italian space agency to study Saturn and its system of rings and moons. It was the first spacecraft to orbit Saturn.
Artemis Lunar Program	<ul style="list-style-type: none"> NASA recently unveiled the calendar for the "Artemis" program that will return astronauts to the Moon for the first time in half a century including the first woman astronaut to moon.
PUNCH mission	<ul style="list-style-type: none"> Polarimeter to Unify the Corona and Heliosphere (PUNCH) will image regions beyond the Sun's outer corona. It is expected to be launched in 2022. It is focused on understanding the transition of particles from the Sun's outer corona to the solar wind that fills interplanetary space. Other missions such as NASA's Parker Solar Probe and the ESA-NASA joint project, Solar Orbiter, which is due to be launched in 2020, can study the structures of the Sun's atmosphere. The PUNCH mission enhances these by tracking these structures in real time.
SnowEx	<ul style="list-style-type: none"> It is a five-year program launched in 2016-17 by NASA to understand how much water is contained in each winter's snowfall and how much will be available when it melts in spring.
Spitzer Space Telescope	<ul style="list-style-type: none"> It is a space-borne observatory, one of the elements of NASA's Great Observatories Program that includes Hubble Space Telescope, Chandra X-Ray and Compton Gamma-Ray Observatory. It is designed to detect infrared radiation and was able to reveal cooler objects in space, like failed stars (brown dwarfs), extrasolar planets, and organic molecules that may hold the secret to life on other planets. It will come to an end since it is low on fuel and has been drifting away from Earth for a few years now
Starliner	<ul style="list-style-type: none"> It is a space capsule built to ferry astronauts to the International Space Station. The capsule has been built by Boeing and launched by NASA.
SOLar Orbiter mission (SOLO)	<ul style="list-style-type: none"> It is a collaborative mission between European Space Agency and NASA dedicated to solar and heliospheric physics. It will study about the development of planets and the emergence of life, how the Solar System works, the origins of the Universe, and the fundamental physics at work in the Universe.
NASA Selects Four Possible Missions to Study the Secrets of the Solar System	<ul style="list-style-type: none"> Four missions are: <ul style="list-style-type: none"> DAVINCI+: Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging Plus- To analyse Venus atmosphere. IVO: Io Volcano Observer is a proposal to explore Jupiter's moon Io. TRIDENT: To explore Neptune's icy moon, Triton. VERITAS: Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy- To map Venus's surface. They're not official missions yet and some ultimately may not be chosen to move forward.

2.3. OTHER SPACE MISSIONS

Raavana-1	<ul style="list-style-type: none"> Sri Lanka's first satellite 'Raavana-1', designed and developed indigenously, was successfully launched into orbit from the international Space Station. It is a Cube satellite (type of Nano satellite), deployed using the Japanese Aerospace and Exploration owned Kibo experiment module.
Spektr-RG	<ul style="list-style-type: none"> Recently, Russia launched an all-sky-survey satellite, Spektr-RG.

	<ul style="list-style-type: none"> It is a joint project between the Russian space agency, Roscosmos, and the German space agency, DLR.
Skybot F850	<ul style="list-style-type: none"> Recently, Russia sent the humanoid robot Fedor, also known as Skybot F850 to International Space Station. It will spend 10 days in space to assist astronauts. Fedor is Russia's first robot in space. Previously in 2011 NASA sent up Robonaut 2, a humanoid developed with General Motors and in 2013 Japan sent up a small robot called Kirobo, developed with Toyota which holds conversations in Japanese.
Chang'e-4	<ul style="list-style-type: none"> It is part of the second phase of China's lunar programme. It is the first mission to land on the far side of the Moon. It landed at the South Pole- Aitken Basin. Recently, Cotton seeds have reportedly just sprouted in an experiment aboard Chang'e 4 moon lander.
Hope Spacecraft (Emirates Mars Mission)	<ul style="list-style-type: none"> It is a Mars mission built by the United Arab Emirates scheduled to launch in July 2020. It will orbit Mars and study the dynamics of the martian atmosphere and its interaction with outer space and the solar wind.
Clearspace -1 Mission	<ul style="list-style-type: none"> The European Space Agency (ESA) is planning to launch a four-armed robot, Chaser, to clean up Earth's orbit in 2025. Chaser is to be developed by a Swiss start-up ClearSpace under ClearSpace-1 mission. Once launched into space, it will grab the chosen piece of space trash, one at a time, using its robotic arms and fall back towards Earth in a controlled descent. The target is a piece of junk called Vespa, around 800km above the Earth. Earth's orbit is home to more than 3,500 defunct satellites and an estimated 750,000 smaller fragments. All of these pieces are flying at a velocity of around 20,000km/h. More debris could lead to more collisions - a cascade effect known as the Kessler syndrome which may render space eventually inoperable for important services like navigation, communications, weather forecasting etc.
Remove DEBRIS mission	<ul style="list-style-type: none"> It is a satellite research project intending to demonstrate various space debris removal technologies. The mission is led by the Surrey Space Centre from the University of Surrey. Some technologies are: <ul style="list-style-type: none"> Net capture: It involves a net that will be deployed at the target CubeSat. Harpoon Capture: Which will be launched at a target plate made of "representative satellite panel materials" Vision-based navigation: Using cameras and LiDAR (light detection and ranging), the platform will send data about the debris back to the ground for processing. De-orbiting process: As it enters Earth's atmosphere, the spacecraft will burn up, leaving no debris behind. Japan earlier launched a cargo ship which will use a 700m 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.
Hayabusa-2	<ul style="list-style-type: none"> It is Japan's asteroid-sampling spacecraft which landed at asteroid Ryugu in June of 2018 and recently began its journey back to earth.

2.4. OTHER SPACE RELATED RESEARCH & DEVELOPMENT

2.4.1. SPACE-BASED INTERNET

Why in News?

American company **SpaceX** recently sent 60 small satellites (under 500 kg each) into Low Earth Orbit (LEO) for building low-cost Internet everywhere on Earth.

Details

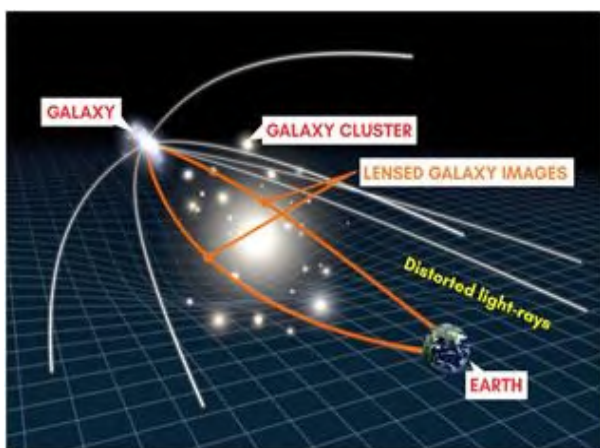
- This project, named **Starlink network**, seeks to build a 42,000-strong constellation aiming to supply non-stop, low-cost Internet everywhere on Earth.
- It uses beacons that beam coordinated signals back to Earth from around (350 km to 1,200 km) away using Ka and Ku frequency bands.
- This allows messages to be sent twice as fast as the fibers used to connect the internet on Earth, regardless of the distance between here and the stars.
- Space-based internet** is the ability to use satellites in orbit around Earth to send and receive data.
 - Although satellite internet already exists, space-based internet is much faster and has the ability to work across the globe.

- To make it work, thousands of low-cost satellites are deployed into orbit above the Earth.
- However, they **differ from the geostationary satellites** (35,786 km) more commonly used in satellite internet. Instead, low Earth orbit (LEO) satellites are used in constellations, or thousands of satellites in a grid-like pattern, to provide continuous internet coverage.
- It provides better accessibility, more affordability, 24*7 availability and revolutionised Internet of Things (IoT) technology. However, area covered is comparatively very less in this internet.

2.4.2. GRAVITATIONAL LENSING

Why in news?

Recently, the NASA has announced that plan to use the phenomena of **gravitational lensing** in its research.



More on news

- NASA is using the **James Webb Space Telescope** to conduct wide range of investigations across the fields of astronomy and cosmology.
 - Recently, NASA announced that they plan to investigate **how new stars are born**. For this, they will take the help of a natural

phenomenon called **“gravitational lensing”**.

- This programme is called **TEMPLATES** (Targeting Extremely Magnified Panchromatic Lensed Arcs and Their Extended Star Formation).

About Gravitational lensing

- It is a phenomenon, which occurs when a huge amount of matter, such as a massive galaxy or cluster of galaxies, creates a **gravitational field that distorts and magnifies the light** from objects behind it, but in the same line of sight.
 - These **large celestial objects** will magnify the light from distant galaxies that are at or near the peak of star formation. So, in a way these objects act as natural, cosmic telescopes and are called **gravitational lenses**.
 - As a result, the galaxies appear **much, much brighter than they actually are**, because they’ve been highly magnified up to 50 times.

Applications of Gravitational Lensing

- **Study the galaxies, which are very far away**- and can’t be seen otherwise with even the most powerful space telescopes.
- **Observe invisible things in the Universe**- since dark matter doesn’t emit or absorb light on its own, so it can’t be observed directly. Using this effect, it can be worked out how much dark matter exists in the universe.
- **Understand the star formation**- by studying how those galaxies are forming their stars, and how that star formation is distributed across the galaxies.
- **Understand the past**- e.g. The Milky Way today forms the equivalent of one Sun every year, but in the past, that rate was up to 100 times greater. Using this effect, the scientists can look billions of years into the past in order to understand how our Sun formed.

2.5. OTHER IMPORTANT NEWS

<p>Bhaskaracharya Institute of Space Applications and Geoinformatics (BISAG), Gujarat as BISAG(N)</p>	<ul style="list-style-type: none"> • Recently, Cabinet has approved Elevation of Bhaskaracharya Institute of Space Applications and Geoinformatics (BISAG), Gujarat as BISAG(N) under Ministry of Electronics & Information Technology. • BISAG was a state agency of the Department of Science and Technology, Government of Gujarat. It will now be an autonomous scientific society under the Government of India instead of the state government. • BISAG works in close co-ordination with Government departments to facilitate the use of spatial and geo-spatial technologies for the planning and developmental activities pertaining to Agriculture, Land and Water Resource Management, Wasteland/Watershed Development, Forestry, Disaster Management, Infrastructure and Education.
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	<ul style="list-style-type: none"> The elevation of BISAG has been done to maintain efficiency and innovation of services, facilitate implementation of expanded scope of activities, efficient rollout of GIS projects and facilitate aid, research and development at the institute.
Longest Space Flight by a woman	<ul style="list-style-type: none"> NASA's Astronaut Christina Koch returned to Earth after spending 328 days in space. World record across genders is 438 days by Valery Polyakov of Russia. Koch's long stay would provide valuable information about long-term effects of space travel on female body as the agency plans to return humans to the Moon under Artemis program and prepare for human exploration of Mars.
Thirty Meter Telescope	<ul style="list-style-type: none"> The TMT is a proposed astronomical observatory with an extremely large telescope (30 m prime mirror diameter). It would be world's largest ground-based telescope. Recently, demand to shift this proposed telescope has been raised due to regular protests at the proposed site of Mauna Kea volcano in Hawaii. <ul style="list-style-type: none"> It is a sacred location for the island's native population. It is an international project being funded by scientific organisations of Canada, China, India, Japan and USA. Thought Works Technologies-based in Pune developed Telescope Common Software for The Thirty Meter Telescope. The level of contribution determines the amount of viewing time that the member-countries' scientists get on the machine. Thus India, in a given year, stands to get 10% of the available slots.
East Asian Observatories (EAO) Consortium	<ul style="list-style-type: none"> India is in preliminary discussions to be a part of the EAO Consortium of eight countries. It consists of China, Japan, Taiwan, South Korea as full members and Thailand, Vietnam, Malaysia and Indonesia as observers. The EAO (East Asian Observatory) is formed by EAOA (East Asian Core Observatories Association) for the purpose of pursuing joint projects in astronomy within the East Asian region.
Ploonets	<ul style="list-style-type: none"> Recently a team of astronomers from Royal Astronomical Society have defined a new class of celestial objects called 'Ploonets'. Ploonets are the orphaned moons that have escaped the bonds of their parent planet and start orbiting their stars instead. Ploonets could help explain some bizarre exoplanetary features and can also provide details on planet formation processes. Astronomers concede, however, that ploonets still remain hypothetical.
Arrokoth	<ul style="list-style-type: none"> Recently, Ultima-Thule was renamed as Arrokoth. Arrokoth is a Native American term meaning "sky" in the Powhatan/Algonquian language. It is a contact binary i.e it's a single object, with two lobes, but the lobes are gently in contact. <ul style="list-style-type: none"> NASA had dubbed the larger lobe Ultima, and the other, which is about three times smaller, Thule. It is located in the Kuiper Belt- a donut-shaped region of icy bodies beyond the orbit of Neptune. <ul style="list-style-type: none"> New Horizons is the first mission to explore the Kuiper Belt. The icy objects of the Kuiper Belt are remnants left over from the formation of the solar system. Many Kuiper Belt objects have remained unchanged for billions of years, and could provide clues to the history of the Solar System, and possibly the conditions that led to the evolution of a habitable world like Earth. Pluto also lies in the Kuiper belt. It was discovered in 2014 by a New Horizons team using the powerful Hubble Space Telescope. <ul style="list-style-type: none"> NASA launched the New Horizons mission in January 2006. After crossing by Pluto in 2015, in January 2019 it flew by Arrokoth. This remains the farthest flyby ever conducted.
Accretion Burst Event	<ul style="list-style-type: none"> The event is very rare: only three such events have been observed, out of all the billions of massive stars in the Milky Way. Recently, rare glimpse of an Accretion Burst in galaxy was caught by Astronomers. After first detection of an accretion burst in 2016, astronomers from around the world agreed in 2017 to coordinate their efforts to observe more. To validate and follow up an accretion burst with more observations a global effort led to the formation of Maser Monitoring Organisation (M2O). <ul style="list-style-type: none"> M2O is an international collaboration of scientists dedicated to flagging masers in order to learn more about the birth of massive stars, among other cosmic phenomena. <ul style="list-style-type: none"> ✓ A maser is the microwave (radio frequency) equivalent of laser. ✓ The word stands for "microwave amplification by stimulated emission of radiation". ✓ Masers are observed using radio telescopes and most of them are observed at centimetre wavelength. ✓ A maser flare can be a sign of an extraordinary event such as the formation of a star. With this event, astronomers will be able to develop and test theories to explain how high-mass stars gain their mass.



Goldilocks Zone	<ul style="list-style-type: none"> NASA's Transiting Exoplanet Survey Satellite (TESS) has discovered an Earth-size planet, named TOI 700 d, orbiting its star named TOI 700 in the Goldilocks Zone. Goldilocks Zone refers to the habitable zone around a star where it is not too hot or cold for liquid water to exist on the surface of surrounding planets. Earth is in the Sun's Goldilocks zone.
New Moons of Saturn Discovered	<ul style="list-style-type: none"> Twenty new moons have been discovered around Saturn, taking its total number of moons to 82. The moons were discovered using the Subaru telescope on Maunakea, Hawaii. Before this discovery Jupiter with 79 moons was planet with largest number of moons in Solar system. Now, Saturn overtook Jupiter. Seventeen of Saturn's new moons orbit the planet in the opposite direction known as retrograde direction. The other three circle in the same direction that Saturn rotates known as prograde direction.
COMET 21/BORISO V	<ul style="list-style-type: none"> It is the first identified comet to have come close to the sun from another stellar system. It has become the second interstellar object to be identified till date to have passed through our solar system. (First was 1I/Oumuamua spotted in 2017) Objects born in our solar system travel in elliptical orbits around the sun while interstellar bodies follow the hyperbolic path. It was confirmed that 21/Borisov has a more hyperbolic path than any other comet which has been studied to date. Interstellar objects can provide unique data about the star systems of their origin, particularly about their building blocks.
ASTEROID BENNU	<ul style="list-style-type: none"> NASA's Osiris-Rex team confirmed a sample collection site designated Nightingale on asteroid Bennu. This site is located near the North pole of Asteroid Bennu. So, temperatures in the region are lower than elsewhere on the asteroid and the surface material is well-preserved. OSIRIS-Rex mission also selected 'Osprey' as a backup sample collection site, if any significant disturbance to Nightingale's surface would make it difficult to collect a sample.
Hygiea	<ul style="list-style-type: none"> Recently, the astronomers have suggested that Hygiea may possible be considered as a dwarf planet. Currently, there are officially five dwarf planets in our Solar System, namely, Pluto, Eris, Makemake, Haumea and Ceres. The International Astronomical Union sets four criteria for a dwarf planet, which are, it orbits around the Sun; it is not a moon; it has not cleared the neighbourhood around its orbit and lastly it has enough mass that its own gravity pulls it into a roughly spherical shape. Hygiea, which was considered as an asteroid till now, lies in the asteroid belt between Mars and Jupiter. Earlier it was thought that Hygiea qualifies only first three criteria. But now, new observations made through the European Space Organisation's SPHERE instrument at the Very Large Telescope (VLT), show that Hygiea satisfies the fourth criteria too and thus qualifies to be classified as a dwarf planet.
Helium hydride	<ul style="list-style-type: none"> Scientists have spotted the helium hydride molecule (HeH+) for the first time in space. The helium hydride ion or hydridohelium (1+) ion is a cation (positively charged ion) with chemical formula HeH+. It consists of a helium atom bonded to a hydrogen atom, with one electron removed. It can also be viewed as protonated helium. It is the lightest heteronuclear ion, and is believed to be one of the first compounds formed in the Universe after the Big Bang.
Tardigrade	<ul style="list-style-type: none"> The Israeli spacecraft Beresheet which recently crashed landed on moon had thousands of Tardigrades on board. Tardigrade also called water bear or moss piglet refer to any of more than 1,100 species of free-living tiny invertebrates belonging to the phylum Tardigrada. They are considered to be close relatives of arthropods (e.g., insects, crustaceans). They are near microscopic animals about 1 mm (0.04 inch) or less in size. It is the only animal to have survived all five extinctions known to man.
Neptunian Desert	<ul style="list-style-type: none"> It is the region close to stars where no Neptune-sized planets are found. This area receives strong irradiation from the star, meaning the planets do not retain their gaseous atmosphere as they evaporate leaving just a rocky core. Recently, rogue exoplanet was discovered NGTS-4b, nick-named 'The Forbidden Planet' with its own atmosphere in the Neptunian Desert. <ul style="list-style-type: none"> It is smaller than Neptune but three times the size of Earth.
Planet Nine	<ul style="list-style-type: none"> It is a hypothetical planet in the outer region of the Solar System. Its gravitational effects could explain the unusual clustering of orbits for a group of extreme trans-Neptunian objects (eTNOs), bodies beyond Neptune that orbit the Sun at distances averaging more than 250 times that of the Earth.



Water Found on Exoplanet K2-18b	<ul style="list-style-type: none">• Astronomers have for the first time discovered water in the atmosphere of an exoplanet, K2-18b orbiting a distant dwarf star K2-18 outside our solar system with Earth-like temperatures that could support life.• K2-18b, which is eight times the mass of Earth, is also categorised as Super-Earth (exoplanets with masses between those of Earth and Neptune).• The results revealed the molecular signature of water vapour while also indicating the presence of hydrogen and helium in the planet's atmosphere.
Planet Orbiting White Dwarf Star Discovered	<ul style="list-style-type: none">• It is the first time any such planet has been found orbiting the white dwarf star.• White-dwarf star represent the endpoint of the evolution of intermediate- and low-mass stars.• A white dwarf is what stars like the Sun become after they have exhausted their nuclear fuel. Near the end of its nuclear burning stage, this type of star expels most of its outer material, creating a planetary nebula. Only the hot core of the star remains.
2020 CD3	<ul style="list-style-type: none">• It is small object orbiting Earth, which have been dubbed as “mini-moon” or the planet’s “second moon”.• It is actually an asteroid, about the size of a car; its diameter is about 1.9-3.5 m.• Unlike our permanent Moon, the mini-moon is temporary; it will eventually break free of Earth’s orbit and go off on its own way.
Stardust	<ul style="list-style-type: none">• It is the oldest solid material ever found on Earth. It was trapped in a meteorite that fell in Australia about 50 years ago.• It is about 5 to 7 billion years old and predates the sun, which is about 4.6 billion years old.
Supergiant star Betelgeuse	<ul style="list-style-type: none">• Betelgeuse is a red supergiant star (over 20 times bigger than Sun) in constellation Orion.• Using European Space Organisation’s Very Large Telescope, astronomers have noticed unprecedented dimming and change in shape of this star.

3. IT & COMPUTER

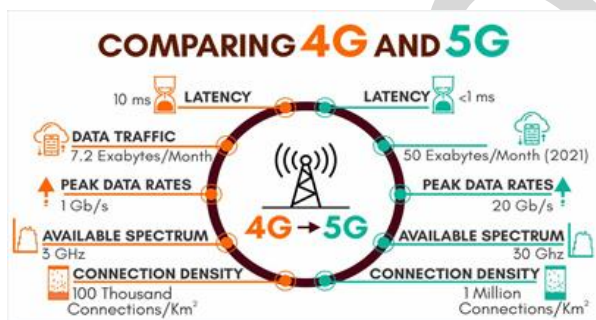
3.1. 5G NETWORK

Why in news?

Department of Telecommunications has decided to allow mobile operators to start 5G trials from June 2020.

About 5G

- 5G is a wireless communication technology using **radio waves** or radio frequency (RF) energy to transmit and receive data.
- It is the next generation mobile networks technology after 4G LTE networks. 5G technologies will enter services gradually, beginning in 2019 and advance to a full range of services by 2024.
- 5G will **provide the capacity and bandwidth** as per the need of the user to accommodate technologies such as **Internet of Things**.
 - Thus, it will help to incorporate **Artificial Intelligence** in our lives. It can also support Virtual Reality and Augmented Reality services.
- It will **provide Faster Data Speed, Ultra-low latency** etc. (refer infographics)



Related Information

- **2G and 3G mobile networks** relied on microwave wireless backhaul to connect cell sites with the nearest switching centre.
- **4G LTE introduced IP-based connectivity**, replacing copper- or microwave-based cell sites with optical fibre.
- **5G deployment** is based on optical fibre infrastructure.

Steps taken

- **BharatNet programme:** Plans to link 2.5 lakh gram panchayats through optical fibre network.
- **National Digital Communications Policy 2018**, envisages a digitally empowered economy and society, which essentially means that the information and communications needs of the citizens and enterprises are met with a ubiquitous, resilient and affordable digital communications infrastructure and services.

- The Government has launched a program titled '**Building an End-to-End 5G Test Bed**'. The program envisages close collaboration between the universities and small technology companies to build broadly compliant with the 3GPP standards.
- Several smaller academic R&D programs around 5G themes have also been funded by **DST and MEITY**.
- Ericsson has installed the first public access 5G test bed at IIT Delhi.
- The report of the **Steering Committee of the High Level Forum** laid out three priority areas in 5G:
 - **Deployment** – An early roll out of 5G services to maximise the value proposition of 5G as a technology.
 - **Technology** – To build indigenous industrial and R&D capacity, especially for the design and Intellectual Property.
 - **Manufacturing** – To expand the manufacturing base for 5G technologies, which includes both semiconductor fabrication and equipment assembly and testing.

5G Hackathon

- It is aimed at **shortlisting India focussed cutting edge ideas** that can be converted into workable 5G products and solutions.
- It is organised by **Department of Telecommunications (DoT)** in association with government, academia & industry stakeholders.
- It is open to developers, students, start-ups, SMEs, academic institutions & registered companies in India & NRIs.
- It was organised along side **India Mobile Congress (IMC), 2020**, New Delhi.
 - India Mobile Congress is the **largest digital technology forum in South Asia** organised by the DoT and Cellular Operator Association of India.

3.2. BLOCKCHAIN TECHNOLOGY

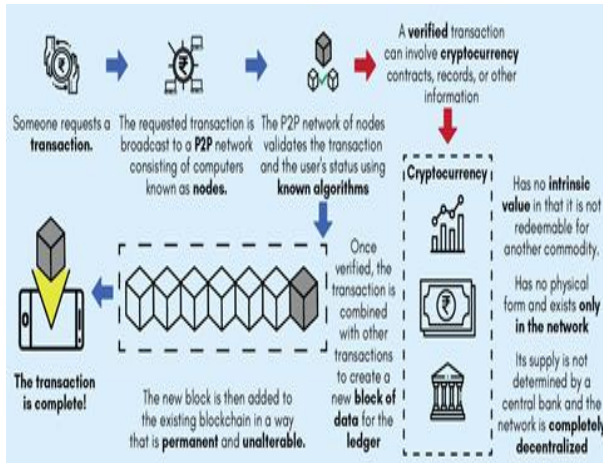
Why in news?

National Informatics Centre (NIC) has set up the **Centre of Excellence (CoE) in Blockchain Technology** in Bengaluru, Karnataka.

More on news

- It aims to provide Blockchain as a service and allowing all stakeholders to benefit from shared learning, experiences and resources.
- It will **facilitate the Government Departments** in building proof of concepts for use of Blockchain technology in different dimensions of governance leading to large scale deployment of some such applications.

- New and previously unforeseen applications of Blockchain in the Government are expected to enhance transparency, traceability and trust in e-governance systems.



About Blockchain technology

- A blockchain is a specific type of data structure which can be used to transact across nodes or participants. The ownership rights are recorded in **cryptographically** stored and **linked blocks** which contain records of ownership of assets among the participants that can remain anonymous.
- Blockchains are open, distributed ledger that can chronologically record transactions between two or more parties efficiently in near real time.
- The prerequisite for each subsequent transaction to be added to the ledger is the respective consensus of the network participants (called nodes), thereby creating a continuous mechanism of control regarding manipulation, errors, and data quality.
- The blockchain technology generally has **key characteristics** of **decentralization, persistency, anonymity** and **auditability**. With these traits, blockchain can greatly save the cost and improve the efficiency. It has various applications like in field of banking, capital markets, cybers security, healthcare, agriculture, telecom, governance etc.

Government Steps

- Ministry of Electronics and Information Technology (MeitY) has supported a multi institutional project titled **Distributed Centre of Excellence in Blockchain Technology** with C-DAC, IDRBT and VJTI as executing agencies.
- Ministry of Skill Development and Entrepreneurship (MSDE) in partnership with NASSCOM has launched **FutureSkills platform**. It focuses on 10 emerging technologies including Blockchain, Artificial Intelligence, etc.

• **Department of Science and Technology** has launched **National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)**. It has a roadmap to develop Blockchain, AI, Internet of Things, Big Data Analytics, Robotics etc.

3.3. ARTIFICIAL INTELLIGENCE

Why in news?

Government inked pact with IBM India for undertaking a pilot study to utilise **Artificial Intelligence (AI)** and weather technology solutions in agriculture.

About Artificial Intelligence

- It refers to the **ability of machines to perform cognitive tasks** like thinking, perceiving, learning, problem solving and decision making and **execute tasks in real time situations** without constant supervision.
- It can be **deployed to take over a variety of tasks, enable connectivity and enhance productivity**.
- The field of artificial intelligence is essentially when machines can **do tasks that typically require human intelligence**.
- It encompasses **machine learning**, where machines can learn by experience and acquire skills without human involvement.

Application of AI

- **Healthcare:** increased access and affordability of quality healthcare,
- **Agriculture:** enhanced farmers' income, increased farm productivity and reduction of wastage,
- **Education:** improved access and quality of education,
- **Smart Cities and Infrastructure:** efficient and connectivity for the burgeoning urban population,
- **Smart Mobility and Transportation:** smarter and safer modes of transportation and better traffic and congestion problems.

Various steps taken towards regulation of AI

- **OECD Principles on Artificial Intelligence** - adopted by 42 countries including OECD members and non-members.

Status of India in this regard

- **National Strategy for Artificial Intelligence-** NITI Aayog has identified five areas where AI can be useful. It has noted the lack of regulation around AI as a major weakness for India.
- **Center of Excellence in Artificial Intelligence (CoE in AI)** by National Informatics Centre (NIC) which is a platform for innovative new solutions in AI space, a gateway to test and develop

solutions for projects undertaken by NIC at central and state level.

- **Center of Excellence in Artificial Intelligence (CoE in AI)** by National Informatics Centre (NIC) which is a platform for innovative new solutions in AI space, a gateway to test and develop solutions for projects undertaken by NIC at central and state level.
- Government has begun the use of Artificial Intelligence on pilot basis for **crop cutting and yield estimation** under scheme **Pradhan Mantri Fasal Bima Yojana**.
- **Responsible AI for Social Empowerment 2020 (RAISE 2020)**
 - It is a **global meeting of minds to use Artificial Intelligence (AI) for social empowerment**, inclusion and transformation in key areas like Healthcare, Agriculture, Education and Smart Mobility amongst other sectors.
 - A Startup challenge- Pitchfest was also launched during the event.
- It is organized by **Ministry of Electronics and Information Technology** in partnership with Industry & Academia.

3.4. QUANTUM COMPUTING

Why in News?

The government in its Budget 2020 has announced the largest ever science mission- **National Mission on Quantum Technologies & Applications (NM-QTA)**.

What is quantum computing?

- Quantum computing is the area of study **focused on developing computer technology based on the principles of quantum theory**, which explains the nature and behaviour of energy and matter on the quantum (atomic and subatomic) level.
- Quantum Computers encode information as **quantum bits, or qubits**, which can exist in superposition.
- Qubits represent atoms, ions, photons or electrons and their respective control devices that are working together to act as computer memory and a processor.
- Because a quantum computer can contain these multiple states simultaneously, it has the potential to be millions of times more powerful than today's most powerful supercomputers
- **Application:** Quantum computers could spur the development of new breakthroughs in science, medications to save lives, machine learning methods to diagnose illnesses sooner, materials to make more efficient devices and structures, financial strategies to live well in

retirement, and algorithms to quickly direct resources such as ambulances.

Quantum computing and India

- There are no quantum computers in India yet.
- In 2018, the Department of Science & Technology unveiled a programme called **Quantum-Enabled Science & Technology (QuST)** to accelerate research on Quantum computing.

Quantum computers vs classical computer

- **Classical computers process information in a binary format, called bits**, which can represent either a 0 or 1. **Quantum computers, in contrast, use logical units called quantum bits**, or qubits for short, that can be put into a quantum state where they can simultaneously represent both 0 and 1 and their correlations.
- While the **bits in a classical computer all operate independently from one another**, in a quantum computer, the status of one qubit effects the status of all the other qubits in the system, so they can all work together to achieve a solution.

About the mission

- It will be implemented by the Department of Science & Technology (DST), Ministry of Science and Technology.
- It is proposed to provide an outlay of 8000 crore over a period five years.
- **The areas of focus** for the Mission will be in fundamental science, translation, technology development, human and infrastructural resource generation, innovation and start-ups to address issues concerning national priorities.
- **Applications which will receive boost** include those in aero-space engineering, numerical weather prediction, simulations, securing the communications & financial transactions, cyber security, advanced manufacturing, health, agriculture, education and other important sectors with **focus on creation of high skilled jobs, human resources development, start-ups & entrepreneurship leading to technology lead economic growth.**

Related News

- Recent paper from Google's quantum computing lab announced that the **company had achieved quantum supremacy**.
- **Quantum supremacy means** that researchers have been able to use a quantum computer to perform a single calculation that no conventional computer, even the biggest supercomputer, can perform in a reasonable amount of time.
- Google's quantum computer, **named Sycamore**, claimed 'supremacy' because it reportedly did the task in 200 seconds that would have apparently taken a supercomputer 10,000 years to complete.

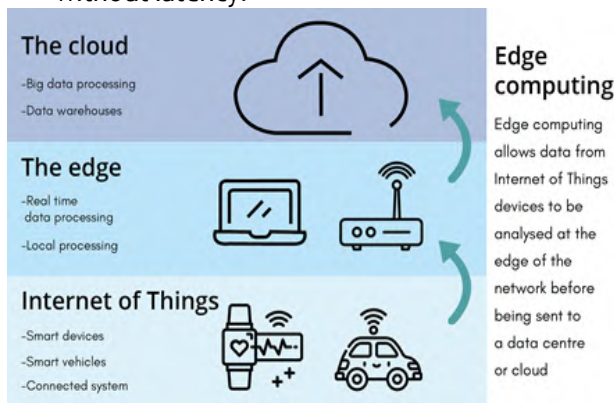
3.5. EDGE COMPUTING

Why in news?

According to a research, by 2025 companies will generate and process more than 75% of their data outside of traditional centralised data centres — that is, at the “edge” of the cloud.

What is Edge computing?

- Edge computing enables data to be analysed, processed, and transferred at the edge of a network. Meaning, the data is analysed locally, closer to where it is stored, in real-time without latency.



- **How it differs from cloud computing?**
 - The basic difference between edge computing and cloud computing lies in where the data processing takes place.
 - In simple terms, cloud computing means storing and accessing data and programs over the Internet instead of your computer's hard drive.
 - Currently, the existing Internet of Things (IoT) systems perform all of their computations in the **cloud using data centres**.
 - Edge computing, on the other hand, manages the massive amounts of data generated by IoT devices by **storing and processing data locally**.
- **Benefits of edge computing**
 - It offers **high speed, reduced latency & better reliability** which allows for quicker data processing and content delivery.
 - It offers better **security** by **distributing** processing, storage, and applications across a wide range of devices and data centers, which makes it difficult for any single disruption to take down the network
 - It offers a **far less expensive route to scalability and versatility**, allowing companies to expand their computing

capacity through a combination of IoT devices and edge data centers.

3.6. DARK NET

Why in news?

Recently, the **Narcotics Control Bureau (NCB) arrested the country's first 'darknet' narcotics operative**, who allegedly shipped hundreds of psychotropic drug parcels abroad.

Narcotics Control Bureau

- It was constituted by the Government of India in **1986** under the **Narcotic Drugs and Psychotropic Substances Act, 1985**.
 - The act provides for the penalty of property derived from or used in illegal traffic in narcotic drugs.
- It is the apex drug law enforcement and intelligence agency responsible for fighting drug trafficking and the abuse of illegal substances in India.
- It **works in close cooperation with** the Customs and Central Excise/GST, State Police Department, Central Bureau of Investigation (CBI), Central Economic Intelligence Bureau (CEIB) and other Indian intelligence and law enforcement agencies both at the national and states level.
- The NCB **provides resources and training** to the personnel of India's Drug Law Enforcement Agencies in fighting drug trafficking. It also **monitors India's frontiers** to track down points where smuggling activities take place with foreign traffickers.
- The Narcotics Control Bureau's **national headquarters is located in Delhi and is affiliated to Ministry of Home Affairs**.

What is Dark Net?

- **Also known as Dark Web**, Dark Net is that **part of the Internet which cannot be accessed through traditional search engines** like Google nor is it accessible by normal browsers like Chrome or Safari.
- It **generally uses non-standard communication protocols** which makes it inaccessible to internet service providers (ISPs) or government authorities.
- **The content on Dark Net is encrypted** and requires specific browser such as **TOR (The Onion Ring)** browser to access those pages.
- **Dark Net itself is only a part of the Deep Web** that is a broader concept, which includes sites that are protected by passwords. **For e.g.-** A person's bank statements which are available online but will not be pulled up in generalised Internet searches. Only difference is that while

the **Deep Web is accessible, the Dark Net is deliberately hidden.**

- The part of internet that is readily available to general public and searchable on standard search engines is called as **Surface Web.**
- **It is used by** journalists and citizens working in oppressive regimes (to communicate without any government censorship), researchers and students to do research on sensitive topics, law enforcement agencies & Access content blocked.
- However, it is **surrounded by concerns over** Anonymity, Haven for illicit activity, Technical-challenges to establish digital evidence in courts, Privacy and ethical concerns, use of crypto currencies etc.

- This will help law enforcement agencies track cyber criminals who sell illegal products and services on such platforms and also track terrorism-related communications and activities,
- **Kerela police have established a specialised darknet lab in Cyberdome** and four officers have been trained as darknet analysts to monitor these activities.

3.7. DATA LOCALIZATION

Why in news?

In clarification to its directive in April 2018 on ‘Storage of payment system data’, RBI announced that the payment system providers need to store entire payments data in a system only in India.

TOR (The Onion Ring)

- **TOR browser was developed in the mid-1990s** by the United States Naval Research laboratory employees to protect US intelligence communications online.
- It is termed so as the traffic from the **browser creates several layers like those of an Onion before reaching the destination site.** In other words, unlike normal surfing, the computer does not connect directly to the server where the website is located. Instead, a whole series of servers are involved in the connection in order to create the greatest possible anonymity.

What is data localization?

- Data localization is a concept that the **personal data of a country's residents should be processed and stored in that country.** It may restrict flow entirely or allow for conditional data sharing or data mirroring (in which only a copy has to be stored in the country)
- There is a growing perception that data localization will aid countries asserting sovereignty in digital domain, ensure informational security of its citizens & fare better in governance (as it goes digital).

Related information

- **Clarifying Lawful Overseas Use of Data (CLOUD) Act of US** seeks to de-monopolize control over data from US authorities & allows tech companies to share it with foreign governments.
- **General Data Protection Regulation (GDPR)** of European Union allows cross-border movement of data, but requires destination country to have stringent cybersecurity rules.



About RBI's data localization directive

RBI issued a directive in April 2018 advising all Payment System Operators (PSOs) to ensure that the entire data relating to payment systems is stored within databases located in India within 6 months.

Steps taken in India

- The Centre has directed all **law enforcement agencies to have control over foreign-based content providers of data and meta data** and to make **legislative changes to provide immunity for cyber hackers**, which law enforcement agencies use to counter Dark web transactions.
- Centre for Development of Advanced Computing (CDAC) is working with CSIR on developing a **darknet/network telescope-based cyber security monitoring and interference framework.**

- Directives are **applicable to Payment System providers** authorized by RBI under Payment and Settlement Systems Act, 2007. This includes many companies from payment gateways like MasterCard and Visa to e-wallets like PayTM.
- It includes end-to-end transaction details and information pertaining to payment or settlement transaction.
- There is **no bar on overseas processing of strictly domestic transactions**; however in such cases, the data should be deleted from the systems abroad and brought back to India

not later than the one business day or 24 hours from payment processing, whichever is earlier.

- **Data can be shared with the overseas regulator**, if required, depending upon the nature/origin of transaction with prior approval of the RBI.
- **RBI has rejected proposals** by overseas service providers to **allow data mirroring**, which allows them to retain a copy of the data on their overseas servers as well.

Other measures towards data localization

- In 2018, a draft data protection law by **BN Shrikrishna Committee** also recommended that **all personal data of Indians have at least one copy in India**. It also defined a category of data as **critical personal data**, which must be stored and processed only in India.
- A similar clause was incorporated in **Government's draft e-commerce policy**, which recommended localization for “**community data** generated by users in India from various sources including e-commerce platforms, social media, search engines etc.”
- **Draft Digital Information Security in Healthcare Act (DISHA)** seeks to empower the health regulator to localize data.

3.8. THE PERSONAL DATA PROTECTION BILL, 2019

Why in news?

Recently, the **Personal Data Protection Bill, 2019** was introduced in Lok Sabha.

Data protection in India

- **India does not have any dedicated legal framework for data protection**. Presently some acts cover the data protection in general.
- **Sec 43A of Information Technology Act 2000** protects user data from misuse but it is applicable to only corporate entities and not on government agency. Also, the rules are restricted to sensitive personal data only — medical history, biometric information among other things.
- Other acts like **Consumer Protection Act 2015**, **Copyrights Act 1957** among others also attempt to protect the personal information.
- In 2018, a draft version of the bill was prepared by a committee headed by retired **Justice B N Srikrishna**.

Key features of the Bill

- **Personal data (data that can identify an individual)**: The bill talks about various types of personal data, such as:
 - **Sensitive personal data** (related to finances, health, official identifiers, sex life, sexual orientation, biometric, genetics,

transgender status, intersex status, caste or tribe, religious or political belief or affiliation)

- **Critical personal data** (military or national security data and the government can define it from time to time)
- **General personal data**- other than sensitive and critical personal data.
- **Applicability**: The Bill governs the processing of personal data by:
 - Government
 - companies incorporated in India
 - foreign companies dealing with personal data of individuals in India.
- **Obligations of data fiduciary (an entity or individual who collects and decides the means and purpose of processing personal data)**:
 - Personal data can be processed only for **specific, clear and lawful purpose**.
 - All data fiduciaries must undertake certain transparency and accountability measures such as:
 - ✓ implementing security safeguards (such as **data encryption and preventing misuse of data**)
 - ✓ instituting **grievance redressal mechanisms** to address complaints of individuals.
- **Rights of the data principal (the individual whose data is being collected and processed)**: These include the right to:
 - obtain confirmation from the fiduciary on whether their personal data has been processed
 - restrict continuing disclosure of their personal data by a fiduciary, if it is no longer necessary or consent is withdrawn. It also includes the **right to be forgotten** which will allow users to erase their personal data published online and give them the freedom to ask entities such as Facebook and Twitter to delete any data they do not want in the public domain.
- **Grounds for processing personal data**: The Bill allows processing of data by fiduciaries only if consent is provided by the individual. However, **in certain circumstances, personal data can be processed without consent**. These include:
 - if required by the State for providing benefits to the individual
 - legal proceedings
 - to respond to a medical emergency
- **Social media intermediaries**: platforms with larger number of users and having potential to impact electoral democracy or public order,

have certain obligations, which include providing a voluntary user verification mechanism for users in India.

- According to official sources, while the process can be voluntary for users and can be completely designed by the company, it will decrease the anonymity of users and “prevent trolling”.
- **Data Protection Authority:** The Bill sets up a Data Protection Authority which may:
 - take steps to protect interests of individuals
 - prevent misuse of personal data
 - ensure compliance with the Bill.
- **Transfer of data outside India:**
 - **Sensitive personal data** may be transferred outside India for processing if explicitly consented to by the individual and subject to certain additional conditions. However, such sensitive personal data should continue to be stored in India.
 - **Critical personal data** can only be processed in India.
 - **Personal data other than sensitive and critical personal data** don't have such localisation mandates.
- **Exemptions:**
 - The central government can exempt any of its agencies from the provisions of the Act:
 - ✓ in interest of security of state, public order, sovereignty and integrity of India and friendly relations with foreign states
 - ✓ for preventing incitement to commission of any cognisable offence (i.e. arrest without warrant) relating to the above matters.
 - Processing of personal data is also exempted from provisions of the Bill for certain other purposes such as:
 - ✓ prevention, investigation, or prosecution of any offence
 - ✓ personal, domestic
 - ✓ journalistic purposes
- **Sharing of non-personal data with government:** The central government may direct data fiduciaries to provide it with any:
 - non-personal data
 - anonymised personal data (where it is not possible to identify data principal) for better targeting of services.

3.9. 3D PRINTING

Why in News?

Recently, Israel created an **world's first 3D-printed heart** made from human cells.

About 3D Printing

- It is an **additive process** wherein an object is **created by laying down successive layers of material** until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.
- It is also known as **additive manufacturing** which uses materials such as plastics, metals etc. to convert products envisaged on **computer-aided design to real three-dimensional items**.
- It allows the **creation of lighter, more complex designs** that are too difficult or too expensive to build using traditional dies, molds, milling and machining.
- It has **multiple applications** like in aerospace, healthcare, automotive, product development etc. to create 3d object.

3.10. BIOMETRICS

Why in News?

India has become the first country in the world to issue Biometric Seafarer Identity Document (BSID), capturing the facial bio-metric data of seafarers.

More about News

- The BSID has the dimensions of a smart ID card. It introduces modern security features like an embedded biometric chip, as well as optical security features such as micro prints/micro texts and Unique Guilloche pattern.
- The new card is in confirmation of the Convention No. 185 of the International Labour Organisation on BSID. India ratified the Convention in October 2015.
- It has been developed with collaboration with Centre for Development of Advanced Computing (CDAC), Mumbai.

About Biometrics

- Biometrics are physical or **behavioral human characteristics** to that can be used to digitally identify a person to grant access to systems, devices or data.
- Each of these identifiers is considered unique to the individual, and they may be used in

combination to ensure greater accuracy of identification.

- Biometrics can be divided into **three main categories of characteristics**:
 - **Biological**: DNA blood

- **Morphological** (form and structure of organisms): shape of the hand, palms, fingerprints, vein patterns, face, iris, vein, pattern in the retina, voice, ear
- **Behavioral**: walking, handwritten signatures, keyboard strokes.

3.11. RFID

Why in News?

Indian Railways (IR) is taking up **Radio Frequency Identification (RFID) project** which aims to automatically and accurately track and trace rolling stock as they move across the country with a special focus on improving their safety and reliability.

More about News

- All the rolling stock which includes coaches and wagons will be fitted with **RFID tags by 2021**.
- **RFID project** has been undertaken under ‘**Make in India**’ initiative by **Centre for Railway Information Systems**.
- It enables **enhanced operational efficiency** of IR.

RFID technology	Bluetooth	Near Field Communication (NFC)
<ul style="list-style-type: none"> • It is an electronic tag that can exchange data with an RFID reader through radio waves. 	<ul style="list-style-type: none"> • It is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves. 	<ul style="list-style-type: none"> • It works on the Radio waves technology. It is used for small information exchange or to do a small action and such as for contactless card payments.
<ul style="list-style-type: none"> • In this an antenna broadcasts energy to the tag, which in turn returns the modulated energy back in the form of back-scatter. 	<ul style="list-style-type: none"> • It communicates on a frequency of 2.45 gigahertz (actually between 2.400 GHz and 2.483.5 GHz, to be exact). This frequency band is one of a handful of frequencies that has been set aside by international agreement for the use of industrial, scientific and medical devices (ISM). 	<ul style="list-style-type: none"> • It transmits at 13.56 megahertz with a max speed of 424 kilobits per second. Most tags are passive devices that contain an antenna and a microchip. The antenna is a coil and NFC device picks power from the magnetic field. This power is used by the NFC tag to transmit information. Thus the magnetic field provides a communication medium as well as power.
<ul style="list-style-type: none"> • It is faster connection and its operational range is about 100m. 	<ul style="list-style-type: none"> • It is slow connection and its operational range is about 40 m indoors and 100 m outdoors. 	<ul style="list-style-type: none"> • It is faster connection and operational range is very less to close to inches.
<ul style="list-style-type: none"> • RFID tag typically sends out information hence only one-way information. 	<ul style="list-style-type: none"> • In case of bluetooth the connection is based on handshaking which is two way, though it can support broadcast mode in the latest release. 	<ul style="list-style-type: none"> • Information is sent in both directions, the NFC tags not only give out info, it can be even written in to by other NFC tags.

Related information

FASTag

- Under a new “**One Nation One FASTag**” scheme, the National Highway Authority of India (NHAI) is trying to get states on board so that one tag can be used seamlessly across highways, irrespective of whether it is the state or the Centre that owns/manages it.
- It employs **Radio Frequency Identification (RFID) technology** for payments directly from the prepaid or savings account linked to it. It is affixed on the windscreen that can enable electronic payment when it crosses a booth without stopping.
- A FASTag is valid for five years and can be recharged as and when required.

3.12. MISCELLANEOUS

Central Equipment Identity	<ul style="list-style-type: none"> • Recently, the CEIR portal has been launched by the government to facilitate blocking and tracing of stolen/lost mobile phones in Delhi. • The initiative is undertaken by the Department of Telecom (DoT) and was first launched in Mumbai.
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Register (CEIR)	<ul style="list-style-type: none"> • CEIR acts as a central system that connects to the IMEI database of all network Operators to share black listed mobile devices. • Devices blacklisted in one network will not work on other networks even if the Subscriber Identity Module (SIM) card in the device is changed. • The National Telecom Policy of 2012 called for the establishment of a National Mobile Property Registry to address the issue of “security, theft, and other concerns including reprogramming of mobile handsets”.
Broadband Readiness Index (BRI)	<ul style="list-style-type: none"> • Department of Telecom (DoT) and the Indian Council for Research on International Economic Relations (ICRIER) signed a Memorandum of Understanding (MoU) to develop a BRI for Indian States and Union Territories (UT). • It will appraise the condition of the underlying digital infrastructure and related factors at the State/UT level which will be conducted annually until 2022. • It will provide useful insights into strategic choices made by States for investment allocations in ICT programmes. • The BRI consists of two parts. <ul style="list-style-type: none"> ○ Part I will focus on infrastructure development based on the measurement of nine parameters like state policy, towers, number of fibres etc. ○ Part II consists of demand side parameters which will be captured through primary surveys. It will include indicators such as percentage of households using computers/ laptops with internet connection, percentage of households with fixed broadband connection etc. • It is also envisaged in National Broadband Mission by Ministry of Communications.
TechSagar	<ul style="list-style-type: none"> • Recently, the National Cyber Security Coordinator's office and Data Security Council (DSCI) of India launched TechSagar –an online portal for India’s technological capability. • The portal will list business and research entities from the IT industry, startups, academia, and individual researchers. • TechSagar is a consolidated and comprehensive repository of India’s cyber technology capabilities of the Indian Industry, academia and research across 25 technology areas such as: Internet of things (IoT), Artificial Intelligence (AI), Machine Learning (ML) etc. • Data Security Council of India <ul style="list-style-type: none"> ○ It is a not-for-profit, industry body on data protection in India. ○ Setup by NASSCOM, it is committed to making the cyberspace safe, secure and trusted by establishing best practices, standards and initiatives in cyber security and privacy.
Wifi Calling	<ul style="list-style-type: none"> • Bharti Airtel recently introduced India’s first Voice over Wi-Fi (VoWiFi). Reliance Jio also followed the suit. • VoWiFi is a Wi-Fi-based Voice over Internet Protocol (VoIP) service, which allows users to make high definition (HD) voice calls using Wi-Fi even in places with poor or no cellular network. • Calls made over VoWiFi provides users with a shorter call connection time along with superior call quality compared to calls made over VoLTE or any existing cellular technology. • Users don’t have to pay extra for these calls as it is using a Wi-Fi network. VoWiFi service does not need any separate app or a new number or any log-in to work. • This is similar to a voice call using WhatsApp or any other over-the-top messaging platform, but here the call is from one number to another, and not using an app.
Wi-Fi 6	<ul style="list-style-type: none"> • It is the next generation standard in WiFi technology. • Wi-Fi 6 also known as “AX WiFi” or “802.11ax WiFi” builds and improves on the current 802.11ac WiFi standard. • About WiFi technology • It is a wireless network technology that allows computers and other devices to be connected to each other into a LAN and to the Internet without wires and cables. • It is also referred to as WLAN, which stands for wireless LAN, and 802.11, which is the technical code for the protocol. • The technology uses radio signals to transmit information between Wi-Fi enabled devices and the internet, allowing the device to receive information from the web in the same way that a radio or mobile phone receives sound. • LiFi is another mobile wireless technology that uses light rather than radio frequencies to transmit data.
Dark fibre	<ul style="list-style-type: none"> • It is the extra optical fibre laid by companies in order to avoid cost repetition when more bandwidth is needed. • In a bid to cut down on capital expenditure, telecom service providers — Reliance Jio Infocomm, Bharti Airtel and Vodafone Idea — have reached out to Bharat Broadband Network Limited to use dark fibre laid by latter.

	<ul style="list-style-type: none"> The hitherto unused infrastructure will be used by these companies to expand their presence in rural India
Deepfakes	<ul style="list-style-type: none"> Deepfakes refer to manipulated videos, or other digital representations produced by sophisticated artificial intelligence, that yield fabricated images and sounds that appear to be real.
Pegasus	<ul style="list-style-type: none"> It is a mobile spyware developed by Israeli cyberarms firm, NSO Group. It can infect both Android and iOS phones. It is usually deployed by sending a specially created link to the target device. Once deployed, the hacker has complete access to the data on the victim's phone.
Strandhogg	<ul style="list-style-type: none"> It is a bug that allows malware applications to pose as genuine applications and access user data of all kind. Recently, Home Ministry has sent an alert to all States warning them about the vulnerability of the Android operating system to this bug.
Virtual Human NEON	<ul style="list-style-type: none"> NEON is a computationally created virtual being that looks and behaves like a real human, with the ability to show emotions and intelligence. The word derives from NEO (new) + humaN.
XENOBOT	<ul style="list-style-type: none"> It is world's first ever living, self-healing robot developed by engineering frog embryos in the lab to behave like living, programmable organisms. They are small enough to travel inside human bodies Xenobots may lead to novel machines in a wide range of fields like detecting toxic contamination in environment, gathering microplastic in oceans, scrapping out blocks in blood vessels etc.
Cerebras Wafer Scale Engine	<ul style="list-style-type: none"> It is believed to be the world's largest processor which has 1.2 Trillion transistors and 400,000 AI-optimised cores and 18 gigabytes of memory (A typical PC processor will have about 2 billion transistors, four to six cores and a fraction of the memory). It measures roughly 8 inches by 8 inches that's at least 50 times larger than similar chips available today. It is mainly built for Artificial intelligence software which requires huge amounts of information to improve, so processors need to be as fast as possible to crunch all this data.
AJIT Microprocessor	<ul style="list-style-type: none"> IIT Bombay develop the country's first indigenously designed and fabricated microprocessor AJIT. It is a medium-sized processor which can be used inside a set-top box, as a control panel for automation systems, in a traffic light controller or even robotic systems. This innovation would reduce the country's imports and make India self-reliant in electronics.
India's first RoboCop	<ul style="list-style-type: none"> Kerala Police has become the first police department in the country to use a robot named KP-Bot (SI-ranked) for police work. It will be deployed to perform duties of the front office of the police headquarters which means that it will receive visitors and direct them to different places as and when required.

4. DEFENCE TECHNOLOGY

4.1. MISSILES

Astra Missile	<ul style="list-style-type: none"> Recently India successfully test-fired its first indigenous air-to-air missile 'Astra'. It is designed and developed by DRDO. It works on beyond visual range air to air missile (BVRAAM) technology that enables fighter-pilots to shoot precisely at the enemy targets which are beyond their visual range. It was launched from Sukhoi-30 MKI fighter jet and will be further integrated with other jets such as Mirage 2000, the MiG-29 and Tejas. With this India joined the league of other countries having this technology such as France, Germany, UK, South Africa etc. Specifications of the missile: <ul style="list-style-type: none"> Speed - over 4.5 mach (5555 km/h). Mach number - ratio of velocity of the jet to the local speed of sound. Advance features- <ul style="list-style-type: none"> ✓ Electronic Counter-Countermeasures (ECCM)- that improves the missile's target tracking capability by reducing the effect of electronic countermeasures of the enemy targets in jamming environments. ✓ Lock on Before Launch (LOBL) and Lock on After Launch (LOAL). The latter option allows the fighter aircraft to safely shoot and scoot after launching the missile towards the target. It uses an inertial guidance system with an active radar seeker with a homing range of 25 km and is extremely effective in a multi-target scenario.
BrahMos supersonic cruise missiles	<ul style="list-style-type: none"> Recently, Defence Research & Development Organisation (DRDO), Indian Air Force (IAF) and BrahMos jointly successfully conducted two BrahMos supersonic cruise missiles tests one each from land and air platforms. BrahMos is a joint venture India and Russia. It is a medium-range ramjet supersonic cruise missile capable of being launched from submarines, warships, fighter jets or land and has a strike range of nearly 300 kilometres. The missile is operational with the Indian Army, Navy and Air Force.
Akash-1S missile	<ul style="list-style-type: none"> DRDO successfully test fires Akash-1S surface to air supersonic missile. It is a new version of the Akash missile fitted with an indigenous seeker. Akash has been developed by the Defence Research and Development Organisation (DRDO) under the Integrated Guided Missile Development Plan along with Agni, Trishul, Prithvi and Nag. It has a strike range of about 25 km and can carry a 55- kg fragmentation warhead. It can reach an altitude of 18 km and can be fired from both tracked and wheeled platforms. The new Akash weapon system has combination of both command guidance and active terminal seeker guidance.
'Strum Ataka' anti-tank missile	<ul style="list-style-type: none"> India has signed Rs 200 crore deal to acquire 'Strum Ataka' anti-tank missile from Russia for its fleet of Mi-35 attack choppers (exported from Russia). The deal was signed under the emergency clauses through which the missiles would be supplied within 3 months of contract signing. <ul style="list-style-type: none"> After the Pulwama attack, government gave emergency powers to the three services to buy the equipment of their choice within three months at the cost of up to Rs 300 crore per case. The IAF had also acquired the Spice-2000 stand-off weapon system from Israel under the emergency provisions to equip itself for sudden war. The Army is also in the process of acquiring the Spike anti-tank guided missile from France and Igla-S air defence missiles from Russia.
AGNI-II	<ul style="list-style-type: none"> Recently, India successfully conducted the night trial of Agni-II missile for the first time. It is surface-to-surface medium-range nuclear-capable ballistic missile. It is developed by the Defence Research and Development Organisation (DRDO). It has already been inducted into the armed forces. It is 20-metre-long, and has a strike range of 2,000 km. It has a launch weight of 17 tonnes and can carry a payload of 1,000 kg. It is a two-stage missile equipped with advanced high accuracy navigation system, was guided by a novel state-of-the-art command and control system and propelled by solid rocket propellant system.
Pranash ballistic missile	<ul style="list-style-type: none"> DRDO is developing the 200-km strike range Pranash ballistic missile which would be used for tactical missions. It is a surface-to-surface ballistic missile and will be used by the Army and the Air Force for destroying enemy targets at short ranges.

	<ul style="list-style-type: none"> The missile would be an advanced version of the 150-km strike range Prahar missile developed by the DRDO. It will be a non-nuclear missile and will be propelled by a single-stage solid propellant engine. It will be one of the cheapest missiles in the world in its range category. The missile could be exported to friendly foreign countries as it is outside the purview of the Missile Technology Control Regime (MTCR), which places export restrictions on missiles with ranges of more than 300km.
Pinaka Missile System	<ul style="list-style-type: none"> It was successfully flight-tested from the Integrated Test Range, Chandipur off the Odisha coast. It is an Artillery Missile System developed by DRDO and capable of striking up to a range of 75 kilometres with high precision. There are two versions: Pinaka MK-I (40 km range) and MK-II (75 km range)
Quick Reaction Surface To Air Missile (QRSAM)	<ul style="list-style-type: none"> QRSAM developed by DRDO has been successfully flight tested from Integrated Test Range in Odisha's Chandipur. It is an all-weather, all-terrain surface-to-air missile equipped with electronic counter measures against jamming by aircraft radars. It operates on the move and comprises of fully automated command and control.
K-4 Missile	<ul style="list-style-type: none"> It is intermediate-range, nuclear-capable submarine-launched ballistic missile (SLBM) with 3,500-km range. It is developed by DRDO and will be inducted to Arihant-class submarines.
Avangard	<ul style="list-style-type: none"> Recently, Russia deployed first hypersonic nuclear-capable missiles "Avangard". Hypersonic missiles travel faster than Mach 5 (~3,800mph). <ul style="list-style-type: none"> It has enhanced maneuverability and smooth flight path, which is much harder to track than that of traditional missiles. These missiles are capable of delivering conventional or nuclear payloads at ultra-high velocities over long ranges. It consist of a Supersonic Combustion Ramjet, or Scramjet propulsion system to enable such high speeds. A Scramjet engine is an engine that uses "air breathing" technology which means that the engine collects oxygen Conventional Ramjet Engine from the atmosphere as it is traveling and mixes the oxygen with its hydrogen fuel, creating the combustion needed for hypersonic travel.

4.2. SUBMARINE AND SHIPS

Scorpene-class submarine Vela	<ul style="list-style-type: none"> The Scorpene-class submarine Vela, the fourth of six underwater warships being built in India with French collaboration, was launched in Mumbai recently. A contract was signed in 2005, between French collaborator Ms Naval Group (formerly DCNS), and Mazgaon Dock Limited under Indian Navy's Project-75 for the construction and transfer of technology for six scorpene-class submarines. The first submarine INS Kalvari was commissioned in December 2017 while two other submarines - INS Khanderi and INS Karanj are in the advanced stages to join the Navy fleet. Vagir and Vagsheer are the remaining two submarines in the country's Scorpene Submarine programme, they are in the advanced stages of manufacturing.
Varunastra	<ul style="list-style-type: none"> Indigenously-built heavyweight anti-submarine electric torpedo Varunastra has been successfully inducted in the navy, making India one of the eight countries to have the capability to design and build such a system. It can be fired from the Rajput class destroyers, Delhi class and all future Anti-Submarine Warfare (ASW) ships capable of firing heavy weight torpedoes. The weapon has been developed by the Naval Science and Technology Laboratory (NTSL), a premier laboratory of DRDO and Bharat Dynamics Limited (BDL) is manufacturer of this weapon system. India also intends to sell the heavyweight torpedo to friendly nations.
INS Nilgiri	<ul style="list-style-type: none"> Recently, INS Nilgiri was launched by Indian Navy. It is designed indigenously by the Indian Navy's Directorate of Naval Design, New Delhi It is the first major warship in India which is built using an integrated construction methodology that involves constructing small modules and assembling them together. It is the first of seven new stealth frigates under Project 17Alfa. Project 17Alfa frigates are a design derivative and upgrade of the existing Shivalik class frigates with advanced features and indigenous weapons and sensors for improved survivability, sea keeping, stealth and ship manoeuvrability.
Indian Coast Guard Ship	<ul style="list-style-type: none"> Recently, Indian Coast Guard Ship (ICGS) VARAHA was commissioned. It is a Coast Guard Offshore Patrol Vessel and fourth in the series of seven 98-m vessels.

(ICGS) VARAHA	<ul style="list-style-type: none"> It has been designed and built indigenously by Larsen & Toubro (L&T) at its Katupalli ship building yard in North Chennai. It has capabilities to operate twin engine Advanced Light Helicopters (ALH) and will also carry four high speed boats including two rigid hull inflated boats for boarding operation, search and rescue, law enforcement and maritime patrol. It is also capable of carrying Pollution response equipment to contain oil spill at sea.
'Yard 45006 VAJRA'	<ul style="list-style-type: none"> It is an Offshore patrol vessel (OPV) that would be utilized for day and night patrol along with anti-terrorist, anti-smuggling operations in the Exclusive Economic Zone (EEZ) as well as Coastal Security. This is the sixth in the series of seven OPV projects being built by Larsen Toubro under the 'Make in India' campaign.
INS Jamuna	<ul style="list-style-type: none"> It is a Sandhayak class Hydrographic Survey Ship of Indian Navy. It has been deployed to Sri Lanka based on a mutual agreement to carry out Joint Hydrographic Survey off the South West Coast of Sri Lanka.
INS Shivaji	<ul style="list-style-type: none"> President presented President's Colour to Indian Navy's INS Shivaji. President's Colour is the highest honour that can be bestowed upon any military unit. INS Shivaji was established in 1945 and it is one of the premier training establishments of Indian Navy.

4.3. AIRCRAFTS AND HELICOPTERS

ABHYAS	<ul style="list-style-type: none"> The DRDO has successfully conducted the flight test of ABHYAS - High-speed Expendable Aerial Target (HEAT) from a test range in Odisha. It offers a realistic threat scenario for practice of weapon systems. 'Abhyas' is designed for autonomous flying with the help of an autopilot. The configuration of 'Abhyas' is designed on an in-line small gas turbine engine and it uses indigenously developed micro-electro-mechanical systems-based system for navigation and guidance.
Apache helicopters (AH-64E)	<ul style="list-style-type: none"> Recently, eight US made Apache helicopters (AH-64E) were inducted into the Indian Air Force. India had signed a deal for 22 Apache helicopters with US Company, Boeing in September 2015 to replace Russian-built Mi-25 and Mi-35 helicopters. It is the most advanced multi-role heavy attack helicopter in the world and are also known as 'Flying Tank'. It is an all-weather helicopter. It has a vertical rate of climb of over 2,000 feet per second and a maximum speed of 279km per hour, making it useful for swift deployment. It can deliver a variety of weapons with one helicopter having the capacity to carry 8 missiles. It also has modern electronic warfare capabilities to provide versatility to the helicopter in network-centric aerial warfare. The helicopter is capable of flying further lower and faster than other similar machines through which it cannot be picked up by radar, while skimming the earth.
LCA Tejas	<ul style="list-style-type: none"> Naval version of India's Light Combat Aircraft Tejas made its first arrested landing on aircraft carrier INS Vikramaditya. LCA is the smallest and lightest Multi-Role Supersonic Fighter Aircraft of its class. It is designed and developed by Aeronautical Development Agency (ADA) with HAL as the principal partner along with DRDO, CSIR, BEL, DGAQA, Indian Airforce and Navy.
Saras aircraft	<ul style="list-style-type: none"> The first-ever indigenous light passenger aircraft Saras will be inducted into the Indian Air Force (IAF) from 2024. This Saras Mk2 project is led by the Council of Scientific and Industrial Research (CSIR)-National Aerospace Laboratories (NAL). The first attempt to design and develop a multi-role transport aircraft began in 1999. It will have various applications such as troop movement, VIP transport and supply roles during emergency situations. It has low acquisition and operating costs, high aircraft performance abilities and the latest generation technologies compared to any contemporary aircraft. The Saras project will pave the way for the knowledge generation, design and development of the 70-90 seat aircraft for regional passenger connectivity. The first successful maiden flight took off in 2004, thus enabling India to join the elite club of five nations to manufacture the light passenger transport aircraft.
Light Combat Helicopters (LCH)	<ul style="list-style-type: none"> LCH production centre was inaugurated in Bengaluru, under the Make in India initiative. LCH is a 5.5-tonne class multi-role combat helicopter designed and developed by Hindustan Aeronautical limited (HAL).

	<ul style="list-style-type: none"> It is powered by two Shakti engines and inherits many technical features of the Advanced Light Helicopter. The features that are unique to LCH are sleek and narrow fuselage, tri-cycle crashworthy landing gear, crashworthy and self-sealing fuel tanks, armor protection and low visibility features which makes it agile and survivable. LCH has the distinction of being the first attack helicopter to land in Forward Bases at Siachen, 4,700 mts above sea level with 500kg load.
HAL Dhruv (Advance Light Helicopter)	<ul style="list-style-type: none"> It is a multi-role and multi-mission helicopter, intended for both military and civil operators. Current military operators of the HAL Dhruv are India, Bolivia, Burma, Israel, Maldives and Nepal.
Sukhoi Jets	<ul style="list-style-type: none"> Recently, the Indian Air Force (IAF) inducted the first batch of six of 18 Russian Sukhoi-30 MKI fighter jets at Tamil Nadu's Thanjavur Air Force Station. It will bolster India's offensive capabilities in the Indian Ocean Region against China as they can fly 1,500km without having to refuel mid-air, thus help providing security cover to island territories and sea lines of communication. These fighter jets are equipped with the air variant of the BrahMos cruise missile, with a range of 290km. The Indian Navy already has the Boeing built P-8I long-range, multi-mission maritime patrol aircraft in the area that is armed with Harpoon anti-ship missiles and is capable of conducting anti-submarine warfare.
C-295 transport aircrafts	<ul style="list-style-type: none"> The Ministry of Defence has concluded the cost negotiations with Tata and Airbus for the purchase of 62 Airbus C-295 transport aircraft. New C-295 transport aircrafts would replace the IAF's ageing Avro transport aircrafts.
KA-226T Light Utility Helicopters	<ul style="list-style-type: none"> It is a Russian light helicopter with a maximum take-off weight of over 3.5 tonnes and can carry a payload of up to 1 ton. Indo-Russian Helicopters Limited (IRHL), a joint venture between Hindustan Aeronautics Limited (HAL) and Russian Helicopters (RH), will assemble the Ka-226T helicopters in India.
Chinook	<ul style="list-style-type: none"> India has received Boeing Co.'s Chinook helicopters from US that are expected to bolster the heavy-lift capabilities of its air force and further strengthen the fast expanding defence ties with the US. Chinook is a multi-role, heavy lift helicopter, which is used for transporting troops, artillery, equipment and fuel. It is also used for humanitarian and disaster relief operations and in missions such as transportation of relief supplies and mass evacuation of refugees.
Dornier-228	<ul style="list-style-type: none"> IAF has inducted Do-228 Dornier aircraft which is the most versatile and most advanced high-wing aircraft in its class. It has been developed by Hindustan Aeronautics Limited specifically to meet the manifold requirements of utility and commuter transport, third level services and air-taxi operations, coast guard duties and maritime surveillance.
24 MH-60R multi-role helicopters	<ul style="list-style-type: none"> Cabinet Committee on Security cleared procurement of 24 MH-60R multi-role helicopters for the Navy from USA. This will be procured through the foreign military sales (FMS) route from the US government. FMS is the US Government's program for transferring defense articles, services, and training to international partners and international organizations.

4.4. OTHER WEAPONS SYSTEM

Iron Dome Aerial Defence System	<ul style="list-style-type: none"> With the increasing tension between Israel and Ghaza, Israel is using its Iron Dome to intercept incoming rockets. The Iron Dome is a mobile air defence system developed by Israel to intercept and destroy short-range rockets and up to 155mm artillery shells fired from short distances. It can be operated in all weather conditions and can respond to multiple threats simultaneously. Iron Dome operates both day and night, and can detect tickets 4 to 70 km away to destroy target mid air.
Airborne Early Warning And Control (AEW&C)	<ul style="list-style-type: none"> Also named as Netra, it is indigenously designed by DRDO which was handed over to the Indian Air Force (IAF) to augment the service's network centric capabilities. It comprises an active electronically scanned array (AESA) radar, secondary surveillance radar, electronic and communication countermeasures, beyond-line-of-sight datalinks, satellite communication systems, and advanced identification friend-or-foe probes. It is used for detecting & tracking of enemy/hostile aircrafts/ UAVs etc.

Dhanush	<ul style="list-style-type: none"> It is also the first long-range (36-38 km) artillery gun to be produced in India. 2020 for Army It is the indigenously upgraded variant of the Swedish Bofors gun imported in the 1980s.
Mk-45 5inch/62 Caliber (Mod 4) Naval Gun	<ul style="list-style-type: none"> US will sell this naval gun to India for use against warships, anti-aircraft and shore bombardment, in a move that would enhance the lethal capabilities of the Indian Navy.
Integrated Air Defence Weapon System (IADWS)	<ul style="list-style-type: none"> US has approved sale of IADWS to India to modernise its armed forces and to expand its existing air defence architecture to counter threats posed by air attacks. This will further be enhancing greater interoperability between India, US and other allies. IADWS package includes a range of sensors, weapons systems, and support equipment.
K9 Vajra-T Gun	<ul style="list-style-type: none"> It is a tracked self-propelled howitzer (artillery gun) manufactured by L&T. The gun weighs 50 tonnes and can fire 47kg bombs at 43-kilometre distant targets. It can also turn around at zero radius.
Sharang	<ul style="list-style-type: none"> It is a M-46 artillery gun being upgraded by Gun Carriage Factory (GCF) in Jabalpur. With the upgrade, gun's range has now gone from 27km to over 36km. Indigenously designed Sharang will be inducted in the Army by this fiscal end.

4.5. SPACE WEAPONISATION

Why in News?

Recently, US President has directed the establishment of the **U.S. Space Force (USSF) as the sixth branch of the armed forces** after the Army, Air Force, Navy, Marines, and Coast Guard which raises the debate on Weaponization of Space.

About Weaponization of Space

- It includes **placing weapons in outer space or on heavenly bodies** as well as **creating weapons that will transit outer space** or simply 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.
- The weaponization of space is **different from the militarization of space**, which includes using space-based assets for C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance).
 - The militarization of space assists armies on the conventional battlefield, whereas via the weaponization of space, **outer space** itself emerges as the battleground, sometimes referred to as the **“fourth frontier of war.”**

Related Laws for outer space

- Outer Space Treaty**
 - The Outer Space Treaty, formally the **Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space**, including the Moon and Other Celestial Bodies, is a treaty that forms the basis of international space law.
 - It was adopted by the UN General Assembly in 1963 and entered into force in 1967.
 - India** is a signatory to this treaty, and **ratified it in 1982.** The Outer Space Treaty prohibits only weapons of mass destruction in outer space, not ordinary weapons.
 - It mandates that use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind.
- Prevention of an Arms Race in Outer Space (PAROS)**
 - It is a UN resolution that reaffirms the fundamental principles of the 1967 Outer Space Treaty and advocates for a **ban on the weaponization of space.**
 - It is currently being discussed in the **Conference on Disarmament (CD).**
 - Till now, the parties have discussed various issues and possible solutions. Some parties like the Russian federation and Venezuela, have even pledged to **not be the first to deploy** any type of weapon in outer space.
 - It would prevent any nation from gaining a military advantage in outer space.

Related information**Mission Shakti**

- In 2019, DRDO tested its **first anti-satellite (ASAT) missile** as part of ‘Mission Shakti’ against a “live” satellite launched by it a few months earlier before this test.
- India joined a select group of nations **USA, Russia and China** with a similar technology.
- DRDO’s ballistic missile defence interceptor was used. India used **Kinetic Kill**, a space technology in which India has developed capability.
 - **Kinetic Kill:** The destructive capability of the missile is provided by the delivery to a target of a considerable load of kinetic energy unlike conventional missiles.
- Mission Shakti was done in a **low orbit of less than 300 kilometres** and at a particular angle to ensure that minimal debris were disbursed above into space to avoid damage to other satellites or the International Space Station (ISS).

IndSpaceEx

- The Indian armed forces are all set to conduct the **country’s first-ever simulated space warfare exercise “IndSpaceEx”**.
- The tri-Service integrated defence staff (IDS) under the defence ministry is conducting the **two-day “IndSpaceEx”**, with all military and scientific stakeholders in the backdrop of China’s rapidly expanding space and counter-space capabilities.
- This was **first such exercise that is being planned after India successfully tested an anti-satellite (A-Sat) interceptor missile**.

4.6. DRONE REGULATION

Why in news?

Ministry of Civil Aviation announced a scheme **providing a window up to January 31, 2020 for voluntary registration of all drones and their operators**.

More about News

- On successful submission of voluntary disclosure of possessing drone, a **Drone Acknowledgement Number (DAN) and an Ownership Acknowledgement Number (OAN) will be issued online** which will help in validation of operation of drones in India.
- However, the **DAN and the OAN do not confer any right to operate drones in India** if it does not fulfil the DGCA’s drone regulations.
- Further, ownership of drones in India without a valid DAN or OAN shall invite **penal action as per applicable laws**.

Drones in India

- As per Ministry of Civil Aviation, drones are **defined** as a technology platform that has

wide-ranging application from photography to agriculture, from infrastructure asset management to insurance.

- Drones range in **size** from very small and those that can carry multiple-kilograms of payload. The DGCA has defined five different categories of drones:
 - **Nano:** Less than or equal to 250 grams
 - **Micro:** From 250 grams to 2kg
 - **Small:** From 2kg to 25kg
 - **Medium:** From 25kg to 150kg
 - **Large:** Greater than 150kg
- The **industry value** of unmanned aircraft systems (UAS) in India is projected to touch \$885.7 million by 2021, while the global market size is expected to reach \$21.47 billion.
- However, the number of **illegal drones** in India is likely to be between 50,000 and 60,000, as on October 2019 which requires a regulation of drones in India.

Drone Regulation in India

- In August 2018, the Centre came up with the first set of norms **Drone Regulations 1.0** which are intended to enable **visual line-of-sight daytime-only** and a **maximum of 400 ft** altitude operations of Drones.
- Under these guidelines, air space has been partitioned into:
 - **Red zone** denotes “no fly zone” (include airspace around airports; near international border, Vijay Chowk in Delhi; State Secretariat Complex in State Capitals, strategic locations/vital and military installations; etc.)
 - **Yellow zone** is controlled airspace which signifies airspace requiring Air Defence Clearance or Air Traffic Control clearance.
 - **Green zone** signifies unrestricted airspace zones. However, even for the Green zone, there is a **need to get clearance** from the Digital Sky Platform.
- Under these regulations, a process has been prescribed for drone operators to obtain **Unique Identification Number (UIN), Unmanned Aircraft Operator Permit (UAOP)** and other permissions.
- Currently, India has a ‘**No Permission-No Take off**’ (NPNT) clause, which implies that a drone cannot be operated in Indian skies unless the regulatory permission is received through **the Digital Sky Platform**.
 - Users will be required to do a **one-time registration** of their drones, pilots and owners. **For every flight** (exempted for the nano category), users will be required

to ask for permission to fly on a **mobile app** and an automated process permits or denies the request instantly.

- The pilot also needs certification, requiring a **remote pilot licence** before operating a drone.
- In January 2019, a white paper on drone policy 2.0 was released, that paved the way for wider application of drones, such as the **delivery of goods beyond visual line of sight (BVLOS)**.
- Foreigners are currently not allowed to fly drones in India. For commercial purpose, they need to lease the drone to an Indian entity who in-turn will obtain Unique Identification Number (UIN) and UAOP from DGCA.

About Digital Sky Platform

- It is a software-based **self-enforcement unmanned traffic management (UTM) system** which is expected to facilitate registration and licensing of drones and operators in addition to giving instant (online) clearances to operators for every flight.
- The Platform **regulates all drones** in the micro and higher categories.
- It allows operators to **apply for a Unique Identification Number (UIN)**, that needs to be issued for all drones and Unmanned Aircraft Operator Permit online for approval by the civil aviation regulator.

About Unmanned Aircraft Operator Permit (UAOP)

- UAOP is a permit required by the owners of the drones to fly them which can be obtained from the **Director General of Civil Aviation**.
- These UAOPs are not transferrable and shall be applicable for not more than five years.

India's Draft Drone Policy 2.0 (Released in 2019)

- **New forms of air freight permitted:** It recommends expanding operations to beyond VLOS and beyond the current limit of 400 feet.
- **Drone corridors:** The policy conceives of drone corridors to keep commercial UAS operations out of non-segregated airspace in which manned aircraft operate.
 - Additionally, designated areas known as **'Droneports'** to facilitate the landing and take-off of drones.
- **Life cycle for drones:** Proposes maximum life cycle for drones to ensure airworthiness and operators must apply for re-certification at the end of a drone's life cycle.
- **Drone Directorate:** Recommends establishing a Drone Directorate within the Directorate General of Civil Aviation (DGCA).
- **DigitalSky service providers (DSPs):** It introduces new players DSPs which would be public or private agencies registered in India.
- **Permissible Night-time Operations:** Permissions and other necessary requirements to be obtained to enable night-time drone flights.

- **FDI:** It proposes 100% FDI under automatic route in UAS and RPAS-based commercial civil aviation services. Under Drone Policy 1.0, there is no mention of FDI.

4.7. OTHER IMPORTANT NEWS

<p>DRDO Young Scientist Laboratories (DYSLs)</p>	<ul style="list-style-type: none"> • Prime Minister dedicated the five Young Scientists Laboratories of Defence Research and Development Organisation (DRDO) to the nation. • DRDO Young Scientist Laboratories (DYSLs) are located in five cities viz, Bengaluru, Mumbai, Chennai, Kolkata and Hyderabad. • Each lab will work on a key advanced technology of importance to the development of futuristic defence systems viz, Artificial intelligence, Quantum technologies, Cognitive technologies, Asymmetric technologies and Smart materials. • DYSLs will employ only scientists under age of 35 to develop cutting-edge and futuristic technologies for military weaponry. • It will boost indigenous research capabilities in the defence sector by involving youth in defence research related activities.
<p>Government Owned Contractor Operated (GOCO) Model</p>	<ul style="list-style-type: none"> • Army has decided to transfer Army Base Workshops (ABW) presently being operated by the Central Government, on the lines of GOCO model to improve operational efficiency. • Under GOCO model, government will provide land, infrastructure, plant and machinery, equipment system support, oversight and facilitate the contractor. • The contractor operates and utilises the facilities available, manages all types of work and is also responsible to get required licences, certifications and accreditations to deliver mutually agreed targets and maintains the plant machinery and services integral to the venture. • It will be operated by the private industry for agreed upon terms and will enhance private participation in defence. • This model is based on the recommendations of Lt. Gen. DB Shekatkar (Retd.) committee to "enhance combat capability and re-balancing defence expenditure."



5. HEALTH

5.1. VIRAL DISEASES

NOTE: COVID-19 will be covered in detail in updated material.

5.1.1. POLIO

Why in news?

Recently, Global Commission for the Certification of Poliomyelitis Eradication officially declared that **wild poliovirus type 3 has been eradicated.**

More about news

- This is the second wild poliovirus to be declared eliminated — **the first was in 2015 when type 2 wild poliovirus was declared as eliminated.**
- With two of the three wild polioviruses eliminated, **only type 1 wild poliovirus** is still in circulation and is restricted to just two countries — **Afghanistan and Pakistan.**
- It opens up the possibility of switching from the currently used **bivalent oral polio vaccine** containing type 1 and type 3 to a **monovalent vaccine containing only type 1.**
- In last one year, polio has made a comeback in countries such as Myanmar, China, Cameroon, Indonesia mostly as **vaccine-derived polio infection (VDPI).**
 - VDPI is extremely rare and found in children with immune-deficiency and among populations with low immunity levels.
- Polio **remains endemic** in three countries – **Afghanistan, Nigeria and Pakistan.**

About Polio

- It is highly infectious viral disease which **invades the nervous system and can cause irreversible paralysis within hours.**
- Polio spreads in vulnerable populations in areas **where there is no immunity and sanitation is poor.**
- There are **three individual and immunologically distinct** wild poliovirus strains: **wild poliovirus type 1 (WPV1), wild poliovirus type 2 (WPV2) and wild poliovirus type 3 (WPV3).**
 - Symptomatically, all three strains are identical, but there are **genetic and virological differences**, which make these three strains three separate viruses that must each be eradicated individually.
- There **are two vaccines** used to protect against polio disease, **oral polio vaccine and inactivated poliovirus vaccine.**

- **Oral polio vaccine:** It consists of a mixture of **live attenuated strains** of polioviruses of three (now only two OPV 1 and OPV 3) different types of serotypes.
 - ✓ These **viruses mimic the immune response of the actual polioviruses**, but with a reduced ability to spread and affect the central nervous system
 - ✓ In rare cases, the OPV virus can **accumulate changes over time and become like wild poliovirus (WPV) infecting new individuals.** These new viruses are called **vaccine-derived polioviruses (VDPV)** and can cause polio disease.
 - ✓ OPV vaccines also **produce a local immune response in the lining of the mucous membrane of the gut** (developing gut immunity) which is the primary site for multiplication of poliovirus.
- **IPV or inactivated poliovirus vaccine** is produced from wild-type poliovirus strains of each serotype that have been inactivated (killed) with formalin.
 - ✓ This vaccine is in **the form of an injection** and can be administered in combination with other vaccines as well.
 - ✓ IPV protects people against all **three types of poliovirus.**
 - ✓ IPV **does not contain live virus**, so people who receive this vaccine **do not shed the virus** and cannot infect others and the vaccine cannot cause disease.
- **Status in India**
 - Though, India is a **wild, poliovirus, disease-free country currently.** But, the cases of Vaccine Derived Polio Virus (VDPV) disease, can be seen.
 - In January 2014, **India was declared polio-free** after three years on zero cases.
 - India launched the **Pulse Polio Immunisation programme** in 1995 brought down polio cases from 50,000-100,000 each year in the 80s **to zero in 2012.**
 - India introduced the **injectable polio vaccine** in **Universal Immunisation Programme** to reduce chances of VDPI, which continues to happen in the country.
- Government since March 2014 has made the **Oral Polio Vaccination mandatory** for those

travelling between India and polio-affected countries.

Related news
Acute flaccid myelitis

- **Acute flaccid myelitis (AFM)**, being referred to as a 'polio-like condition', has been **tested negative for the polio virus**, according to the Centers for Disease Control and Prevention (CDC) of the United States.
- AFM is a **neurological illness**, with weakness or paralysis of the limbs and inflammation of the spinal cord.
- It is a **rare** but serious condition. The symptoms of AFM, particularly, weakening of limbs, are similar to polio.
- **In India incidence rate of AFM was 120 per million population in 2010.**

5.1.2. NEW HIV SUBTYPE FOUND BY GENETIC SEQUENCING

Why in News?

Recently, a new **subtype of the Human Immunodeficiency Virus (HIV)** that causes AIDS has been identified through genome sequencing.

Details

- It is called **HIV-1 Group M, subtype L**. Such a discovery was made for **first time in two decades**. This subtype is said to have caused the most infections.
- There are **two major types** of the human immunodeficiency virus.
 - HIV-1, representing the vast majority of infections worldwide,
 - HIV-2 is far less common and primarily concentrated in the west and central African regions.
- Further, strains of HIV-1 can be classified into four groups. Of these, M is the 'major' group and is responsible for the majority of the global HIV epidemic while other three groups - N, O and p-are quite uncommon.
 - Within group M, there are known to be at least nine genetically distinct subtypes of HIV-1 based on genetic sequence data. These are subtypes A, B, C, D, F, G, H, J, K and CFRs (Circulating Recombinant Forms.).
- Group M viruses are responsible for the **global pandemic**, which can be traced back to the **Democratic Republic of Congo (DRC)** in Sub-Saharan Africa.

Related information
Dolutegravir (DTG)

- World Health Organisation (WHO) has recommended the use of the **HIV drug dolutegravir (DTG)** as the preferred **first-line** and **second-line** treatment for all **populations**, including pregnant women.

- Recent studies comparing DTG to another drug Efavirenz (EFV) found it to be more effective, easier to take and having fewer side effects.
- In the present scenario of rising drug resistance, it is important that DTG has a high **genetic barrier** to developing **drug resistance**.

5.1.3. OTHER VIRAL DISEASES

Dengue	<ul style="list-style-type: none"> • Recently, Spanish health authorities confirmed world's first case of dengue being transmitted through sex, which until recently was thought to be transmitted only by mosquitos. • Dengue is a viral disease transmitted mainly through the Aedes Aegypti mosquito, which thrives in tropical climates.
H1N1 Virus (Swine Flu)	<ul style="list-style-type: none"> • Swine Flu is an infection of the respiratory tract characterized by the usual symptoms of flu — cough, nasal secretions, fever, loss of appetite, fatigue, and headache. • It is called swine flu because it was known in the past to occur in people who had been in the vicinity of pigs. • The virus is transmitted by short-distance airborne transmission, particularly in crowded enclosed spaces. Hand contamination and direct contact are other possible sources of transmission.
Chickenpox	<ul style="list-style-type: none"> • Health Department has issued an advisory following a spurt in chickenpox cases in the Alappuzha District of Kerala. • It is a viral infection caused by varicella-zoster virus (VZV) and is highly contagious.
H9N2	<ul style="list-style-type: none"> • Indian scientists have detected the country's first case of infection with a rare variant of the virus that causes avian influenza, or bird flu. • H9N2 is a subtype of the influenza A virus, which causes human influenza as well as bird flu. • H9N2 viruses are found worldwide in wild birds and are endemic in poultry in many areas.

5.2. BACTERIAL DISEASES

5.2.1. TUBERCULOSIS

Why in news?

- Recently, **World Bank and the Government of India** signed a loan agreement of \$400 million

for the **Program Towards Elimination of Tuberculosis**.

- World Health Organization released its **annual Global Tuberculosis Report for 2019**.

More about the agreement

- This program will cover **nine States** and it will support the government's **National Strategic Plan to end TB in India by 2025**.
- It will provide **financial incentives to private sector care providers** for reporting cases of TB and ensuring that their patients complete the treatment regimen.
- It will also provide **Direct Benefit Transfers to patients** for acquiring the critical nutrition needed during treatment.
- It will **strengthen the detection, treatment and monitoring of Drug-Resistant Tuberculosis** and will track progress in the detection of additional drug resistance.
- The program will help the Government of India strengthen the monitoring and implementation of **Nikshay—the government's web-based TB case monitoring system**.

About Tuberculosis

- It is communicable disease (through air) caused by **bacteria (Mycobacterium tuberculosis)** that most often affect the lungs (pulmonary TB) and sometimes also affects other organs (extrapulmonary TB).
- The total TB incidence rate in India has decreased by 50,000 patients over the past one year. In 2017, India had 27.4 lakh TB patients, which came down to 26.9 lakh in 2018.
- India's **TB burden is the highest in the world**, followed by Indonesia and China. **26.9 per cent of the global TB burden in 2018 was from India**. In 2017, the figure was 27 per cent.
- About a 1/3rd of the world's population is diagnosed with **latent TB (without evidence of clinically manifested active TB)**, which means they have been infected by the TB bacteria from actively sick people without their knowledge.
- **Drug Resistant TB:**
 - **Multidrug Resistance TB (MDR):** It is TB that does not respond to at least **isoniazid and rifampicin** (2 of the most powerful first line drugs).
 - **Extensively drug-resistant tuberculosis (XDR-TB):** It is resistant to at least four of the core anti-TB drugs. It involves 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).

- **Totally drug-resistant tuberculosis (TDR-TB):** TB which is resistant to all the first- and second-line TB drugs.

Related News

World Health Organization released its annual **Global Tuberculosis Report for 2019**.

Major findings of the report

- **The world is not on track to reach the 2020 milestones of the End TB Strategy.** For instance:
 - The **END TB strategy** by the WHO aimed to reduce TB by 20 per cent from 2015-18. However, between 2015 and 2018, only 6.3 per cent TB cases showed a cumulative decline.
 - The End TB Strategy milestone of 35 per cent decrease by 2020.
- **Under reporting of the cases:** Of the 10 million new cases worldwide, 3 million cases went unreported to the authorities. In India 1.99 million of the 2.69 million in India were reported.
- **66 per cent of that burden came from eight countries:** India (27%), China (9%), Indonesia (8%), the Philippines (6%), Pakistan (6%), Nigeria (4%), Bangladesh (4%), and South Africa (3%).
- **Key five risk factors attributable to new cases of TB:** undernourishment, smoking (especially among men), alcohol abuse, HIV infection, and diabetes.

Global Efforts for TB

- **Moscow Declaration to End TB:** It is the outcome of first global ministerial conference on ending TB, in 2017.
- **WHO- End TB Strategy**
 - **Vision:** A world free of TB with zero deaths, disease and suffering due to TB.
 - It has three high-level, overarching indicators and related targets for 2035:
 - ✓ 95% reduction in number of TB deaths compared with 2015.
 - ✓ 90% reduction in TB incidence rate compared with 2015.
 - ✓ Zero the level of catastrophic costs for TB-affected families.

Related news

TrueNat

- World Health Organisation has endorsed TrueNat, which is a new molecular test that **can diagnose tuberculosis (TB)** in one hour as well as testing for resistance to the drug rifampicin.
- It has been developed by an Indian firm MolBio Diagnostics Pvt Ltd.

Govt interventions to eliminate TB

- Under **Universal Immunization Programme**, Vaccination is provided for 12 life threatening diseases: **tuberculosis, diphtheria, pertussis**

(whooping cough), tetanus, poliomyelitis, measles, Hepatitis B, Diarrhoea, Japanese Encephalitis, rubella, Rotavirus and Pneumonia (added in May 2017).

- Under **Mission Indradhanush**, Immunisation is provided against seven vaccine preventable diseases namely; Diphtheria, Pertussis, Tetanus, **Childhood Tuberculosis**, Polio, Hepatitis B and Measles.
- **Revised National TB Control Programme (RNTCP)** is being implemented under the umbrella of National Health Mission which has achieved global benchmark of case detection and treatment success and achieved millennium development goals in 2015 of halting and reversing the incidence of TB.
- **TB Harega Desh Jeetega Campaign:** Recently, Ministry for Health and Family Welfare announced this Campaign to improve and expand the reach of TB care services across the country, by 2022.
 - **The campaign has three pillars** - clinical approach, public health component and active community participation.
 - Other supporting elements of the campaign comprise **private sector engagement, patient support, and political and administrative commitment at all levels.**
 - The government will ensure that all patients, at private or public hospitals, receive free-of-cost and high-quality TB care.

National Strategic Plan to end TB in India by 2025

- RNTCP released this framework in 2017 for the **control and elimination of TB in India by 2025.**
- It provides **goals and strategies for the country's response to the disease during the period 2017-2025** and aims to direct the attention of all stakeholders to the most important interventions to eliminate TB.
- It targets to **eliminate TB five years ahead of the global End TB targets under Sustainable Development Goals** to attain the vision of a TB-free India.
- TB elimination has been integrated into the four strategic pillars of **“Detect – Treat – Prevent – Build” (DTPB).**
 - **Detect:** Find all Drug Sensitive TB and Drug Resistant TB cases with an emphasis on reaching TB patients seeking care from private providers and undiagnosed TB in high-risk populations.
 - **Treat:** Initiate and sustain all patients on appropriate anti-TB treatment wherever they seek care, with patient friendly systems and social support.
 - **Prevent** the emergence of TB in susceptible populations.
 - **Build** and strengthen enabling policies, empowered institutions, additional human resources with enhanced capacities, and provide adequate financial resources.

5.2.1.1. GLOBAL FUND FOR AIDS, TB AND MALARIA

- India has announced a contribution of \$22 million to the Global Fund for AIDS, TB and Malaria (GFTAM) for the 6th replenishment cycle (2020-22).
- **About the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund)**
 - It is an international financing institution based on a unique **partnership between governments, civil society, the private sector and affected communities.**
 - It was created to raise, manage and disburse large amounts of **additional financing to fight three of the world's most devastating diseases (AIDS, Tuberculosis and Malaria),** and to direct those resources to areas of greatest need.
 - It is **registered as a Non-Profit Foundation in Switzerland** and maintains its **secretariat in Geneva, Switzerland.**
 - The **World Bank is the trustee of funds** contributed to the Global Fund. The Global raises funds in multiyear cycles known as Replenishments.
 - Funding of the Global Fund comes from **voluntary financial contributions from all sectors** - governments, the private sector, social enterprises individuals etc.

5.2.2. OTHER BACTERIAL DISEASES

Glanders	<ul style="list-style-type: none"> • Recently, Ministry of Fisheries, Animal Husbandry and Dairying has released the National Action Plan for Control and Eradication of Glanders. • Glanders is a contagious and fatal disease of equines (including horses, donkeys and mules). Humans can also get the disease. • It is caused by the bacterium Burkholderia mallei. No vaccine is available for the disease.
Salmonella	<ul style="list-style-type: none"> • Recently, the United States Food and Drug Administration (FDA) has found salmonella bacteria contamination in MDH products. • It is a group of bacteria that can cause food-borne illnesses known as salmonellosis that affects the intestinal tract. • The World Health Organisation (WHO) identifies Salmonella as one of four key global causes of diarrhoeal diseases. • In humans, it is generally contracted through the



	<p>consumption of contaminated food of animal origin (mainly eggs, meat, poultry, and milk).</p> <ul style="list-style-type: none"> • Other foods, including green vegetables contaminated by manure, have been implicated in its transmission. • Person-to-person transmission can also occur through the faecal-oral route.
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5.3. OTHER DISEASES

5.3.1. RARE DISEASES

Why in news?

Ministry of Health and Family Welfare recently released the **draft National Policy for Rare Diseases**.

What are Rare Diseases?

- It is a **health condition of low prevalence**, affecting a small number of people, as compared to other prevalent diseases in the general population.
- **WHO** defines rare disease as often debilitating lifelong disease or disorder condition with a **prevalence of 1 or less, per 1000 persons**. However, different countries have their own definitions.
- These diseases are known as **Orphan Diseases** as the market for its drug development is not economically viable.
- They include **genetic diseases, rare cancers, infectious tropical diseases and degenerative diseases**. 80% of rare diseases are genetic in origin and hence **disproportionately impact children**.
- Despite being less prevalent and individually rare, collectively they affect **between 6% and 8% of total population in any country**.

Indian Scenario

- In India, **about 95% rare diseases have no approved treatment** and less than one in 10 patients receives disease-specific treatment.
- Very few pharmaceutical companies manufacture drugs to treat rare diseases and **India has no domestic manufacturer**.
- The **most common rare diseases** include Haemophilia, Thalassemia, Sickle-cell Anaemia and Primary Immuno Deficiency in children, auto-immune diseases etc.

Salient Features of Draft Policy

- It lists **450 diseases as rare** but does not provide a detailed roadmap on treatment.
- It creates **three categories of rare diseases-**

- diseases requiring one-time curative treatment,
- diseases which need long-term treatment, but cost is low,
- diseases that require life-long treatment and cost is high.

- **Standardisation and monitoring: National Registry for Rare Diseases** will be created at Indian Council of Medical Research which will help to arrive at a definition of rare diseases, best suited to India.

- **Financial support for treatment:** Provide financial support to patients of rare diseases living below the poverty line under its umbrella scheme **Rashtriya Arogya Nidhi**.

- It will also fund one-time treatment cost to the tune of ₹15 lakh for certain treatable rare diseases, for patients under its health insurance scheme, **Ayushman Bharat/ Pradhan Mantri Jan Arogya Yojana**, which covers 40% of the population.
- There is no clarity of Centre and State responsibilities and on category III patients.

- **Institutional framework:** Government plans to notify certain medical institutes as **Centers of Excellence for Rare Diseases**.

- Constituting an inter-ministerial **Consultative Committee** at National Level to co-ordinate and oversee activities on rare diseases.
- Constituting a **Rare Diseases Cell** within MoHFW, ICMR and DoP in the Ministry of Chemicals and Fertilizers.

- **Funding framework:** Creating a **corpus fund** at Central and State Level for rare diseases.

- It recommends **crowd funding as a source to fund treatment of rare diseases** and advises hospitals to report such cases on digital platforms to gather funds.

- **Awareness generation:** developing materials for generating awareness in the general public, patients and their families and for training of health care providers.

Related information

Lysosomal Storage Diseases

- They are a **group of about 50 rare inherited metabolic disorders** that result from defects in lysosomal function.
- Lysosomes are a kind of **waste disposal system of the cell**. They help to keep the cell clean by digesting any foreign material as well as worn-out cell organelles (and hence are called the **suicide bags of the cells**).

5.3.2. LYMPHATIC FILARIASIS

Why in news?

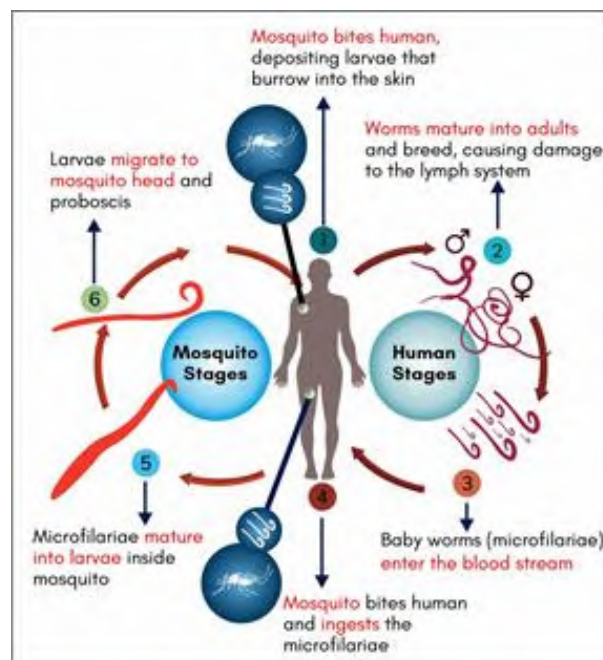
Recently, Union Minister for Health & Family Welfare inaugurated **National Symposium on the theme ‘United to Eliminate Lymphatic Filariasis’** and signed the ‘Call to Action to eliminate Lymphatic Filariasis by 2021’.

Neglected tropical diseases (NTDs)

- These are a **diverse group of communicable diseases** that prevail in tropical and subtropical conditions in 149 countries.
- They are neglected in the pharmaceutical industry’s research and development efforts due to their limited geographical incidence, small market size of drugs for such diseases.
- These **affect more than one billion people** and cost developing economies billions of dollars every year.
- Populations living in poverty, without adequate sanitation and in close contact with infectious vectors and domestic animals and livestock are those worst affected.
- Indian government has pledged to ensure that diseases such as Lymphatic Filariasis (Hathi Paon) and Visceral Leishmaniasis (Kala-Azar) are eliminated from India.
- The **Sustainable Development Goals (SDGs) provide an effective framework for successful elimination of NTDs.**

About Lymphatic Filariasis

- Lymphatic filariasis, **commonly known as elephantiasis**, is globally considered as a **neglected tropical disease**.
- It is a **parasitic disease** caused by microscopic, thread-like filarial worms.
- There are 3 types of these thread-like filarial worms of which *Wuchereria bancrofti* is responsible for 90% of the cases.
- Infection occurs when filarial parasites are **transmitted to humans through mosquitoes** such as *Culex*, *Anopheles*, and *Aedes*.
- Infection is **usually acquired in childhood** causing hidden damage to the lymphatic system.
- It **impairs the lymphatic system** and can lead to the abnormal enlargement of body parts, causing pain, severe disability and social stigma.
- Repeated mosquito bites over several months to years are needed to get lymphatic filariasis thus **people living for a long time in tropical or sub-tropical areas where the disease is common are at the greatest risk** for infection. Short-term tourists have a very low risk.



Lymphatic Filariasis in India

- Lymphatic Filariasis (LF) is **one of the biggest public health challenges** that India faces today. In India, **650 million Indians across 21 states and union territories are at risk of lymphatic filariasis.**
- Infection levels have been reduced to below the threshold level for further transmission in almost 37 percent of districts. However, **active transmission persists in 160 districts.**
- Steps taken:
 - India is the first country in southeast Asia to adopt a drug regime to prevent LF.
 - Since 2004, India has adopted a **twin pillar strategy** - prevention through Mass Drug Administration (MDA) using a combination of 2 anti-filarial drugs (DEC and Albendazole) and providing Morbidity Management and Disability Prevention (MMDP) services to those affected by the disease.
 - The Government launched the **Accelerated Plan for Elimination of Lymphatic Filariasis (APELF) in 2018**, and as part of intensifying efforts towards elimination later rolled out **IDA (triple drug therapy - Ivermectin, Diethylcarbamazine and Albendazole (IDA))** treatment in a phased manner.
 - India is set to **scale-up the use of Triple Drug Therapy (IDA)** in a phased manner from- November 2019 and working with state governments and other partners to ensure high level of compliance to these drugs by communities living in endemic districts.

WHO Recommendations

- Lymphatic Filariasis is declared by the World Health Organization (WHO) as the **second most common cause of long-term disability after mental illness.**
- The WHO launched its **Global Programme to Eliminate Lymphatic Filariasis (GPELF) in 2000.**
- In 2012, the WHO's neglected tropical diseases roadmap reconfirmed the target date for achieving elimination by 2020.
- The GPELF aims to provide access to a minimum package of care for every person with associated chronic manifestations of lymphatic filariasis in all areas where the disease is present, thus alleviating suffering and promoting improvement in their quality of life.

5.3.3. TYPHOID CONJUGATE VACCINE

Why in News?

Pakistan became the first country in the world to introduce World Health Organisation-recommended typhoid conjugate vaccine (TCV).

More about the News

- Pakistan introduced TCV called **Typhbar TCV** in its national immunisation program against **extensively drug-resistant (XDR)** typhoid outbreak.
- **Typhbar TCV** is being administered in Pakistan with funding support from the **Global Alliance for Vaccine Initiative (GAVI).**
- **Typhbar TCV** is manufactured by **India based company, Bharat Biotech.** It became the world's first conjugate vaccine prequalified by the WHO.

Global Alliance for Vaccine Initiative (GAVI)

- GAVI is a global **health partnership of public and private sector** organizations dedicated to "immunisation for all".
- It is backed by several global organisation, including the Bill & Melinda Gates Foundation, the WHO, the World Bank and the UNICEF, which arranges bulk buys to lower vaccine costs for poor countries.

Conjugate Vaccines

- Vaccines are used to prevent diseases by **invoking an immune response to an antigen** (the foreign part of a bacteria or virus that the immune system recognizes).
- This is usually accomplished with an **attenuated or dead version** of a bacteria or virus in the vaccine, so that the immune system can recognize the antigen later in life. Many vaccines contain a **single antigen** that the body will recognize.
- However, the antigen of some bacteria does not elicit a strong response from the immune system, so a vaccination against this weak antigen would not protect the person later in life.

- **Conjugate vaccines** combine **this weak antigen with a strong antigen** as a carrier so that the immune system has a stronger response to the weak antigen.

Pneumonia

- It is a lung infection that is most commonly caused by viruses or bacteria. These infections are generally spread by direct contact with infected people.
- Recently, Ministry for Health and Family Welfare launched **'SAANS'- Social Awareness and Action to Neutralise Pneumonia Successfully.**
- **It aims**
 - To reduce child mortality due to pneumonia.
 - To mobilise people to protect children from pneumonia,
 - To train health personnel and other stakeholders to provide prioritised treatment to control the disease.
- Under the campaign, a child suffering from pneumonia can be treated **with pre-referral dose of anti-biotic amoxicillin by ASHA workers.**
- Health and wellness centres can use pulse oximeter device to identify low oxygen levels in the blood of a child, and if required, treat him by use of oxygen cylinders.

Malaria

- Malaria is a life-threatening disease **caused by Plasmodium parasites.**
 - The parasites are spread to people through the bites of infected **female Anopheles mosquitoes,** called "malaria vectors."
 - There are 5 parasite species that cause malaria in humans, and 2 of these species – P. falciparum and P. vivax – pose the greatest threat.
- Recently, **Algeria and Argentina** have been officially recognized by **WHO as malaria-free.**
 - Certification is granted when a country proves that it has interrupted indigenous transmission of the disease for **at least 3 consecutive years.**
 - Globally, a total of 38 countries and territories have now been declared malaria-free, with **Maldives and Sri Lanka achieving status** in 2015 and 2016 respectively.



- **E-2020 initiative**
- WHO is working with different countries and other partners on the **E-2020 initiative** to eliminate **Malaria** in these countries by 2020.
- It is part of the **Global Technical Strategy for Malaria 2016-2030** endorsed by WHO which aimed to dramatically lower the global malaria burden over this 15-year period.

5.4. LIVESTOCK AND AVIAN DISEASES

5.4.1. INITIATIVE TO CONTROL LIVESTOCK DISEASES

Why in news?

Union cabinet approved initiative to control and subsequently eradicate **Foot and Mouth disease (FMD)** and **Brucellosis**.

Details

- The Cabinet cleared a total outlay of Rs. 13,343 crores for the next five years to fully control these diseases in order to support livestock rearing farmers in the country and create better livelihood opportunities for them.
- The **FMD** component of the scheme envisages **vaccination** coverage to 30 crore bovines (cows-bulls and buffaloes) and 20 crore sheep/goat and 1 crore pigs at six months' interval along with primary vaccination in bovine calves.
- The **Brucellosis** control programme shall extend to cover **100% vaccination coverage** of 3.6 crore female calves.

Foot and mouth disease

- It is a severe, highly contagious **viral disease** of livestock affecting cattle, swine, sheep, goats and other cloven-hoofed ruminants. It is **not zoonotic** and rarely transmits to humans.
- There are seven strains which are endemic in different countries worldwide. Each strain requires a specific vaccine to provide immunity.
- The disease is estimated to circulate in **77%** of the **global livestock population**. Intensively reared animals are more susceptible to the disease than traditional breeds.
- If a cow/buffalo gets infected with FMD, the milk loss is upto 100% which could last for four to six months.

Brucellosis

- It is a **zoonotic** and contagious disease of livestock caused by various **bacteria** of the family **Brucella**.
- It affects cattle, swine, sheep and goats, camels, equines, and dogs. It may also infect other ruminants, some marine mammals and humans.
- Transmission to humans is most often by drinking raw milk from infected animals, causing a severe debilitating disease in people.
- The disease in animals is characterized by **reproductive failure**. While animals typically recover, and will be able to have live offspring following the initial abortion, they may continue to shed the bacteria.
- In case of Brucellosis the milk output reduces by 30%, during the entire life cycle of animal.

5.4.2. AVIAN BOTULISM

Why in News?

Recently, Avian botulism became reason for bird deaths at Sambhar lake in Rajasthan.

Avian botulism

- Avian botulism is caused by a **bacterium called Clostridium botulinum**. It affects the nervous system of birds, leading to flaccid paralysis in their legs and wings and neck touching the ground.
- The bacteria *Clostridium botulinum* commonly found in the soil, river, and sea water.
- Factors that favoured the growth of *clostridium botulinum* include low levels of salinity, suitable temperature and high demand for chemical oxygen.

5.5. PHARMACEUTICALS

5.5.1. ANTIMICROBIAL RESISTANCE

Why in news?

Recently, the Interagency Coordination Group on Antimicrobial Resistance (IACG) has released a report titled, "**No Time to Wait: Securing The Future From Drug Resistant Infections**", which highlights the financial fall-out of uncontrolled antimicrobial resistance.

Interagency Coordination Group on Antimicrobial Resistance (IACG)

- It was convened by the **Secretary-General of the United Nations** after the UN High-Level Meeting on Antimicrobial Resistance in 2016.

- The IACG brought together partners across the UN, international organizations and individuals with expertise across human, animal and plant health, as well as the food, animal feed, trade, development and environment sectors, to formulate a blueprint for the fight against antimicrobial resistance.
- The World Health Organization (WHO) provided the Secretariat for the IACG, with contributions from the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE).

Details

- **Antimicrobial resistance (AMR)** is the ability of a microorganism (like bacteria, viruses, and some parasites) to stop an antimicrobial (such as antibiotics, antivirals and antimalarials) from working against it. As a result, standard treatments become ineffective, infections persist and may spread to others.
- Antibiotic resistance occurs naturally, but misuse of antibiotics in humans and animals is accelerating the process. Poor infection prevention and control further accelerate it.

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. WHO's report states that anti-biotic resistance may cause rise in death of Indians to 20 lakhs per year by 2050.

Steps taken

- 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).
- Government has formulated a **National Action Plan to combat Antimicrobial Resistance** in 2017 and National Policy for containment of antimicrobial resistance in 2011.
 - Recently, MP has **become the second state in India after Kerala** to develop an action plan to manage antimicrobial resistance (AMR).
 - The Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance

(MP-SAPCAR) focuses on a 'One Health' approach to containing AMR through key strategic priority areas and multi-sectoral involvement.

- It is in line with the National Action Plan on AMR (NAP-AMR) which calls for states to develop state level action plans to ensure on-the-ground implementation.

Related news

Global Antimicrobial Resistance (AMR) Research and Development (R&D) Hub

- **India has joined** Global AMR R&D Hub as a new member.
- This expands the global partnership working to address challenges and improve coordination and collaboration in global AMR R&D to 16 countries, the European Commission, two philanthropic foundations and four international organisations (as observers).
- It was launched in 2018 in the margins of the 71st session of the **World Health Assembly**, following a call from G20 Leaders in 2017.
- It **supports global priority setting and evidence-based decision-making** on the allocation of resources for AMR R&D through the identification of gaps, overlaps and potential for cross-sectoral collaboration and leveraging in AMR R&D.
- The operation of the Global AMR R&D Hub is supported through a Secretariat, established in Berlin and currently financed through grants from the German Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Health (BMG).

Related information

AWaRe Tool For Battling AMR

- It is a new online **tool developed by WHO** which aims at guiding policymakers and health workers to use antibiotics safely and more effectively.
- **AWaRe** groups antibiotics into three main categories based on their strength and potential impact on Antimicrobial resistance (AMR).
 - **'Access'** antibiotics are first- or second-line treatments for common infections and should be widely accessible.
 - **'Watch'** category should be applied only to a limited group of well-defined syndromes.
 - **'Reserve'** category is last resort to treat multi- or extensively-drug resistant bacteria.
- There is also a fourth category, **'discouraged antibiotics'**, refers primarily to irrational antibiotic combinations that may negatively impact AMR and patient safety.

IMPACT OF ANTIMICROBIAL RESISTANCE

- Risks to food and feed production, businesses and trade, interaction with climate change
- Increased morbidity and mortality in humans & animals
- Economic damage, loss of productivity & increased health care expenditures

DRIVERS OF ANTIMICROBIAL RESISTANCE

- HUMANS:** Misuse and overuse of antimicrobials; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; population movement
- PLANTS & CROPS:** Misuse and overuse of antimicrobials; poor infection and disease prevention and control
- FOOD & FEED:** Poor infection and disease prevention and control; transmission of resistant pathogens in food production, storage, distribution and preparation
- TERRESTRIAL & AQUATIC ANIMALS:** Misuse and overuse of antimicrobials; poor access to quality, affordable medicines vaccines and diagnostics; lack of awareness and knowledge; movement of animals
- WATER, SANITATION & HYGIENE:** Lack of access to clean water, sanitation and hygiene; poor infection and disease prevention and control in health care facilities and farms
- ENVIRONMENT:** Discharge of waste form health care facilities, pharmaceutical manufacturing & farms

5.5.2. USE OF ANTIBIOTICS IN ANIMAL FOOD

Why in News?

The health ministry has banned the manufacture, sale and distribution of the antibiotic colistin and its formulations for food producing animals and animal feed supplements.

About Colistin

- Colistin or polymyxin E is an **old antibiotic** first introduced in 1952.
- The drug has been used for treating infections caused by Gram-negative bacilli, which are responsible for various diseases such as plague, cholera and typhoid.
- However, it was revealed that colistin has side effects of nephrotoxicity and neurotoxicity, prompting to restrict the use of the drug and

replace it with other antibiotics which were considered safer at that time

- According to the World Health Organisation (WHO), Colistin is a “reserve” antibiotic, which means it is supposed to be considered a “**last-resort” option** in treatment and used only in the most severe circumstances, when all other alternatives have failed.
- It is found that the misuse of colistin in the poultry industry is said to be a **major reason for the increase in antibiotic resistance in India.**
- The ban has been **imposed under provisions of the Drugs and Cosmetics Act, 1940.**
- The ban follows recommendations by the Drugs Technical Advisory Board, and the National Antimicrobial Resistance Action Plan committee.
- The government also makes it mandatory for the **manufacturers of antibiotic colistin to write clearly on the label that the drug is not to be used in food-producing animals, poultry, aqua farming and animal-feed supplement.**
- **Reasons for use of Antibiotics in Animal food**
 - For the treatment of animals that show clinical signs of an infectious disease.
 - As growth promoter to boost the weight of the animals.
 - Easy availability of antibiotics.
 - Currently, few laws in India govern antibiotic use in food animals, and most pertain only to animal products for export.

Related information

Antibiotics in Crops

- **Aureofungin, Kasugamycin, Validamycin and Streptomycin+ Tetracycline combination** are antibiotics which are registered under the Insecticide Act 1968 for use as pesticides to combat certain fungal and bacterial diseases in plants.

5.5.3. MEDICAL DEVICES

5.5.3.1. GOVERNMENT NOTIFIES MEDICAL DEVICES AS ‘DRUGS’

Why in news?

Recently, the Union Ministry of Health has notified that starting from April 1, 2020, all medical equipment would qualify as “drugs” under the Drugs and Cosmetics Act, 1940.

More on the news

- As per the new notification, **all devices**, including instruments and implants, whether used alone or in combination for **various purposes** like diagnosis, prevention,

monitoring, among others, **will be regulated under the legislation.**

- Medical equipment under this definition include implantable medical devices such as knee implants, CT scan, MRI equipment, defibrillators, dialysis machine, PET equipment, X-ray machine etc.
- The manufacture, import and sale of all medical devices will now need to be certified by the **Central Drugs Standard Control Organisation.**

Law/regulatory body	Remark
CDSCO	Body under Ministry of Health and Family Welfare, Government of India provides general information about drug regulatory requirements in India
NPPA	Drugs (Price Control) Order 1995 and other orders enforced by NPPA
The Drugs and Cosmetics Act, 1940	Regulates the import, manufacture, distribution, and sale of drugs in India
The Pharmacy Act, 1948	Regulates the profession of Pharmacy

CDSCO: Central Drugs Standard Control Organization
NPPA: National Pharmaceutical Pricing Authority

MEDICAL DEVICE CLASSIFICATION IN INDIA ACCORDING TO THE PROPOSED SCHEDULE M-III DRAFT

The draft Schedule M-III released by the Central Drug Standards Control Organization (CDSCO) of India, includes a proposed risk classification for medical devices, based on their intended use.

Class	Risk Level	Device Examples
A	Low Risk	Thermometers/tongue depressors
B	Low-Moderate Risk	Hypodermic needles/suction equipment
C	Moderate-High Risk	Lung ventilator/bone fixation plate
D	High Risk	Heart valves/implantable defibrillator

5.5.3.2. MEDICAL DEVICES AMENDMENT RULES, 2020

Why in News?

Health Ministry released **Medical Devices Amendment Rules, 2020**, by amending the Medical Devices Rules, 2017 for **mandatory registration of medical devices.**

More about News

- Medical devices shall be **registered with Central Licensing Authority** through an identified online portal established by CDSCO.
- The registration will remain **voluntary for 18 months.**

Central Drugs Standard Control Organisation (CDSCO)

- CDSCO under Directorate General of Health Services, Ministry of Health & Family Welfare is the National Regulatory Authority of India.
- Its **headquarter** is located at **New Delhi.**
- Under the **Drugs and Cosmetics Act**, CDSCO is responsible for approval of Drugs, Conduct of Clinical Trials, laying down the standards for Drugs, control over the quality of imported Drugs and coordination of the activities of State Drug Control Organizations.
- CDSCO along with state regulators, is jointly responsible for **grant of licenses** of certain specialized categories of critical Drugs such as blood and blood products, I. V. Fluids, Vaccine and Sera.

5.5.3.3. NATIONAL ESSENTIAL DIAGNOSTIC LIST

Why in News?

Recently, the Indian Council of Medical Research (ICMR) finalised India's **first National Essential Diagnostics List (NEDL).**

Details

- This list aims to **bridge the current regulatory system's gap**, which does not cover all the medical devices and in-vitro diagnostic device (IVD).
 - Even though WHO's Essential Diagnostics List (EDL) acts as a reference point for development of national EDL, India's diagnostics list has been customised and prepared as per landscape of India's health care priorities.
- With this, India has become the **first country to compile such a list** that would provide guidance to the government for deciding the kind of diagnostic tests that different healthcare facilities in villages and remote areas require.
 - It builds upon the **Free Diagnostics Service Initiative** and other diagnostics initiatives of the Health Ministry to expand this basket of diagnostic tests.
 - It also encompasses tests relevant for new programmes such as Health and Wellness Centres (HWCs) under the Pradhan Mantri Jan Arogya Yojana.

5.5.4. NANO-PHARMACEUTICALS

Why in News?

Department of Biotechnology under Ministry of Science and Technology has prepared **draft**



guidelines for evaluation of nano-pharmaceuticals in India.

About Nano-Pharmaceuticals

- **Nanoscience** is the study of materials which are in nanoscale range.
 - Conversion of any material in nanoscale results in alteration of its physicochemical, biological, mechanical, optical, electronic, etc. properties which can be utilized for different useful activities.
- **Nano-pharmaceutical** is an emerging field that combines nanotechnology with pharmaceutical and biomedical science with the goal of **targeted drug delivery** which may improve efficacy and safety profile.
- There are **no uniform internationally acceptable guidelines** for nano-pharmaceuticals.
- It overcomes the limitations of the conventional drug delivery systems and **precision targeting**, offer the ability to **detect diseases** at much earlier stages and **reduces the cost** of drug discovery.
- However, the main challenges faced by regulatory institutions in India include: regulatory capacity, information asymmetry, Inter-agency coordination, overlapping roles and mandates etc.

Salient features of the Draft guidelines

- They aim to **ensure the quality, safety and efficacy** as well as encourage the **commercialization of nanotechnology** based innovation with high benefit and low risk ratio.
- **Defines nano-pharmaceuticals:** as a **pharmaceutical preparation containing nanomaterials (size scale range of 1 to 100nm)** intended for **internal or external application** on the body for the purpose of therapeutics, diagnostics and any health benefit.
 - It also includes preparations with the particle size is >100nm and <1000 nm as nano pharmaceuticals under certain circumstances.
- **Categorises nano pharmaceuticals:**
 - **According to degradability of nanomaterial:**
 - ✓ **Biodegradable nanoparticles** have been used frequently as drug delivery vehicles due to its improved bioavailability, better encapsulation, control release and reduction of toxic potential. Examples: albumin, chitosan, gelatin, polycaprolactone etc.

- ✓ **Nonbiodegradable nanoparticles** are relatively less used in pharmaceutical products (though these systems are more commonly used in cosmeceuticals). Almost all non-biodegradable nanoparticles have potential to toxic effects. Examples: titanium oxide, iron oxide, and metals such as gold, silver, platinum, etc.
- **According to nature of nanomaterial:** Nanomaterial may be organic or inorganic in nature. It may also be multicomponent nanoparticle.
 - ✓ **Organic Nanoparticles:** are the nanomaterials or nanoparticles composed of organic compounds like lipids, proteins, carbohydrates. They have been primarily developed for drug delivery to reduce or overcome the risk of toxicity.
 - ✓ **Inorganic Nanoparticles:** are **more stable** than organic nanostructures. They are **easier to prepare** with a defined size and a very narrow size distribution. However, most of the inorganic nanoparticles may **not be biodegradable**.
 - ✓ **Multicomponent nanoparticles** are the nanoparticles composed of two or more different materials.
- **According to nanoform of the ingredient:**
 - ✓ A nanocarrier is a nanomaterial being used as a transport module for another substance like a drug.
 - ✓ Some of the conventional/traditional drugs may be converted into nanocrystals, thereby increasing their potential for improved dissolution and bioavailability.
- **According to the approval status of drug and nanomaterial.**
- It mandates that the stability testing of nanopharmaceuticals should be done according to the general requirements specified in Drugs and Cosmetics Rules, 1945.

Related information

Mission on Nano Science and Technology (Nano Mission)

- Ministry of Science and Technology launched the Nano Mission in 2007 as an "umbrella capacity-building programme".
- The Mission's programmes will target all scientists, institutions and industry in the country.
- It will also strengthen activities in nano science and technology by promoting basic research, human resource development, research

infrastructure development, international collaborations, orchestration of national dialogues and nano applications and technology development.

- It is steered by a Nano Mission Council chaired by an eminent scientist.

5.5.5. TRADITIONAL MEDICINE

Why in News?

Recently, Ministry of AYUSH hosted World Health Organization meeting on developing **Standardized Terminologies** and **Benchmarks documents for Practice for Traditional Medicine**.

More in News

- **WHO is developing Benchmarks Document** for Practice of Ayurveda, Panchakarma & Unani and International Terminologies Documents in Ayurveda, Siddha & Unani.
- Development of these benchmarks documents is included in the Project Collaboration Agreement (PCA) signed between World Health Organization (WHO) and Ministry of AYUSH on **Cooperation in the field of Traditional and Complementary Medicine under WHO Traditional Medicine Strategy 2014-2023**.

What is Traditional Medicine?

- Traditional medicine describes a **group of health care practices and products with a long history of use**.
- It frequently **refers to medical knowledge developed by indigenous cultures** that incorporates plant, animal and mineral-based medicines, spiritual therapies and manual techniques designed to treat illness or maintain wellbeing.
- **Major traditional medicines in India include:** Ayurveda, Yoga, Siddha, Unani, Sowa-Rigpa, Naturopathy etc.

WHO Traditional Medicine Strategy 2014-2023

- **The strategy has two key goals:**
 - To support Member States in harnessing the potential contribution of Traditional Medicine to health, wellness and people centered health care
 - To promote the safe and effective use of Traditional Medicine through the regulation of products, practices and practitioners.
- **These goals will be reached by implementing three strategic objectives:**
 - Building the knowledge base and formulating national policies;

- Strengthening safety, quality and effectiveness through regulation; and,
- Promoting universal health coverage by integrating Traditional Medicine services and self-health care into national health systems.

Benefits of Traditional Medicine

- **Addresses gaps in health services:** Traditional medicine therapies are generally available and commonly used in low- and middle-income countries.
 - According to data provided to WHO, in India **70 percent of the population** depends on Traditional Medicine for primary health care.
 - Traditional medicines provide **low cost services** and are perceived to have lower side effects.
- **Treatment of major disease:** World Health Organisation has acknowledged that traditional medicine and its practitioners play an important role in treating chronic illnesses, and improving the quality of life of those suffering from certain incurable diseases.
- **Holistic approach to treatment:** In Ayurveda, a human being is seen as a combination of body, mind, soul and senses. So, in order to treat any illness, the system takes all four into account and treats the patient more holistically.
- **New drug development:** Traditional knowledge can provide valuable guidance in selecting and obtaining plant material of potential therapeutic interest.
 - Traditional medicines are the source of some modern antimalarial drugs.

- **Ayurveda** is an ancient medicine system of the Indian subcontinent which focuses more on healthy living than treatment of diseases. The main concept of Ayurveda is that it personalizes the healing process.
 - **Panchakarma** is an Ayurvedic treatment therapy that combines five (panch) different processes (karma) aimed at removing Ama (toxins) from the body. These processes are Vamanam (Emesis Therapy or vomiting), Virechanam (Purgation), Aasthaapana/Niruham, Anuvaasan (Oil enema) and Nasyam.
- **Yoga** is one of the six systems of Vedic philosophy which is essentially a spiritual discipline based on an extremely subtle Science which focuses on bringing harmony between mind and body. It is an art and science for healthy living.
- **Siddha** means achievements and Siddhars were saintly persons who achieved results in medicine. Eighteen Siddhars were said to have contributed

towards the development of this medical system. It is largely therapeutic in nature.

- **Unani System of Medicine** was introduced in India by the Arabs and Persians around the eleventh century. Involving the use of herbal remedies, dietary practices, and alternative therapies, Unani medicine addresses the prevention and treatment of disease.
- **Sowa-Rigpa** is an ancient Indian medical system which was enriched in the entire Trans-Himalayan region. At present Sowa-Rigpa is more popular in Himalayan societies especially in J & K region, Ladakh, Himachal Pradesh (Lahoul & Spiti), West Bengal (Darjeeling), Sikkim and Arunachal Pradesh and other parts of India. It is also being practiced in countries like Bhutan, Mongolia and Russia etc.
- **Naturopathy** is an art and science of healthy living and a drugless system of healing based on well founded philosophy. It has its own concept of health and disease and also principle of treatment.
- **Homeopathy** is a medical system based on the belief that the body can cure itself. Those who practice it use tiny amounts of natural substances, like plants and minerals. They believe these stimulate the healing process.

Related news

ICoSDiTAUS-2020

- International Conference on Standardisation of Diagnosis and Terminologies in Ayurveda, Unani and Siddha Systems of Medicine (**ICoSDiTAUS**) was jointly **organized by the Ministry of AYUSH and the World Health Organization (WHO)**.
- **Objective:** To mobilize commitment for **International Classification of Diseases (ICD-11) implementation and further development of the supplementary chapter on traditional medicine diagnoses in ICD-11.**
- The **sixteen countries** which took part in conference are: India, Sri Lanka, Mauritius, Serbia, Curacao, Cuba, Myanmar, Equatorial Guinea, Qatar, Ghana, Bhutan, Uzbekistan, Switzerland, Iran, Jamaica, and Japan.
- **Outcome:** Adopted '**New Delhi Declaration on Collection and Classification of Traditional Medicine (TM) Diagnostic Data**' and emphasised the commitment of the countries to Traditional Medicine as a significant area of health care.

International Classification of Diseases

- ICD is **international standard for reporting diseases and health conditions**. It is the **diagnostic classification standard** for all clinical and research purposes.
- ICD defines the universe of diseases, disorders, injuries and other related health conditions, listed in a comprehensive, hierarchical fashion.
- The ICD is maintained by WHO.

- **ICD-11** is eleventh revision of ICD containing necessary terminological and ontological elements for seamless use in digital health.

Related news

- Union Cabinet approved the establishment of the **National Institute for Sowa-Rigpa (NISR) in Leh** as an autonomous organization under the Ministry of AYUSH.
- The Institute will also provide opportunities for students of Sowa-Rigpa not only in India but also from other countries.

5.5.6. VACCINE HESITANCY

Why in news?

World Health Organization, recently included '**vaccine hesitancy**' as **one of the 10 threats to global health** highlighting that **overcoming 'vaccine hesitancy'** can reduce the global spread of measles infection.

What is Vaccine Hesitancy?

- As per WHO, Vaccine Hesitancy is defined as "reluctance or refusal to vaccinate despite the availability of vaccines" and is influenced by **factors such as complacency, convenience and confidence**.
 - Hesitancy in relation to vaccination may be caused by individual, group, and contextual influences, as well as any vaccine-specific issues causing people to reject it for themselves or their children.
- Vaccine hesitancy is a **dangerous global trend** – in both, populous emerging economies like India and China as well as advanced economies including the United States and Europe.
- **Factors responsible for Vaccine Hesitancy** like
 - Rise of the anti-vaccination movement in the West, Fear of risks associated with vaccines, Influenced by religious suspicions and rumours, lack of parental consent etc.
 - A **complex web of historical, political, sociocultural and economic factors** including everyday community social networking processes shape parents' choices not to vaccinate their children.

5.6. FOOD AND HEALTH

5.6.1. FOOD FORTIFICATION

Why in news?

Department of Food and Public Distribution under the Ministry of Consumer Affairs recently approved a centrally-sponsored pilot scheme on **fortification of rice** and its **dispersal through Public Distribution System (PDS)**.



More on news

- **Financial assistance** of up to 90 per cent in case of North-Eastern, Hilly and Island States and up to 75 per cent in case of rest of the States has been extended by GOI.
- Government of India has also advised all states and UTs especially those states and UTs, which are distributing wheat flour through PDS, to distribute fortified wheat flour through PDS.

What is food fortification?

- Food fortification is the **deliberate addition of one or more micronutrients** to food so as to correct or prevent a deficiency and provide a health benefit.
- These nutrients may or may not have been originally present in the food before processing.
- According to Food Safety and Standards (Fortification of Foods) Regulations, 2018 **fortification of staple foods is not mandatory.**
- Food fortification is a “complementary strategy” and not a replacement of a balanced & diversified diet to address malnutrition.
- **Food fortification:**
 - Can improve the health of a **large section of the population**, all at once since the nutrients are added to staple foods that are widely consumed.
 - **is safe method** of improving nutrition among people as the quantity added is very small and well regulated as per prescribed standards.
 - **is a socio-culturally acceptable way** to deliver nutrients to people as it does not require any changes in food habits and patterns of people and does not alter the characteristics of the food—the taste, the feel, the look.
 - **is cost effective and delivers quick results.** The **Copenhagen Consensus** estimates that every 1 Rupee spent on fortification results in 9 Rupees in benefits to the economy.

Why the need for food fortification?

- **Nearly 70% of people** in India **consume less than half** of their **recommended dietary allowance (RDA) of micronutrients.** The deficiency of micronutrients is also known as “**hidden hunger**” and leads to various diseases like Night Blindness (Vit A), Goitre (Iodine), Anaemia (Iron) and various birth defects.
- According to the National Family Health Survey (NFHS-4):
 - **58.4 percent of children** (6-59 months) are **anaemic.**

- **53.1 percent women** in the reproductive age group are **anaemic.**
- **35.7 percent** of children under 5 are **underweight.**
 - Around 50-70% of these birth defects are preventable, caused due to deficiency of **Folic Acid.**

Food Safety and Standards (Fortification of Foods) Regulations, 2018.

- It has **prescribed standards** for fortification of various food products such as All fortified foods must not fall below the minimum level of micro-nutrients.
- **Quality assurance:**
 - Every manufacturer and packer of fortified food shall give an undertaking on quality assurance
 - random testing of fortificants and fortified food
- Every package of fortified food shall carry name of the fortificant and the logo to indicate. **FSSAI** has recently introduced **+F logo for fortified staple food products.**
- The Food Authority shall take steps to encourage the production, manufacture, distribution, sale, and consumption

5.6.2. EAT RIGHT INDIA CAMPAIGN

Why in News?

The ‘EAT RIGHT INDIA Campaign’, with its new logo and tagline ‘Sahi Bhojan, Behatar Jeevan’ was released by the Union Health minister.

About Eat Right India movement

- Eat Right Movement was launched in 2018 by **Food Safety and Standards Authority of India** to improve public health in India and combat negative nutritional trends to fight lifestyle diseases.
- It is built on two broad pillars of **Eat Healthy and Eat Safe.**
- It brings together three ongoing initiatives of FSSAI that target citizens:
 - **The Safe and Nutritious Food (SNF) Initiative,** focused on social and behavioural change around food safety and nutrition at home, school, workplace and on-the-go.
 - **The Eat Healthy Campaign** focused on daily intake of salt, sugar, fat, phasing-out trans-fats.
 - **Food fortification,** focused on promoting five staple foods- wheat flour, rice, oil, milk and salt, with key vitamins and minerals added to improve their nutritional content.

- The Eat Right Movement brings together the **stakeholders on both the demand and supply-side.**
 - On the demand side, the **Eat Right Movement focuses on empowering citizens** to make the right food choices.
 - On the supply side, it **nudges food businesses to reformulate their products, provide better nutritional information to consumers and make investments in healthy food as responsible food businesses.**

About Trans-Fat
WHO has urged developing nations to **eliminate man-made trans fatty acids (TFA)** from their food supplies.

- TFA are of 2 types-
 - **Natural Trans-Fat**- Occur naturally in the dairy and some meat products.
 - **Artificial Trans-Fat**- They are created when the oil goes through hydrogenation, which involves adding hydrogen to the liquid oil to make it more solid.
- They help to **increase the shelf life of oils and foods** and stabilise their flavours.
- In India, Vanaspati, desi ghee, butter and margarine are the main sources of trans fat. Vanaspati is favoured by the industry as it prolongs a food product's shelf life and is cheap.
- The current **permitted level of trans fat** is 5 per cent (by weight) in India.
- FSSAI has further proposed to limit the maximum amount of trans fat in vegetable oils, vegetable fat and hydrogenated vegetable oil to 2 per cent to make India **trans-fat free by 2022**, a year ahead of the global target by the WHO for complete elimination of trans fat.
- WHO has released a step by step guide **"REPLACE"** for the industry to eliminate trans fats from the food by 2023.

5.6.3. NATIONAL DIGITAL HEALTH BLUEPRINT

Why in News?

J. Satyanarayana committee has recently submitted its report named National Digital Health Blueprint (NDHB) to Ministry of Health.

About NDHB

- NITI Aayog mooted the idea of National Health Stack (NHS) last year. NDHB is the **architectural document** for the implementation of the NHS.
- **Vision:**
 - To **create a National Digital Health Ecosystem** that supports Universal Health Coverage in an efficient, accessible,

inclusive, affordable, timely and safe manner.

- Ensuring the security, interoperability, confidentiality and privacy of health-related personal information.
- **Institutional Framework:** envisages a specialised organisation, **National Digital Health Mission (NDHM)**, that can drive the implementation of the blueprint, and promote and facilitate the evolution of a national digital health ecosystem.
- **Standards and Regulations:** Standards related to exchange of healthcare data, data privacy and patient security are given to enable interoperability.
- **Action Plan:** Expected outcomes like access to Electronic Health Records, continuum of care etc have been outlined. Methods needed for systematic implementation of the blueprint include:
 - a Federated Architecture
 - Unique Health Id (UHID)
 - Data Analytics
 - EHR (Electronic Health Record)
 - multiple access channels like call centre, Digital Health India portal and MyHealth App.
 - Legislation and Regulations on Data Management, with focus on Privacy and Security
 - Directories of Providers, Professionals and Para-medicals

About National Health Stack (NHS)

- NHS is digital infrastructure built with the aim of making the healthcare system more transparent and robust for the smooth functioning of healthcare interventions like Ayushman Bharat.
- Components of NHS
 - **E- national health registry** to serve as a single source of health data for the nation
 - **A coverage and claims platform** for health protection schemes like Ayushman Bharat and to enable a robust system of fraud detection
 - **A federated personal health records (PHR) framework**
 - **A national health analytics platform** to use health information for evidence-based policy making
 - **Other horizontal components-** unique digital health ID, health data dictionaries and supply chain management for drugs, payment gateways, etc.
- It will be India's first futuristic nationally shared digital healthcare infrastructure usable by both the Centre and states across public and private sectors.

5.6.4. E-CIGARETTES

Why in news?

Recently, Parliament has passed the Prohibition of Electronic Cigarettes (Production, Manufacture, Import, Export, Transport, Sale, Distribution, Storage, and Advertisement) Bill, 2019. It will replace an Ordinance promulgated in September 2019.

Key provisions of the Act

- **Definition of E-cigarette:** The Bill defines electronic cigarettes (e-cigarettes) as **electronic devices that heat a substance, which may contain nicotine and other chemicals, to create vapour for inhalation.** These e-cigarettes can also contain different flavours and include all forms of electronic nicotine delivery systems (ENDS), heat-not-burn products, e-hookahs, and other similar devices. Smoking e-cigarettes is also called **vaping**.
- **Prohibition on e-cigarettes-** It makes production, manufacture, import, export, transport, sale, distribution or advertisements of e-cigarettes a **cognizable offence**.
- **Storage of e-cigarettes:** No person is allowed to use any place for the storage of any stock of e-cigarettes. If any person stores any stock of e-cigarettes, he will be punishable with an imprisonment of up to six months, or a fine of up to Rs 50,000 or both.
 - Moreover, the owners of existing stocks of e-cigarettes will have to declare and deposit these stocks at the nearest office of an authorised officer.
- **Powers of authorised officers:** If an authorised officer believes that any provision of the Bill has been contravened, he can search any place where trade, production, storage or advertising of e-cigarettes is being undertaken. The authorised officer can seize any record or property connected to e-cigarettes found during the search. Further, he may take the person connected with the offence into custody.

5.7. OTHER NEWS

Arogyapacha plant	<ul style="list-style-type: none"> • Scientist had decoded the genetic make-up of Arogyapacha (Trichopus zeylanicus). • Arogyapacha is medicinal plant endemic to the Agasthya hills, also known as 'miracle plant' for its traditional use by the Kani tribal community to combat fatigue. • A drug named Jevanni was developed from Arogyapacha plant and it is patented by the Indian research institute Jawaharlal Nehru Tropical Botanical Garden and Research Institute (JNTBGRI).
Indian Brain Atlas (IBA 100)	<ul style="list-style-type: none"> • Researchers at the International Institute of Information Technology, Hyderabad (IIIT Hyderabad) have created the first ever Indian Brain Atlas known as IBA 100. • To construct this Indian population-specific human brain atlas, the researchers took MRI scans of 100 Indians. • The study from this atlas has revealed the average brain size of an Indian was smaller in height, width and volume in comparison to people of the Caucasian and eastern (Chinese and Korean) races. • Until now, Montreal Neurological Institute (MNI)'s Caucasian brains were used as standard to study brain. So, these MNI templates were not ideal for Indian population due to difference in ethnicity and ran the risk of misdiagnosis due to the difference in size of the brains. • IBA 100 will help in better/early diagnosis of Alzheimer's and other brain-related ailments. • The MNI and International Consortium for Brain Mapping (ICBM) had created first-ever digital human brain atlas in 1993.
3S Project	<ul style="list-style-type: none"> • Centre is planning to expand the reach of the Smart Safety Surveillance or 3S programme. <ul style="list-style-type: none"> ○ It is a project to optimize post-marketing surveillance of priority drugs and vaccines. ○ It was recommended by the World Health Organization (WHO), considering the limited safety data on vaccines introduced in India. • It aims to ensure the vaccines distributed under the universal immunization programme are safe. • As part of the 3S project, India is evaluating the recently-introduced rotavirus vaccines. • It is also trying to strengthen the collaboration among key stakeholders, such as Ministry of Health and Central Drugs Standard Control Organisation (CDSCO), to ensure high levels of vigilance.
National Deworming Day (NDD)	<ul style="list-style-type: none"> • Recently, tenth round of National Deworming Day (NDD) was conducted by Ministry of Health and Family Welfare. • NDD was launched in 2015 to make every child in the country worm free.



	<ul style="list-style-type: none">• As part of this campaign, children and adolescents aged 1-19 years are being administered Albendazole (400 mg) across government-aided schools, anganwadis, private schools and other educational institutions.• First round of NDD is conducted on February 10 each year. Bi-annual round of deworming is recommended in the States where prevalence of STH infection is more than 20%.• According to World Health Organization 241 million children between the ages of 1 and 14 years are at risk of parasitic intestinal worms in India, also known as Soil-Transmitted Helminths (STH).• Soil-transmitted helminths refer to the intestinal worms infecting humans that are transmitted through contaminated soil (“Helminth” means parasitic worm).
Myeloma	<ul style="list-style-type: none">• It is cancer of the plasma cells.• Plasma cells are white blood cells that produce disease- and infection-fighting antibodies in the body.• Myeloma cells prevent the normal production of antibodies, leaving the body's immune system weakened.
Yaravirus	<ul style="list-style-type: none">• The unusual virus was discovered in a lake in Brazil.• It infects amoeba and has genes that have not been described before, something that could challenge how DNA viruses are classified.• A DNA virus is a virus that has DNA as its genetic material and replicates using a DNA-dependent DNA polymerase (unlike an RNA virus whose genetic material is RNA).• Amount of unknown proteins composing Yaravirus particles reflects variability existing in viral world and how much potential of new viral genomes are still to be discovered.

6. IPR

6.1. INTERNATIONAL INTELLECTUAL PROPERTY (IP) INDEX

Why in news?

Recently **International Intellectual Property Index 2020** was released by US Chamber of Commerce's Global Innovation Policy Centre (GIPC).

More on news

- **India's ranked 40th among 53 countries**, while in 2019 India was ranked at **36th position out of 50 countries**.
- However, **India's score increased** from 36.04 per cent in 2019 to 38.46 per cent in 2020, a 2.42 per cent jump in an absolute score.
- **The US, the UK, Sweden, France and Germany remained the top five** economies on the index.



Other observations by GIPC with respect to India

- Since the **National IPR Policy 2016**, the Government of India has **made effort to support investments in innovation and increasingly robust IP protection and enforcement**.
- The policy has improved the speed of processing for patent and trademark applications, increased awareness of IP rights among Indian innovators and creators.
- However, it noted that **“job is not yet done”** on establishing stronger IP protections.
- India needs to do more in the field of patent enforcement, compulsory licensing, regulatory data protection, transparency in reporting seizures by customs, signing **Singapore Treaty on Law of Trade Marks and Patent Law Treaty**.

What is Intellectual Property?

- Intellectual Property (IP) refers to creations of mind such as inventions, literary and artistic works, designs and symbols, names and images in commerce.
- By striking the right balance between the interests of innovators and wider public interest, the IP system aims to foster an environment in which creativity and innovation can flourish.
- IPR are the rights which allow creators of patents, trademarks or copyrighted work to benefit them for their own work or investment. These rights have been outlined in **Article 27 of Universal Declaration of Human Rights**.
- The importance of IPR was first recognized in the **Paris Convention for the protection of Industrial Property (1883)** and **Berne Convention for the Protection of Literary and Artistic Works (1886)** (both administered by WIPO).
- IP activity in India is showing remarkable upward movement in the last 15 years with the number of Patents filed increasing nearly nine times.
- The **Office of the Controller General of Patents, Designs & Trade Marks (CGPDTM)** supervises the working of the Patents Act, 1970, as amended, the Designs Act, 2000 and the Trade Marks Act, 1999 and also renders advice to the Government on matters relating to these subjects.
 - It works under the Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry.
 - In order to protect the Geographical Indications of goods a **Geographical Indications Registry** has been established to administer the Geographical Indications of Goods (Registration and Protection) Act, 1999 under the CGPDTM.

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.
 - 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.
 - Trade marks in India are governed by Trade Marks Act 1999 which was amended in 2010.
 - Trade Mark Rules, 2017 has been notified which provides for ease of filing trademarks, rationalised trademark fee etc.
 - Modalities for determining well-known trademarks has been introduced for the first time
- **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.
 - 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.
 - 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”.

Related news

Global Innovation Index (GII)

- Recently, India has improved its ranking in the **GII** by five places to 52nd in 2019 from 57th position in 2018.
- It has been developed by the World Intellectual Property Organization (**WIPO**) together with top business universities like Cornell University, INSEAD etc.
 - It measures the **innovative capacity and outputs** of 129 economies, using **80 indicators** ranging from standard measurements such as research and development investments and patent and trademark filings, to mobile-phone app creation and high-tech net exports.
 - 2019 **GII** theme hosted by India was “**Creating Healthy Lives: The Future of Medical Innovation**” which is important and relevant for India because we would need a strong focus on medical innovation towards the goal of bringing healthcare and its delivery to all Indians.

World Intellectual Property Organisation (WIPO)

- WIPO is the **global forum** for intellectual property (IP) services, policy, information and cooperation.
- They are a **self-funding agency of the United Nations**, with 193 member states.
- **India is among its member states.**
- Their mission is to lead the development of a balanced and effective international IP system that enables innovation and creativity for the benefit of all.
- Their mandate, governing bodies and procedures are set out in the **WIPO Convention, which established WIPO in 1967.**

- **The Patent Law Treaty (PLT)** was adopted in 2000 with the aim of **harmonizing and streamlining formal procedures** with respect to national and regional **patent applications and patents** and making such procedures more user friendly.
- **Singapore Treaty on the Law of Trademarks** aims to create a modern and dynamic international framework for the **harmonization of administrative trademark registration procedures.**
- India is **not a signatory** to both the treaties.

National IPR Policy 2016

National IPR Policy is a vision document that aims to create and exploit synergies between all forms of intellectual property (IP), concerned statutes and agencies.

Seven objectives of IPR Policy

- **IPR Awareness:** To create public awareness about the economic, social and cultural benefits of IPRs.

- **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 owners with larger public interest.
- **Administration and Management:** To modernise and strengthen service oriented IPR administration.
- **Commercialization of IPRs:** 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.

6.2. PATENT PROSECUTION HIGHWAY PROGRAMME

Why in News?

Recently, the Union Cabinet approved a proposal for **Bilateral Patent Prosecution Highway (PPH) Programme** between the Indian Patent Office and patent offices of other interested countries.

Details

- With this, the **patent offices of India and Japan** have inked an agreement for expeditious grant of patents to Indian entities and individuals by entering into the **pilot programme on PPH** for a period of three years.
 - Under this pilot programme, **Indian Patent Office** may receive patent applications in certain **specified technical fields only**, like electrical, electronics, computer science, information technology, physics, civil, mechanical, textiles, automobiles and metallurgy while **Japan Patent Office** may receive applications in **all fields of technology**.
- The **PPH programme will lead to benefits like:**
 - reduction in disposal time and pendency of patent applications.
 - consistency in quality of granted patents.
 - more inbound investments by companies.
 - introduction of newer technologies thereby giving fillip to Make in India and increasing employment opportunities.

7. ALTERNATIVE ENERGY

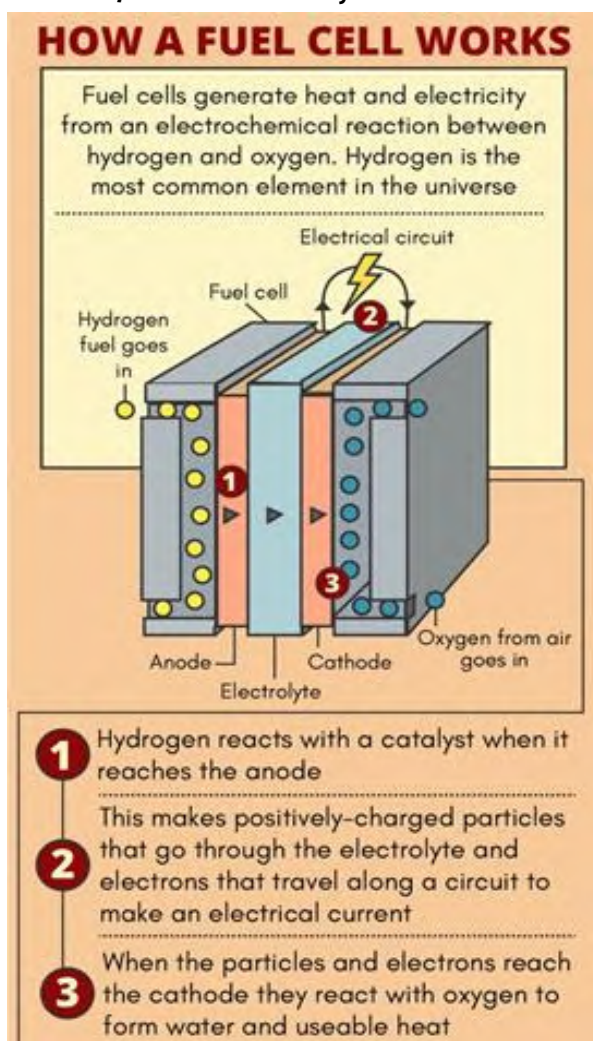
7.1. INDIGENOUS FUEL CELL

Why in news?

Recently, **India's first Indigenous Fuel Cell system** was unveiled.

More about the news

- It is **developed by Council of Scientific and Industrial Research (CSIR)** in partnership with Thermax Ltd, a Pune-based engineering firm.
- It is developed under the flagship program named **'New Millennium Indian Technology Leadership Initiative (NMITLI)**.
- It will be a **5 kW fuel cell system** and will use **methanol/bio-methane** to generate power with **70% more efficiency** than other sources.



About Fuel cell technology

- A fuel cell is like a battery that generates **electricity from an electrochemical reaction**.
- It **uses a source of hydrogen as fuel** but involves **no combustion**.
- With the help of oxygen present in the air, oxidation of hydrogen atoms occur and in the

process, electrons are released which flow through an external circuit as an electric current.

- The **byproducts** of fuel cell include heat and water.
- Fuel cells can vary from tiny devices producing only a few watts of electricity, right up to large power plants producing megawatts.

Related Information

Fuel Cell Electric Vehicles (FCEV)

- It uses **hydrogen as source of fuel and an oxidant** to create electricity.
- Unlike a battery-electricity vehicle, it **does not store energy** and, instead, relies on a constant supply of fuel (Hydrogen) and oxygen.
- Unlike the combustion engine cars, **there are no moving parts in the fuel cell**, so they are more efficient and reliable by comparison.
- They produce much **smaller quantities of greenhouse gases**.

New Millennium Indian Technology Leadership Initiative (NMITLI)

- It is an **initiative of CSIR** and is the largest public-private-partnership effort within the R&D domain in the country.
- It seeks to catalyze innovation centered scientific and technological developments as a vehicle to attain for Indian industry a global leadership position, in selected niche areas.
- NMITLI has so far evolved more than 50 largely networked projects in diverse areas viz. Agriculture & Plant Biotechnology, General Biotechnology, Bioinformatics, Drugs & Pharmaceuticals, Chemicals, Materials, Information and Communication Technology and Energy.

Council of Scientific & Industrial Research (CSIR)

- It was established as an autonomous society by the Government of India in 1942 under **Societies Registration Act, 1860**.
- The **Prime Minister of India acts as its President**.
- It is an R&D organization known for its cutting edge R&D knowledgebase in diverse S&T areas.
- CSIR has pan-India presence with a dynamic network of 38 national laboratories, 39 outreach centres, 3 Innovation Complexes and 5 units.
- It is mainly **funded by the Ministry of Science and Technology**.

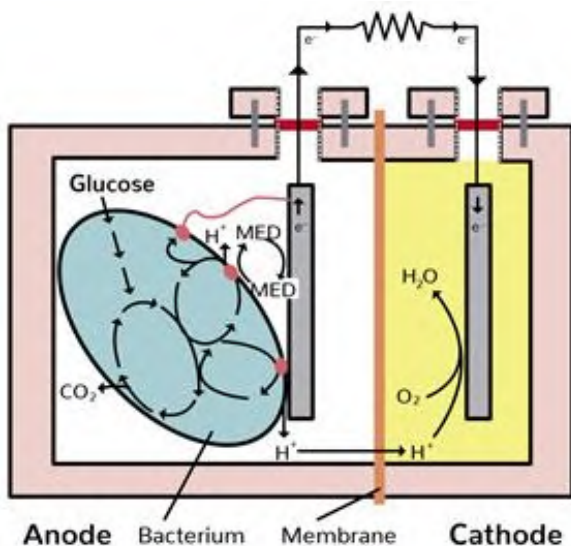
7.2. MICROBIAL FUEL CELLS

Why in News?

Zoological Society of London (ZSL) scientists used plants to power sensors in the wild by **installing microbial fuel cells**.

About Microbial fuel cells

- A microbial fuel cell (MFC) is a **bio-electrochemical device** that harnesses the power of respiring microbes to convert organic substrates directly into electrical energy.
- It transforms **chemical energy into electricity** using oxidation reduction reactions
- It relies on **living biocatalysts** to facilitate the movement of electrons throughout their systems instead of the traditional chemically catalyzed oxidation of a fuel at the anode and reduction at the cathode.
- It has **various applications** especially where there is low power requirement where replacing batteries may be impractical, such as wireless sensor networks, biosensors etc.



How do Microbial Fuel Cells Work?

- Microbial fuel cells work by **allowing bacteria to oxidize and reduce organic molecules**.
- **Bacterial respiration** is basically one big redox reaction in which electrons are being moved around.
 - An oxidation-reduction (redox) reaction is a type of chemical reaction that involves a transfer of electrons between two species.
- Whenever you have moving electrons, the **potential exists for harnessing an electromotive force to perform useful work**.
- A MFC consists of an **anode and a cathode separated by a cation specific membrane**.
- Microbes at the anode oxidize the organic fuel generating **protons** which pass through the membrane to the cathode, and **electrons** which pass through the anode to an external circuit to generate a current.
- The trick of course is **collecting the electrons released by bacteria as they respire**.

7.3. HYDROTHERMAL CARBONISATION

Why in news?

Recently, IIT Kharagpur has developed Hydrothermal Carbonisation technology which can generate energy from solid waste with high moisture content.

About Hydrothermal Carbonisation

- The technology is aimed at **conversion of wet biomass into hydro-char (a coal like fuel)** under suitable temperature and pressure conditions.
- The hydro-char, rich in carbon and high calorific content, can be utilized as fuel, as an alternative for coal, as feedstock for gasification, as a soil additive for nutrient enrichment, or as an adsorbent for activated carbon.
- Its by-products include ash which can be applied as a plant nutrient enhancer because of its phosphorus content, and also a potassium loaded liquid that can be used for watering plants.

Why India needs such technology?

- **High percentage of wet waste:** Of the 55 million tonnes of Municipal Solid Waste generated every year in India, 85% is biodegradable waste which has a very high moisture content ranging between 60 and 70 per cent of the total.
- **Realisation of target:** the technology will help India in achieving the renewable energy target of 10 GW bio power by 2022.
- **Indegenisation of technology:** This technology is **already in use in Japan and Germany**. And the development has led to India having its own technology.

7.4. BIOFUEL FROM MICROORGANISMS

Why in news?

Recently, **International Centre for Genetic Engineering and Biotechnology (ICGEB)** scientists developed a method to improve the **growth rate and sugar content** of a marine microorganism.

Details

- They have successfully engineered a marine **cyanobacterium called Synechococcus sp. PCC 7002**, which showed a higher growth rate and

sugar (glycogen) content of the cells, which will help in biofuel production.

- Generally, **sugars come from the photosynthesis** in plants, that converts carbon dioxide into biological components such as sugars, proteins and lipids.
- However, **Cyanobacteria (blue-green algae) can also perform photosynthesis** and produce sugar by fixing the carbon dioxide in the atmosphere. Further, cyanobacterial biomass **provides a nitrogen source in the form of proteins**.
- Bio fuel is **any hydrocarbon fuel** that is produced from organic matter (living or once living material) in a short period of time.

International Centre for Genetic Engineering and Biotechnology (ICGEB)

- The ICGEB is an **intergovernmental organisation** established as a special project of **United Nations Industrial Development Organization**, in 1983.
- The Organisation has three Component laboratories in:
 - Trieste, **Italy**,
 - New Delhi, **India**
 - Cape Town, **South Africa**.
- It became **fully autonomous** since 1994 and is running 46 laboratories and forms an interactive network with over **65 Member States**.
- It operates within the United Nations Common System, as **Centre of excellence for Research, Training and Technology Transfer to industry to promote sustainable global development**.

7.5. SODIUM SULPHUR BATTERY

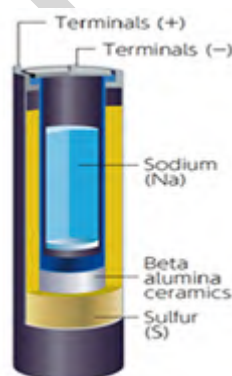
Why in News?

- Researchers at the Indian Institute of technology (IIT) Madras have designed a new sodium sulphur battery that can be operated at room temperature.

- By doing so, team was able to achieve higher charge storage capacity (technically called the specific capacity) and nearly zero self-discharge when the battery is not being used.

About Sodium Sulphur Battery

- It is a **high-temperature battery** which operates at 300°C and utilises a solid electrolyte, making it unique among the common secondary cells (rechargeable batteries).
- It has a **high-power density** and is suitable for **large-scale energy storage and space applications**.
- As electrodes are solid are room temperature and therefore inactive when cold and the battery can be stored for more than 50 years in that state. The battery **must be activated with a heat source** and the electrodes become liquid.
- The biggest advantage of sodium is in the cost area, as it is a far more common material than lithium and is much more widely available.
- However, the safety concerns greatly inhibit their widespread adoption.



8. RESEARCH & DEVELOPMENT

8.1. INDIA ADOPTS NEW DEFINITION OF KILOGRAM

Why in news?

National Physical Laboratory recently recommended updation of definition of Kilogram in the syllabi and textbooks in India recently.

Details

- The 26th General Conference on Weights & Measures (CGPM) last year redefined World's standard definition of **Kilogram, Ampere, Kelvin, and Mole**.
- Earlier, the kilogram derived its provenance from the weight of a block of a platinum-iridium alloy housed at the **International Bureau of Weights and Measures**.
- All other prototypes that served as national reference standards, including the one at New Delhi's CSIR-National Physical Laboratory (NPL), were calibrated to it.
- The NPL institute is also in the process of making its own '**Kibble Balance**' (in which the weight of a test mass is offset by an electromagnetic force), a device that was used to measure the Planck Constant and thereby reboot the kilogram.

THE SEVEN FUNDAMENTAL UNITS		
UNIT	QUANTITY	HOW IT IS/WILL BE DEFINED
Meter*	Distance	Based on speed of light
Kilogram**	Mass	To be based on Planck constant
Second*	Time	Based on hyperfine-transition frequency of caesium-133 atom
Ampere**	Current	To be based on an electron's charge
Kelvin**	Temperature	To be based on Boltzmann constant (Equal to a change in thermal energy of 1.380649×10^{-23} joules)
Mole**	Amount of substance	To be based on Avogadro constant ($6.02214076 \times 10^{23}$)
Candela*	Luminous intensity	From luminous efficacy of monochromatic light of frequency 540×10^{12} Hz

*Current definition stands**Being redefined

Impact of changes in definitions

- It will result in **uniform and worldwide accessible SI system** for high- technology manufacturing, basic science, etc. For example, earlier the scientific definition of the "second" had helped ease communication across the world via technologies like GPS and the Internet.

- The units shall be **stable in the long term**, internally self-consistent and practically realisable being based on the present theoretical description of nature at the highest level.
- It will **not be bound by the limitations of objects in our measurement** of the world, but have universality accessible units that can pave the way to even greater accuracy and accelerate scientific advancement.
- It will **not change measurements in our day to day life** like in kitchen, trade & transport etc. Thus for most people, everyday life will carry on as normal despite the redefinitions.

General Conference on Weights and Measures (CGPM)

- CGPM is the highest international body of the world for accurate and precise measurements.
- India became a signatory in 1957.**
- The CGPM meets usually once every four years.
- The International Bureau of Weights and Measures (BIPM), the main executive body of CGPM has the responsibility of defining the International System of Units (SI).

8.2. SUPERCONDUCTIVITY AT ROOM TEMPERATURE

Why in news?

Recently, a team from the Indian Institute of Science (IISc), Bengaluru has come up with a material, which exhibits **major properties of superconductivity** at ambient temperature and pressure.

About Superconductivity

- Superconductivity is a phenomenon in which the **resistance of the material to the electric current flow is zero**. When current is passed through an ordinary conductor, such as copper, a part of it is lost to the surroundings in the form of heat energy generated due to the resistance offered to its flow by the material. Low resistance means more of the supplied power gets to its intended destination. With the use of superconductors, this loss can be cut down.
- Significance of the recent development** - Till now, scientists have been able to make materials superconduct only at temperatures much below zero degree C and hence making practical utility very difficult, as maintaining such low temperatures are energy intensive and, thus, expensive.

- **The material confirmed** by the team is in the form of nano-sized films and pellets made of silver nanoparticles embedded in a gold matrix.

Applications of such material

- **Energy Storage**- Unlike conventional batteries, which degrade over time, semiconductors, which have zero loss of energy, can be used to store power. With more and more energy being produced from renewable sources, which needs to be stored, the power sector is looking for options, **which have minimum losses**.
- **Railways**- the trains running on magnetic levitation (**maglev**) have the potential to revolutionary transportation.
- **Power Transmission**- Currently, in the electricity grid, with wires running a long distance, a lot of energy is lost in the form of heat energy. It can be minimised using superconductors.
- **Other important applications include-**
 - **SQUIDS** (Superconducting Quantum Interference Devices) are used to detect even the weakest magnetic field. They are used in mine detection equipment to help in the removal of land mines.
 - **Large hadron collider or particle accelerator** - Superconductors are used to make extremely powerful electromagnets to accelerate charged particles very fast (to near the speed of light).

8.3. PROTON THERAPY

Why in News?

Vice President of India inaugurated **India's first proton therapy centre** in Chennai for the treatment of Cancer.

More in news

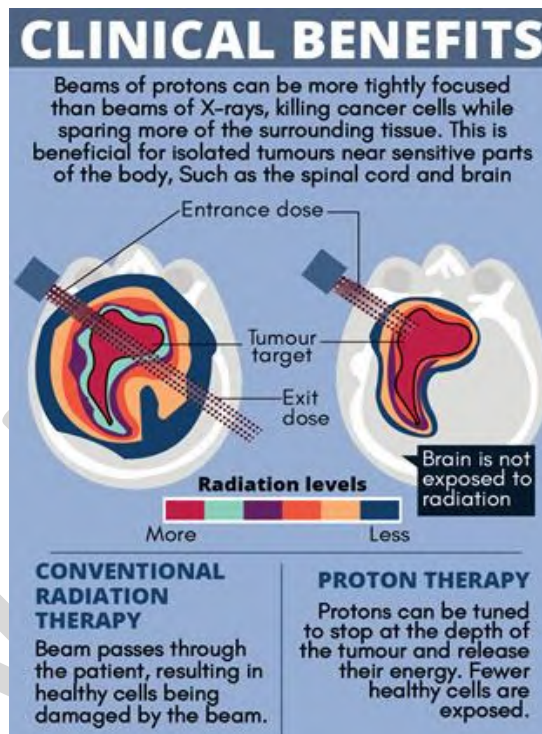
- The name of the centre is Apollo Proton Cancer Centre (APCC) and is launched by **Apollo Hospitals Group**. It is **South Asia's first** such centre.
- With this India becomes **16th country in the world** to offer the therapy.

About Proton Therapy

- It is a type of radiation therapy which uses protons rather than x-rays to treat cancer.
- It is considered as one of the most advanced forms of **external beam radiation therapy for cancer treatment** in the world. It is also known as **Proton Beam Therapy** and offers high levels

of precision as compared to other treatment options.

- It is particularly effective for paediatric cancers and tumours affecting the brain, eye, colon, breast, gastrointestinal area, pelvis, and prostate and those close to the spinal cord, brain stem and other vital organs.



Proton

- Atoms are the basic units of matter and the defining structure of elements. Atoms are made up of three particles: protons, neutrons and electrons
- The **proton** has a positive electrical charge, equal and opposite to that of the electron.

Advantages over standard radiation therapy

- **Standard radiation therapy** utilises x-rays, which deposits the majority of the radiation dose immediately upon entering the body. While X-ray beams are effective in controlling many cancers, they also deliver an 'exit dose' along the path beam. This exposes not just the targeted tumor to the radiation, but also the nearby healthy tissues.
 - This exit dose is a cause of concern as the damage to the normal tissue or organs can affect the patient's quality of life post-treatment.
- In comparison, protons slowly deposit their energy as they travel towards the cancerous tumor and then due to a unique physical characteristic called the **Bragg Peak**, deposit the majority of the **radiation dose directly in the tumor**.

- **Bragg Curve** describes energy loss of ionizing radiation during travel through matter.
- Proton beams target the tumour with **sub-millimetre accuracy**, leaving the nearby tissues and organs unharmed. Also, there is **no 'exit dose'** in case of proton beam. Protons stop after depositing the radiation dose in the tumor.

Challenges with Proton Therapy

- Proton Therapy is **highly specialised and expensive** treatment.
- It is **not applicable to all type of cancers**.
- More **research and clinical trials are needed** to make this treatment more affordable and applicable to all types of cancers.

8.4. OPTOELECTRONICS

Why in News?

Recently, researchers from IIT Madras have found a way of enhancing the **optoelectronic properties** of tungsten diselenide.

About Optoelectronics

- **Optoelectronics** is the study and application of electronic devices and systems that source, detect and control light.
- It is based on the quantum mechanical effects of light on electronic materials, especially semiconductors.
- It encompasses the design, manufacture and study of electronic hardware devices that, as a result, **converts electricity into photon signals** for various purposes such as medical equipment, telecommunications and general science.
- Some materials such as **tungsten diselenide** and **molybdenum diselenide** are being studied keenly for their optoelectronic properties.
- A key property of these materials is **photoluminescence**, in which the material absorbs light, generating an excited state, and then light of lower frequency is re-emitted.

Applications of Optoelectronics

- **Solar Cells**- that use **Photovoltaic**, which is the direct conversion of light into electricity.
- **Laser Diodes**- which are applied in compact disc (CD) players, laser printers, remote-control devices, and intrusion detection systems.
- **Light Emitting Diodes**- using electroluminescence, emits light when current flows through it.

- **Optical Fiber**- where data is transmitted in the form of light particles or **photons** that pulse through a fiber optic cable.

8.5. SHORT WAVE RADIO TRANSMISSION

Why in news?

Prasar Bharati has asked All India Radio (AIR) to come up with a proposal to phase out Short Wave (SW) transmitters.

Short Wave Radio transmission:

- It is transmission and reception of information by means of electromagnetic waves of about **10 to 100 m in length** having frequencies of approximately 3 to 30 megahertz.
- Radio waves in the shortwave band can be reflected or refracted by the ionosphere. Such wave propagation is called **skywave** or **"skip" propagation**.
- This refraction by ionosphere makes shortwave useful for very long distance communication, sometimes even beyond continents.
- **Dearth of revenue from** short wave transmission and **dwindling audience** with advent of digital mediums has called for phasing out of SW transmitters.
- However, AIR is resisting the move arguing that it will limit its global reach as short wave is the only effective way to reach to any part of the world, FM and other modes don't work always.
 - It cannot be easily blocked, even when states try to disrupt its signals using jamming transmitters. It is particularly useful in areas where information is censored or religious broadcasting is banned.
- Shortwave is **still significant** in much of **Africa, South Asia** and parts of **Latin America**.

Medium wave radio transmission

- It covers wavelength of 100 to 1000 metres and frequency of 0.3 to 3 MHz.
- There is very little daytime reflection of medium wave radio signal from the ionosphere resulting in a coverage of about 100 kms only.
- It is mostly used for **local broadcasting**, particularly rural communities.

Amplitude Modulation Radio

- With AM radio, the amplitude, or overall strength, of the signal is varied to incorporate the sound information.

- While changes in amplitude occur on FM radio as well, they are more noticeable in AM radio because they result in audible static.
- Its frequency lies between 500kHz–1.7MHz and wavelength is 600-170m.

Frequency Modulation

- Unlike AM radio, sound is transmitted through changes in frequency.
- Its frequency usually lies between 88-108 MHz and wavelength is between 3.4m-2.8m.
- It is used in **community-based radio stations**, over a limited geographical area since it has short-range signal - generally to anywhere within sight of the transmitter, with excellent sound quality.

8.6. CERAMIC MEMBRANES

Why in news?

Recently, Central Glass and Ceramic Research Institute, Kolkata has developed Ceramic Membranes for treatment of water contaminated with heavy metals.

About Ceramic membrane

- It is **prepared from a mixture of inorganic substances** such as alumina and clay.
- This filter is **able to segregate metals such as Iron, Arsenic, fluoride, Arsenic** etc along with the other pollutants when water passes through these membranes.
- Its **absorption capacity is upto 8 times higher** than other membranes and minimises water wastage and can operate under harsh operating environments.
- These membranes last for around 10-15 years without replacement. They can also be used in other sectors like food and beverage, drug and chemicals, waste recovery and recycling industries and are especially useful in petrochemical processing, where it is not possible to use organic membranes.

Why this technology is significant for India?

- **Water borne disease burden** According to an estimate, 50-60% of population in urban as well as rural areas suffers from water borne diseases in India. Heavy metals in water causes cardiovascular diseases, developmental

abnormalities, neurologic and neurobehavioral disorders, diabetes, hearing loss, hematologic and immunologic disorders.

- **Limitations of available technologies** Other micro water filters available in India such as RO, UV, UF can remove dissolved impurities, microorganisms, chemicals and salts but are unable to remove metal pollutants in water.

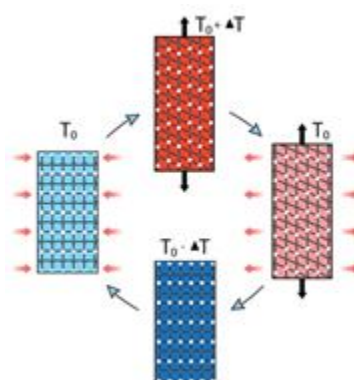
8.7. ELASTOCALORIC EFFECT

Why in News?

Recently, some researchers have highlighted that if harnessed effectively, Elastocaloric effect may help find alternatives to **fluid refrigerants** used in fridges and air-conditioners.

Details

- The elastocaloric effect occurs when **stress is applied or removed** inducing an internal transformation in the structure of the material.
- For instance, when the rubbers bands are twisted and untwisted, it produces a cooling effect. When the rubber band is stretched, it absorbs heat from its environment, and when it is released, it gradually cools down., and a phase transformation is induced.
- It is because in the elastocaloric effect, the **transfer of heat** works much the same way as when fluid refrigerants are compressed and expanded in the similar manner.
- Elastocaloric materials are those solids, which are capable of stress-induced reversible phase transformations in their structure during which latent heat is released or absorbed.



8.8. OTHER IMPORTANT NEWS

Global Innovation and Technology Alliance (GITA)	<ul style="list-style-type: none"> • It is a Public Private Partnership (PPP) between Technology Development Board (TDB), Department of Science & Technology (DST) and India's apex industry association Confederation of Indian Industry (CII). • GITA will assist DST in implementing Industrial R&D Programme with different countries under bilateral & multilateral Science & Technology Cooperation agreements.
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	<ul style="list-style-type: none"> The GITA has been envisaged as an industry-driven body for supporting competitive innovation clusters which in future can be entrusted with administering of Innovation Fund under a PPP model, IP acquisition by the government for non-exclusive licensing for public and social good, sectors of R&D and promotion of innovation culture in centres of excellence. It focuses on <ul style="list-style-type: none"> Professionally managing Government's industrial innovation funds, Providing flexibility to industry for R&D, including with global partners and Delivering commercial products and services to Indian and global markets.
SUPRA	<ul style="list-style-type: none"> Science and Engineering Research Board has developed a newly approved scheme SUPRA (Scientific and Useful Profound Research Advancement). <ul style="list-style-type: none"> It has sole objective of funding exploration of new scientific and engineering breakthroughs with global impact with long-term impact on our fundamental scientific understanding. It is designed to attract high quality research proposals consisting of new hypotheses or challenge existing ones and provide 'out-of-box' solutions. Funding will be provided normally for a period of three years, which could be extended to 2 years (5 years total) as assessed by an expert committee. SERB is a statutory body under Department of Science and Technology to promote and fund research in different scientific disciplines.
Science For Equity, Empowerment and Development (SEED)	<ul style="list-style-type: none"> This Division has been set up under the Department of Science and Technology. It is established with the broad objectives of providing opportunities to motivated scientists and field level workers to take up action oriented and location specific projects aiming towards socio-economic upliftment of poor and disadvantaged sections of the society through appropriate technological interventions especially in the rural areas. Under this Division efforts have been made to associate concerned National Labs or other specialist S&T institutions with each major program so as to build-in expert input, utilize national S&T infrastructure and link it up with grassroots S&T interventions/initiatives.
National Science Day	<ul style="list-style-type: none"> Theme in 2020- "Women in science". The Government of India designated 28 February as National Science Day (NSD) in 1986 and theme-based science communication activities are carried out all over the country. It is celebrated every year on 28th February to commemorate the discovery of the 'Raman Effect' by Sir C.V. Raman for which he was awarded the Nobel Prize in 1930. <ul style="list-style-type: none"> Raman effect can be defined as change in the wavelength of light that occurs when a light beam is deflected by molecules. Nodal Agency- National Council for Science & Technology Communication (NCSTC), Department of Science and Technology (DST) acts as a nodal agency to support, catalyze and coordinate celebration of the National Science Day throughout the country in scientific institutions, research laboratories and autonomous scientific institutions associated with the Department of Science and Technology.
ICAR-FUSICONT	<ul style="list-style-type: none"> Scientists from the 'Indian Council of Agricultural Research' (ICAR) have created an innovative technology called ICAR-FUSICONT to control disease named 'Panama Wilt' affecting banana crop in regions of Uttar Pradesh and Bihar. The disease Panama Wilt is caused by a fungus resulting in the loss of crop by more than 50%.
Chain-Melted State	<ul style="list-style-type: none"> It is newly discovered state of physical matter, in which atoms are both solid and liquid at the same time. This state was achieved by applying extreme pressure and extreme temperature to metal potassium. Generally, there are three basic states of matter namely – solid, liquid or gas. Further, two more exotic states of matter – plasma and Bose-Einstein condensate (BEC), both of which only exist in some extreme conditions.
Artificial Leaf	<ul style="list-style-type: none"> It is also known as Quantum Leaf which was developed by Indian Institute of Sciences' researchers. It uses water, sunlight and carbon dioxide to produce a widely-used gas syngas (mixture of hydrogen and carbon monoxide) without releasing any carbon dioxide into the air. This will help in reducing carbon footprint. It is composed of completely biocompatible, earth abundant, semiconductor nano crystals called Quantum dots which act as catalyst to convert absorbed CO₂ into bicarbonate and then 'formate' (derivative of formic acid) that can be used as bio fuel.
Carbon Nitrides	<ul style="list-style-type: none"> The carbon nitrides like C₃N₅, C₃N₆, C₃N₇ – have unique semi conducting characteristics. It has led to the development of technologies for conversion of carbon dioxide into fuel using sunlight and water and clean tech like sodium ion batteries to power electric vehicles.



	<ul style="list-style-type: none"> • Carbon nitride can be used as a metal free photo catalyst for water splitting, metal free system for carbon capture and conversion, electrode material for supercapacitors and battery, as an electrode catalyst for fuel cells, electrode for solar cell. • It will help in finding a solution for twin problems of pollution and fossil fuel depletion.
Goldschmidtite	<ul style="list-style-type: none"> • Recently, a new mineral, Goldschmidtite, has been discovered inside a diamond unearthed from a mine in South Africa. The mineral has an unusual chemical signature for a mineral from Earth's mantle. • Goldschmidtite has high concentrations of niobium, potassium and the rare-earth elements lanthanum and cerium, whereas the rest of the mantle is dominated by other elements, such as magnesium and iron. <ul style="list-style-type: none"> ○ For potassium and niobium to constitute a major proportion of this mineral, it must have formed under exceptional processes that concentrated these unusual elements.
Anthropogenic Mineral	<ul style="list-style-type: none"> • They are mineral that have been made on Earth, of substances formed as a result of human activities such as mining and mineral processing. • There are about 208 human-made minerals which have been approved as minerals by the International Mineralogical Association. • Example of Anthropogenic mineral: <ul style="list-style-type: none"> ○ Hydrotalcite are produced when asbestos tailings passively absorb atmospheric carbon dioxide. • Other type is True mineral which is naturally occurring and formed by geological processes either on Earth or in outer-space. True minerals comprise the majority of the approximately 5,200 known minerals. <ul style="list-style-type: none"> ○ Edscottite, recently in news, was discovered after an examination of the Wedderburn Meteorite, a metallic-looking rock found in Central Victoria back in 1951. It is made of iron and carbon, and was likely formed within the core of another planet.
Winter-grade diesel for high altitude	<ul style="list-style-type: none"> • Indian Oil Corporation (IOC) has launched a special winter-grade diesel for high altitude regions like Ladakh. • In regular diesel fuel, paraffin wax is added to improve for improving viscosity and lubrication but at low temperatures of -30° Celsius, it thickens or “gels” leading to freezing of diesel. • The winter-grade diesel developed by IOC has a low pour point of -33° Celsius which means that it has certain additives that enable the fuel to remain fluid in extremely low temperatures during the winter months in high-altitude sectors like Ladakh or Kargil. <ul style="list-style-type: none"> ○ Pour Point - It is the temperature below which the liquid loses its flow characteristics. • It is likely to reduce the hardships faced by the local people for transportation and mobility during winter months, helping facilitate the local economy and tourism.
High Flash High Speed Diesel (HFHSD – IN 512)	<ul style="list-style-type: none"> • Indian Oil Corp has developed a special class diesel conforming to NATO grade for use in ships and vessels of Indian Navy. • It also has lesser environmental impact due to low Sulphur content and would result in the better performance of engines. • This fuel will facilitate the Indian Navy to enhance its global footprint and will allow India to fuel the vessels of friendly foreign countries with recommended NATO grade fuel.
Purified Terephthalic Acid (PTA)	<ul style="list-style-type: none"> • In the recent Budget, government abolished an anti-dumping duty being levied on imports of PTA in public interest. • PTA is a raw material used to make various man-made fabrics or their components such as, polyester staple fibre and spun yarn. It makes up for around 70-80% of a polyester product. • Owing to its properties such as weathering resistance, strength and flexibility, PTA's usage is growing across various end-use industries such as food and beverages, electronics, and industrial fibre. • Removing the duty will allow PTA users to source from countries like China, Taiwan, Malaysia, Indonesia, Iran, Korea and Thailand, making it upto \$30 per 1,000 kg cheaper. <ul style="list-style-type: none"> ○ The move will also help to make the textiles sector a globally competitive industry.
Torrefaction	<ul style="list-style-type: none"> • India is testing this Swedish technology that can convert rice stubble into 'bio-coal'. • The technology involves heating up straw, grass, saw- mill residue and wood biomass to 250°C - 350°C. • This changes the elements of the biomass into 'coal-like' pellets. These pellets can be used for combustion along with coal for industrial applications like steel and cement production.
Microdot technology	<ul style="list-style-type: none"> • In the microdot technology, the body and parts of the vehicle or any other machine are sprayed with microscopic dots, which give a unique identification. • The use of this technology helps check not only vehicle theft but also use of fake spare parts. • Microdots are "permanent and nearly invisible" that can be read physically with a microscope and identified with ultraviolet light source.

9. AWARDS

9.1. NOBEL PRIZES 2019

9.1.1. NOBEL PRIZE IN PHYSICS

Why in news?

The Nobel Prize in Physics 2019 was awarded to three scientists- James Peebles, Michel Mayor and Didier Queloz “for contributions to our understanding of the evolution of the universe and Earth’s place in the cosmos”.

More about the news

- **James Peebles** was awarded for “theoretical discoveries in physical cosmology”.
- Peebles’ theoretical tools are the foundation of our modern understanding of the universe’s history, **from the Big Bang to the present day**. His theoretical tools and calculations helped interpret traces from the infancy of the universe.
- **Michel Mayor and Didier Queloz** were awarded for discovering “an exoplanet orbiting a solar-type star”.
- They discovered **the first planet outside our solar system**, an exoplanet, named **51 Pegasi B** orbiting a solar-type star in our home galaxy, the Milky Way, in 1995.
- It **started a revolution in astronomy as more than 4,000 exoplanets** have since been discovered in the Milky Way since then.
- These discoveries challenged the world’s existing ideas about planetary systems and building up on them in the future might just help **find answer humanity’s eternal quest about whether life exists outside of the earth and the solar system**.

9.1.2. NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

Why in news?

The Nobel Prize in Physiology or Medicine has been awarded to **William Kaelin, Peter Ratcliffe** and **Gregg Semenza** for discovering the complex processes behind how human cells respond to change in levels of oxygen.

More on news

- The research has tried to explain how cells adapt to higher or lower amounts of the molecule in the atmosphere.
- When the body detects that less oxygen is present, the kidneys release a hormone called **erythropoietin**, or **EPO**, which tells the body to

make more red blood cells to carry more oxygen around.

- They found that a protein called **hypoxia-inducible factor**, or **HIF**, rises when there’s less oxygen around.
 - HIF then bonds to sections of DNA near the gene that produces EPO.
 - Extra HIF protein around the EPO gene acts like a turbo charge for the hormone’s production, which is how the body knows to make more red blood cells.
 - When there’s sufficient oxygen available again, HIF levels drop, as do red blood cell counts.

Significance

- **Understand body functioning-** This research can help understand the processes behind the generation of new blood vessels, the production of red blood cells, certain immune system functions and even fetal and placenta development.
- **Tackling diseases-** Much more information can be obtained about the diseases arising from these pathways, such as cancers that proliferate using the oxygen-sensing system to grow tumors.
 - The new knowledge would help to treat major diseases like **cancer** and **anaemia**.
- **Formulation of drugs-** Already, a number of drugs have been developed on the back of the understanding of this oxygen-sensing pathway. More experimental drugs on blocking blood vessel formation, aiming to prevent tumor growth in some cancers can be introduced.

9.1.3. NOBEL PRIZE IN CHEMISTRY

Why in news?

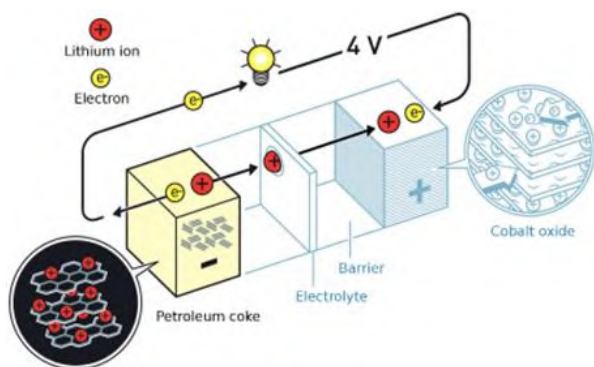
The 2019 Nobel Prize in Chemistry was awarded to **John D. Goodenough, M. Stanley Whittingham** and **Akira Yoshino** for their roles in the development of **lithium-ion batteries**.

More in news

- **M. Stanley Whittingham:** laid foundations of Lithium (Li) ion batteries in 1970s, when he used titanium disulphide as cathode and metallic lithium, which is highly reactive, as anode.
- **John B. Goodenough:** In 1980s, he replaced titanium disulphide with cobalt oxide as the cathode doubling the battery’s potential.

However, the use of reactive lithium remained a concern.

- **Akira Yoshino:** The first commercially viable lithium-ion battery was developed by him in 1991. He replaced lithium anode with petroleum coke anode, which drew Li-ions towards it from the Lithium Cobalt oxide cathode.



About Lithium ion batteries

- A lithium-ion battery is a type of rechargeable battery.
- Lithium-ion batteries are commonly used for portable electronics (smartphones, laptops etc) and electric vehicles and for military and aerospace applications.
- **Advantages:**
 - It is **light weight and has high energy density** (i.e. stores more energy per unit of weight when compare to other kind of batteries.) It is able to store 150 watt-hours electricity per kg of battery.
 - Li-ion battery cells can **deliver up to 3.6 Volts, 3 times higher** than technologies such as Nickel Cadmium (Ni-Cd) batteries.
 - Rechargeable lithium-ion batteries **have 5000 cycles or more** compared to just 400-500 cycles in lead acid batteries.
 - Li-ion batteries are also **comparatively low maintenance**, and do not require scheduled cycling to maintain their battery life.
 - Li-ion batteries have **no memory effect**, a detrimental process where repeated partial discharge/charge cycles can cause a battery to 'remember' a lower capacity.
 - Li-ion batteries also have **low self-discharge rate** of around 1.5-2% per month.
 - They **do not contain toxic cadmium**, which makes them easier to dispose of than Ni-Cd batteries.
- **Limitations of Li-ion batteries:**
 - They have a tendency to overheat, and can be damaged at high voltages. In some cases this can lead to combustion. This can

cause transportation restrictions on large quantities of Li-ion batteries.

- Li-ion batteries require safety mechanisms to limit voltage and internal pressures, which can increase weight and limit performance in some cases.
- Another factor limiting their widespread adoption is their cost, which is around 40% higher than Ni-Cd.

Related information

Four-Fold Jump in Li-Ion Battery Imports Since 2016

- As per a Government reply in Lok Sabha, **India has quadrupled its imports of lithium-ion (Li-ion) batteries** and more than tripled its import bill on the product, from 2016-2018.
 - **Indian manufacturers** source Li-ion batteries from China, Japan and South Korea and the country is **among the largest importers in the world**.
- **Steps taken by India**
 - Union Cabinet in 2019 approved a programme, **National Mission on Transformative Mobility and Battery Storage** in the NITI Aayog to drive clean, connected, shared, sustainable and holistic mobility initiatives.
 - **ISRO has commercialized indigenously developed li-ion battery technology** and has selected 14 companies for transfer of technology.
 - Central Electro Chemical Research Institute (CECRI), under Council of Scientific & Industrial Research (CSIR) and RAASI Solar Power Pvt Ltd have **signed a Memorandum of Agreement for transfer of technology for India's first Li-ion Battery project in 2018**.

ISRO has transferred its indigenous technology to produce space-grade Li-ion cells to BHEL

- In March 2018, BHEL signed the Technology Transfer Agreement with ISRO for acquiring the Li-Ion Cell production technology.
- Under the agreement, space-grade Li-Ion cells manufactured by BHEL are meant for meeting national requirements only.
- However, BHEL can also sell the space-grade Li-Ion cells to parties outside India after obtaining prior written consent from ISRO.

9.2. SHANTI SWARUP BHATNAGAR PRIZE FOR 2019

Why in news?

Recently, twelve scientists have been awarded the prestigious Shanti Swarup Bhatnagar award for science and technology for 2019.

About Shanti Swarup Bhatnagar prize

- **Awarded by:** Council of Scientific and Industrial Research. It was first awarded in 1958.

- **Purpose:** It awarded annually for notable and outstanding research, applied or fundamental, in the disciplines namely:
 - Physical Sciences,
 - Chemical Sciences,
 - Biological Sciences,
 - Medical Sciences,
 - Mathematical Sciences,
 - Engineering Sciences and
 - Earth, Atmosphere, Ocean and Planetary Science.
- **Eligibility:** Any citizen of India engaged in research in any field of science and technology up to the age of 45 years. Overseas citizen of India (OCI) working in India are also eligible.
- **Prize:** The prize carries a cash component of Rs 5 lakh each.

About Dr Shanti Swarup Bhatnagar

- Dr Shanti Swarup Bhatnagar was the **Founder Director (and later first Director General) of Council of Scientific & Industrial Research (CSIR)** who is credited with establishing twelve national laboratories. He was awarded the Padma Vibhushan in 1954 by the President of India.
- He played a **significant role in building of post independent S & T infrastructure and in the formulation of India's S & T policies.**
- His research contributed to several areas of chemical sciences **including emulsions,**

colloids and industrial chemistry. His pioneering research in the **field of magneto-chemistry is acclaimed throughout the world.**

- He played an instrument role in the establishment of the **National Research Development Corporation (NRDC)** of India.

9.3. SWARNA JAYANTI FELLOWSHIPS

Why in News?

Recently, **Swarna Jayanti Fellowships have been awarded to 14 Scientists** associated with projects containing innovative research idea and with potential of making impact on Research & Development in the respective disciplines.

More about News

- The Swarna Jayanti Fellowships scheme was instituted by Government of India to commemorate India's fiftieth year of independence.
- Under this scheme, a selected number of young scientists, with proven track record, are **provided special assistance and support to enable them to pursue basic research** in frontier areas of science and technology.
- The **awardees are supported by Department of Science & Technology**, for fellowship and research.

10. MISCELLANEOUS

10.1. ANNULAR SOLAR ECLIPSE

Why in news?

Recently, parts of Kerala, Karnataka and Tamil Nadu witnessed an annular solar eclipse. Rest of the country witnessed a partial solar eclipse.

About Solar eclipse

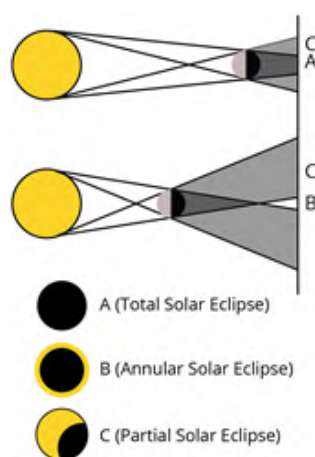
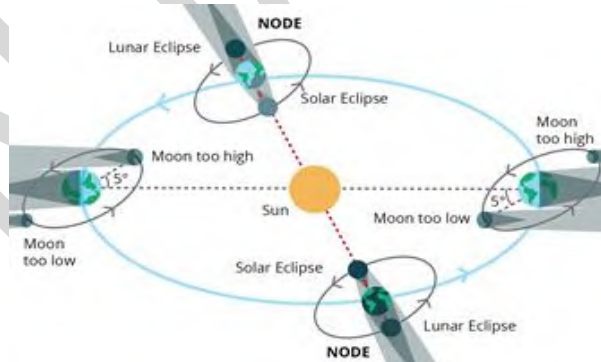
Solar eclipse happens when the moon, while orbiting the Earth, comes in between the Sun and the Earth, thereby blocking the sun's light, **fully or partially**.

There are four types of eclipses:

- **Total solar eclipse:** Total solar eclipses are rare at any particular location because totality exists only along a narrow path on the Earth's surface traced by the Moon's full shadow or umbra.
 - It happens when:
 - ✓ it is New Moon.
 - ✓ the Moon is near perigee (the closest point of the Moon from Earth).
 - ✓ the Moon is at (or very near) a lunar node, so the Earth, the Moon, and the Sun are aligned in a straight (or nearly straight) line.
 - It is visible only from a small area on Earth.
 - People who are able to view the total solar eclipse are in the centre of the moon's shadow as and when it hits the Earth.
- **Partial solar eclipse:** In it the shadow of the moon appears on a small part of the sun.
- **Annular solar eclipse (ASE):**
 - It occurs when the angular diameter of the Moon falls short of that of the Sun so that it cannot cover up the latter completely.
 - Since the moon does not block the sun completely, it looks like a "dark disk on top of a larger sun-colored disk" forming a "ring of fire" (or annulus).
 - For an ASE to take place, three things need to happen-
 - ✓ there should be a **New Moon**
 - ✓ the Moon **should be at or very near a lunar node** so that the Sun, Moon and the Earth all are in a straight line
 - ✓ the Moon **should be near the apogee** (the farthest point of the Moon from Earth) so that the outer edge of the Sun is visible.
 - During one of the phases of the ASE a phenomena called **Bailey's Beads'** are visible. This is a thin fragmented ring

caused by passage of sunlight through the rough edge of the Moon.

- This is the only time when one can find **two shadows** for everything in all the sides under the sunlight because the light source during Annularity is a giant illuminating ring.
- During an ASE, NASA uses ground and space instruments to view top layer of the sun or **corona** when the sun's glare is blocked by the moon.
- During partial and annular solar eclipses, it is dangerous to view sun without proper equipment and techniques. Not using proper methods and equipment for viewing can cause permanent eye damage or severe visual loss.
- **Hybrid Eclipse:** This is a very rare eclipse where the eclipse will only be annular for the first few seconds. For the rest it will be a total eclipse.



Lunar nodes

- The Moon's orbit around the Earth is tilted with relation to the Earth's orbital plane by **5 degrees** with two intersecting points - '**Ascending Node**' and '**Descending Node**'.
- Thus, despite the Moon being between the Earth and Sun on every new Moon, the three do not always come on a straight line or cause an eclipse.



- These nodes also rotate around the Earth once in **18 years**.
- In this way, if a new Moon takes place when a node is also between the Earth and Sun, the three come in a straight line and an eclipse takes place.

10.2. SCIENTIFIC SOCIAL RESPONSIBILITY (SSR)

Why in News?

Department of Science and Technology (DST) released a **draft of its proposed Scientific Social Responsibility (SSR) policy**.

About Scientific Social Responsibility (SSR)

- India is going to be **possibly the first country in the world to implement a Scientific Social Responsibility (SSR) Policy** on the lines of Corporate Social Responsibility (CSR).
- It is the **confluence of scientific knowledge with visionary leadership and social conscience**.
- SSR is **about building synergies among all stakeholders in scientific knowledge community** and also about developing linkages between science and society.
- It aims to **encourage science and technology (S&T) institutions and individual scientists** in the country to proactively engage in science outreach activities to connect science with the society.
- SR policy would involve **four different categories of stakeholders**:
 - beneficiaries (students; school/college teachers; local bodies; communities; women's groups etc.),
 - implementers (institutions, science centers, Central Ministries, State Governments etc.),
 - assessors (Internal assessment cell or external agency) and
 - supporters (government agency, Corporate bodies etc. providing grants/funds).
- The **main objective of SSR policy** is to harness the voluntary potential that is latent in the country's scientific community to strengthen science and society linkages so as to make S&T ecosystem vibrant through Science-society connect & cultural change.

Policy directives

- **10 person-days of SSR per year**: Individual scientists or knowledge workers will be required to devote at least 10 person-days of

SSR per year for exchanging scientific knowledge to society.

- **Appraisal and evaluation**: It has also been proposed to give credit to knowledge workers/scientists for individual SSR activities in their annual performance appraisal and evaluation.
 - **No institution would be allowed to outsource** or sub-contract their SSR activities and projects.
 - All knowledge workers would be **sensitised** by their institutions about their ethical responsibility to contribute.
 - There should be an SSR monitoring system in each institution to assess institutional projects and individual activities.
- **Implementation agency**: A central agency will be established at DST to implement the SSR. Other centre & state ministries would also be encouraged to make their own plans to implement SSR as per their mandate.

Related news: SATHI

- IIT Kharagpur has been selected for setting up a **Sophisticated Analytical and Technical Help Institute (SATHI)**.
- **About SATHI**:
 - It is an **initiative of the Department of Science and Technology**.
 - SATHI will be developed as a state-of-the-art shared, professionally managed science and technology infrastructure facility.
 - They will be equipped with major analytical instrument and advanced manufacturing facility, which is usually not available at Institutes / Organisations.
 - The aim is **to provide professionally managed services** with efficiency, accessibility and transparency under one roof to service the demands of industry, start-ups and academia.
 - SATHI facilities will be used for 80% of their available time by External Users i.e. out-side of the Host Institutes.
 - **IIT Kharagpur will treat the SATHI Centre as its Social Scientific Responsibility (SSR) programme** to promote the culture of science-based entrepreneurship and start-ups in the country.
 - IIT-Delhi and BHU-Varanasi are other institutes where SATHI facilities will be located.

10.3. PERSONALITIES

10.3.1. SRINIVAS RAMANUJAN

Why in News?

Scientists from Technion — Israel Institute of Technology have developed a concept named the



Ramanujan Machine, after the Indian mathematician.

About Ramanujan Machine

- It is an algorithm that reflects the way **Srinivasa Ramanujan worked** during his brief life.
 - Throughout his life, Ramanujan **came up with novel equations and identities** including equations leading to the value of pi and it was usually left to formally trained mathematicians to prove these.
- The purpose of the machine is **to come up with conjectures in the form of mathematical formulas that we can analyze.**
- In most computer programs, **humans input a problem and expect the algorithm** to work out a solution. But with the Ramanujan Machine, it **works the other way around.**
 - Feed in a constant, say the well-known pi, and the algorithm will come up with an equation involving an infinite series whose value, it will propose, is exactly pi.

About Srinivas Ramanujan

- He was one of **India's greatest mathematical geniuses** born in Madras (1887-1920).
- With very little formal training, he engaged with the most celebrated mathematicians of the time, particularly during his stay in England (1914-19), where he eventually became a **Fellow of the Royal Society and earned a research degree** from Cambridge.
- He discovered **Hardy Ramanujan number i.e. 1729** which is the smaller number which can be expressed as the sum of two cubes in two different ways- $1729 = 1^3 + 12^3 = 9^3 + 10^3$.
- Ramanujan made substantial contributions to the **analytical theory of numbers and worked on elliptic functions, continued fractions and infinite series.**

10.3.2. DR. VIKRAM SARABHAI

Why in news?

ISRO is planning for a yearlong programme for commemorating the birth centenary of its founder father Dr. Vikram Sarabhai.

About Dr. Vikram Sarabhai

- Born in Ahmedabad in 1919, Dr. Vikram Sarabhai is considered as the **father of India's space program.**
- He was a great institution builder and established or helped to establish a large number of institutions in diverse fields.

- He was instrumental in establishing the Physical Research Laboratory (PRL) in Ahmedabad in 1947.
- He also founded the **Ahmedabad Textile Industry's Research Association in 1947** and looked after its affairs until 1956.
- After Russia's Sputnik launch, he managed to convince the Indian government on the need for India, a developing country, to have its own space program. For this he **established the Indian National Committee for Space Research** in 1962, which was later, **renamed the Indian Space Research Organization (ISRO).**
- He helped **set up the Thumba Equatorial Rocket Launching Station in Thiruvananthapuram**, with its inaugural flight in 1963. It was later **renamed as the Vikram Sarabhai Space Centre (VSSC).**
- He along with other Ahmedabad-based industrialists played a major role in the creation of the **Indian Institute of Management, Ahmedabad.**
- He had worked on India's first satellite '**Aryabhata**'.
- Some of the other well-known institutions established by Dr. Sarabhai are:
 - Community Science Centre, Ahmedabad
 - Darpan Academy for Performing Arts, Ahmedabad (along with his wife)
 - Space Applications Centre, Ahmedabad (This institution came into existence after merging six institutions/centres established by Sarabhai)
 - Faster Breeder Test Reactor (FBTR), Kalpakkam
 - Variable Energy Cyclotron Project, Calcutta
 - Electronics Corporation of India Limited (ECIL), Hyderabad
 - Uranium Corporation of India Limited (UCIL), Jaduguda, Bihar
- After the death of physicist Homi Bhabha in 1966, Sarabhai was appointed chairman of the Atomic Energy Commission of India. Carrying forward Bhabha's work in the field of nuclear research, Sarabhai was largely responsible for the establishment and development of India's nuclear power plants. He laid the foundations for the indigenous development of nuclear technology for defense purposes.

Awards and honours

- He received the Shanti Swarup Bhatnagar Award in 1962, Padma Bhushan in 1966 and was conferred the Padma Vibhushan posthumously in 1972.

- In 1973, a crater on the moon was named after him.
- Lander of Chandrayaan 2, India's 2nd mission to moon is named 'Vikram' to honour late Dr. Vikram Sarabhai.

10.4. OTHER IMPORTANT NEWS

Denisovans	<ul style="list-style-type: none"> • Scientists have for the first time restructured Denisovans' skeletal features, using DNA methylation (chemical changes), to understand how the long-lost human relative looked like, as reported by The Nature. • Denisovans are an extinct species of hominid and a close relative to modern humans. <ul style="list-style-type: none"> ○ Scientists first identified Denisovan remains from Denisova cave located in the Altai mountains in Siberia in 2010. ○ Denisovans may have ranged from Siberia to Southeast Asia during the last Ice Age. ○ Denisovans share a common ancestor with both modern humans and Neanderthals. This common ancestor, called Homo heidelbergensis, most likely lived in Africa. <p>Danuvius guggenmosi</p> <ul style="list-style-type: none"> • It is an ape that lived about 11.6 million years ago which combined attributes of humans - straight lower limbs adapted for bipedalism - with those of apes - long arms able to stretch out to grasp tree branches. • This indicates Danuvius was able to walk upright on two legs and also use all four limbs while clambering through trees.
Global Bio-India Summit, 2019	<ul style="list-style-type: none"> • Recently Global Bio-India Summit, 2019 was held in Delhi. It was India's first largest biotechnology conference. • It was organised by The Department of Biotechnology (under Ministry of Science and Technology) and Biotechnology Industry Research Assistance Council (BIRAC).

	<ul style="list-style-type: none"> • It showcased the potential of India's biotech sector to the international community. • BIRAC is a not-for-profit, Public Sector Enterprise, set up by Department of Biotechnology (DBT). <ul style="list-style-type: none"> ○ It acts as an Interface Agency to strengthen and empower the emerging Biotech enterprise to undertake strategic research and innovation, addressing nationally relevant product development needs.
Merger of NIMH and NIOH	<ul style="list-style-type: none"> • The National Institute of Miners' Health (NIMH) has been dissolved and merged with the ICMR-National Institute of Occupational Health (NIOH), Ahmedabad. • National Institute of Miners' Health (NIMH) was setup in 1990 as an autonomous Institute under Ministry of Mines (MoM). • ICMR-National Institute of Occupational Health (NIOH) comes under Ministry of Health & Family Welfare (MoH&FW). The focus area of NIOH is occupational health including occupational medicine and occupational hygiene. • It will lead to enhanced expertise in the field of occupational health coming from both the institutes, besides the efficient management of public money.
Sheath Blight disease	<ul style="list-style-type: none"> • Recently a team of Indian scientists has deciphered the genomic diversity associated with aggressiveness of two strains of Rhizoctonia solani, the fungal pathogen, responsible for the Sheath Blight disease in rice. • Sheath Blight: It is a fungal disease, can cause up to 60 per cent reduction in rice yield. Due to this, infected leaves senesce or dry out and die more rapidly. As a result, the leaf area of the canopy can significantly be causing yield reduction. Plants are more vulnerable to sheath blight during the rainy season.

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