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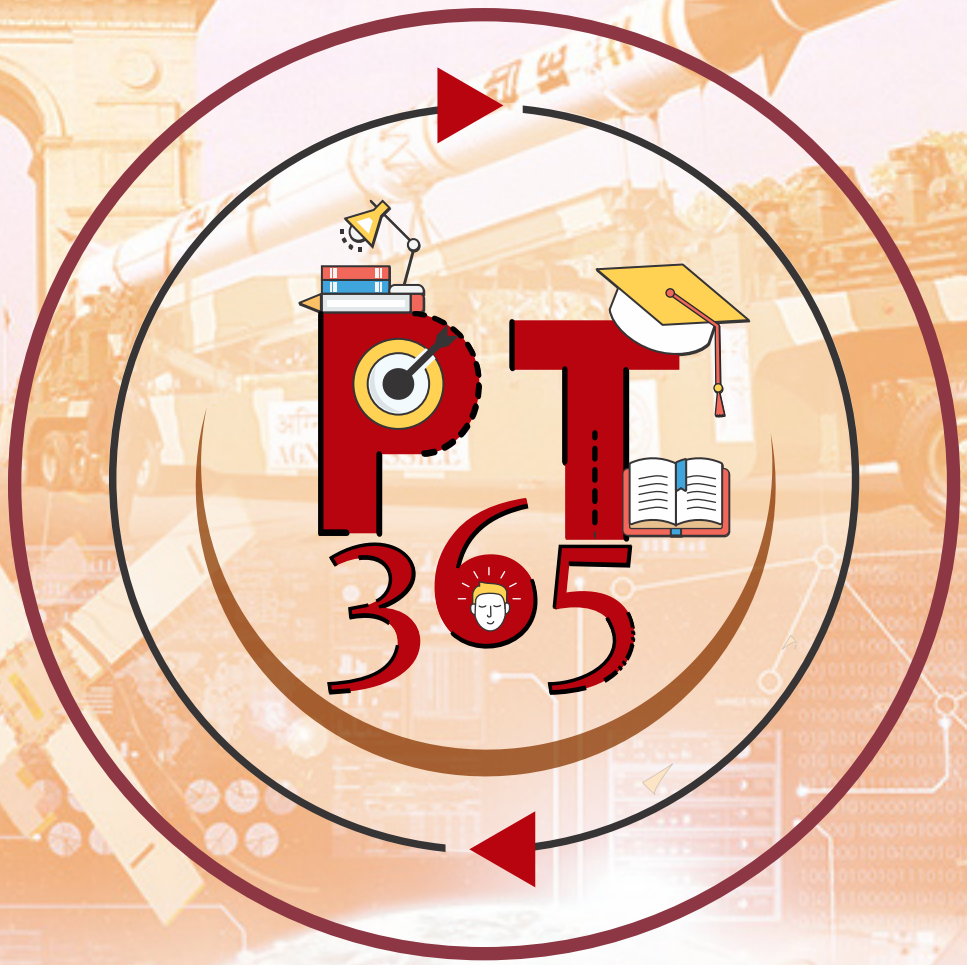

SCIENCE & TECHNOLOGY

Classroom Study Material

(May 2021 to January 2022)

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SCIENCE AND TECHNOLOGY

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Note:

PT 365 documents comprehensively cover the important current affairs of last 1 year (365days) in a consolidated manner to aid Prelims preparation.

In our endeavour to further enhance the document in the interest of the aspirants, following additions have been incorporated:

1. Different colours have been used in the document for easy classification and recollection of a variety of information.
2. QR based Smart quiz has been added to test the aspirant's learnings and understanding.
3. Infographics have been added to ease understanding, provide for smoother learning experience and ensure enhanced retention of the content.

QUIZ **SMART QUIZ**	You can scan this QR code to practice the smart quiz at our open test online platform for testing your understanding and recalling of the concepts.	

1. BIOTECHNOLOGY

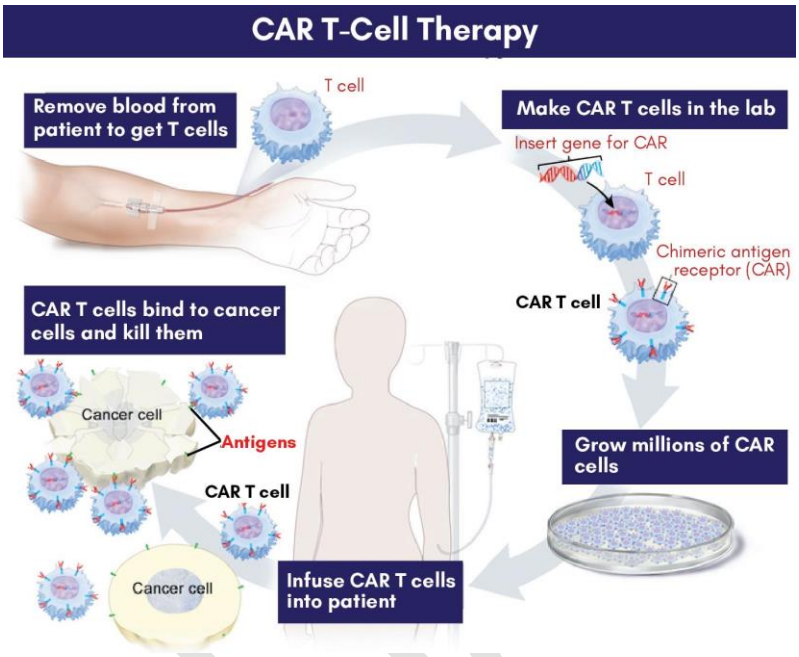
1.1. GENOME EDITING

Why in News?

Recently, Department of Biotechnology (DBT) supported First Chimeric Antigen Receptor T-cell (CAR-T) therapy was conducted.

About CAR-T therapy

- It is a way **to get immune cells called T cells** (a type of white blood cell) **to fight cancer by editing them in the lab** so they can find and destroy cancer cells.
  - T cells are **taken from the patient's blood** and are changed in the lab by adding a gene for a man-made receptor (called CAR).
  - This helps them better identify specific cancer cell antigens. The CAR T cells are then given back to the patient.
- It is also sometimes talked about as a **type of cell-based gene editing, because it involves altering the genes** inside T cells to help them attack the cancer.
- In order to promote and support development of CAR-T cell technology, Biotechnology Industry Research Assistance Council **(BIRAC)** and DBT have taken initiatives in the last 2 years.
  - Development of CAR-T cell technology for **diseases including acute lymphocytic leukemia, multiple myeloma, glioblastoma, hepatocellular carcinoma, and type-2 diabetes is supported** through DBT.

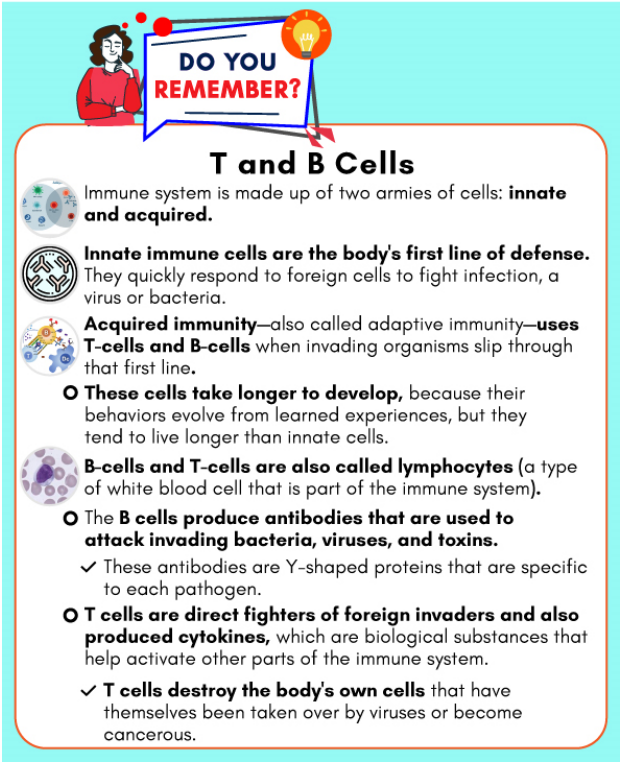


Situation in India

- Several rules, guidelines, and policies backed by the "**Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells, 1989**" notified under the Environment Protection Act, 1986, regulate genetically modified organisms.
- **National Ethical Guidelines for Biomedical and Health Research involving human participants, 2017**, by the Indian Council of Medical Research (ICMR), and the Biomedical and Health Research Regulation Bill implies regulation of the gene-editing process.

What is gene editing?

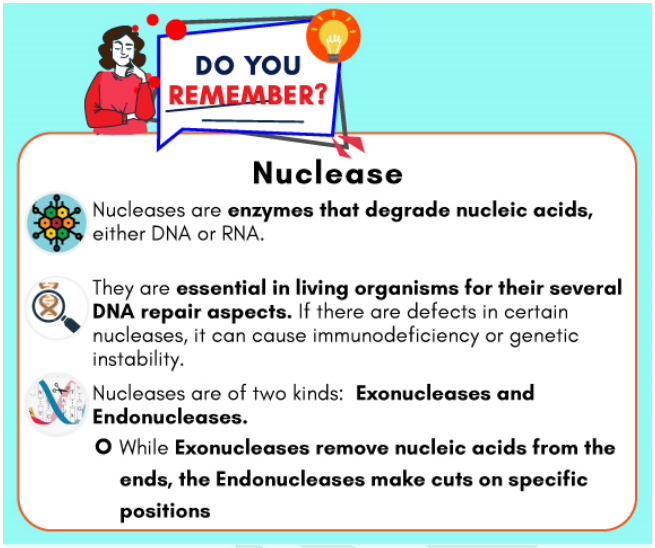
- Genome (or gene) editing is a **way of making specific changes to the DNA of a cell or organism.** This allows genetic material to be added, removed, or altered at particular locations in the genome.
- It is a three-stage complex mechanism of **unwinding, cleaving** (cut paste) **and rewinding of DNA.**
- By editing the genome the **characteristics of a cell or an organism can be changed.**
  - **Germline gene therapy targets the reproductive cells,** meaning any changes made to the DNA will be **passed on to the next generation.**



- **Advantage of Genome Editing:** For research, to treat disease (including Leukemia & AIDS), For biotechnology (genetically modifying crops/cattle), Therapeutic cloning etc.

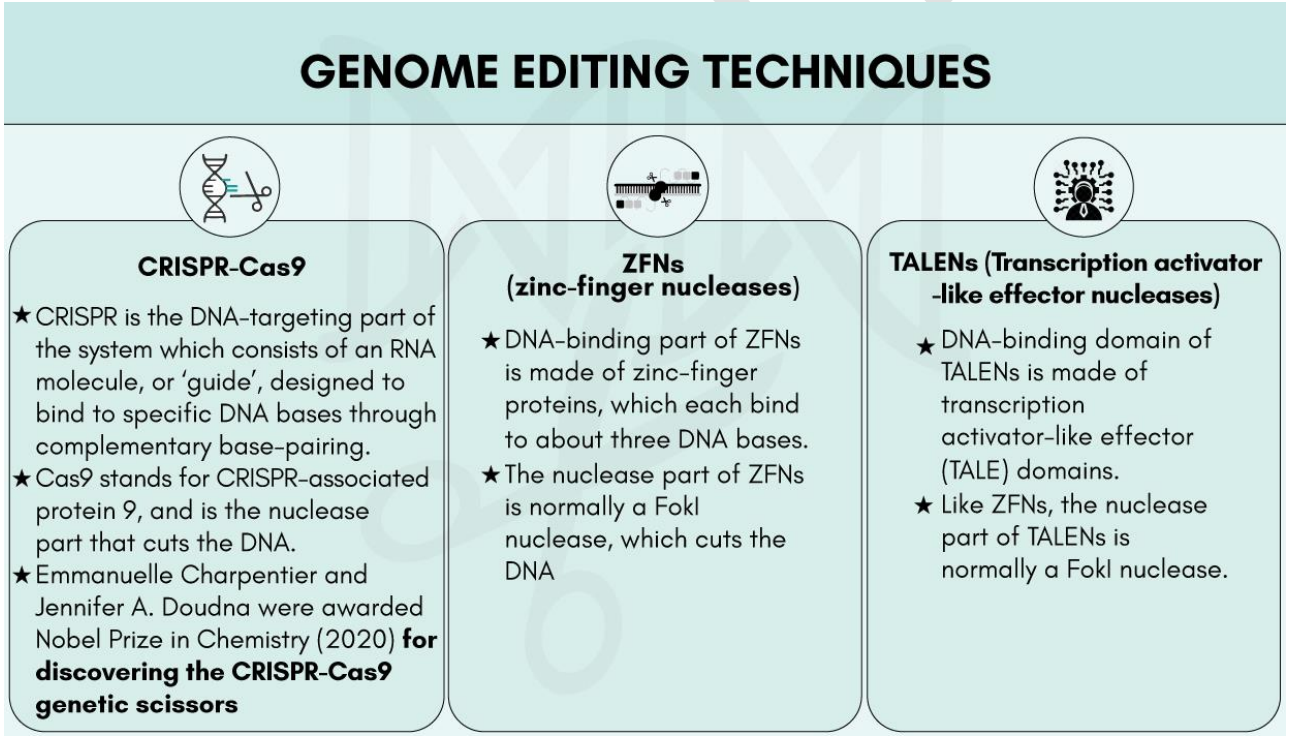
How does it work?

- Genome editing **uses a type of enzyme called an 'engineered nuclease' which cuts the genome** in a specific place.
  - **Engineered nucleases are made up of two parts:**
    - ✓ A nuclease part that cuts the DNA and
    - ✓ A DNA-targeting part to guide the nuclease to a specific sequence of DNA.
- After cutting the DNA in a specific place**, the cell will naturally repair the cut**.
- This **repair process can be manipulated to make changes** (or 'edits') to the DNA in that location in the genome.
- **Types of Genome editing includes:** Small DNA Changes, Removal of a section of DNA, insertion of section of DNA.



Techniques used for Genome editing

- They mainly **differ in how they recognise the DNA to cut.**
  - **Protein based:** contain a protein that recognises and binds to the target DNA to be cut.
  - **RNAbased:** contain a short sequence of RNA that binds to the target DNA to be cut.



Related News

- Recently, **CRISPR-based system was developed to safely restrain mosquito vectors** via sterilization.
- **precision-guided sterile insect technique (pgSIT) was used to alter genes in Aedes aegypti,** the species responsible for spreading malaria, dengue, chikungunya and Zika.
  - pgSIT **uses CRISPR to sterilise male mosquitoes and render female mosquitoes** (which spread disease) **flightless.**
- Unlike 'gene drive' the pgSIT**system is self-limiting and is not predicted to persist or spread in the environment.**
  - **"Gene drive"** systems could **suppress disease vectors by passing desired genetic alterations indefinitely from one generation to the next.**
- **In a related development,** A Bill Gates-funded biotech firm (Oxitec) released **genetically modified male Aedes aegypti mosquitoes to combat insect-borne diseases** like dengue fever and Zika virus.

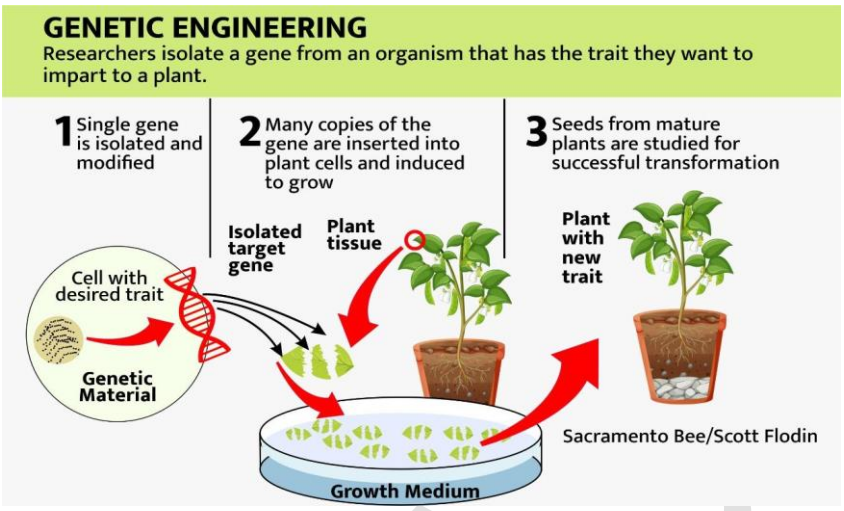
1.1.1. GENETICALLY MODIFIED CROPS

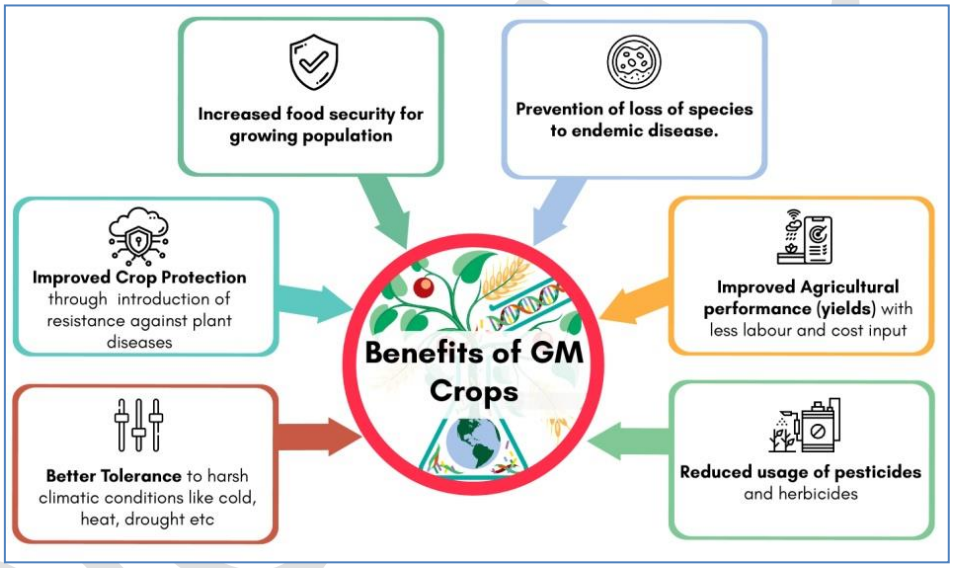
Why in news?

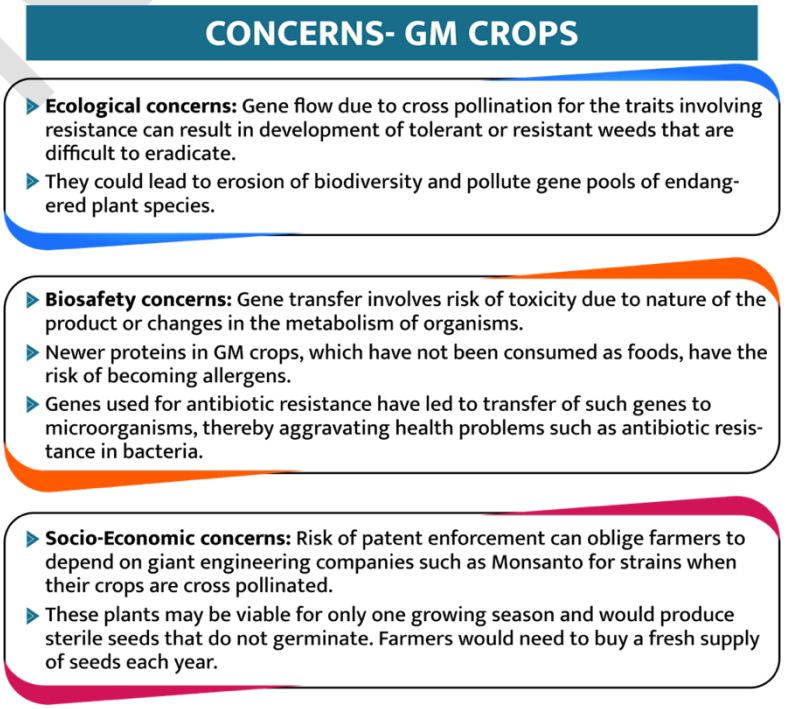
India will import genetically modified (GM) soyameal for the first time to be used as livestock feed.

More on news

- Ministry of Environment, Forest, and Climate Change (MoEFCC) cleared the proposal, **on the grounds that material was non-living.**
  - **Genetic Engineering Appraisal Committee (GEAC),** a special committee under MoEFCC entrusted to govern matters related to GM crops, **was bypassed, given the non-living nature of the material.**
- Soyameal is a protein-rich solid leftover raw material after extracting oil from soyabean seed. **It is a major ingredient of poultry feed.**
  - Poultry feed makes up 65% of the cost of production for the farmer and poor harvest of soy has led to high prices of soymeal.



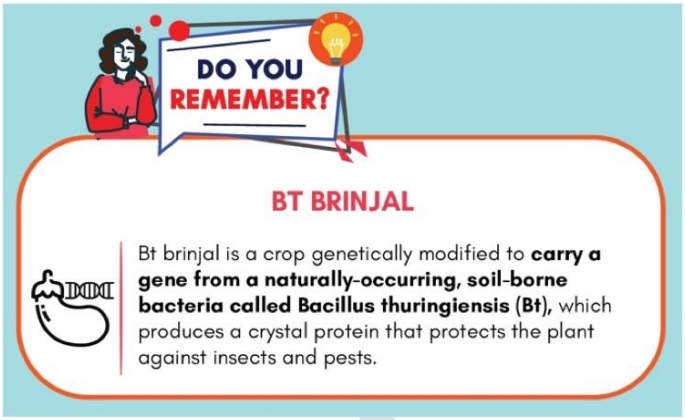




What are GM Food crops?

- According to WHO, genetically modified organisms (GMOs) are **organisms in which the genetic material (DNA) has been altered** in a way that does not occur naturally by mating and/or natural recombination.
  - Foods produced from or using GM organisms are referred to as GM foods.
  - GM crops carry **genes of other species artificially inserted** into them.
- Globally **GM crops were commercially introduced in 1996.** Crops such as corn, cotton, and soybean have been engineered to resist insect pests and herbicides and are now planted widely in many parts of the world.

- **USA, Brazil, Argentina, India and Canada** are top GM crops growing countries, together accounting for approx. 90% area of the GM cultivation.



- **Bt cotton is the only genetically modified (GM) crop that has been approved for commercial cultivation in 2002** in India.
  - GM mustard Dhara Mustard Hybrid 11 (DMH 11) developed by Delhi University is pending for commercial release as GEAC has advised to generate complete safety assessment data on environmental biosafety.
    - ✓ GM mustard uses a system of genes from soil bacterium that **makes the plant better suited to hybridisation than current methods.**
  - **GEAC has allowed biosafety research field trials of two new transgenic varieties of indigenously developed Bt Brinjal** – namely Janak and BSS-793, containing Bt Cry1Fa1 gene (Event 142) – **in eight states** during 2020-23 only after taking no-objection certificate (NOC) from states concerned and confirmation of availability of isolated stretch of land for this purpose.
    - ✓ These indigenous transgenic varieties of are **developed by the National Institute for Plant Biotechnology, (NIPB, erstwhile National Research Centre on Plant Biotechnology, New Delhi), Indian Council of Agricultural Research (ICAR).**

Regulatory Procedure involved in the development and approval of GM crops in India

- The rules governing the handling of GMOs and products thereof **were notified in 1989 under Environment Protection Act 1986 and guidelines issued later**.
- Two government agencies, **MoEFCC and the Department of Biotechnology (DBT)** are responsible for implementation of the regulations.
- There are **various authorities to handle different aspects of the regulation**.
  - These are Recombinant **DNA Advisory Committee, Institutional Bio Safety Committee, Review Committee on Genetic Manipulation, GEAC, State Biotechnology Coordination Committee and District level Committee**.
- **A series of guidelines for safety assessment proceduresto be followed** at various stages of development of GMOs have been adopted from time to time.
- **GEAC shall have powers to revoke approvals in case of:**
  - Any new information on harmful effects of GMOs.
  - GMOs cause such damage to the environment as could not be envisaged when approval was given.
  - Non-compliance of any conditions stipulated by GEAC.

Related News

Draft Notification on Food Safety & Standards (Genetically Modified or Genetically Engineered Foods) Regulations, 2021

- **New regulations are proposed by Food Safety and Standards Authority of India (FSSAI)** under the Food Safety and Standards Act (2006) **and will apply to**:
  - **Genetically Modified Organisms** (GMOs) or **Genetically Engineered Organisms** (GEOs) or **Living Modified Organisms** (LMOs) intended for direct use as food or for processing;
    - ✓ GMOs/GEOs/LMOs mean **any living organism that possesses a novel combination of genetic material** obtained through use of modern biotechnology.
  - **Food or Processed food** containing Genetically Modified ingredients (GEI) produced from but not containing LMOs or GEOs or GMOs.
- **Key provisions of draft regulations**
  - **Prior Approval from FSSAI for manufacture, storage, distribution, sale and import** etc. of any food or food ingredient derived from GMOs.
  - **If GMOs or GEOs contain LMOs,** it requires **prior approval from GEAC** to get FSSAI approval and direct approval from FSSAI if no LMOs.
  - Specifies the **requirements for Food Laboratories to be designated for GM foods testing.**
  - **Labelling Standards for GM foods** if GEI is 1% or more.

Genetically Modified (GM) Rubber

- Recently, **world's first GM rubber plant was planted in Assam.**
- GM rubber plant, which is the first of its kind **developed specifically for the northeast** and is expected to flourish in the region's climatic conditions.
- With **additional copies of the gene MnSOD**(manganese-containing superoxide dismutase) inserted in it, GM rubber plant is expected **to tide over the severe cold conditions during winter** which is a major factor affecting the growth of young rubber plants.
  - **Natural rubber is a native of warm humid Amazon forests** and is not naturally suited for the colder conditions.
- It is developed by the Kerala-based **Rubber Research Institute of India.**

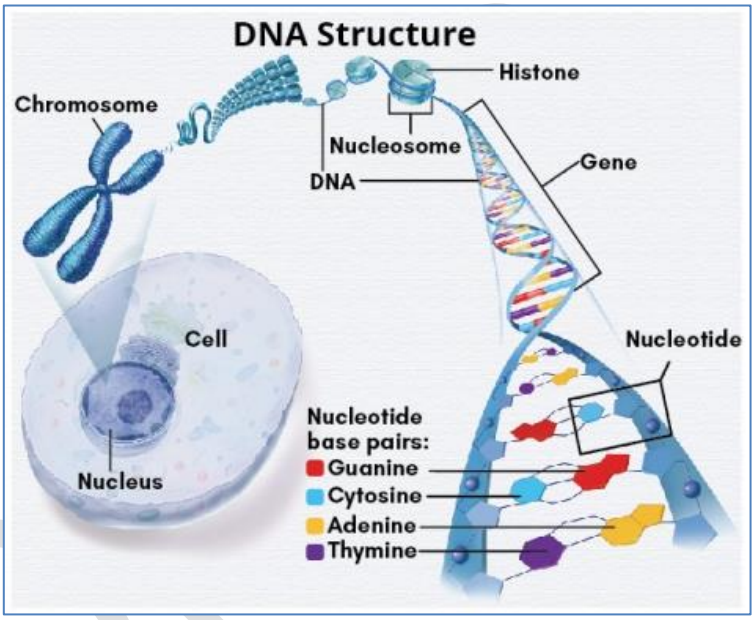
1.2. GENOME SEQUENCING

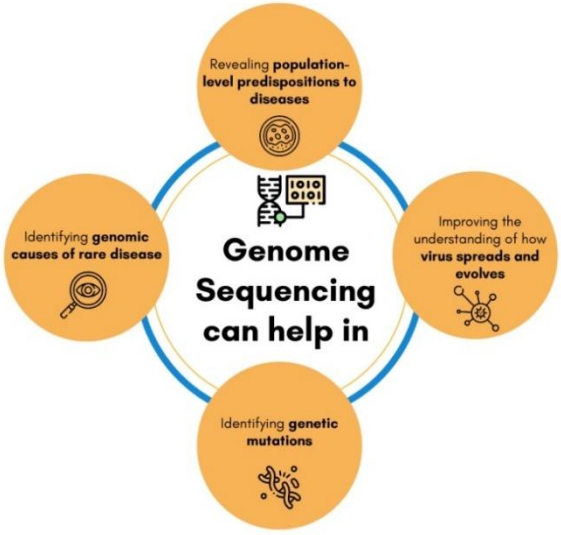
Why in News?

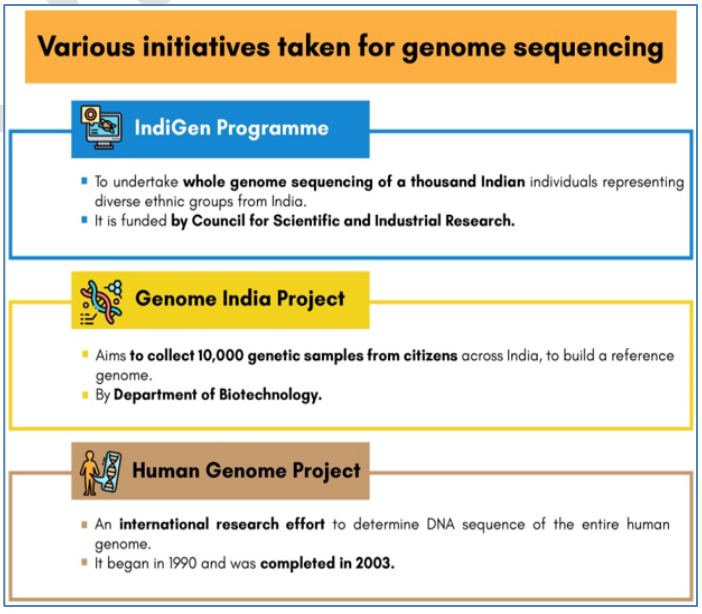
Researchers at the **Telomere-to-Telomere consortium, an international collaboration,** have sequenced the first complete human reference genome.

About Genome sequencing

- Genome sequencing means **deciphering the exact order of base pairs** (refer infographic) in an individual.
- **A genome is anorganism's complete set of DNA.** It includes all chromosomes, which houses DNA, and genes (specific sections of DNA).
- Human genome contains about 3 billion base pairs that spell out the **instructions for making and maintaining a human being.**







Related News

Nanopore gene sequencing

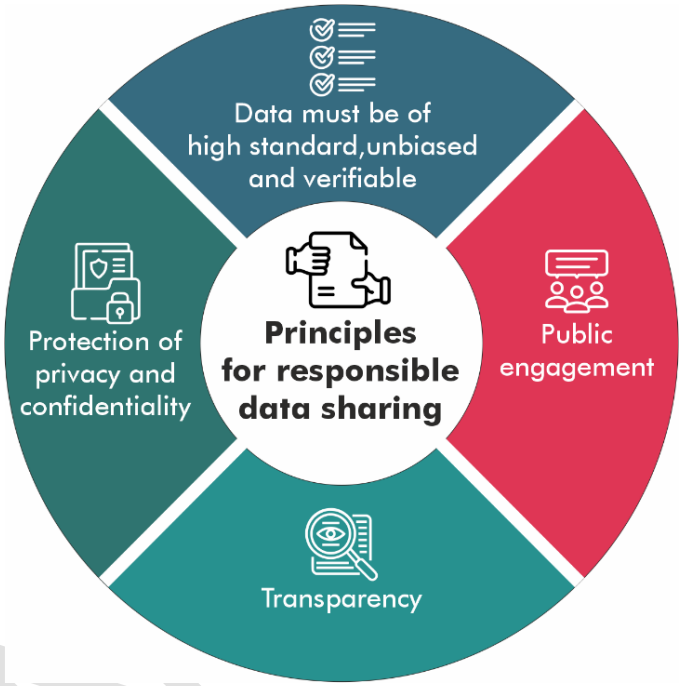
- It enables **direct, real-time analysis of long DNA or RNA fragments** at a faster and cheaper rate than previously possible with older technologies.
- It works by **monitoring changes to an electrical current** as nucleic acids are passed through a protein nanopore.
  - Nucleic acids are **essential for all forms of life and are found in all cells and viruses.** Nucleic acids come in **two natural forms called DNA and RNA.**
- Resulting **signal is decoded to provide specific DNA or RNA sequence.**

1.3. BIOTECH-PRIDE GUIDELINES

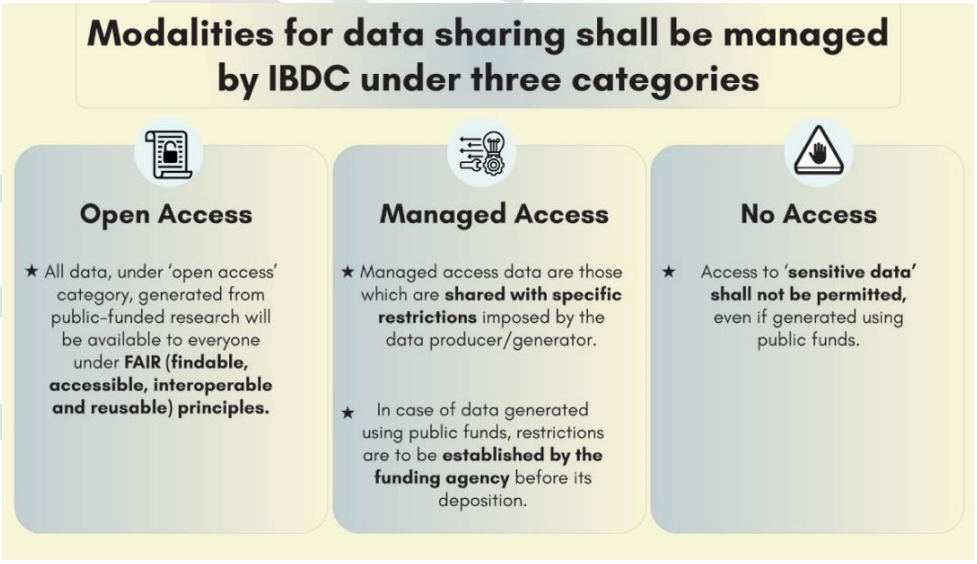
Why in news?

"**Biotech-PRIDE (Promotion of Research and Innovation through Data Exchange) Guidelines**" developed by **Department of Biotechnology (DBT)**, Ministry of Science and Technology were released recently.

About Guidelines



- Biotech-PRIDE guidelines have been formulated in conformity with the principles of **NDSAP (National Data Sharing and Accessibility Policy) 2012**, for enabling the **sharing, access and storage** of biological data.
  - At present, biological data in India is deposited in International Repositories **and there are no guidelines** for sharing it.
- Under the guidelines, it is the **responsibility of the data-generator/ producer/submitter to deposit data** in an appropriate database in the notified Data Repository.
- **Data withdrawal may be granted** if the individual or the organization, whose data have been placed on a publicly accessible database, make a **justified request either directly or through the submitter**, with valid claims to the data.
- These Guidelines **will be implemented through Indian Biological Data Centre (IBDC)** at Regional Center for Biotechnology supported by DBT. Other datasets/ data centres will be bridged to the IBDC which will be called **Bio-Grid.**
  - The Bio-Grid will be a **National Repository for all biological knowledge, information and data** generated through research within the country and will be responsible for:
    - ✓ **Enabling its exchange** to facilitate the Research and Innovation,
    - ✓ Developing measures for **safety, standards and quality for datasets** and
    - ✓ Establishing **detailed modalities** for accessing data.



1.4. RIBONUCLEIC ACID INTERFERENCE

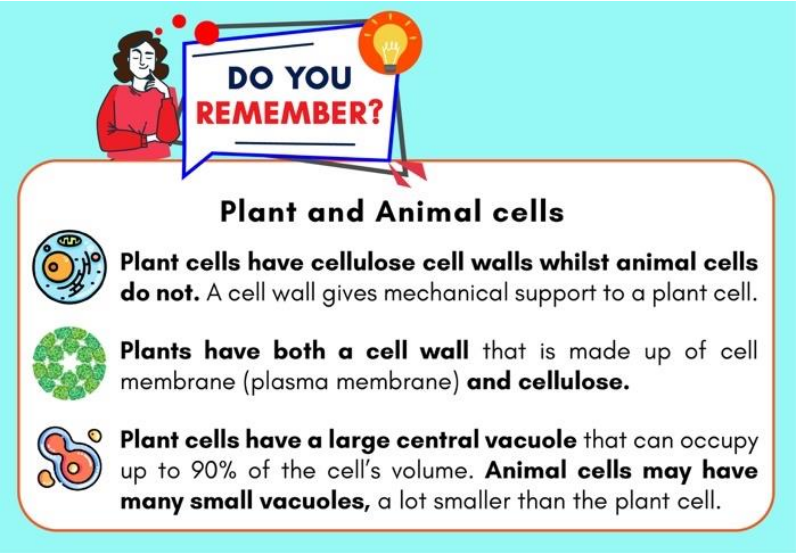
Why in News?

Recently **RNA interference (RNAi) technology** has been suggested for manufacturing pesticides.

Procedure for RNAi use in pesticides

- Scientists first **identified proteins necessary for survival of pests** at cellular level.

- Using **RNAi technology**, they created a **specific RNA to prevent those proteins from being formed in the pest**.
    - This can help **in targeting only specific pests** and **avoid damage to friendly insects** such as bees, earthworms etc.
- RNA molecules can be externally delivered to plants, through applications like **spray, stem injection, root drenching, or seed treatment**.
- Thus, by "vaccinating" plants, i.e., delivering the specific RNA molecule to pests from plants, they are protected from infestation.



About RNA interference (RNAi)

- Cell produces molecules it needs by **reading the genetic code written in the DNA**. This is known as **gene expression**.
- **RNA interference regulates gene expression** by a highly precise mechanism called **sequence-directed gene silencing** by **degrading specific messenger RNAs (mRNAs)** or by blocking its translation into protein.
    - mRNA is a **single-stranded molecule that carries genetic code from DNA in a cell's nucleus to ribosomes,** the cell's protein-making machinery.
- Under RNAi, special enzymes known as **'Dicer'** are used to **cleave (split) 'double stranded RNA' (dsRNA)** into small fragments known as **'small interfering RNA' (siRNA)**.
- The siRNA is deployed to **'interfere' in gene expression** and manipulate function of genes.
- RNAi **occurs naturally in almost all eukaryotes** (organisms whose cells contain a nucleus and other membrane-bound organelles) such as **animals, insects, fungi** etc.
- **Benefits of RNAi:**can be used in developing therapies for the treatment of cancer, to produce crop plants that are resistant to viral pathogens.

1.5. OTHER IMPORTANT NEWS

Dark genome	• Scientists investigating the DNA outside our genes (the 'dark genome) have **discovered recently evolved regions that generate proteins** associated with schizophrenia and bipolar disorder.
	• Dark genome refers to '**DNA outside of the regions of the human genome** that are not usually recognized as genes but **can still code for proteins.**
	  ○ They are **genes/proteins for which there is minimal knowledge** on biological function and, allied to this, **limited tools for their analysis** (such as antibodies).
	  ○ Thus, it **adversely affects the precision medicine initiative.**

Borg DNA	• Scientists analysing samples in the western United States have found **novel DNA structures, much like the fictional Star Trek 'Borg' aliens** who assimilate the knowledge and technology of other species. • Borgs are DNA structures (not like any that's been seen before), that **seem to scavenge and 'assimilate' genes from microorganisms** in their environment. • **Borgs seem to house many genes** needed for entire metabolic processes, **including digesting methane.** • **One potential application** that the researchers see for Borgs could be as an **aid in the fight against climate change.** • **Borgs are extrachromosomal elements,** meaning that these DNA sequences are **found outside the chromosomes** that lie within nucleus of most cells and that **contain majority of an organism's genetic material.**
National Gene Bank (NGB)	• Refurbished **NGB at National Bureau of Plant Genetic Resources (NBPGR),** Pusa was inaugurated recently.

	○ NBPGR is the nodal institute at national level for acquisition & management of **indigenous & exotic plant genetic resources** for food and agriculture in India. • Established in 1996, NGB **works towards preserving the seeds of Plant Genetic Resources (PGR)** for future generations. • Refurbished NGB is the **2nd largest Gene Bank of the world with capacity to preserve 1 million germplasm.** ○ Presently, the bank is protecting 4.52 lakh accessions, of which 2.7 lakh are Indian germplasm and the rest have been imported from other nations. • **Primarily, NGB has four kinds of facilities,** namely, Seed Genebank (- 18°C), Cryogenebank (-170°C to -196°C), In vitro Genebank (25°C), and Field Genebank. • **Svalbard Global Seed Vault in Norway** houses the world's largest collection of seeds. ○ **India's seed vault is at Chang La** (Ladakh) in the Himalayas.

2. NANO TECHNOLOGY

2.1. NANO TECHNOLOGY

Why in News?

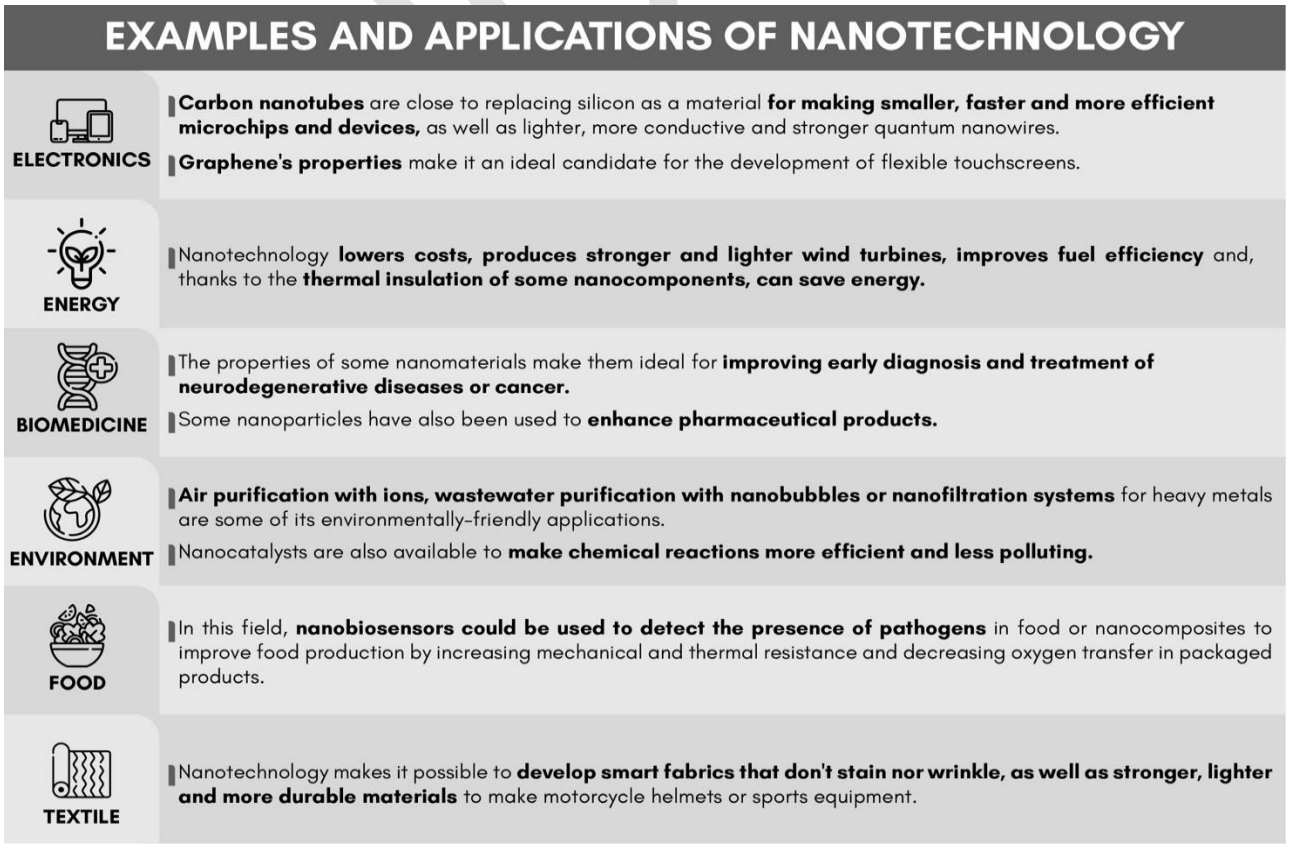
National Fertilisers Limited (NFL) and Rashtriya Chemicals and Fertilisers Ltd (RCF) signed MoU with IFFCO for **'transfer of technology'** of **Nano Urea Liquid (NUL)** fertiliser.

About Nano Urea Liquid (NUL)

- NUL **contains nano-scale nitrogen particles** which have **more surface area** and **number of particles** making it more impactful.
- India has become the **first country globally to start commercial production** of NUL.
- **Significance**
  - **Reduces the requirement of conventional Urea** by 50% or more.
  - Improves Soil, Air & Water quality.
  - **Cheaper than conventional urea.**

About Nanotechnology

- Nanotechnology is science, engineering, and technology **conducted at the nanoscale, which is about 1 to 100 nanometers.**
  - A nanometer (nm) is one thousand millionth of a meter. A single human hair is about 80,000 nm wide, a red blood cell is approximately 7,000 nm wide.
- The **properties of materials can be different on a nanoscale** for two main reasons.
  - **First, nanomaterials have, relatively, a larger surface area** than the same mass of material produced in a larger form.
    - ✓ This can **make materials more chemically reactive** and **affect their strength or electrical properties.**
  - **Second, below 50 nm, the laws of classical physics give way to quantum effects,** provoking optical, electrical and magnetic behaviours different from those of the same material at a larger scale.
    - ✓ These effects **can give materials very useful physical properties** such as exceptional electrical conduction or resistance, or a high capacity for storing or transferring heat, and can even modify biological properties.



2.2. OTHER IMPORTANT NEWS

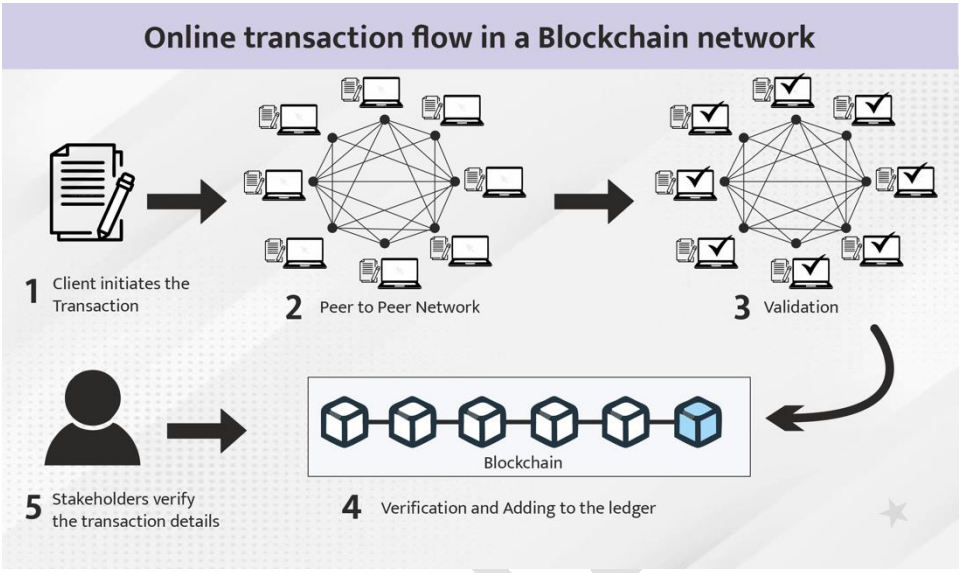
Triboelectric Nanogenerators (TENG)	• Scientists from the Centre for Nano and Soft Matter Sciences (CNSMS) have fabricated a cost-effective, bio-compatible **nanogenerator that can generate electricity from mechanical energy in the form of vibrations present everywhere.** ○ CNSMS is an autonomous institute under the Department of Science & Technology. • The energy harvesting TENG **works on the principle of creation of electrostatic charges** (deficiency or excess of electrons which occurs on ungrounded or insulating surfaces). • Applications include **optoelectronics, self-powered devices, and other biomedical applications.**

3. IT & COMPUTER

3.1. NATIONAL STRATEGY ON BLOCKCHAIN

Why in news?

National Strategy on Blockchain has been formulated by the **Ministry of Electronics & Information Technology (MeitY).**



Blockchain Technology Overview

- Blockchain is a **distributed or decentralised ledger technology** which was first introduced in the design and development of cryptocurrency, Bitcoin in 2009.
- Blockchain technology is an **amalgamation of various technologies** such as distributed systems, cryptography, etc
- Blockchain is a series of blocks, where **each block contains details of transactions executed over the network,** hash(address) of the previous block, timestamp etc.
- Data and transactions stored in blocks are **secured against tampering using cryptographic hash algorithms** and are validated and **verified through consensus** (consensus protocols) across nodes of the Blockchain network.
- **Blockchain platforms** are being developed to offer Blockchain based digital transaction platforms. Popular blockchain platforms include **Hyperledger, Cosmos, Polkadot, Redbelly, Ethereum etc.**

Potential Blockchain Applications	
• **Transfer of Land Records** (Property Record Management); • **Digital Certificates Management** (Education, Death, Birth, agreements, etc); • **Pharmaceutical supply chain;** • **e-Notary Service** (Blockchain enabled e-Sign Solution); • **Farm Insurance;** • Identity management; • **Power distribution;**	• Duty payments; • Agriculture and other supply chains; • **eVoting;** • Electronic Health Record Management; • **Digital Evidence Management System;** • Public Service Delivery; • IoT Device Management and Security; • **Vehicle lifecycle management;** • **Chit fund operations** administration; Microfinance for Self-Help Groups (SHG)

Strategies and Outcomes targeted for next 5 years: National Blockchain Framework (NBF)

- **Need:** Reports predicts that by 2030, Blockchain would be used as a foundational technology for 30% of the global customer base.
- **Plan:** MeitY has initiated a project on design and development of a **NBF** for creation of a shared Blockchain infrastructure and offering Blockchain as-a-Service (BaaS). Initially, NBF would be used for e-governance domain transitioning to incorporate various use cases over time.

This framework comprises following components for a multi-pronged strategy:

- **Geographically distributed nodes** across the country, to enable citizen services at large scale and enable cross domain (such as health, agriculture, education, finance, etc.) application development.
- **R&D for Blockchain Challenges** and detection of vulnerabilities in Blockchain technology based solutions.
- **To design and develop an indigenous Blockchain platform.**
- **Integration with important National Level Services** such as online Electronic Signatures (e-Sign), ePramaan and Digilocker.
- **Awareness Creation:** to sensitize the MSME/ Government departments/ judiciary and law enforcement agencies (LEAs), to boost the adoption.
- **Others:** updated Policies & Regulations, **fiscal and non-fiscal incentives** to enable large scale adoption, **multi-Institutional Approach** to plan and implement NBF, **Human Resource Development etc.**
  - Government has already started the **Future Skills Prime program** for upskilling and reskilling in emerging technologies including Blockchain in association with NASSCOM.
  - Further, **Blockchain Advisory Council** and **Steering Committee** shall be constituted to provide overall guidance and for regular review and monitoring of the implementation of the Strategy respectively.
- **Challenges in Blockchain adoption:** Inefficient technology design, scalability as it is still unable to accommodate large-scale users, high power consumption, lack of regulation, lack of adequate skill set, lack of adequate security/privacy etc.

Other prominent efforts in this direction

- **Centre of Excellence (CoE) in Blockchain technology** was established by NIC in association with **National Informatics Centre Services Inc.** (NICSI) to accelerate adoption & deployment of Blockchain technology in Government.
- **NITI Aayog** in collaboration with Gujarat Narmada Valley Fertilizers & Chemicals Limited (GNFC) has developed a **Blockchain based system for fertilizer subsidy**.
- **State Level efforts:** Blockchain technology based solution for property registration has been developed and is piloted at Shamshabad District, Telangana.

Blockchain Models

Public/Permissionless	Private/Permissioned
1. **Anyone can join, read,** write and commit 2. All are allowed to participate in **consensus and anonymous resilient** 3. **Truly decentralized** because of participation of unknown actors. 4. **Finality of transaction could take longer time** due to more number of participants	1. **Only authorized participants** can write and commit 2. **Authorized nodes only can participate** in consensus 3. **Partially decentralized** because of participation of known actors 4. **Finality of transactions could be better** in this model due to less number of participants.

Related News

Presidio Principles: Foundational Values for a decentralised future

- Presidio Principles were **released by World Economic Forum's Global Blockchain Council.**
- The document calls on **all actors to uphold these tenets as they build blockchain applications** – and to self-direct their ecosystems in using these principles as a foundational vision for how users can and should be protected.
- The Presidio Principles are **grouped into four broad pillars**: Transparency & Accessibility, Privacy & Security, Accountability & Governance, and Agency & Interoperability.
- The principles are **not legally binding.**

Decentralised applications (dApps)

- dApps are programmes that allow people to **interact with one another without the need for third parties** thereby obviating the need for a middleman and their commissions.
- **Characteristics of dApps:**Exist and run on a blockchain network, Higher computing power than regular apps, Less vulnerable to cyber-attacks.

El Salvador has become the first country in the world to grant legal tender status to bitcoin.

- **Bitcoin is a digital or virtual currency.**
- It **uses peer-to-peer technology**, with no central authority, **to facilitate instant payments.**
- Bitcoins are **created through a complex process known as "mining",** and then monitored by a network of computers across the world.

3.2. 5G TECHNOLOGY

Why in News?

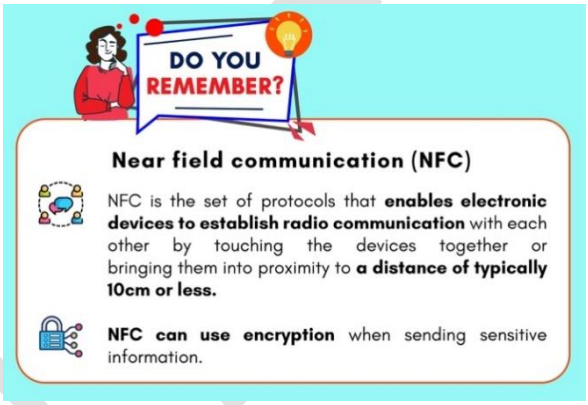
Reliance Jio, Bharti Airtel and Vodafone Idea received a six-month extension from the Department of Telecommunications (DoT) to conduct 5G trials till May 2022.

About 5G technologies

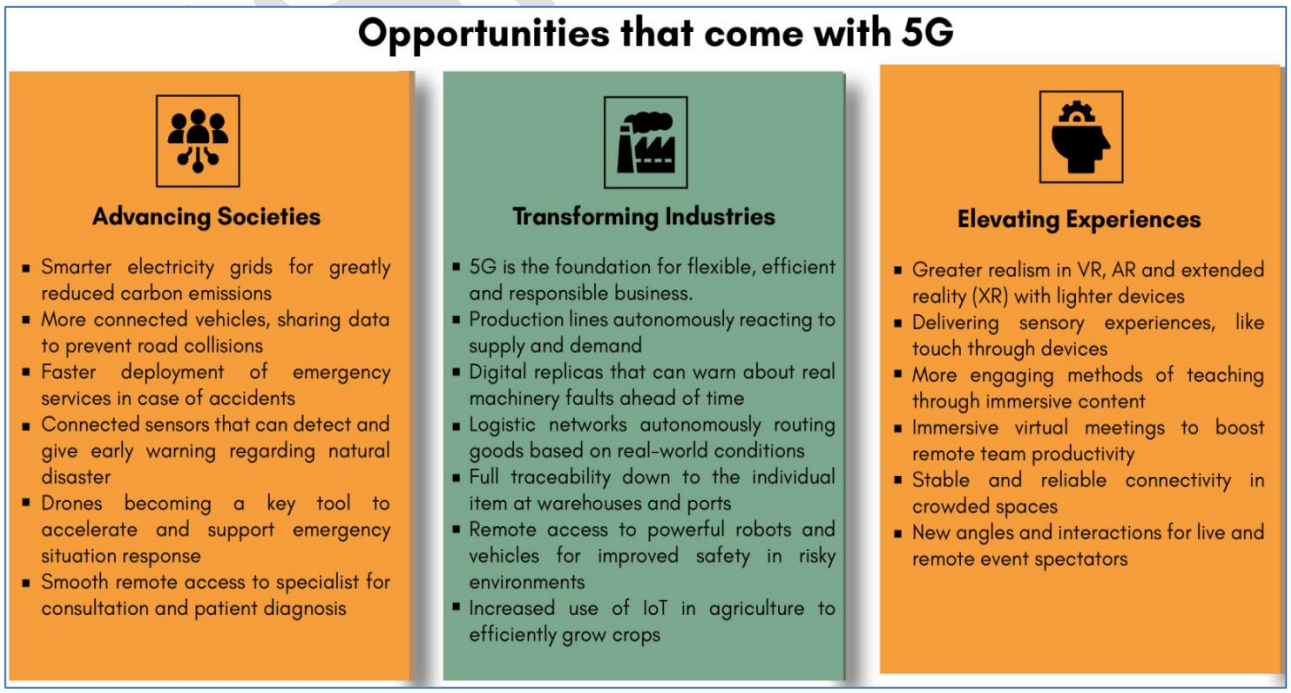
- 5G (the fifth generation of cellular networks) is designed to improve network connections by **addressing the legacy issues of speed, latency and utility,** which the earlier/ current generation of mobile networks could not address.
- **5G operates at higher frequencies** to offer a new kind of network that is **designed to connect virtually everyone and everything together** including machines, objects, and devices.
- It will also have an **enhanced throughput to handle more simultaneous connections** at a time than current-generation networks.
- 5G **mainly works in 3 bands,** namely low, mid and high frequency spectrum.

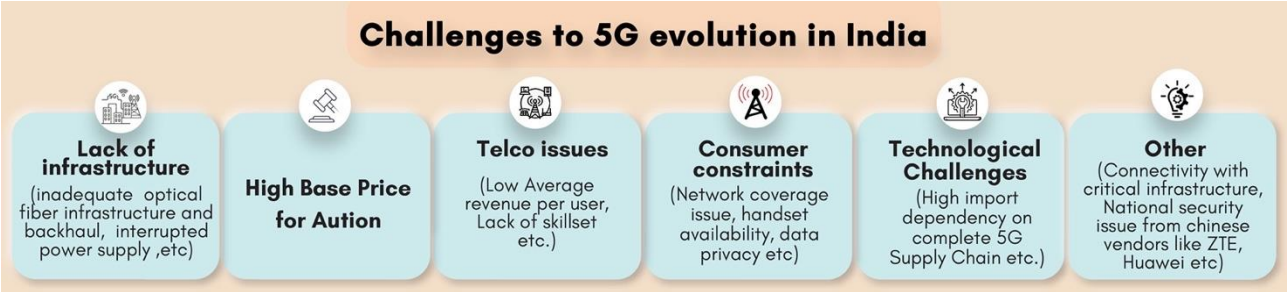
3G vs 4G vs 5G vs 6G

	3G	4G	5G	6G
Deployment	2004-06	2006-10	2020	2028-2030
Bandwidth	2 mbps	200 mbps	>1 gbps	1 tbps
Latency	100-150 millisecond	20-30 millisecond	<10 millisecond	<1 microsecond
Average Speed	144 kbps	25 mbps	200-400 mbps	About 50 times faster than 5G



Spectrum	Uses/Advantage	Limitations
Low band	• Great promise in terms of coverage and speed of internet and data exchange, the maximum speed is limited to 100 Mbps (Megabits per second). • For commercial cellphone users who may not have specific demands for very high speed internet.	• May not be optimal for specialised needs of the industry.
Mid-band	• Higher speeds compared to the low band. • May be used by industries and specialised factory units for building captive networks.	• In terms of coverage area and penetration of signals.
High-band	• Offers the highest speed (as high as 20 Gbps (giga bits per second)) of all the three bands.	• Extremely limited coverage and signal penetration strength.





Steps taken by Government

- **A 5G High Level Forum was set up in 2017** to articulate the Vision for 5G in India and to recommend policy initiatives and action plans to realize this vision.
- **Cellular Operators Association of India (COAI) has formed the 5G India Forum (5GIF)** that is expected to serve as a national initiative where all stakeholderscan meet and discuss the challenges of making 5G a reality in India.
- **'Building an End-to-End 5G Test Bed'**programme that envisages close collaboration between the universities and startups and create an ecosystem that closely resembles a real-world 5G deployment.
- **National Digital Communication Policy-2018** (NDCP-2018) also lays out the following objectives with respect to 5G services in India:
  - **Enabling Hi-speed internet, Internet of Things and M2M** (Machine to machine) by rollout of several 5G technologies.
  - **Enhancing the backhaul capacity** to support the development of next generation networks.

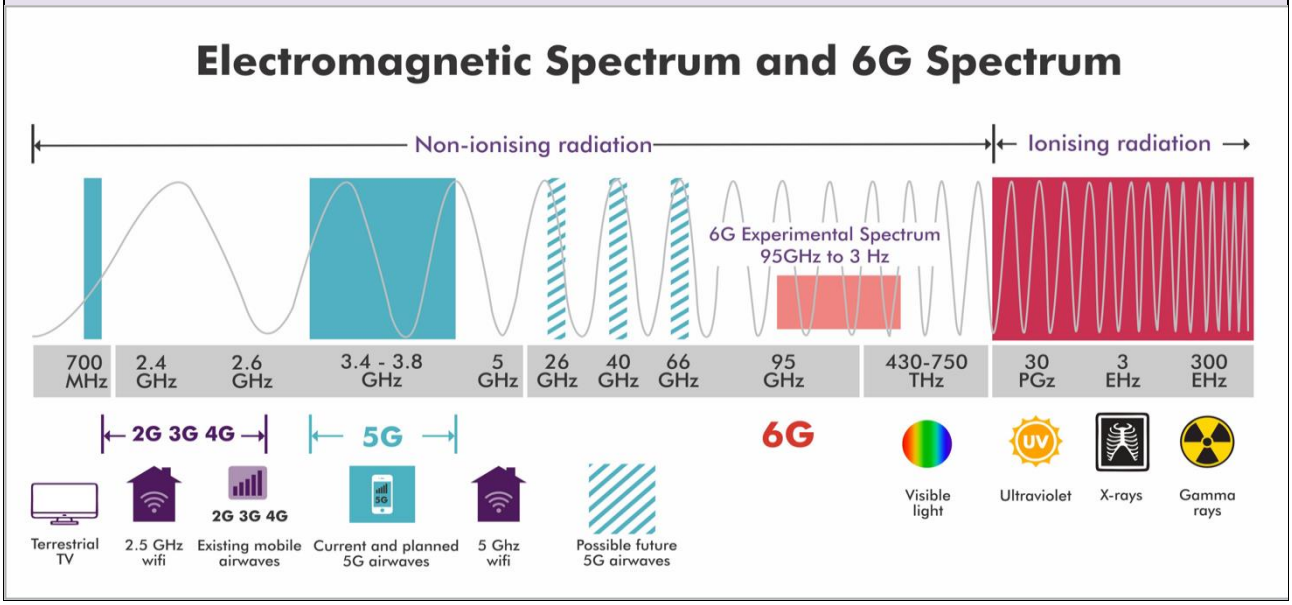
Related News

LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)

- VoLTE is a **technology update to the LTE protocol** used by mobile phone networks.
  - **Under LTE,** the infrastructure of telecom players **only allows transmission of data while voice calls are routed to their older 2G or 3G networks.**
    - ✓ This is why, under LTE, you cannot access your 4G data services while on a call. This leads to problems such as slow internet speeds and poor voice clarity.
    - ✓ LTE is commonly marketed as 4G LTE.
    - ✓ **VoLTE allows voice calls to be 'packaged' and carried through LTE networks**. This would mean 4G data accessibility even during calls.

Innovation Group for 6G

- Department of Telecommunications (DoT) formed a technology innovation group on 6G **headed by K Rajaraman.**
- It will create a roadmap for Research and Development and an action plan for 6G technology.



Related News

5G technology poses a serious threat to the airline safety

- **About the concern**
  - US auctioned **mid-range 5G bandwidth** to mobile phone companies in the **3.7-3.98 GHz range** on the spectrum.
  - This bandwidth is close to the **airwaves the altimeters use,** giving rise to concerns about potential interference of 5G with sensitive aircraft electronics like radio altimeters.

- **Interference can prevent engine and braking systems** from transitioning to landing mode and in the event of bad weather, cloud cover or even heavy smog pilots will be left with visual approaches only.

- **Potential solutions for this technological concern:**
  - **Set lower frequency standards for 5G services.** E.g. EU has a 5G range of 3.4-3.8 GHz.
  - Including a **buffer band** to separate the new 5G signals from those used by radar altimeters.

mmWave or Millimeter Band or **Extremely High Frequency Band**

- Recently, Telecom Regulatory Authority of India (TRAI) sought information on the quantum of mmWave band spectrum to be available for 5G services to reach its base price
- **mmWave**is the band spectrum with usual wavelengths between **10 millimeters** (30 GHz) and **1 millimeter** (300 GHz).
- In India, Telecom companies want inclusion of 26-28Ghz spectrum bands in **National Frequency Allocation Plan (NFAP), 2018** along with existing mid-band spectrum of 3.3-3.6 Ghz for 5G services.
- Critical for 5G and satellite broadband services due to their capacity to carry enormous data, **it will reduce the 5G cost significantly.**

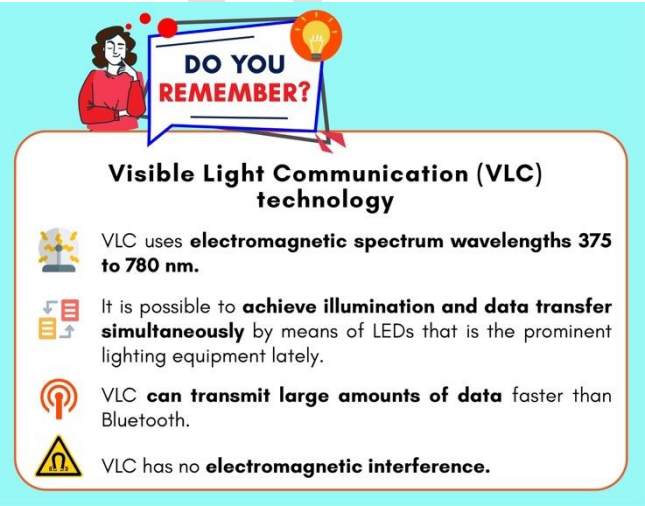
3.3. LIGHT FIDELITY (LIFI) TECHNOLOGY

Why in News?

Recently, Students' Educational and Cultural Movement of Ladakh (SECMOL) institute got LiFi network.

About Light Fidelity (Lifi) Technology

- LiFi is a wireless optical networking technology, which **uses light emitting diodes (LEDs) to transmit data.**
  - It makes a LED light bulb emit pulses of light that **are undetectable to human eye and within those emitted pulses, data can travel** to and from receivers.
- **LiFi is not strictly a line-of-sight technology** i.e. data rate is not dependent on the line of sight but on the signal quality at the device
- **Advantages of LiFi systems**: Provide ultra-fast data connections, Useful in urban areas where radio spectra are congested and also in rural areas wherein Fiber Optic Cables or networks are not reachable etc
- Unlike **Wi-Fi that uses radio waves for data transmission,** LiFi uses light.



Difference between Wifi and Lifi

Feature	LiFi	WiFi
Operation	LiFi transmits data **using light with the help of LED bulbs.**	WiFi transmits data **using radio waves with the help of WiFi router**.
Interference	**Do not have any intereference issues similar** to radio frequency waves.	Will have **intereference issues from nearby access points (routers).**
Privacy	In LiFi, **light does not pass thorugh the walls** and hence will provide a much secure data transfer	In WiFi, **Radio frequencies signal passess thorugh the walls** and hence there is a need to employ techniques to achieve secure data transfer.
Data transfer speed	**About 1 Gbps**	**About 150Mbps.**
Frequency of operation	**10 thousand times frequency spectrum** of the radio	2.4GHz, 4.9GHz and 5GHz
Coverage distance	**About 10 meters**	**About 32 meters** (vary based on transmit power and antenna type)
Data density	work with **high dense environment**	**work in less dense environment** due to interference related issues

3.4. INTERNET OF THINGS

Why in news?

Recently, **Telecommunication Engineering Centre (TEC) released 'Code of Practice for securing consumer Internet of Things (IoT)'.**

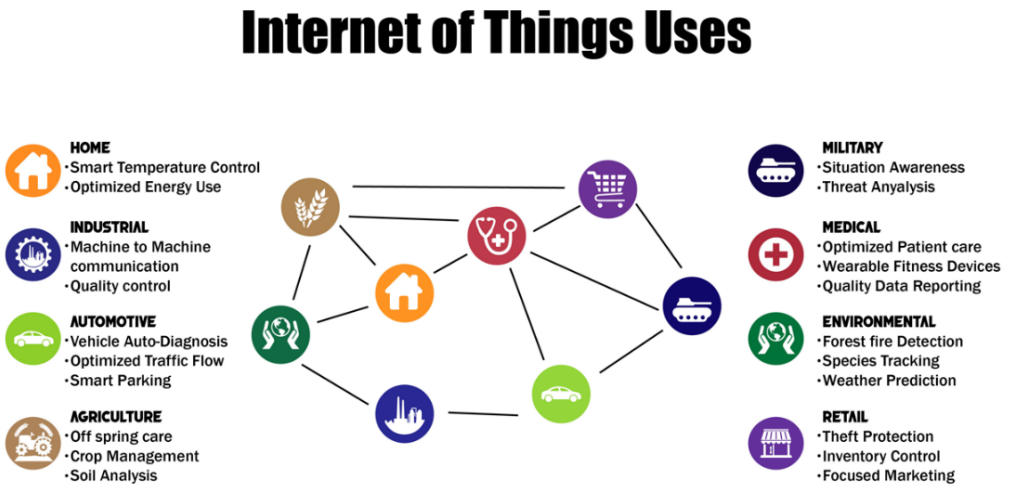
About Internet of Things (IoT)

- It is a **seamless connected network of embedded objects/ devices, with identifiers, in which Machine to Machine (M2M) communication without any human intervention is possible** using standard and interoperable communication protocols.
    - In general terms, it includes **any object or thing that can be connected to an Internet network,** from factory equipment and cars to mobile devices and smart watches.
        - ✓ **Phones, Tablets and PCs** are not included as part of IoT.
    - It specifically comes to mean **connected things that are equipped with sensors, software, and other technologies** that allow them to transmit and receive data.
        - ✓ Traditionally, connectivity was achieved mainly via Wi-Fi, whereas **today 5G and other types of network platforms are increasingly able to handle large data sets** with speed and reliability.

Guidelines for securing consumer IoT

- All IoT device **default passwords shall be unique** per device.
- **Disclosed vulnerabilities** should be acted on **in a timely manner**
- **Software components** should be **securely updateable**.
- **Unused functionality should be disabled**; hardware should not unnecessarily expose access (e.g. unrequired ports both network and logical should be closed).
- **Security-sensitive data** should be **encrypted in transit**.
- In case the device collects or transmits **personal data,** such data **should be securely stored.**

- It is widely being used to create **smart infrastructure in various verticals such as Power, Automotive, Safety and Surveillance, Remote Health Management, Agriculture, Smart Homes and Smart Cities** etc, using connected devices**.**



How does IoT work?

- An IoT ecosystem consists of **web-enabled smart devices use embedded systems, such as processors, sensors and communication hardware,** to collect, send and act on data they acquire from their environments.
- These **share the sensor data they collect by connecting to an IoT gateway or other edge device** where data is sent to the cloud to be analyzed locally.
- Sometimes, **these devices communicate with other related devices** and act on the information they get from one another.
- The devices do most of the work without **human intervention, although people can interact with the devices for instance, to set them up, give them instructions or access the data**.

Significance of IoT

- IoT **encourages the communication between devices,** also known as **M2M communication**.
- M2M communication helps to **maintain transparency i**n the processes. It leads to **uniformity in the tasks** and **maintain the quality of service**.
- M2M interaction provides **better efficiency, hence, accurate results can be obtained fast.**
- Applications of IoT in increased **convenience, better management, thereby improving the quality of life**.
- **Challenges of IoT:** Data Breach, increased dependence on Technology, Complexity in operation, issue of compatibility in tagging and monitoring, lesser Employment of Menial Staff etc.

Measures taken by the government to promote IoT

- **In 2015, Draft IoT Policy** was formulated with a vision to **develop connected and smart IoT based system for our country's economy, society, environment and global needs.**
- **Centre of Excellence for IoT was set up in Bangalore** by GOI and NASSCOM. Also, **Andhra Pradesh will become an IoT hub** with first-of-its-kind policy

- The government came up with the **National Digital Communications Policy (NDCP) 2018, released by Department of Telecommunications (DoT),** to satisfy the modern realities of the telecom such as 5G technology, IoT, M2M communication, etc.
  - As per the **NDCP,** an eco-**system is to be created for 5 billion connected devices by 2022**.
- In October 2021, the Government notified **100% FDI via the automatic route** from previous 49% in the **telecommunications sector**.

3.5. METAVERSE

Why in News?

A recent study ranked **India among top 5 countries in terms of interest in metaverse projects.**

More on News

- Metaverse projects **refer to blockchain-based games and applications** that are set in virtual worlds.
- Such games follow a **play-to-earn model, where gamers are rewarded for being invested** in the game.

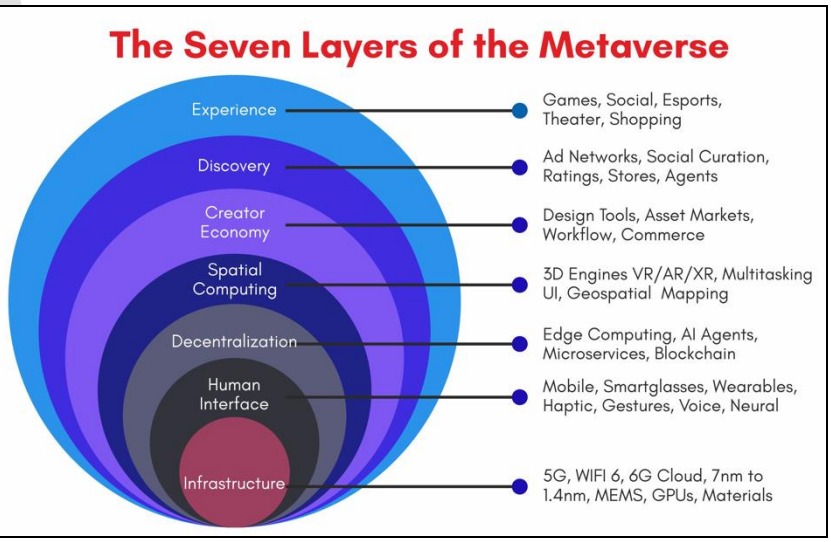
What is Metaverse?

- Metaverse can be understood as a combination of multiple elements of technology, including virtual reality, augmented reality and video where users "live" within a digitally enhanced surrounding.
- **These technologies** are currently being developed by Apple, Google, Amazon, and Microsoft in addition to Facebook.
- To understand how it works and the impact that it may create, it is important to have clarity on following ideas and technologies:
  - **Virtual Reality (VR):** VR can be understood as the use of computer modelling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment. E.g., games like World of Warcraft.
    - ✓ **VR closes the world,** and transposes an individual, providing complete immersion experience.
  - **Augmented Reality (AR):** It is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology. E.g., games like Pokémon Go.
  - **Hologram:** Holograms are virtual three-dimensional images created by the interference of light beams that reflect real physical objects.
  - **Avatar:** An avatar in the metaverse is a representation of an individual in the virtual world, this digital avatar enables the person to function like an actual human being in a digitally created world.
  - **Platform/Developer/User distinction:** In metaverse, digital engagement will get very personal and tailormade for the user. In this context, it is important that role played by the platform, the developers and the users is clearly understood.

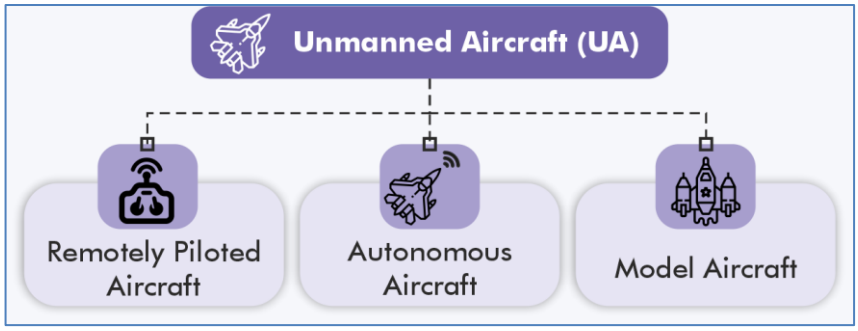
How it works?

Using the aforementioned digital tools, the idea of metaverse aims to **connect people, places and things in multiple environments**.

The metaverse enables this by merging virtual, augmented, and physical reality, and **blurs the line between your interactions online and in real life.** It would enhance our abilities to express pieces of ourselves through avatars in ways that we may not have been able to test out before.



3.6. DRONE REGULATIONS IN INDIA

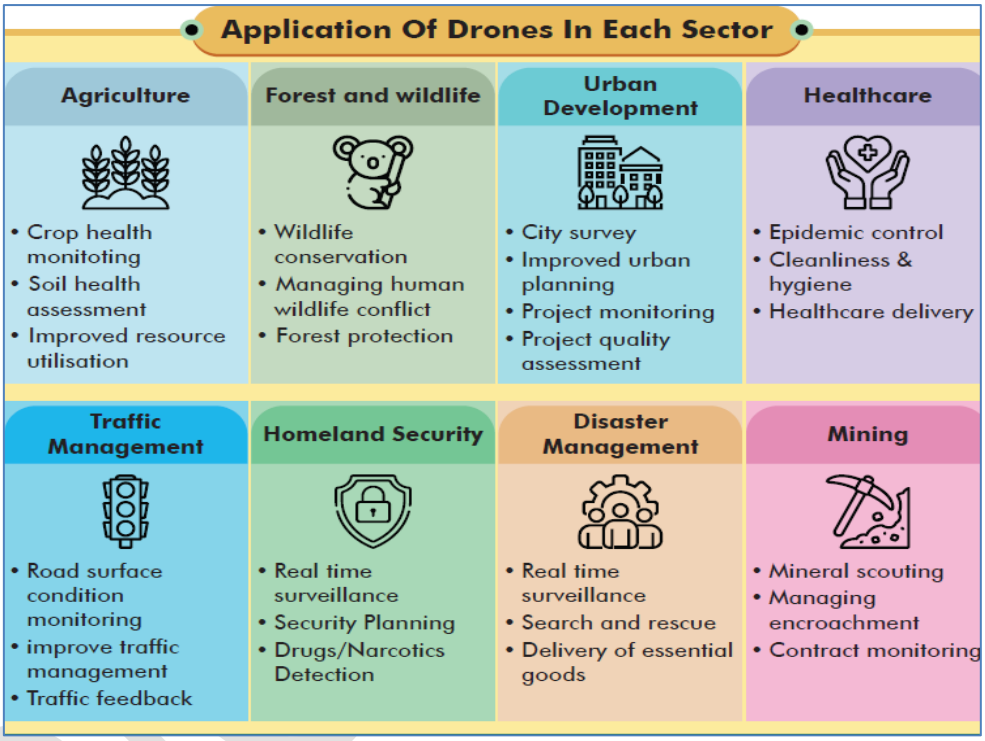


Why in News?

Ministry of Civil Aviation (MoCA) has released the updated – The Drone Rules, 2021.

About Drones

- Drone is a layman terminology for Unmanned Aircraft (UA), an aircraft, **which is intended to operate with no pilot on board.**
- An aircraft and its associated elements, which are operated with no pilot on board is called as Unmanned Aircraft System (UAS).



Draft Drone Rules, 2021

- Drone Rules, 2021 will replace the **Unmanned Aircraft Systems (UAS) Rules 2021** (released on 12 March 2021).
- Objective is to **enable more types of unmanned aircraft operational scenarios, increase the ease of compliance for the unmanned aviation industry, and ensure safety and security.**

Key provisions

Rules will apply to	• A person owning or possessing or engaged in exporting, importing, manufacturing, trading, leasing, operating, transferring, or maintaining a drone in India. • All drones that are being operated for the time being, in or over India. • These **shall not apply to drones used by the naval, military or air force.**
Eligibility conditions for authorization	• **Following natural persons shall be eligible** for a remote pilot license: ○ **Not less than eighteen years of age** and not more than sixty-five years of age. ○ **Have passed class tenth or its equivalent** examination from a recognised Board. ○ **Have completed the training prescribed by the Director General** for the applicable class of remote pilot licence from an authorised remote pilot training organisation. • **No licence shall be required for a person operating** ○ A nano drone. ○ A micro drone for non-commercial purposes ○ For research and development (R&D) organizations operating such drones.
Classification of drones	• Will be **based upon the maximum all-up weight** including payload:

Classification of UAS	
Nano	<= 250g.
Micro	250g - 2kg
Small	2 kg - 25 kg
Medium	25 kg - 150 kg
Large	>150 kg

<table>
<tr><td>Drone Registration</td><td colspan="3">• Drone operators will have to generate a unique identification number of a drone by providing requisite details on the digital sky platform (DSP).
○ DSP is an initiative by MoCA to provide a secure and a scalable platform that supports drone technology frameworks, such as NPNT (no permission, no take-off), designed to enable flight permission digitally and managing unmanned aircraft operations and traffic efficiently.</td></tr>
<tr><td rowspan="3">Drone Operations</td><td colspan="3">• Central Government may publish on DSP, an airspace map for drone operations segregating the entire airspace of India into red, yellow, and green zones.</td></tr>
<tr><td>Green Zone
• Airspace from the ground up to a vertical distance of 400 feet (120 metre) above ground level (AGL) that has not been designated as a red zone or yellow zone in the airspace map.
• Airspace from the ground up to a vertical distance of 200 feet (60 metre) AGL in the area located between a lateral distance of 8 kilometre and 12 kilometre from the perimeter of an operational airport.</td><td>Yellow Zone
• Controlled airspace of defined dimensions above the land areas or territorial waters of India within which drone operations are restricted and shall require permission from the concerned air traffic control authority.</td><td>Red Zone
• Airspace of defined dimensions, above the land areas or territorial waters of India, or any installation or notified port limits specified by the Central Government beyond the territorial waters of India; within which drone operations shall be permitted only under exceptional circumstances by the Central Government;</td></tr>
<tr><td colspan="3">• No person shall operate a drone in a red zone or yellow zone without prior permission.
• In the airspace above 400 feet AGL in a designated green zone and the airspace above 200 feet AGL in the area located between the lateral distance of 8 kilometre and 12 kilometre from the perimeter of an operational airport, the provisions of yellow zone shall apply;
• State Government, UT or law enforcement agency may declare a temporary red zone for a period not exceeding 48 hours at a time.
○ Declaration shall be done by an officer not below the rank of Superintendent of Police or its equivalent.</td></tr>
<tr><td>Drone operations for research and development (R&D)</td><td colspan="3">• Following persons shall not require a certificate of airworthiness, unique identification number, prior permission, and remote pilot licence for operating drones:
○ R&D entities and Educational institutions under the administrative control of, or recognised by Central Government, State Governments or UT.
○ Startups recognised by Department for Promotion of Industry and Internal Trade.
○ Any drone manufacturer having a Goods and Service Tax Identification Number.
• But such drone operations must take place within a green zone and within the premises of the person where such R&D is being carried out; or within an open area in a green zone under such person's control.</td></tr>
<tr><td>Other key highlights</td><td colspan="3">• In case of a drone with maximum all-up-weight more than 500 kilogram, the provisions of the Aircraft Rules, 1937 shall apply.
• Import of drones and drone components shall be regulated by the Directorate General of Foreign Trade.
• No security clearance required before any registration or licence issuance.
• Approvals abolished: unique authorisation number, unique prototype identification number, certificate of conformance, certificate of maintenance, import clearance, acceptance of existing drones, operator permit, authorisation of R&D organisation, student remote pilot licence, remote pilot instructor authorisation, drone port authorisation etc.
• Safety features like 'No permission – no take-off' (NPNT), real-time tracking beacon, geo-fencing etc. to be notified in future.
• Digital sky platform shall be developed as a business-friendly single-window online system.
• Issuance of Certificate of Airworthiness delegated to Quality Council of India and certification entities authorised by it.</td></tr>
</table>

3.6.1. DRONE TECHNOLOGY IN AGRICULTURE

Why in News?

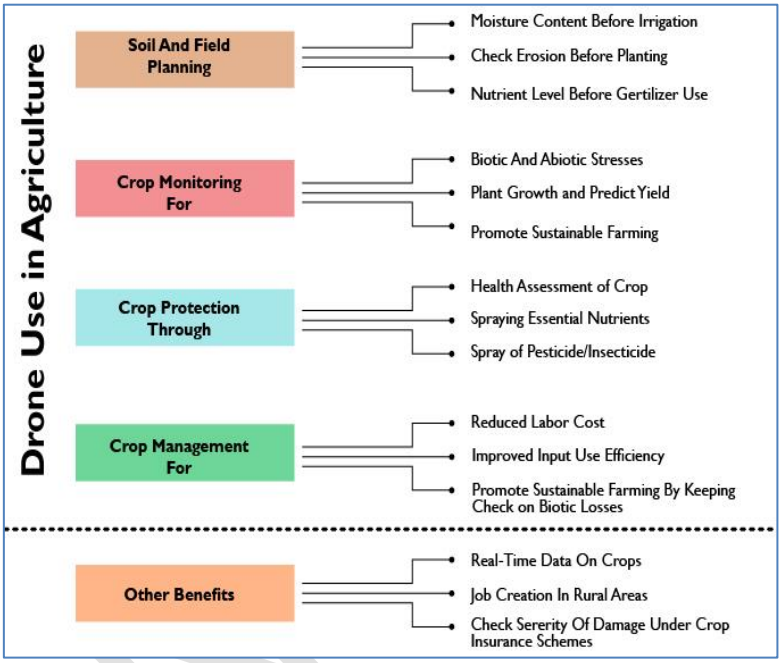
Recently, the Union Agriculture Minister released the **Standard Operating Procedure** (SOP) **for use of Drone in Pesticide Application** for Crop Protection and for spraying Soil and Crop Nutrients.

Major Provisions of the SOPs

- It covers instructions on **pre, post and during operation, emergency handling plan** for effective and safe operations of drones.
- The SOP covers important aspects of **Pesticide application** and drones can be used in Agricultural, Forestry, Non-Cropped Areas, etc.

Potential of Drone Technology use in Agriculture

"Drone" means an **unmanned aircraft system**, i.e., an aircraft that can **operate autonomously** or can be **operated remotely** without a pilot on board (**Drone Rules, 2021**).



- Finding use in many fields, it holds potential to **modernize the routine manual agriculture** activities as well by **linking with artificial intelligence (AI), machine learning (ML)** etc.
  - This includes mining, infrastructure, surveillance, emergency response, transportation, geo-spatial mapping, defence, and law enforcement etc.
- It will also help in finding solutions to:
  - **Addressing Increasing food demand** with world population predicted to reach 9 billion by 2050;
  - **React faster to pest invasions**. E.g. in 2020, drones were used in fight against the attack on crops by swarms of locusts in India.
  - **Help in future needs of agriculture** through micro level resource management to overcome unsuitable farming methods. E.g. In an experiment, drones helped in reducing herbicide use by 52% in a Brazilian soybean field.
  - **Help in Smart Agriculture** through direct communication between drones and other agricultural equipment. It involves processing of drone inputs to create field maps and sending it to farm equipment.

Why use drones for spraying pesticides?

- Being toxic in nature (Biocides), the Conventional pesticide use methods carry issues like:
  - **High Labor Cost, Lower spray uniformity** and **excessive application**.
  - **Health and environment risks** on **Oral, respiratory or dermal** (by skin) contact; pollution of soil and water.
- Drones use can **help address most of these issues.**

Challenges

- **Unviable Commercial Operation** due to small and scattered landholding. E.g. According to the Agriculture Census (2015-16), around 86% farmers in India hold land less than 5 acres.
- **Limited Flight time and range** of Drones due to relatively high payloads (20-60 minutes).
- **High Initial costs** of drones with maintenance issues.
- **Connectivity issues** in rural areas for online coverage.
- **Knowledge and skill issues** as it needs specialized skills and knowledge from farmer to utilize drone inputs,
- **Concerns over misuse of drones** to infringe privacy and security (especially in border areas).
- **Weather dependence** with difficulties to operate in windy or rainy weather.

Modern Technology in Agriculture

- **Agricultural Drone:** By using the correct sensors, drones can provide farmers with realtime information regarding crops, soil deterioration, dry regions, fungal infections, spraying etc.
- **Satellite images** to keep an eye on crops without being present on the farm.
- **Artificial Intelligence** to reach solutions based data that indicates weather conditions, type of harvest a crop would need, and the type of soil most suitable, etc.

- **Soil and Water sensors:** can detect moisture and nitrogen levels.
- **RFID Technology:** Can be used for traceability of particular crops and to provide information that can be associated with farming yields.
- **Vertical Farming:** Provides farmers with a wonderful possibility to increase crop yields while overcoming the problems related to a limited land area.
- **Internet of Things (IoT):** can be used to monitor soil moisture, water meters, rainfall, weather stations, irrigation pumps, and cattle biometrics.
- **Robotics:** could positively impact the production of food, in particular high value crops that require intensive labor.
- **Advantage of using technology in agriculture:** Improved water use efficiency, better crop varieties, climate/weather prediction, reduces farmer's efforts, lower cost of production etc.

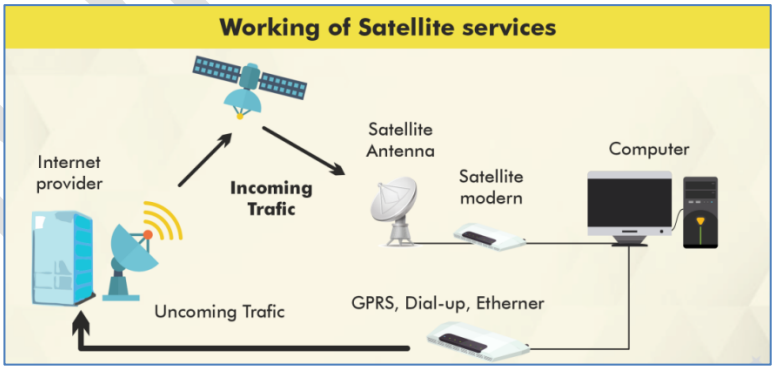
Anti drone technologies that can be used against rouge drones

Radio Jammer	It is a static, mobile, or handheld device that uses a combination of radar and cameras to detect and jam drones in the sky by transmitting radio frequencies
GPS spoofing	This countermeasure involves sending a new signal to the drone, replacing the communication with GPS satellites it uses for navigation.
Electromagnetic Pulse	It will interfere with radio links when fired and disrupt or even destroy the electronic circuits in drones.
Net Guns	Net Cannon fired from the ground can be hand-held, shoulder-launched, or turret-mounted and is used to capture drones effectively between a range of 20m to 300m.
High energy lasers	These are high-powered counter-Unmanned Aerial Systems that shoot an extremely focused beam of light, or laser beam that melts and disrupts a drone's electronics.

3.7. SATELLITE INTERNET SERVICES

Why in News?

Recently, government issued a public advisory to stop Starlink Internet Services from offering satellite-based services in India and asked citizens not to subscribe to it as it is not licensed in India.



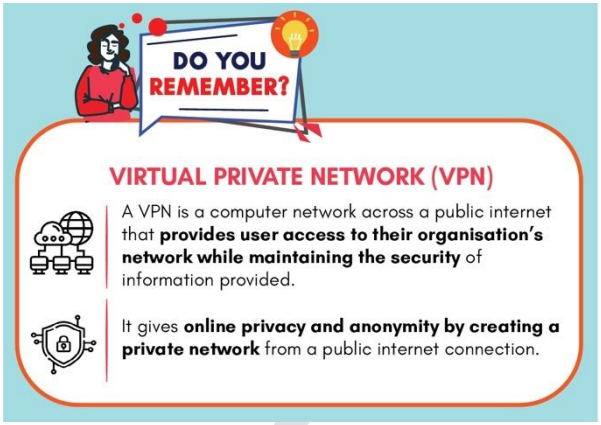
More on News

- For commercial launch of Satellite Internet Services a company needs GMPCS (global mobile personal communication by satellite) license, with **Department of Telecommunications**, as the licensor under **Section 4 of the Indian Telegraph Act of 1885**.
- **GMPCS is a personal communication system providing transnational, regional or global coverage** from a constellation of satellites accessible with small and easily transportable terminals.

What is Satellite Internet Service?

- Satellite Internet Services is a **wireless internet connection** which uses satellites in space to get an internet signal from the Internet Service Provider (ISP) to users.
- It operates using two way satellites like **VSAT (Very Small Aperture Terminal)** or telecommunication satellites to liaison between Internet Service Providers (ISPs) and Users with satellite dishes.
- These can be the geostationary satellites or satellites in **Low Earth Orbit (LEO);** in 500-2000 km by **Starlink** (SpaceX)**, Kupier**(Amazon)and **OneWeb**.
  - **Advantages of** Space-based internet systems **using satellites in LEO compared to GEO:** low Latency in signal transmission.
  - **Advantages of** Space-based internet systems **using satellites in GEO compared to LEO:** Serviceable area on Earth by each satellite is more, easier to establish a transmission link with a satellite.

- It is **different from satellite television** as Internet signals have to go **both ways** with a much **greater amount of bandwidth** to move all that data.
- The other types of **internet services** in India includes- **Digital Subscriber Line (DSL), fixed wireless internet, wireless cellular networks (e.g. 4G, 5G), Fiber optic cables** etc.



Models for satellite-based connectivity include:

- **Hybrid (LPWAN + Satellite) or Indirect Model:** In this, each sensor and actuator in a network may communicate with the satellite through an intermediate sink node, i.e., Low Power Wide-Area Network (LPWAN) gateway.
- **Direct to Satellite Model:** allows devices to directly communicate with the satellite without the need of any intermediate ground gateway.

Benefits of Satellite Internet Services	Challenges in Satellite Internet Services
• **Cheap** and **easy internet** option for rural areas, hilly terrains, and islands for **Last Mile connectivity**. • **Faster than DSL connection** with continuously improving technology with present speeds reaching around **100 mbps**. • Can play a **significant role in emergency** or **disaster recovery** due to limited ground infrastructure.	• **Low Speed** and **High Latency*** in comparison to fiber optic cables, • **High Cost** as compared to wireless cellular networks and others, • **Limitations of Bandwidth** with **high impact of weather aberrations**, • **Potential to damage spacecrafts/satellites** or interrupt **higher satellites frequency** because of its large satellite network need, • **Potential to increase** space junk • **Not compatible for virtual private network (VPN)** Services. ○ A VPN gives online privacy and anonymity by creating a private network from a public internet connection

**- Latency, also known as ping time, refers to how long it takes a single piece of information to make a round trip back and forth over a satellite connection.*

Related news
Indian Satellite Navigation Policy – 2021 (SATNAV Policy – 2021)

- SATNAV Policy has been proposed by the **Department of Space (DOS).**
  - Satellite based Navigation is a constellation of navigation satellites with global or regional coverage and its supporting infrastructure designed to provide all weather, passive, three-dimensional position, velocity and timing data.
- **Major Objectives of the Policy**
  - Ensuring **guaranteed and continuous availability of free-to-air navigation signals** for civilian uses and secured navigation signals for strategic uses.
  - Working towards **compatibility and interoperability** of Indian satellite navigation and augmentation signals **with other Global Navigation Satellite Systems (GNSS) and Satellite based Augmentation Systems (SBAS) signals.**
  - To provide **Position, Velocity and Time (PVT) based services.**
  - **To continue and upgrade Space based navigation services (SBNS) and SBAS** as part of government's Atmanirbhar Bharat.
    - ✓ Secured SBNS exclusively for the Indian strategic community is provided through **Navigation with Indian Constellation (NavIC).**
      - ➢ NavIC or **Indian Regional Navigation Satellite System** (IRNSS) is an **independent regional navigation satellite system** developed by ISRO.
      - ➢ IRNSS is a constellation of seven satellites -three in geostationary orbit and four in geosynchronous orbits.
    - ✓ SBAS services via **GPS Aided Geo Augmented Navigation (GAGAN)** for the Indian airspace.
      - ➢ GAGAN is **jointly developed by ISRO and AAI to provide navigational services and position accuracy** for Aviation.

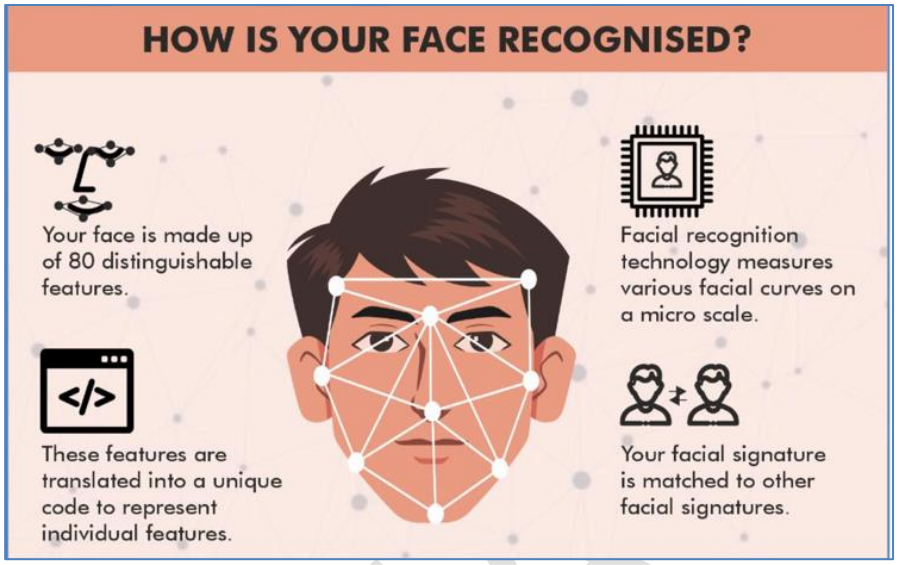
3.8. FACIAL RECOGNITION TECHNOLOGY

Why in News?

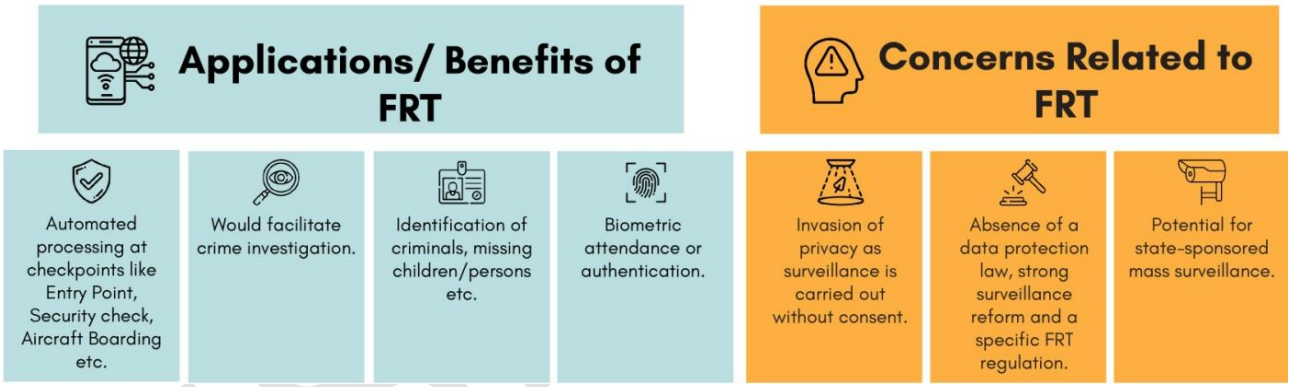
Recently, NITI Aayog okayed study on facial recognition technology (FRT) in India

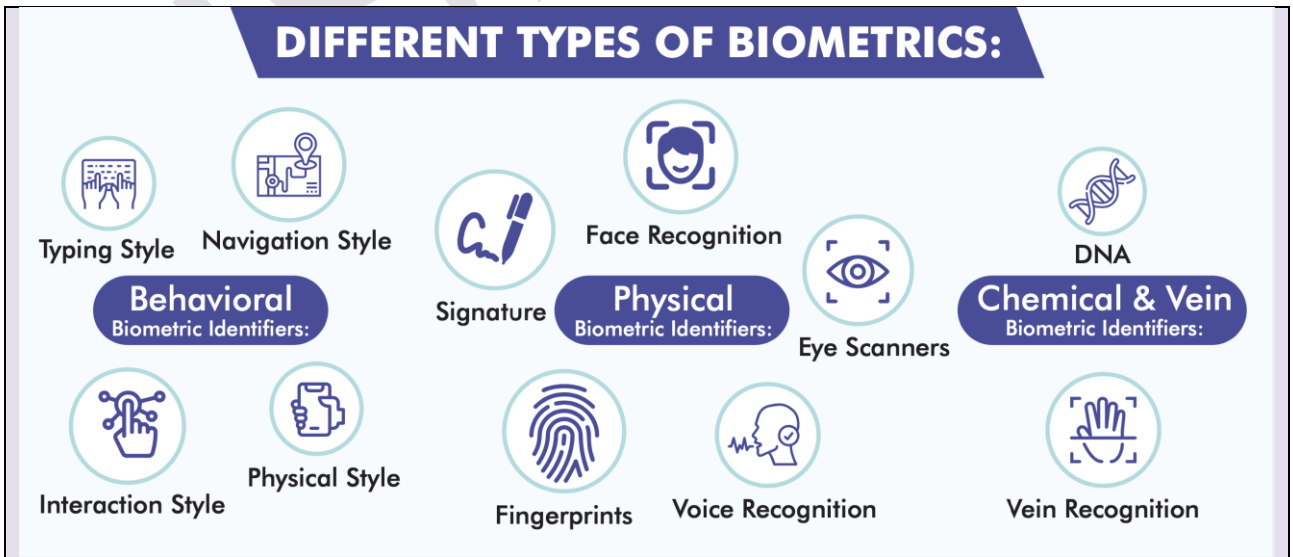
About Facial recognition technology (FRT)

- It is a **way of identifying or confirming an individual's identity using their face.** It can be used to **identify people in photos, videos, or in real-time.**
  - **Computer algorithms map unique facial-landmarks** such as shape of cheekbones, contours of lips etc. **and convert these into a numerical code**—termed a faceprint.
    - ✓ It relies on many of the processes and techniques **associated with artificial intelligence (AI)**
  - For the purposes of 'verification' or 'identification', **system compares the faceprint generated with a large existing database** of faceprints.



- Recently, **Government has approved implementation of National Automated Facial Recognition System (NAFRS).**
  - NAFRS, to be used by police pan-India, **will be issued by NCRB.**





Mechanisms of some of the methods

- **Fingerprint:** Fingerprints are easy to capture, and can verified by comparing the unique loops, arches, and whorls in each pattern.

- **Voice Recognition:** Physically, the shape of a person's vocal tract, including the nose, mouth, and larynx determines the sound produced. Behaviorally, the way a person says something – movement variations, tone, pace, accent, and so on – is also unique to each individual.
- **Retina Scan:** Retinal scans capture capillaries deep within the eye (unique to each person) by using unique near-infrared cameras.
- **Keystroke dynamics:** Keystroke dynamics leverage the fact that people follow a definite pattern while typing on a keyboard or keypad.

Apart from the aforementioned indicators, other biometrics are also emerging like **ear authentication, footprint and foot dynamics and gait recognition (style of walking).**

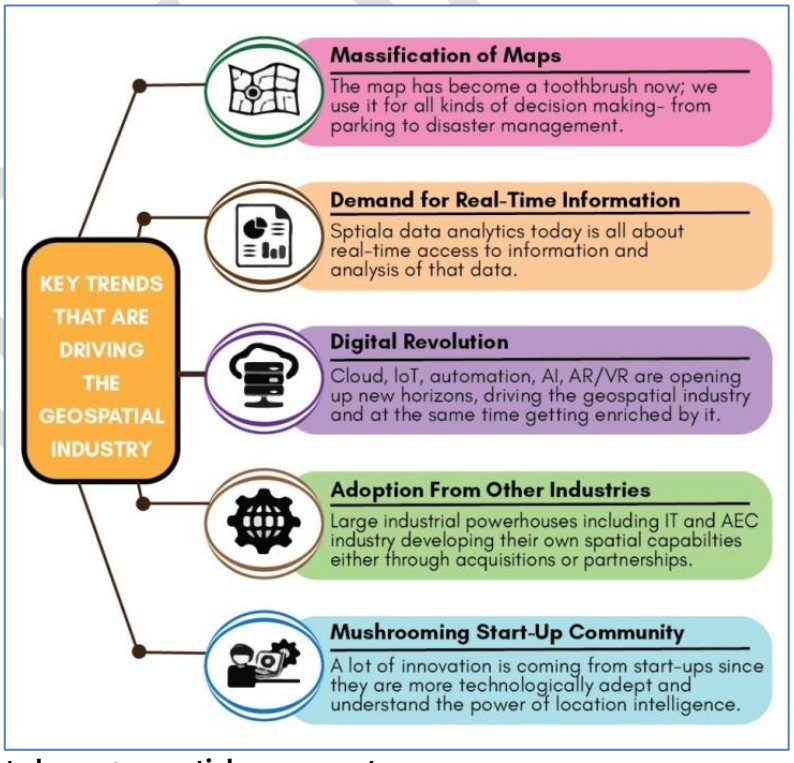
3.9. GEOSPATIAL DATA

Why in News?

Ministry of Science and Technology launched **three web portals to offer geospatial data** collected by Survey of India and National Atlas and Thematic Mapping Organization **either free or at a nominal cost for the first time.**

Applications launched

- **Survey of India (SOI) Geo Spatial Data Dissemination Portal** provides in various downloadable formats 4,000 maps with national, state, district, and tehsil level data.
- **SOI's WEB Geographic Information System, SARTHI**, help users in creating applications for geospatial data visualisation, manipulation, and analysis without a lot of resources at their end.
    - **Geospatial information systems (GIS)** is the physical mapping of data within a visual representation. For example, when hurricane map is overlaid with another layer showing potential areas for lightning strikes.
- **MANCHITRAN Enterprise Geoportal of National Atlas & Thematic Mapping Organisation (NATMO)** makes available thematic maps such as the cultural map of India, the climactic map, or the economic map.



About Geo-Spatial Data

- Geospatial data (also known as "**spatial data**") is used to describe data about objects, events, or phenomena (man-made or natural) that have a location on the surface of the earth. At present, **80% of any data has a geo spatial component.**
    - Examples include the location of a road, an earthquake event, malnutrition among children, or dynamic like a moving vehicle or pedestrian, the spread of an infectious disease etc.
- **The two main types of geospatial data are vector data and raster data.**
    - **Vector Data:** It uses geometric shapes to show the location and shape of geographic features. Points, lines and polygons can represent things like cities, roads and waterways. Vector data is scalable, has small file sizes and ideal for depicting boundaries.
    - **Raster Data:** It represents data through a digital image such a scanned map or photograph. It also includes aerial and satellite imagery. Raster data uses a cell-based format called stair-stepping to record data as pixels or grids with an image. Spatial analysis depends heavily on raster datasets.

About Geospatial Technology

- It includes **Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS).**
- Geospatial Technologies **helps to collect data about assets and resources, enables analysis and interpretation, reporting and monitoring, planning and decision making and to take informed action.**
  - Various missions such as Jal Jeevan Mission, Atal BhujalYojna, have set up projects using these technologies.
- **Several GIS based initiatives** are being implemented in India, such as:
  - Natural Resource Information System (NRIS) under National Natural Resources Management System (NNRMS),
  - National Spatial Data Infrastructure (NSDI) of the Department of Science and Technology (DST),
  - National Urban Information System (NUIS) of Ministry of Urban Development (MUD).

Other application of geospatial Technology

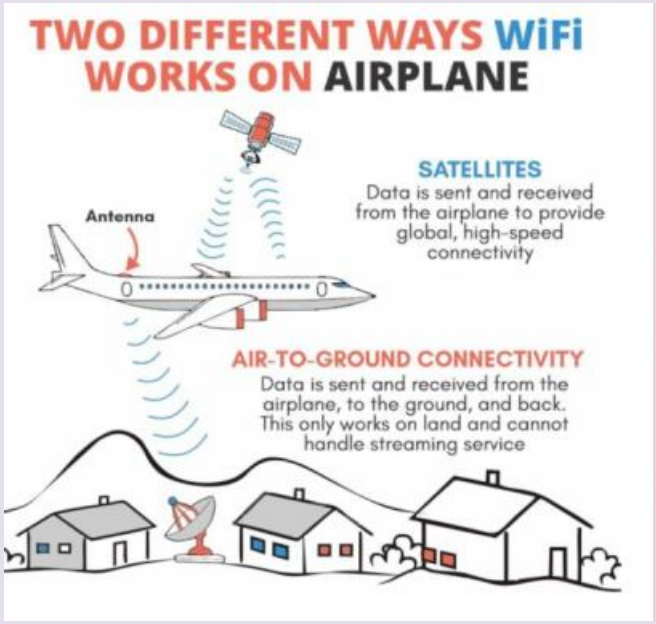
- **Disaster risk reduction and resilience** (early warning systems, detection, vulnerability mapping and for taking preventive measures).
- **Social Development** (agriculture, satellite-based fishing, precision agriculture, monitoring and modelling of crop conditions, insurance monitoring, forestry monitoring).
- **Energy** (determine the suitability of a location for generating solar energy).
- **Connectivity** (Road Asset Management system, land management, scientific maintenance planning, enhance road safety measures etc.)
- **Natural Resource Management**
- **Politics** (Public Administration for election data, property records and zoning/management etc.)
- **Public Work and Utilities, Public Safety Operations** including virus outbreaks, **Public Economic Development etc.**

3.10. OTHER IMPORTANT NEWS

Sophisticated Analytical & Technical Help Institutes (SATHI) scheme by DST	• **The Department of Science & Technology (DST)** has launched a scheme called SATHI.
	• DST is planned to set up **five SATHI Centers every year** for the next four years. **3 centers are already present** at IIT Kharagpur, IIT Delhi and BHU Varanasi.
	  ○ They will provide common services of high-end analytical testing, thus **avoiding duplication and reduced dependency on foreign sources**.
	  ○ The **aim** is to **provide professionally managed services** with efficiency, accessibility and transparency of highest order.

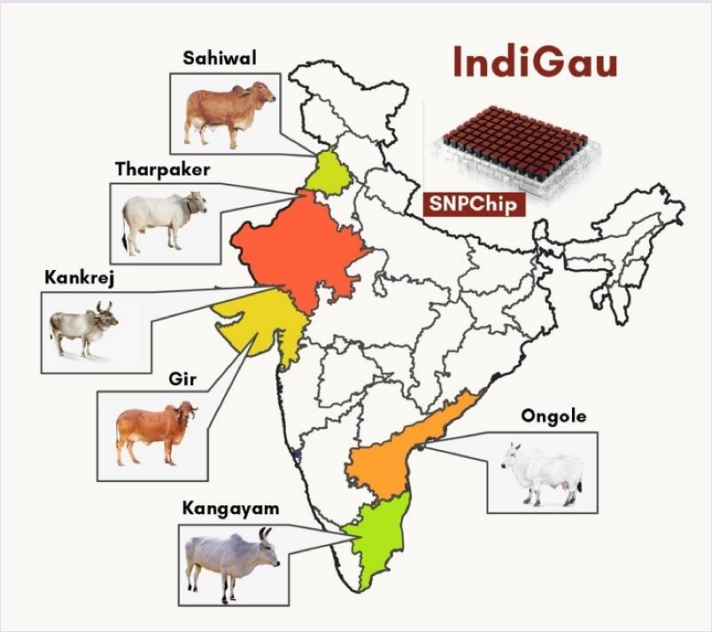
Internet Protocol Version 6 (IPv6)	• Recently, DoT fixed 30 June 2022 as **deadline for complete transition to IPv6 for government organisations**and December 2022 for internet service providers. • **An IP stands for internet protocol.** An IP address is **assigned to each device** connected to a network. Each device uses an IP address **for communication.** ○ An IP address **consists of two parts,** i.e., the first one is a network address, and the other one is a host address. • IPv6 is the most recent version of the Internet Protocol (IP) **to provide an identification and location system for computers on networks and routes traffic** across the Internet known as IP address. • As compared to IPv4, it is **fast and more secure.**
In-flight Wi-Fi	• Telecom Commission **had given its green signal to in-flight connectivity of Internet and mobile communications** on aircraft in Indian airspace in 2018. ○ However, there has been a **muted response for in-flight Wi-Fi.**

	IPv4	IPv6
DEPLOYED	1981	1998
IP ADDRESS	32-Bit	128-Bit
ADDRESSES	4.3 Billion Addresses must be reused and masked	340 undecillion addresses
NOTATION	Numeric dot-decimal Ex: 192.168.5.18	Alphanumeric hexadecimal Ex: 50b2:6400::6c3a:b17d:10a9
CONFIGURATION	DHCP or manual	Auto configuration

	• Broadly, in-flight connectivity systems use two kinds of technologies: **Air-to-ground WiFi and Satellite WiFi** (refer to the infographics).
	• **Main reasons of failure of uptake**
	  ○ Retrofitting antennas for Wi-fi is **extremely costly.**
	  ○ **Difficult to pass on the costs to the customers** in an extremely competitive market.
	  ○ **Low passenger demand** due to COVID-19.
	• **Wi-Fi stands for wireless fidelity.**
	  ○ It is a **radio transmission technology** and is built upon a set of standards that allow high-speed and secure communications between a wide variety of digital devices, access points, and hardware.
	  ○ **The typical range of a standard Wi-Fi network can reach up to 100 meters** in the open air.
	 

Pegasus's spyware	• It has been reported that a **spyware tool called Pegasus**, developed by an Israeli firm, the NSO Group, was used to **spy on journalists and human rights activists** in India. • The NSO Group is a **Tel Aviv-based cyber-security company** that specialises in "surveillance technology". • Pegasus delivers "a chain of **zero-day exploits to penetrate security features** on the phone/other devices. ○ A "zero-day exploit" is a **completely unknown vulnerability** and there is **no patch or fix available** for it.

Eutelsat Quantum Satellite	• Eutelsat Quantum, the **world's first commercial fully re-programmable satellite** lifted off from French Guiana.
	  ○ **Unlike conventional models that are designed and "hard-wired" on Earth** and cannot be repurposed once in orbit, Eutelsat Quantum allows users to tailor it almost in real-time.
	  ○ This means the satellite **can be used to provide mobile coverage for moving objects** such as aircraft and oceangoing vessels, or coverage after a natural disaster or for one-off events.
	• It has been developed under an **ESA (European Space Agency) partnership project** with Airbus.

IndiGau	• It is **India's first Cattle Genomic Chip for the conservation of pure varieties of indigenous cattle breeds** and helps towards doubling farmers' income by 2022.
	  ○ It is the **largest cattle chip in the world** with 11,496 markers.
	• Till now India's dairy development program has been referring to chips which are developed for foreign western breeds of cattle.
	  ○ This **indigenous chip** was **developed** by the **National Institute of Animal Biotechnology** (Hyderabad), an autonomous institution under the aegis of the Department of Biotechnology.
	 

Fakebuster to identify Deepfakes	• IIT, Ropar with Monash University, Australia have developed a unique detector named 'FakeBuster', **a deepfake identification tool for virtual conference.** • **About Deepfakes** ○ Deepfakes, i.e. 'Deep' from deep learning and 'fakes' or forged, are the fake video, audio or other digitally altered media to appear someone else or spread false information

Public and Private Key in Public Key Infrastructure	• Public Key Infrastructure (PKI) is a technology for authenticating users and devices in the digital world.
	• It is used to manage security through encryption, using a pair of keys for this as:
	  ○ **Public Key** which can be used by anyone as it is in open domain and seen as public pieces of data
	  ○ **Private Key or Secret Key** which is used for digitally signing documents, with owner and authorizer as only knowing entity
	• It is commonly used in issuance and management of **Digital Certificates**

Software Technology Park of India (STPI)	• Recently, STPI decided to establish **12 Centres of Excellence** in healthcare, Internet of Things and SmartAgri etc. • STPI was set up in **1991** as a **premier S&T organization** under the Ministry of Electronics and Information Technology (MeitY) with the **objective** of promoting the **development and export** of software and software services including Information Technology (I.T.) Enabled Services / Bio-IT. ○ It works on a **collaborative** model to transform the country into a software product nation as envisaged in **National Policy on Software Products (NPSP) 2019**
Artificial intelligence (AI) for All initiative	• **Intel,** in collaboration with **Central Board of Secondary Education (CBSE)** and **Ministry of Education,** launched this initiative to **create basic understanding of AI for everyone** in India. ○ It is a 4-hour, **self-paced learning programme** that describes AI in an inclusive manner and aims to **introduce AI to one million citizens**. • India's National Education Policy 2020 emphasizes preparing students for an AI driven economy. • NITI Aayog's **National Strategy for AI is built on philosophy of 'AI for All'** and focuses on leveraging AI for inclusive growth.

Delphi	• **It is an Artificial Intelligence (AI) system,** built by researchers in Seattle, **designed to make moral judgments.**
	• It hopes to build **an ethical framework that could be installed in any online service, robot or vehicle.**
	• Such a technology can help in **addressing problems in modern AI systems** such as:
	  ○ Facial recognition systems and digital assistants **that show bias against women and people of colour.**
	  ○ **Controlling hate speech** on social networks like Facebook, Twitter etc.
	  ○ **Arbitrary parole orders** by courts, police departments etc.

Global Positioning System (GPS) clocks	• **Indian Railways will provide GPS clocks (replacing the analog mechanism) for control offices** to enable section controllers coordinate with station masters, loco pilots and other staff directly involved in train operations and avoid accidents. • GPS Clock is a satellite system that **uses atomic clocks to provide everyone on Earth with low-cost access to international atomic time standards.** • Atomic clock, type of clock that uses certain resonance frequencies of **atoms (usually cesium or rubidium)** to keep time with extreme accuracy.
India Internet Governance Forum (IIGF)	• **First Internet Governance Forum was held** in India in November 2021. • IIGF has been **constituted in conformance to the Tunis Agenda** of UN Internet Governance Forum (IGF). ○ IGF is a **UN-based multi-stakeholder platform bringing representatives together from various groups** to discuss public policy issues related to the Internet. • IIGF facilitates **discussion between intergovernmental organisations, private companies,** civil society organisations etc. who all deal with or are **involved in Internet governance related public policy issues.**
Radio Frequency Identification (RFID)	• To enable tracking of real time data of commercial movements on highways, **GST authorities have integrated e-way bill (EWB) system with FASTag and RFID.** • RFID is the **use of radio waves to read and capture information stored on a tag** attached to an object. ○ A tag can be read from up to several feet away and **does not need to be within direct line-of-sight** of the reader to be tracked.
Digital embossing	• This technology is being used for **high-speed production of the maps and to produce Braille maps that can be used for a longer period.** • **About DET**

technology (DET)	○ It is a **digital printing technology that eliminates the need for printing plates, moulds, chemicals, and solvents,** besides releasing no pollutants or waste and reducing overall energy usage. ○ This technology is **designed and implemented for the first time in India by the National Atlas and Thematic Mapping Organisation (NATMO)** under Department of Science & Technology.
Global Cybersecurity index (GCI)	• **India is ranked 10th (among 194 countries)** in the GCI 2020 ahead of China and Pakistan. • GCI is released by the **International Telecommunication Union (ITU)**, the United Nations (UN) agency for information and communication technologies (ICT). ○ The **ranking is based on five pillars**: legal measures, technical measures, capacity building measures, organisational measures and cooperation. ○ In the **Asia-Pacific region India secured the 4th spot**. • **US is ranked first,** followed by UK.

4. SPACE TECHNOLOGY

4.1. GAGANYAAN

Why in news?

ISRO is planning the first unmanned mission of Gaganyaan.

Current status of Gaganyaan programme:

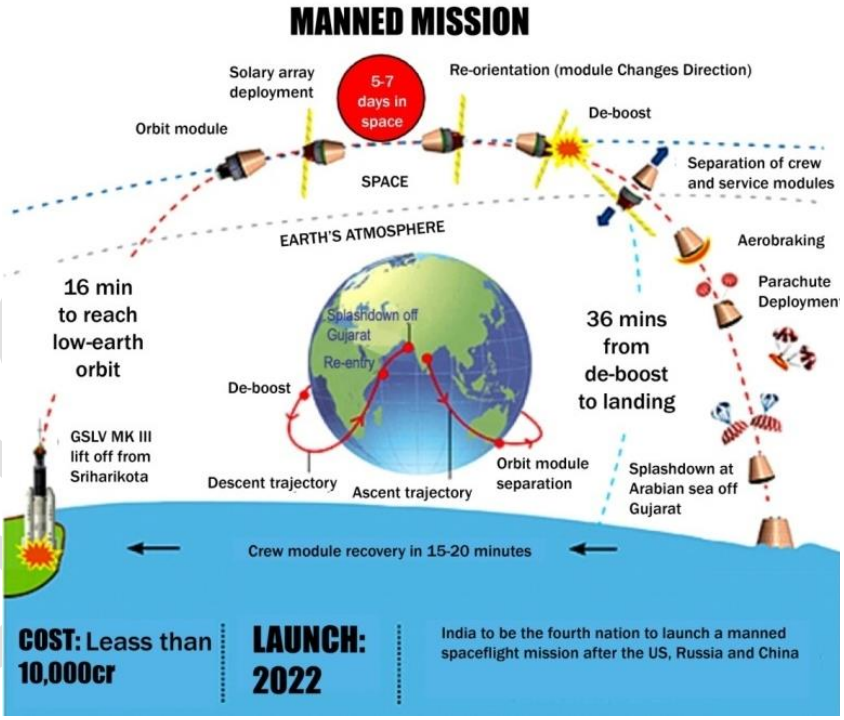
- **The astronaut training facility is getting established at Bengaluru** and in advanced stage of completion.
- **ISRO** successfully carried out the **third long duration hot test** of the liquid propellant **Vikas Engine.**
  - Vikas Engine is a **high thrust engine to enhance lifting power of various Indian Launch Vehicles.**

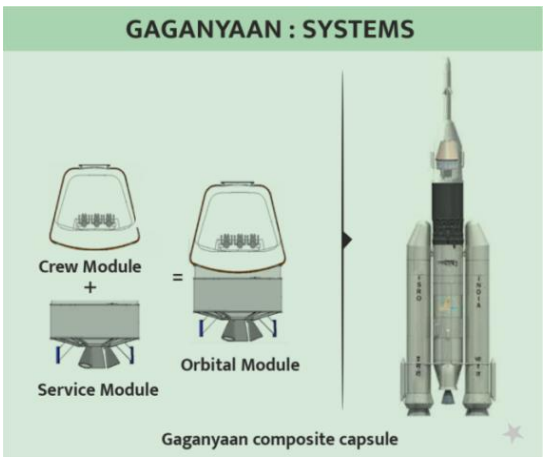
About Gaganyaan

- The **word 'Gaganyaan'** is derived from **Sanskrit,** meaning **'sky-vehicle'.**
- The Gaganyaan Programme envisages **undertaking the demonstration of indigeneous capability to undertake human spaceflight to Low Earth Orbit (LEO).**
- As part of this programme**, two unmanned missions and one manned mission will be carried out.**
  - ISRO is planning to launch the **first uncrewed mission under Gaganyaan in 2022,** following which the **second unmanned mission "Vyommitra" will carry a robot** and this will then be **followed by the manned mission.**
    - ✓ The uncrewed missions are for **technology demonstration, safety and reliability verification** and will aim to **study the performance of systems before crewed flight.**
    - ✓ The **robot will mimic the space crew activities set for the human flight mission** in order to assess all the possible challenges prior to the final mission.
- The overall **programme co-ordination, systems engineering and implementation** will be carried out by **ISRO.**
- The **major new technologies required** for Gaganyaan programme are as follows:
  - **Human rated launch vehicle**
  - **Crew escape systems**
  - **Habitable orbital module**
  - **Life support system**
  - **Crew selection and training and associated crew management activities**

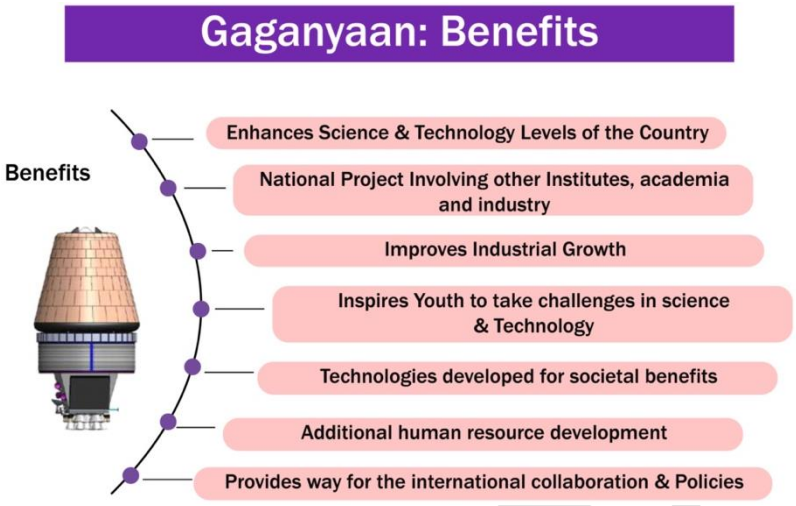
About GSLV Mark III

- It is a **three-stage heavy lift launch vehicle developed by ISRO**.
  - The vehicle has **two solid strap-ons, a core liquid booster and a cryogenic upper stage.**
- It is designed to **carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO)** or **about 10 tons to Low Earth Orbit (LEO),** which is about twice the capability of the GSLV Mk II.





- **The Gaganyaan orbital module** has two parts the Crew Module (CM) and the Service Module (SM) and weighs about 8000 kg.
    - The Crew Module (**CM) is a double walled system** and a **habitat of astronauts**. It has an ablative thermal protection system (TPS) to protect it during the intense aerodynamic heating during the flight.
- The **Orbital module (OM)** will be launched by a human-rated **GSLV MK-III vehicle** and **will orbit the Earth with a velocity of about 7,800 metre/second.**



- For the **first crewed mission** of Gaganyaan programme, astronaut trainees are selected, **based on selection criterion jointly defined by ISRO and Indian air force** which comprises of: **flying experience, fitness, psychological and aeromedical evaluation.**
- Gaganyaan would be **smaller in size** than the current manned missions of **Russian Soyuz, Chinese Shenzhou and NASA's planned Orion spacecraft.**

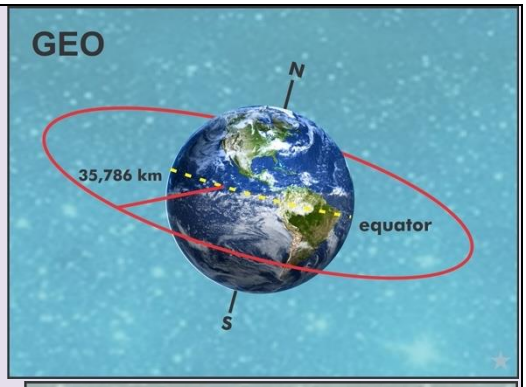
Upcoming Space Missions	Key features
Small Satellite Launch Vehicle (SSLV)	• It would help **to meet the demand of the global launch services market for small satellites (nano, micro etc).** • **New Space India Limited (NSIL), a PSU, will be the sole nodal agency** responsible for providing end-to-end SSLV Launch services. 
Chandrayaan 3	• The space agency is aiming to achieve a **soft landing on the south pole of the lunar surface, which is the least explored region of the Moon to date.** • Unlike its predecessor, Chandrayaan 3 will not carry an orbiter—but will include a lander and a rover to study the lunar surface
NASA-ISRO Synthetic Aperture Radar (NISAR) mission	• It is optimised for **studying hazards and global environmental change and can help manage natural resources better**. • It will provide information to scientists to better understand the effects and pace of climate change.
Shukrayaan-1	• It is a **proposed orbiter to Venus.**

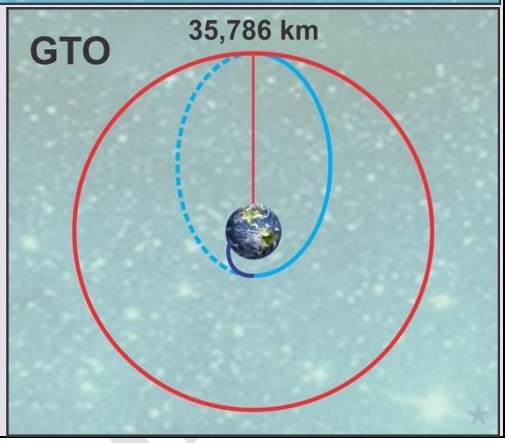
Related News
GISAT-1

- ISRO's **Geo-Imaging Satellite GISAT-1 launch failed** recently.
- Launch was supposed to **place EOS-03, an earth observation satellite, into a geosynchronous Transfer Orbit (GTO) ultimately reaching Geostationary Orbit (GEO) via GSLV-F10 rocket.**
- Mission failed due to the **Cryogenic Upper Stage (3rd Stage of GSLV) ignition did not happen due to technical anomaly.**

- **Cryogenic stage i**s the last stage of space launch vehicles which makes use of **Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) as propellants.**
- Geosynchronous Satellite Launch Vehicle (GSLV) is a 3-stage **expendable space launch vehicle designed, developed, and operated by ISRO** to launch satellites and other space objects into GTO.

- **About GTO and GEO**
  - Satellites in **GEO circle Earth above the equator from west to east** following Earth's rotation by travelling at exactly the same rate as Earth.
  - Transfer orbits are a **special kind of orbit used to get from one orbit to another** (using relatively little energy from built-in motors).
  - This allows a **satellite to reach a high-altitude orbit like GEO** without actually needing the launch vehicle to go all the way to this altitude, which would require more effort.
  - Reaching GEO in this way is an example of one of the most common transfer orbits, **called the geostationary transfer orbit (GTO).**





Radar Imaging Satellite (RISAT)-1A (EOS-4)

- It is the **sixth in the series of RISAT satellites developed by ISRO.**
- It is a remote sensing satellite has been built to map terrains and study Earth's different land areas and oceans.

4.2. SPACE DEBRIS

Why in News?

China rocket debris fell in Indian Ocean near Maldives.

More on news

- **Parts of Long March 5B re-entered the atmosphere** and landed in the Indian Ocean, with the bulk of its components destroyed upon re-entry into the Earth's atmosphere.
  - Long March **5B was carrying components for the construction of China's space station,** which will be completed by the end of next year.
- **Last year, debris** from another Chinese Long March rocket **fell on Ivory Coast,** damaging several buildings.

About Space Debris

- Space debris encompasses both **natural (meteoroid) and artificial (man-made)** particles. Meteoroids are in orbit about the sun, while most **artificial debris is in orbit about the Earth** which is commonly referred to as **orbital debris.**
- Orbital debris is any man-made object in orbit about the Earth which **no longer serves a useful function.** Such debris includes **non-functional spacecraft, abandoned launch vehicle stages, mission-related debris and fragmentation debris.**
- Much of the debris is in **low Earth orbit (LEO),** though some debris can be found in **geostationary orbit.**

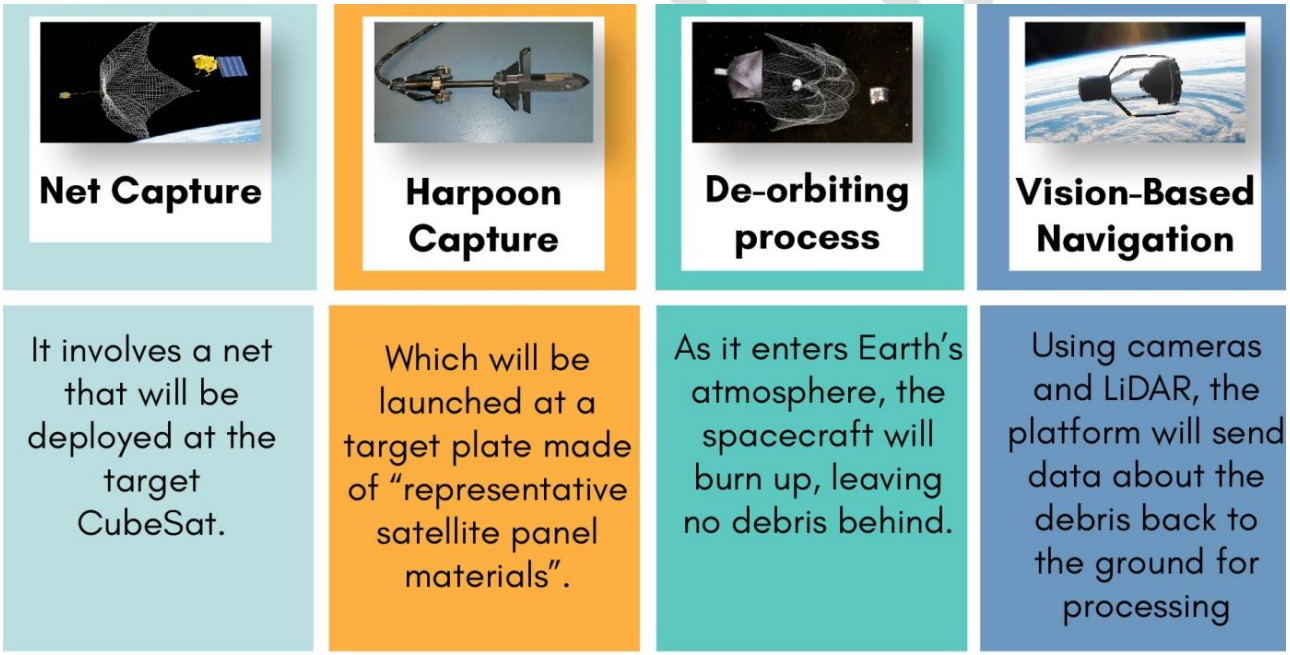
The Kessler Syndrome

- Also called the Kessler effect, is a **scenario in which the density of objects in Low Earth Orbit (LEO) is high enough that collisions between objects could cause a cascade** where each collision generates space debris that increases the likelihood of further collisions.
- It may lead to a situation in which orbit would become impassable in the long run.

- There are **about 500,000 pieces of debris** the size of a marble or larger orbiting the Earth, travelling at speeds up to 17,500 mph.
- International guidelines suggest removing space crafts from LEO **within 25 years of the end of their mission**. However, **only 60 percent of missions** follow the guidelines.

Strategies to Tackle Space Debris

- **Mitigating Damage:** Space debris is **tracked by a number of countries**, including Germany, France, UK and USA.
  - ISRO has come up with **'Project NETRA'** - an early warning system in space to **detect debris and other hazards** to Indian satellites.
  - Indraprastha Institute of Information Technology Delhi is working on a project titled **"Orbit computation of Resident Space Objects for Space Situational Awareness"** to predict collision from space debris.
- **Avoiding future debris: by adopting better designs** of rockets and other objects. For example, making **rockets reusable** could vastly cut down waste.
  - UK's **TechDemoSat-1 (TDS-1)**, was designed in such a way that once its mission is over, a system, would drag the satellite to **re-enter the atmosphere and burn up**.
- **Removal of the debris:**
  - **End-of-Life Services by Astroscale Demonstration (Elsa-D)** was launched to **locate and retrieve used satellites** and other space junk.
    RemoveDebris is an EU research project to give **in orbit demonstrations of cost-effective technologies** that can be used to observe, capture and dispose of space debris. It has performed key technology demonstrations including:



International efforts to tackle Space debris

- **Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation** Guidelines (2002) that focuses on limitation of debris, post-mission disposal, prevention of on-orbit collisions etc.
  - IADC is an **international governmental forum** for the worldwide coordination of activities related to the **issues of man-made and natural debris in space.**
  - ISRO is one among 13 member agencies of IADC.
- Committee **on the Peaceful Uses of Outer Space (COPUOS)** concluded **various international treaties** (like Outer Space Treaty, Liability Convention etc.) which **deal with issues** like **liability for damage** caused by space objects, **Prevention of harmful interference** with space activities and **registration of space activities** etc.
  - COPUOS was set up by UN General Assembly in 1959 to govern the exploration and use of space for the benefit of all humanity.

Self-Eating-Rockets & Vanishing Satellites

- ISRO has been focusing on new technologies, from **self-eating rockets to self-vanishing satellites and from make-in-space concepts to quantum communication and radars.**

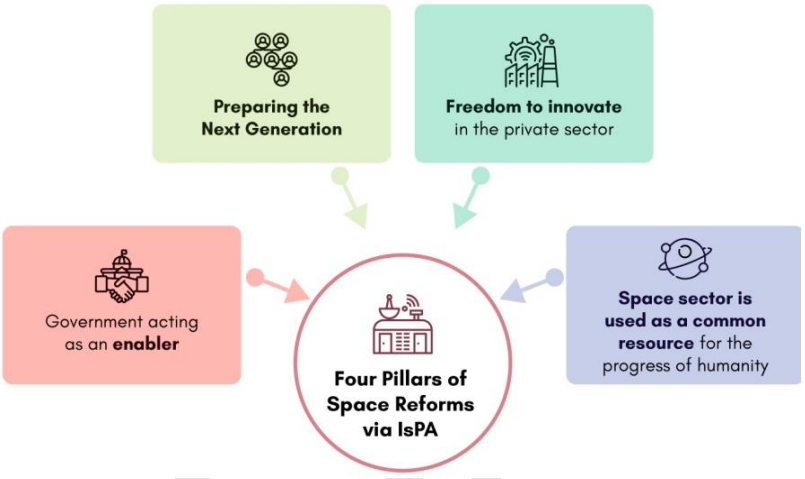
- It is being pursued through **Directorate of Technology Development and Innovation (DTDI),** a futuristic and innovative technology development wing at **ISRO headquarters**.

- **About Self-Eating-Rockets & Vanishing Satellites**
  - ISRO is working on a **Self-Eating rocket based on materials for casings of Rockets that can burn up along with motors at final stage,** helping in mitigating the problem of space debris.
  - **Self-vanishing satellite technology** would **enable spacecraft to be destroyed after its lifetime** through a 'kill-button', or a process that will burn it up.

4.3. PRIVATE SECTOR PARTICIPATION IN SPACE

Why in news?

The Prime Minister recently **launched the Indian Space Association (ISpA),** an industry body consisting of various stakeholders of the Indian space domain.



About ISpA

- The industry association will act as an **independent and a "single-window" agency** for enabling the opening up of the space sector to start-ups and the private sector.
- ISpA will also work towards **building global linkages** for the Indian space industry to bring in **critical technology and investments** into the country to create more high-skill jobs.

Some Private Ventures in Space

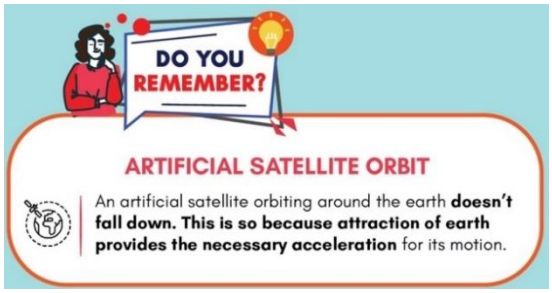
- **Virgin Galactic,** a company founded by Richard Branson, to take tourists to suborbital space.
- **Blue Origin,** controlled by Amazon Chief Jeff Bezos, is building a shepard rocket and capsule combo.
- **SpaceX,** by Tesla founder Elon Musk, is using its reusable falcon rocket for space trips.

Status of India's Space industry

- The current global space economy is **estimated at US$ 360 billion,** with India accounting **for ~2%** (US$ 7 billion).
- In the global space market, **rocket and satellite launch services,** an area in which ISRO specialises, amount to **only 5% share.Satellite-based services and ground-based systems** account for the **remaining 95%.**
- Several private companies are developing plans to take paying customers to space on a regular basis leading to a rapid growth in space tourism industry.

About Space Tourism

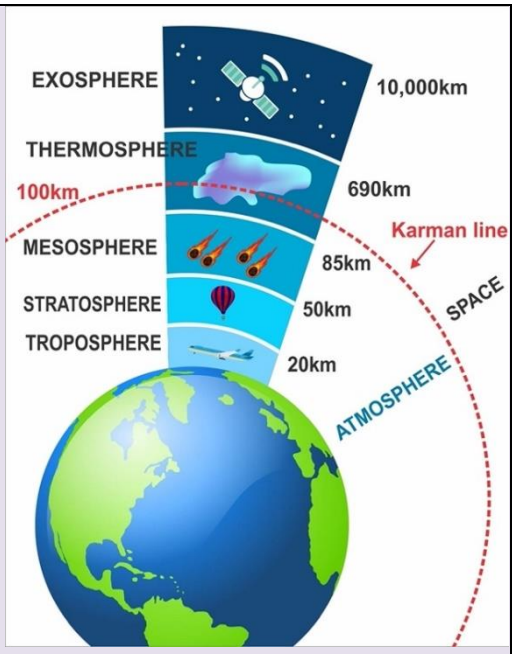
- Space tourism is **space travel for recreational, leisure or business purposes.** There are several different types of space tourism, including orbital, suborbital and lunar space tourism.
- To date, orbital space tourism has been performed only by the Russian Aviation and Space Agency- Roscosmos.
- Several private spaceflight companies are now working towards developing suborbital space tourism vehicles to take paying customers to space.
- **No international space law has defined space tourists.** Existing space treaties such as Outer Space Treaty, Rescue Agreement etc. are only applicable to astronauts, envoys of mankind, or personnel of a spacecraft.
- To send a vehicle to space, it is compulsory for the national and international space law to authorize it according to **Article VI of the Outer Space Treaty.** However, there is lack of clarity on authorization of space travel with tourists aboard.



- According to **Article VII of the Montreal convention**, the international liability for any damage incurred by a space object is imposed on the launching State, regardless of the space object being a public or a private entity.

Space and space travel

- According to the **Fédération Aéronautique Internationale** (world governing body for aeronautic and astronautic records), space starts at an altitude of 100 km (62 miles) above the surface of the earth.
- This is the **Karman line** where atmospheric lift no longer supports a flying object and the object would need to reach orbital velocity or risk falling back to Earth.
- **Space travel** is referred to as any flight operation that takes one or more passengers beyond the altitude of 100 km and thus into space.
- The main **difference between orbital and suborbital flight** is the speed at which a vehicle is traveling.
- An **orbital spacecraft must achieve orbital velocity** i.e. the speed that an object must maintain to remain in orbit around a planet. To orbit 125 miles (200 kilometers) above Earth for instance, a spacecraft must travel at a screaming 17,400 mph (28,000 km/h).
- **Suborbital flight, in contrast, requires much lower speeds** and doesn't have the power to achieve orbit. Instead, it will fly up to a certain height that depends on its speed, and then come back down once its engines are shut off.



- At the top of their flight arc in a suborbital flight, when the object is falling back toward Earth, passengers achieve a few minutes of weightlessness under zero gravity.

Related information
Inspiration4

- It is the first orbital trip where **none of the people aboard is a professional astronaut.**
  - The crew **used a Dragon capsule provided by SpaceX** rocket company.
- Apart from fundraising for charity, the **mission aims to study the biological effects of deep space on the astronauts' bodies.**

4.4. BLACK HOLE

Why in News?

A new study confirmed that Black Holes do not shrink over time.

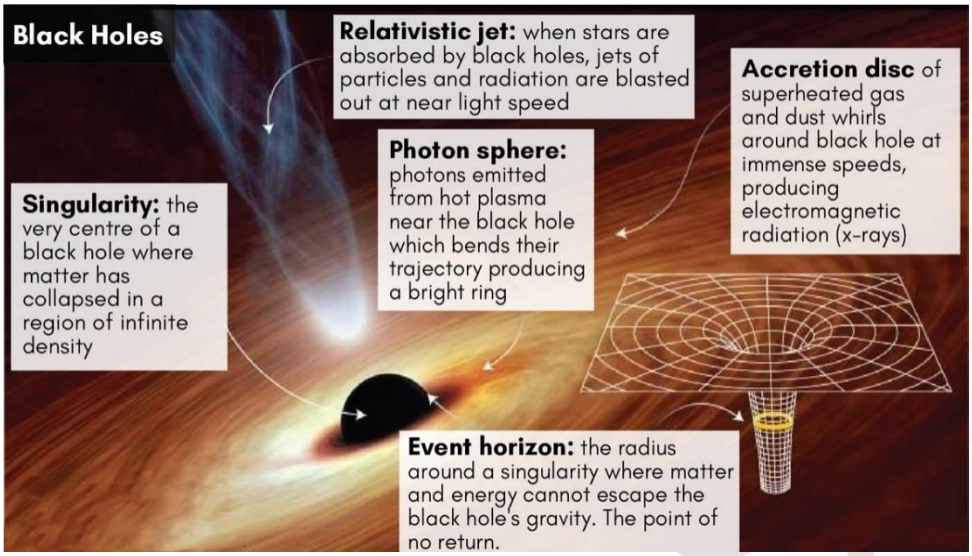
More on News

- **Black hole area theorem, by physicist Stephen Hawking**, which states that it is **impossible for the surface area of a black hole to decrease over time has been proven right.**
- Black hole area theorem was **derived in 1971 from Einstein's theory of general relativity** that defines gravitational waves and black hole.

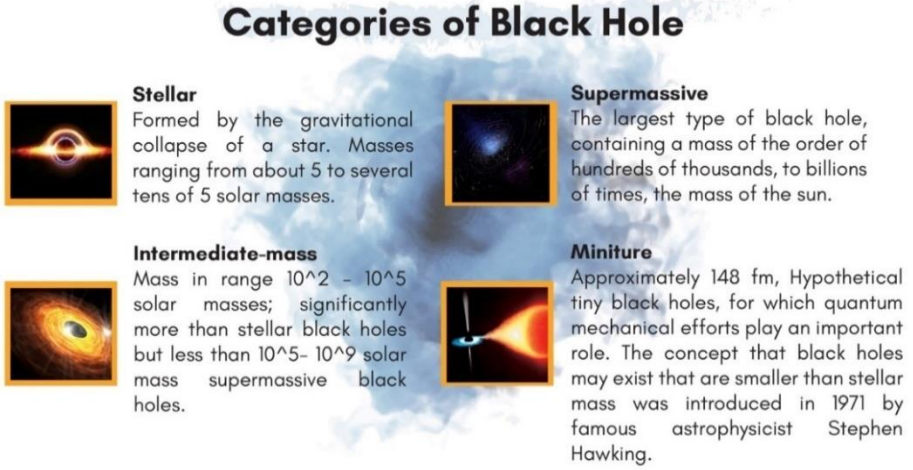
What are black holes?

- A black hole is a place in **space where gravity pulls so much that even light cannot get out.** The gravity is so strong because matter has been squeezed into a tiny space.
  - This can happen **when a big star is dying** (our sun will never turn into a black hole as it is not big enough to make a black hole).
  - Because no light can get out, so **they are invisible.**
  - **In the center of a black hole is a gravitational singularity,** a one-dimensional point which contains a huge mass in an infinitely small space, where density and gravity become infinite and space-time curves infinitely, and the laws of physics as we know them cease to operate.
- **In 2019 scientists got the first optical image of a black hole through Event Horizon Telescope.**
  - It has captured the just outside region of a black hole, located 55 million light-years from Earth, at the centre of a galaxy named **Messier 87.**The image shows a photon (light quantum) can orbit the black hole without falling in. This is called the 'last photon ring'

- **Sagittarius A*** is the second black hole whose photographs have been captured by the Event Horizon Telescope project.



- **On the basis of size black holes can be divided into following categories (refer image).**



- **Detection of Black Holes:**
  - They cannot be directly observed because they themselves do not emit or radiate light, or any other electromagnetic waves that can be detected by instruments built by human beings.
  - But the area just outside the boundary of the black hole (Event Horizon), which has vast amounts of gas, clouds and plasma swirling violently, emit all kinds of radiations, including even visible light.
  - Hence, the presence of black holes can be inferred by detecting their effect on other matter nearby them.

Significance of black hole in space research

- **Evolution of galaxy**: Astrophysicists have gained new insights by calculating how black holes influence the **distribution of dark matter**, how heavy elements are produced and distributed throughout the cosmos, and **where magnetic fields originate**.
- **Star formation**: In particular, Supermassive black holes play an important role in star formation within galaxies.
- **Gravitational waves**: Scientists have detected that **gravitational waves are generated when two black holes collide,** and found that ringing pattern of the wave predicts the cosmic body's mass and spin.
- **General theory of relativity:** The discovery of black hole has opened the door to several new lines of **scientific investigation, enabling quantitative estimates** of black hole related parameters. It has provided another laboratory to test the predictions of the **Einstein's general theory of relativity**.
- **Bending of light:** The **bending of light** around a black hole is very significant because of its **extremely large mass**. Because of this bending, one can see light from material that is behind the black hole, which would not be seen if light were traveling in straight lines.

General Theory of Relativity

- This theory was proposed by **Albert Einstein in 1915.**
- Essentially, it's **a theory of gravity** whose basic idea is that instead of being an invisible force that attracts objects to one another, **gravity is a curving or warping of space.** The more massive an object, the more it warps the space around it.
  - **For example,** the sun is massive enough to warp space across our solar system (a bit like the way a heavy ball resting on a rubber sheet warps the sheet). As a result, Earth and the other planets move in curved paths (orbits) around it.

- **This warping also affects measurements of time**. We tend to think of time as ticking away at a steady rate. But just as **gravity** can stretch or warp space, it **can also dilate time.**
- **Confirmation:**
  - In the first major test of general relativity, **astronomers in 1919 measured the deflection of light from distant stars as the starlight passed by our sun,** proving that gravity does, in fact, distort or curve space.
  - **In 2016, the discovery of gravitational waves** (subtle ripples in the fabric of spacetime) was another confirmation of general relativity**.**
    - ✓ **Gravitational waves are produced by cataclysmic events** such as colliding black holes, supernovae (massive stars exploding at the end of their lifetimes), and colliding neutron stars.
    - ✓ **They travel at speed of light,** squeezing and stretching anything in their path.

Related News

X-ray radiation originating from behind a black hole

- **For the first time** astronomers directly **witnessed flares of X-ray radiation originating from behind a black hole** deep in space.
  - This light behind black hole shows it as a warping space, bending light and twisting magnetic fields around itself.
  - Besides proving Einstein's predictions of how gravity bends light around black holes, the **X-ray echoes contain information about what is happening around a black hole.**

Tsunami in Space

- Recently, NASA used simulations to show that deep in space, **gas escaping the gravitational pull of a supermassive black hole may form tsunami-like structures.**
- Waves are **formed at a relatively cool atmosphere** that exists at a distance where the supermassive black hole loses its grip on the surrounding matter.
- **Black hole** is a place in space where **gravity pulls so much that even light cannot get out.**
- **There are four types of black holes**: stellar, intermediate, supermassive, and miniature.

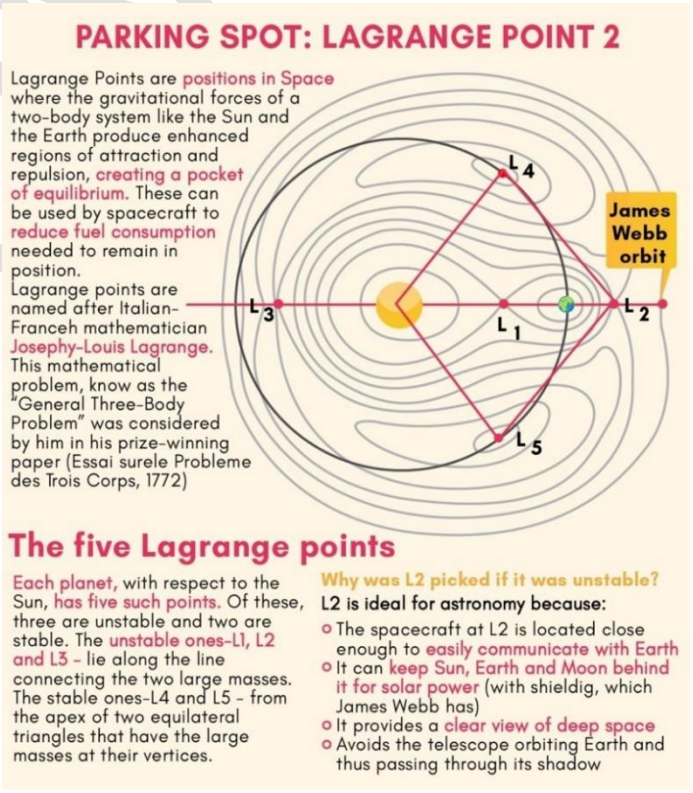
4.5. JAMES WEBB SPACE TELESCOPE (JWST)

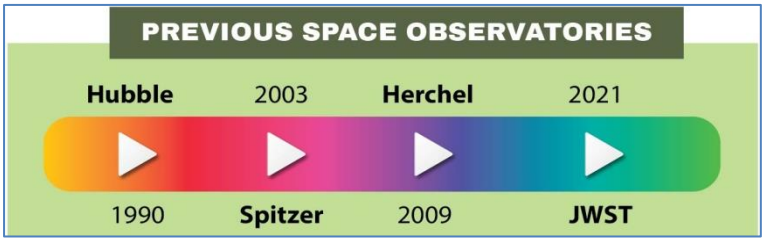
Why in news?

Recently, the James Webb Space Telescope, NASA's most powerful telescope, is rocketed into orbit.

More on news

- The James Webb Space Telescope (JWST) is NASA's **infrared flagship observatory.**
- It is an international collaboration between **NASA, the European Space Agency (ESA), and the Canadian Space Agency (CSA).**
- **Mission goals are**
  - **Search for first galaxies** or luminous objects formed after Big Bang.
    - ✓ Big Bang is **also called expanding universe hypothesis.**
    - ✓ It states that all of the **current and past matter in the Universe came into existence at the same time,** roughly 13.8 billion years ago.
  - **Determine how galaxies evolved.**
  - **Observe stars formation** from the first stages to formation of planetary systems
  - **Measure physical and chemical properties of planetary systems,** including our own Solar System, and investigate potential for life in those systems.





- **JWST is headed for Sun-Earth Lagrange Point 2 (L2).**
- **Scientific instruments on JWST:** Near Infrared Camera, Near Infrared Spectrograph, Mid Infrared Instrument and Fine Guidance Sensors/Near Infrared Imager and Slitless Spectrograph.
- The **JWST is being considered as the successor** of the Hubble Space Telescope (HST).

	Hubble	Webb	Herschel Space Observatory
Distance from Earth	507 Km	1.5 million Km at Second Sun-Earth Lagrange point	Second Sun-Earth Lagrange point
Primary Mirror Diameter	2.4 meter	6.5 meter	3.5 meter
Searching for	Young Galaxies (12.5 Billion years ago)	New Born Galaxies (13.5 Billion years ago)	Most actively star-forming galaxies
Serviceable	Yes	No	No
Wavelengths	Visible, UV, Part of near-infrared	Near and mid infrared	Far-infrared and submillimetre

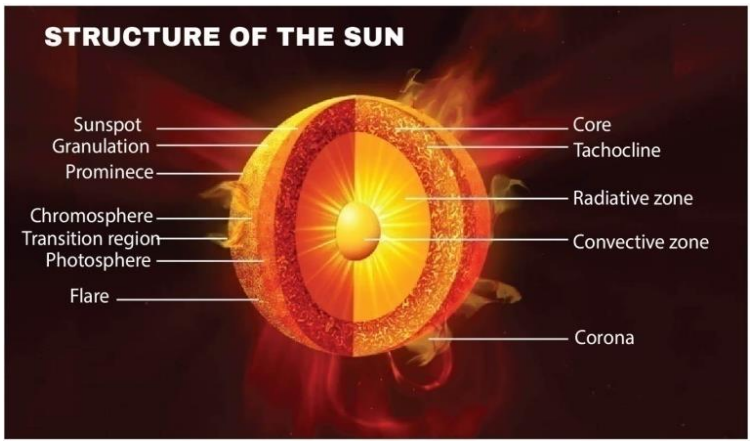
4.6. PARKER MISSION

Why in news?

NASA's Parker Solar Probe (PSP) has now flown through the Sun's upper atmosphere – the corona – and sampled particles and magnetic fields there.

About PSP

- Launched in 2018, the PSP is part of **NASA's Living with a Star program** to explore aspects of the Sun-Earth system that directly affect life and society.
- It is named after Eugene Newman Parker, a physicist who proposed concepts about how stars give off energy.
- It **uses a carbon-composite shield, to withstand temperatures** nearly 2,500 F (1,377 C), to protect itself from Sun's heat.
- It became **the first spacecraft in history** to touch the Sun.
- It uses a series of **gravitational encounters with the planet Venus to gradually lower the orbit of the spacecraft** until it enters the outer atmosphere, or corona, of the Sun.



Relevance of the PSP mission

- **Deeper insights into sun's evolution.**
- **Predicting extreme weather events by** helping in forecasting solar storms(or Geomagnetic storm).
  - Solar storms are the biggest outbursts from the Sun can rattle Earth's magnetic field.
  - In the process, communications may be disrupted, satellites can be knocked offline, and power grids will be vulnerable to electrical surges.

- **Unravelling secrets in Corona:** In Corona some **key processes take** place that currently defy explanation. For example
  - The temperature of the Sun at its **photosphere is roughly 6,000 degree C** but within **the corona** it can reach a staggering **million degrees or more**.
  - It's also within this region that the **outward flow of charged particles** - electrons, protons and heavy ions - suddenly **gets accelerated into a supersonic wind.**

Achievements

- In 2019, Parker discovered that **magnetic zig-zag structures in the solar wind,** called **switchbacks,** are plentiful **close to the Sun.** But how and where they form remained a mystery. Halving the distance to the Sun since then, PSP has now passed close enough to identify one place where they originate: **the solar surface.**
- In April, 2021, the PSP crossed the **outer edge of the corona** termed the **Alfvén critical boundary,** a point that marks the end of solar atmosphere and beginning of the solar wind.
- It should eventually get to **within 7 million km** (4 million miles) of the **photosphere in 2025.**

Some other solar missions

- **NASA's Heliophysics Missions:** NASA's contribution to the **Extreme Ultraviolet High-Throughput Spectroscopic Telescope Epsilon Mission (EUVST) and the Electrojet Zeeman Imaging Explorer (EZIE**) will help us understand the Sun and Earth as an interconnected system.
- **European Space Agency's Solar Orbiter**
- **ISRO's Aditya-L1 mission**
  - ISRO plans to launch it by the middle of 2022.
  - This is the first mission **designated by ISRO to study the Sun's atmosphere.**
  - ISRO has **selected L1, or Lagrangian point 1,** between the Earth and the Sun to place the Aditya satellite.
  - The spacecraft will travel a long journey of 1.5 million km from the Earth for this task.
  - It will conduct **comprehensive research on the processes that occur in the Sun's atmosphere, which would enable us to decipher the outstanding problems in solar physics.**

Related News

- **Solar flares recently caused radio blackout** over Indian Ocean.
  - Recently, sun emitted a large solar flare that was **observed by NASA's Solar Dynamics Observatory (SDO).**
  - SDO **studies how Sun creates solar activity** and drives space weather.

About Solar flares

- **Solar flares** are a sudden explosion of energy **caused by reorganizing of magnetic field lines near sunspots.**
  - **Solar magnetic cycle** that works in deep interior of Sun **creates regions that rise to surface and appear like dark spots. These are sunspots.**
  - They appear dark because they are **cooler than other parts of Sun's surface.**
- In a solar flare, **energy stored in sun's magnetic structures is converted into light and heat energy.** This causes emission of high energy x-ray radiation and highly accelerated charged particles to leave the sun's surface.
- Sometimes solar flares **also cause hot plasma to be ejected from Sun,** causing a solar storm, and this is **called Coronal Mass Ejection (CME).**
- Energy, radiation and high energy particles emitted bysolar flares can trigger intense lights in the sky, called **Auroras** (for **other possible effects refer image**).
  - Auroras are caused by the **interaction of energetic particles** (electrons and protons) of the solar wind **with atoms of the upper atmosphere** occurring primarily in high latitudes of both hemispheres.
  - Auroras in the Northern Hemisphere are called **aurora borealis, aurora polaris, or northern lights**, and in the Southern Hemisphere **aurora australis, or southern lights**.

About Solar Cycle

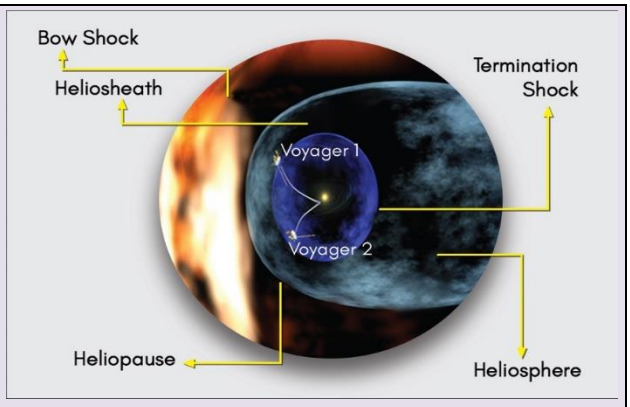
- **Sun's magnetic field goes through a cycle, called solar cycle and** every 11 years or so, Sun's magnetic field completely flips. This means that Sun's north and south poles switch places.
  - **Scientists track a solar cycle by using sunspots,** an area on the Sun that appears dark on the surface as they are relatively cooler than surrounding parts.
  - **Beginning of a solar cycle is a solar minimum,** or when the Sun has the least

Solar flare classification	Possible effects on Earth
B	none
C	Possible effects on space missions.
M	Blackout in radio transmissions and possible damages in astronauts outside spacecraft.
X	Damage to satellites, communication systems, power distribution stations and electronic equipment

Increasing Intensity

Related News

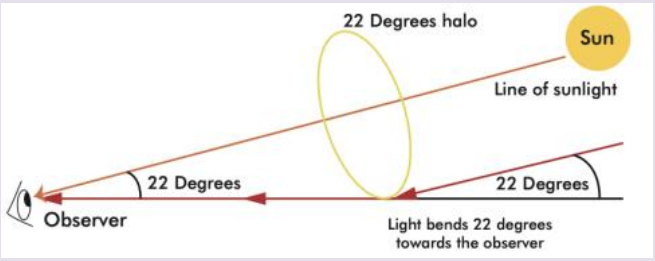
Heliosphere



- Recently, **scientists mapped the boundary of the heliosphere** for the first time.
  - Scientists used data from NASA's Earth-orbiting **Interstellar Boundary Explorer (IBEX) satellite,** which detects particles that come from **Heliosheath** - boundary layer between solar system and interstellar space.
- Developed map shows that the **minimum distance from the Sun to the heliopause is about 120 Astronomical Units (AU)** in the **direction facing the interstellar wind,** and in the **opposite direction,** it extends **at least 350 AU.** (1 AU = Distance between Earth and Sun).
- **About Heliosphere**
  - The sun sends out a **constant flow of charged particles** (protons, electrons, alpha particles etc.) **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 called the **heliosphere**.

Sun Halo

- Recently a sun halo was witnessed in different parts of Karnataka.
- Sun halo is an optical phenomenon that occurs due to **refraction of sunlight by hexagonal ice-crystals** suspended in the atmosphere.
- It is also called **'22-degree halo'** because the light is refracted by 22 degrees from its original direction.
- **Circular halos** specifically are produced by **cirrus clouds,** which are formed at a height of **over 20000 feet.**

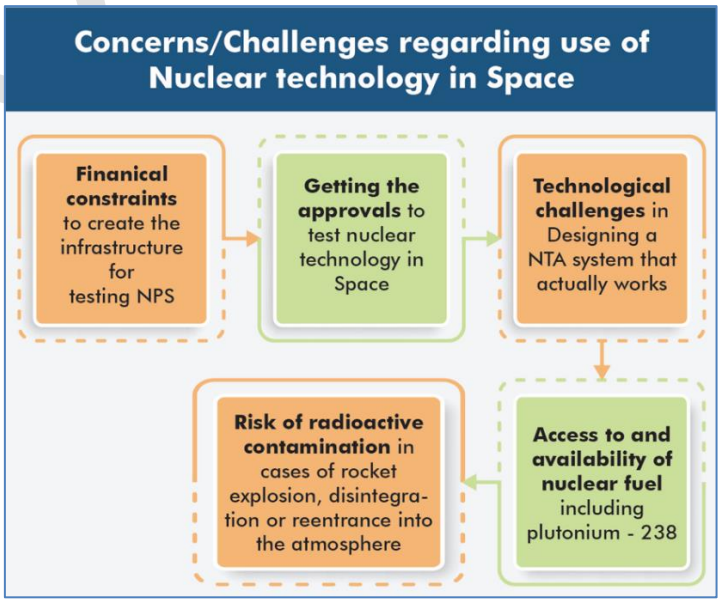


- Sun halos are also **indicative of rainfall** as cirrus clouds are usually precursor to development of **cyclonic warm front.**

4.7. NUCLEAR TECHNOLOGY IN SPACE MISSIONS

Why in News?

Recently, the UR Rao Satellite Centre (URSC) of Indian Space Research Organisation (ISRO) invited proposals for the three-phase development of a 100-Watt **Radioisotope Thermoelectric Generator (RTG).**



More on the News

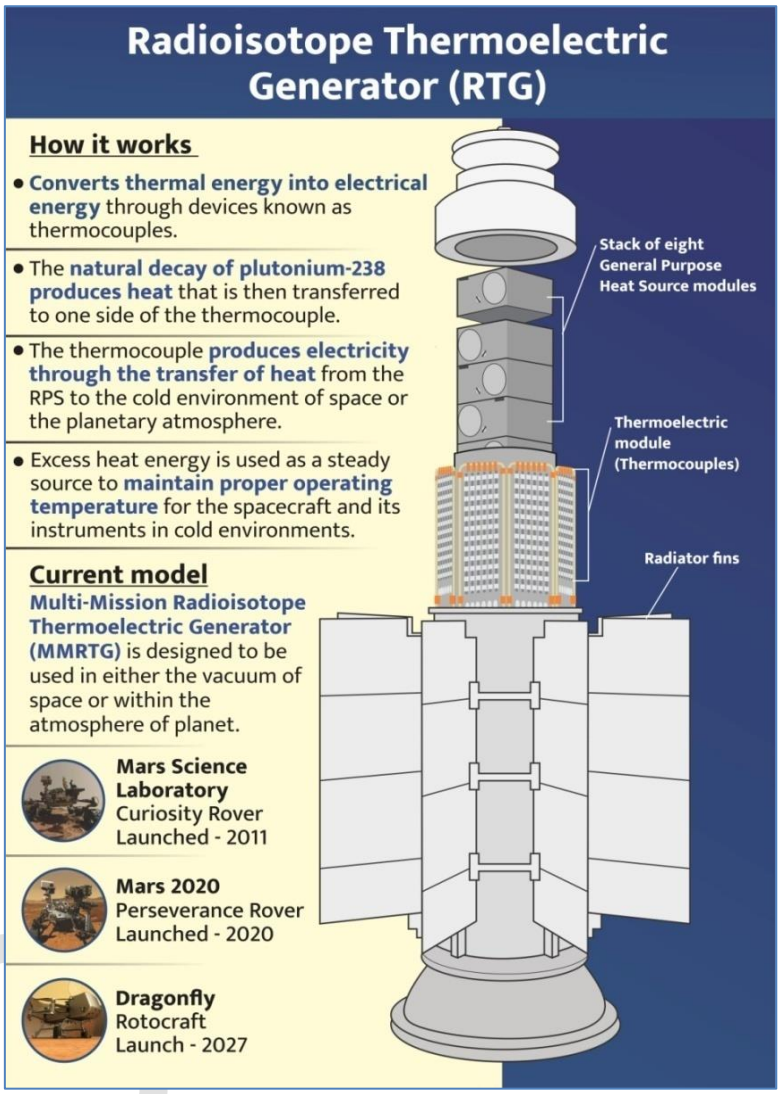
- The centre envisions using **Radioisotope Thermoelectric Generator (RTG)** for power generation and thermal management of ISRO's deep space missions.
- RTG is a type of Nuclear-based power system that is generally used for power generation and thermal management of space missions.

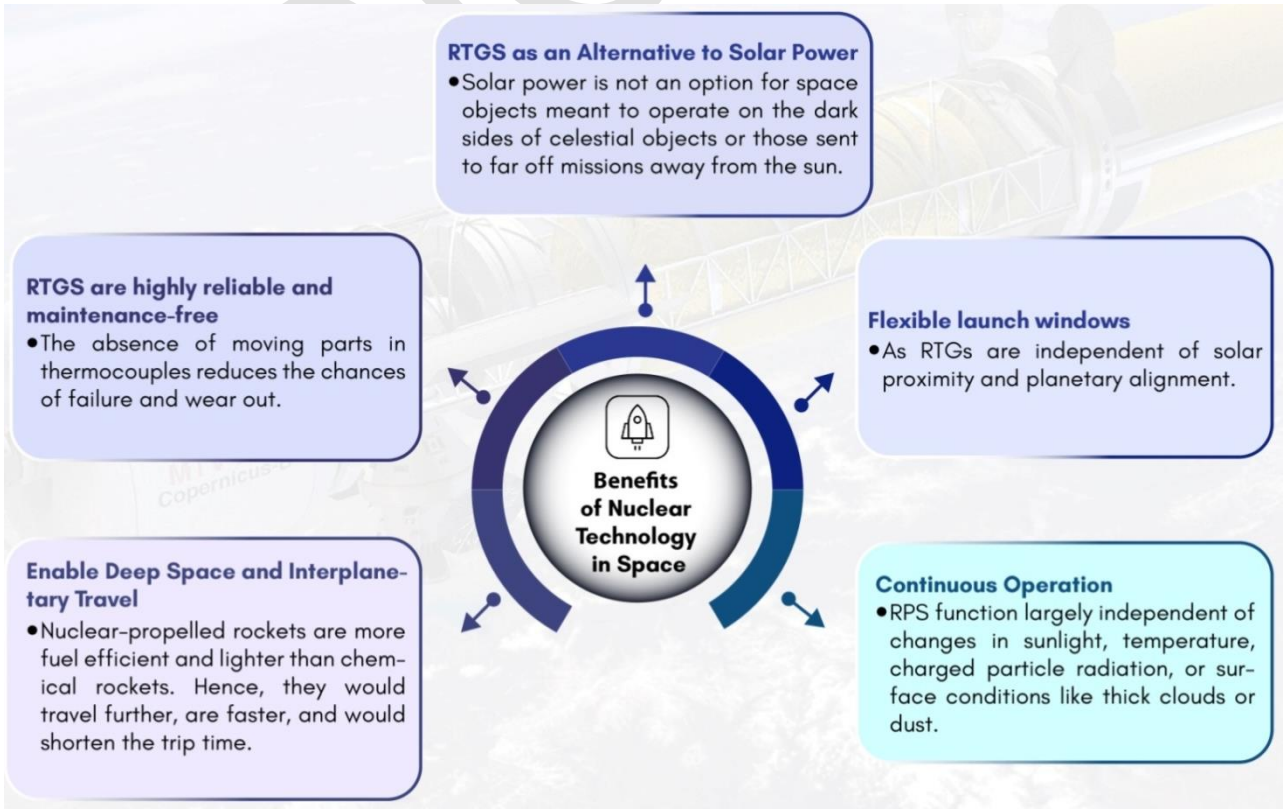
Types of Nuclear Power Systems (NPS) with application in Space missions

- **Radioisotope power systems (RPSs):** They are a type of nuclear energy technology that uses heat (produced by the natural radioactive decay of plutonium-238) to produce electric power for operating spacecraft systems and science instruments. There are **two types** of radioisotope power systems:
  - **Radioisotope Heater Units (RHU):** Small devices that **provide heat** to keep a spacecraft's electronic instruments and mechanical systems operational in the cold temperatures of our solar system.

- **Radioisotope Thermoelectric Generator (RTG):** Flight-proven systems that **provide power and heat** to a spacecraft **(see infographic)**. RTGs were first used in space during the Cold War in 1961 for the US's Transit-4A Mission.

- **Nuclear Propulsion Systems:** Nuclear power can be used for a **rocket propulsion system.** NASA is currently working on development of nuclear thermal propulsion (NTP) systems, which are powered by Nuclear Fission.
  - NTP systems work **by pumping a liquid propellant, most likely hydrogen,** through a reactor core. Uranium atoms split apart inside the core and release heat through fission.
  - This **physical process heats up the propellant and converts it to a gas,** which is expanded through a nozzle to produce thrust.
  - NTP systems are not designed to produce the amount of thrust needed to leave the Earth's surface. Instead, they will be **launched into space by chemical rockets before they are turned on.**





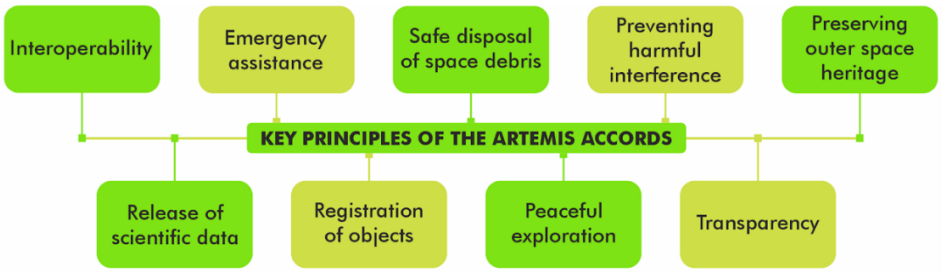
4.8. ARTEMIS ACCORDS

Why in news

Singapore has become the latest nation and joins 17 other countries (as on 30th March 2022) to sign the Artemis Accords.

About the Artemis Accords

- It was announced by **NASA**, the U.S. civil space agency, in 2020.
- It is a **set of guidelines surrounding the Artemis Program** for crewed exploration of the Moon. This **agreement is for lunar exploration and beyond,** with participation of both international partners and commercial players.



- The accords describe a shared vision for principles, **grounded in the Outer Space Treaty of 1967** to create a safe and transparent environment.
- **Major Signatories:** US, New Zealand, Australia, Canada, Italy, Japan, Luxembourg, the Republic of Korea, the United Kingdom, the United Arab Emirates, and Ukraine.
- Major space players like **India, Russia, China, France and Germany are not a signatory** of the accord. The European Space Agency (ESA) as an organisation has not signed on to the accords either, but a number of ESA member states have.

Factors that may prompt India to sign the Artemis Accords

- **Enhanced space cooperation among Quad countries:** as US, Japan and Australia are already signatories of the accords.
  - India is also collaborating with Japan on a future lunar mission, called LUPEX.
- By being a part of the accords, India's **space companies could become part of a global supply chain.**
- **Opportunities to learn about interplanetary missions and human spaceflight.**

4.9. POSITRON EXCESS

Why in News?

Researchers from Raman Research Institute (RRI), Bengaluru, an autonomous institution of Department of Science and Technology have resolved **mystery of 'positron excess' phenomenon.**

About Positron Excess

- Over the years, astronomers have observed an **excess of positrons having energy of more than 10 giga-electronvolts, or 10 GeV.** Positrons with energy more than 300 GeV, however, are lower in comparison to what astronomers expect.
  - This behaviour of positrons between 10 and 300 GeV is what astronomers call the 'positron excess'.

About Positron

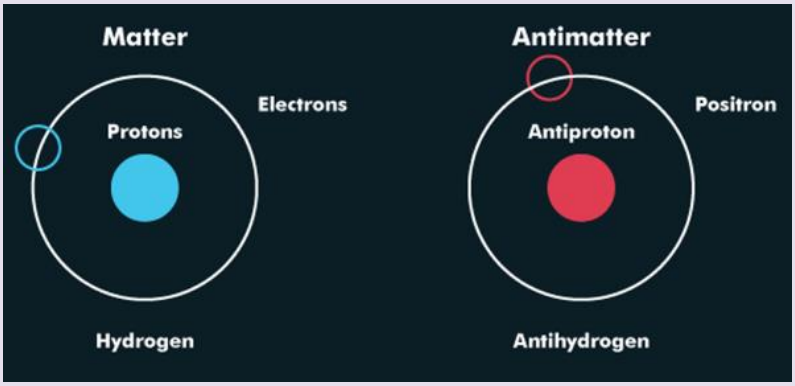
- Positron is the **anti-particle of the electron.**
- Also known as **anti-electron**, it has the same properties as the electron with the exception of electric charge.
  - **Electron** has a **negative** charge while the **positron** has a **positive** charge.

- Now the researchers from RRI proposed that **cosmic rays while propagating through the Milky Way galaxy interact with matter producing other cosmic rays**, primarily electrons and positrons.
  - Cosmic rays are **high energy particles** that move through space at nearly the speed of light. They provide one of our few **direct samples of matter from outside the solar system.**
  - Cosmic rays interact with molecular hydrogen and can give rise to other cosmic rays.
- Researchers argue that **these new cosmic rays are the origin of the 'positron excess' phenomenon.**

Related information
Matter Antimatter asymmetry

- For each basic particle of matter, there exists **an anti-particle with the same mass but the opposite electric** charge.
  - For example, the negatively charged electron has a positively charged anti-particle called the positron.
- But when a **particle and its anti-particle collide**, they are **"annihilated"** in a flash of energy**,** yielding new particles and anti-particles.

- Physicists think that the **Big Bang** should have created **equal amounts of matter and antimatter.**
- Yet, paradoxically, today we live in a **Universe made up overwhelmingly of matter**.
- **Anti-matter is rare today**. It can be produced in "atom smashers", in nuclear reactions or by cosmic rays.
- What happened to all the anti-matter is regarded by many researchers as **one of the biggest mysteries in cosmology**
- Physicists believe that the dominance of matter in the Universe is possible only if there are differences in the behaviour of particles and anti-particles.



- **At CERN** (a European research organization) near Geneva, **physicists make antimatter to study in experiments.**
  - **India** is also an **associate member to CERN**

4.10. MISSIONS IN NEWS

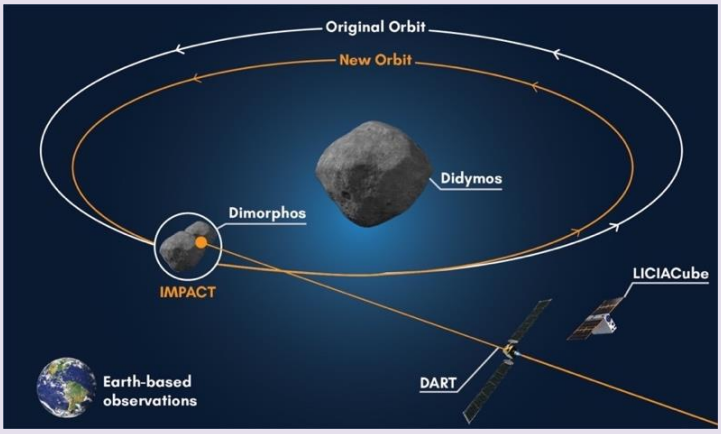
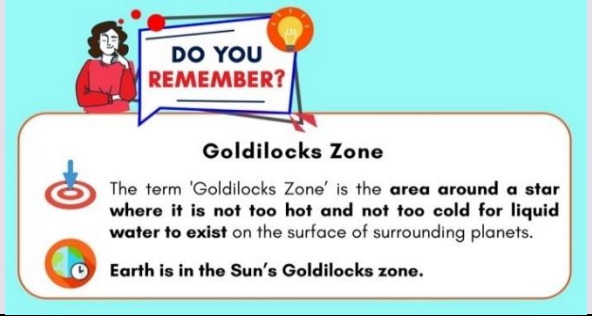
4.10.1. NASA

New Missions to Venus	• NASA has announced two missions to Venus, Earth's closest planetary neighbour, as part of its **'Discovery Program'** that aims to explore and study the solar system.
	  ○ Discovery Program, which began in 1992, **gives scientists the chance to launch some missions that use fewer resources** and have shorter developmental times.
	• **About new missions:**
	  ○ **DAVINCI+ (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging) mission**
	  ✓ It will try **to understand Venus' composition to see how the planet formed** and evolved.
	  ○ **VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy)**
	  ✓ It **will map the planet's surface to determine its geologic history** and understand the reasons why it developed so differently from Earth.
	• The last US probe to visit the planet was the **Magellan orbiter in 1990.**
	• Venus is the **hottest planet in the solar system** because of the heat that is trapped by its thick cloud cover.
	  ○ **Venus spins** on its axis **from east to west**. Venus also **does not have a moon and no rings.**
	  ○ It is **called the Earth's twin** because of their similar sizes.
	• A recent study concluded that **a single Venusian rotation takes 243.0226 Earth days.**

Perseverance Rover of NASA	• Recently, **NASA's Perseverance Rover**, part of **Mars 2020 Mission**, drilled the first hole on the Martian Surface but failed to lift samples.
	• Landed at **Jezero Crater** of Mars in February, the rover is on an **astrobiology** mission to
	  ○ Seek **signs of ancient life** and
	  ○ **Collect samples** of rock and regolith (broken rock and soil) for **possible return to Earth**.
	• Earlier, **Ingenuity**, a small robotic helicopter sent with perseverance, completed the first powered controlled flight by an aircraft outside earth.

Volatiles Investigating Polar Exploration Rover (VIPER) Mission	• It is **NASA's mission** that **will explore the extreme environment of the Moon** in search of water ice and other potential resources. • VIPER is a mobile robot that **will roam around the Moon's south pole** looking for water ice. • It is the **first-ever resource mapping mission on another celestial body.** • The data which will be transmitted back to Earth **will be used to create resource maps, helping scientists determine the location and concentration of water ice** on the Moon and the forms it's in.

Lucy Mission	• It is NASA's **first mission to study Jupiter's Trojan asteroids** to gain new insights into the solar system's formation 4.5 billion years ago.
	  ○ Trojans **orbit the Sun in two loose groups,** with one group leading ahead of Jupiter in its path, the other trailing behind.
	• **Asteroids and Comets**
	  ○ **Asteroids,** sometimes called minor planets, **are rocky, airless remnants left over from the early formation of our solar system** about 4.6 billion years ago.

	✓ **Comets are cosmic snowballs of frozen gases, rock, and dust** that orbit the Sun. o Most of the **asteroids can be found orbiting the Sun between Mars and Jupiter** within the main asteroid belt. ✓ There are likely **billions of comets orbiting our Sun in the Kuiper Belt.** • **Comets show a perceptible glowing tail,** while asteroids don't. • **Asteroids can be divided into following categories** o Those **found in the main asteroid belt,** between Mars and Jupiter. o **Trojans asteroids** that share an orbit with a larger planet. o **Near-Earth Asteroids,** which has orbits that pass close to the Earth.
Near-Earth Asteroid (NEA) Scout	• NASA's **new spacecraft NEA Scout** has been safely tucked inside the **Space Launch System (SLS)** rocket. • It is a **miniaturized spacecraft**, known as **CubeSat.** Its main mission is to fly by and **collect data from a near-Earth asteroid**. o It will be **America's first interplanetary mission** using special solar sail propulsion. • It will provide critical **information on asteroid's physical properties** such as orbit, shape, volume, rotation, the dust and debris field surrounding it, plus its surface properties.
Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx)	• NASA's OSIRIS-Rex, **first mission to visit a near-Earth asteroid**, begin journey back to earth. • In October 2020 OSIRIS-REx spacecraft **collected samples of dust and pebbles from the asteroid Bennu.** • **About Asteroid Bennu** o Bennu believed to have been **born in the Main Asteroid belt between Mars and Jupiter.** o Bennu is a **B-type asteroid** i.e. it contains **significant amounts of carbon** and various other minerals. Hence, it reflects **about 4% of the light that hits it** (Earth reflects about 30%). o It was formed in the first 10 million years of the solar system's creation and **has not gone through a lot of composition-altering change** through billions of years.
Double Asteroid Redirection Test (DART) Mission	• It is **NASA's first planetary defense test mission** to be launched. • Aim of the mission is **to test the newly developed technology that would allow a spacecraft to crash into an asteroid** and change its course. o Mission will test the new technology **to be prepared in case an asteroid heads towards Earth** in the future. • The **target of the spacecraft is a small moonlet called Dimorphos** (that orbits a larger asteroid named Didymos). o Moonlet is a **small natural or artificial satellite.** • The asteroid and the moonlet **do not pose any threat to Earth** and the mission is to test the new technology. 
Imaging X-ray Polarimetry Explorer (IXPE)	• IXPE observatory is a **joint effort of NASA and the Italian Space Agency.** • Mission **will study the most extreme and mysterious objects in the universe** – supernova remnants, supermassive black holes, and dozens of other high-energy objects. • Mission's primary length is two years and the **observatory will be at 600 kilometers altitude, orbiting around Earth's equator.** • It will help in answering questions like **How do black holes spin, How do pulsars shine so brightly etc.**
Transiting Exoplanet Survey Satellite (TESS)	• TESS mission has **spotted three planets** that are orbiting dangerously close to their stars. • TESS is a **Massachusetts Institute of Technology (MIT) led NASA mission designed to discover thousands of exoplanets** around nearby bright stars. o An exoplanet is **any planet beyond our solar system.** 

	○ **Most orbit other stars,** but free-floating exoplanets, called **rogue planets, orbit the galactic center** and are untethered to any star. • Prime mission (a two-year survey of the solar neighborhood) ended in July 2020 and **TESS is now in an extended mission.**
Laser Communications Relay Demonstration (LCRD)	• NASA has launched its **first-ever laser communications** system i.e **LCRD.** ○ Currently, most NASA spacecraft use **radio frequency communications**. • **Advantages of Laser communication:** ○ It uses infrared light and has a **shorter wavelength than radio waves** which helps in the transmission of **more data in a short time**. ○ With current radio frequency systems, it takes **roughly nine weeks to transmit a completed map of Mars** back to Earth. Lasers can accelerate it to about **nine days.**

4.10.2. CHINA NATIONAL SPACE ADMINISTRATION

Zhurong rover	• An un-crewed Chinese spacecraft, **Tianwen-1,** successfully landed on the surface of Mars, **making China the second space-faring nation after the United States to land on Mars.** • **Zhurong rover** (part of the **Tianwen-1 mission**) landed on a site on a vast plain known as Utopia Planitiaie more than 2,000 km away **from Jezero Crater where US rover Perseverance landed**. ○ **Zhurong** rover, Powered by solar panels, will **probe the surface and subsurface** of the planet, performing **in-situ chemical analysis** on soil composition.
Shenzhou-12 spacecraft	• **Shenzhou-12 spacecraft:** China launched **Shenzhou-12 spacecraft carrying 3 astronauts** to dock with the Tiangong space station. ○ China has already sent 11 astronauts into space since becoming the **third country to do so on its own in 2003.** • **US legislation bars Chinese astronauts on the International Space Station** (ISS), a collaboration between US, Russia, Canada, Europe and Japan.
Fine-grained object recognition in the high resolution remote sensing imagery' (FAIR1M)	• A satellite imaging database containing detailed information of millions of locations has been **launched in China to help reduce errors made by artificial intelligence (AI)** when identifying objects from space. • The database called **'fine-grained object recognition in the high resolution remote sensing imagery' (FAIR1M)** is going to tens or even a hundred times larger than similar data sets used in other countries. • With more information on the images, the **database would train AI to become smarter** by enabling it to distinguish different objects and accurately identify them from orbit. • The whole Chinese database will be **open to the international community.** • Its **real-life applications** include tracking the speed of urban expansion, infrastructure development, wild animal movements etc

4.10.3. OTHERS DEVELOPMENTS

Tundra satellite	• **Russia placed a military satellite** (believed to be Tundra satellite) into the orbit. • Tundra, also known as Unified Space System (USS), is a **constellation of Missile Early Warning Satellites** established by Russiabetween 2015 and 2020 to close a gap in space-based missile tracking capabilities. • Tundra satellites **are equipped with next-generation infrared surveillance devices** that make it possible to register with high precision the launches of missiles. • The satellites are also **capable of tracking the trajectory of the flight of ballistic missiles.**
Plasma Kristall Investigation	• It is a **Russian-European experiment** running on International Space Station since 2001. • It focuses **on formation of materials on an atomic scale and will help understand unique phenomena on Earth,** like how an object melts, waves form in fluids and currents change at atomic level. ○ Plasma Kristall models **atomic interactions on a larger scale** (not possible on Earth), making their motion visible. • Research is offering **knowledge about use of Plasma** (an electrically charged gas) in various sectors including healthcare.
EnVision	• It is an **European Space Agency led mission to planet Venus,** with contributions from NASA. It is likely to be launched sometime in the 2030s. • It will study the **planet's atmosphere and surface, monitor trace gases in the atmosphere** and analyse its surface composition.

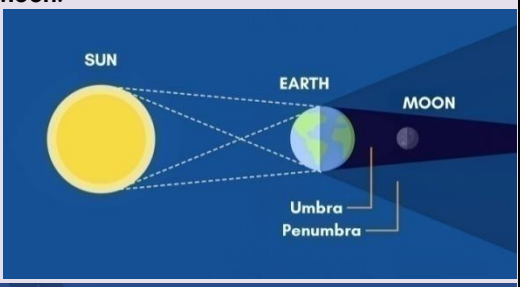
Hope Probe's first image of Mars Aurora	• United Arab Emirates' (UAE) **Hope Mars mission is designed to study Mars' atmosphere across all its layers** and at a global scale throughout the course of the year. • **First image shows Aurora on Mars are seen all around the planet** at night time unlike auroras on Earth, which are seen only near north and south poles.
Beresheet 2 Project	• Expected to be launched in **2024, Beresheet 2 Project** is the second lunar mission from **SpaceIL organization and Israel Aerospace Industries.** ○ The **Beresheet 1 spacecraft** crash landed on the moon after its launch in February 2019 on a used SpaceX Falcon 9 rocket. • Beresheet 2 Project will include **three spacecraft**- an **orbiter** and **two landers**- to the moon, to conduct experiments and collect data. • Presently, United States, the Soviet Union and China had successful spacecraft landing on moon.
Polar-Areas Stellar-Imaging in Polarisation High-Accuracy Experiment (PASIPHAE)	• It is an **international collaborative sky surveying project.** • Aim to study the **polarisation in the light coming from millions of stars.** It can help to determine a star's location. • A novel instrument, **Wide Area Linear Optical Polarimeter (WALOP)** will be used to detect polarised light signals emerging from the stars along high galactic latitudes. • **India is a part of this project.**

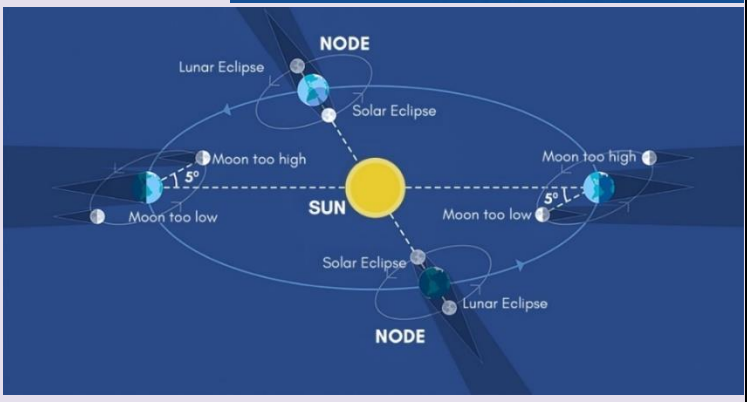
4.11. OTHER IMPORTANT NEWS

4.11.1. SPACE PHENOMENON & EXPERIMENTS

Lunar Eclipse and Super Moon

- A Lunar eclipse occurs when the **Sun, Earth and the Moon** are in Straight line in the **plane of the ecliptic** and **Earth lies between the Sun and the Moon**.
  - The Lunar Eclipse can be of three types:
    - ✓ **Total Lunar Eclipse:** When Moon is exactly in the plane of ecliptic with Umbra or inner part of earth shadow falling on Lunar Surface
    - ✓ **Partial Lunar Eclipse:** When Moon is close to the plane of ecliptic with Umbra covering only a part of Lunar Surface
    - ✓ **Penumbral Lunar Eclipse:** When moon passes through the partial shadow of the Earth, i.e. Penumbra

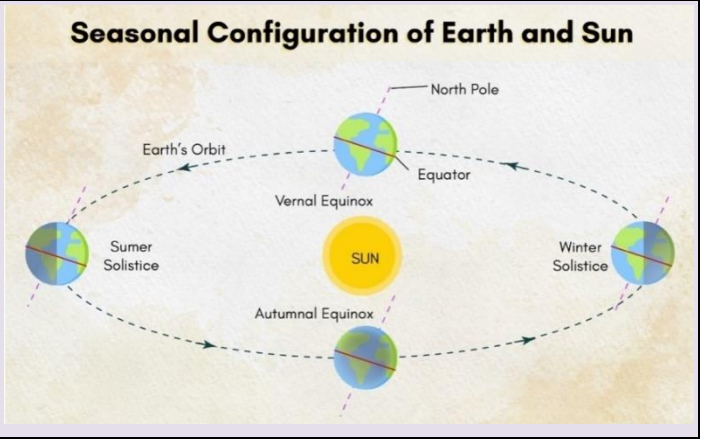


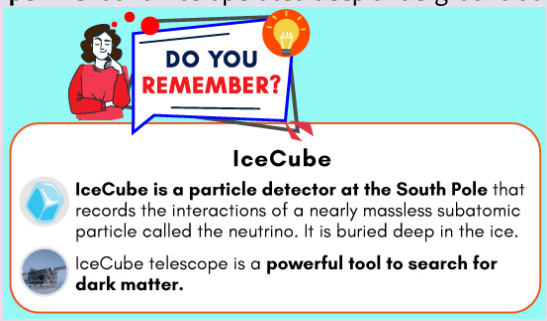


- **Super Moon** occurs when during the Full Moon or New Moon, it is closest to the Earth in its perigee.

Summer Solstice

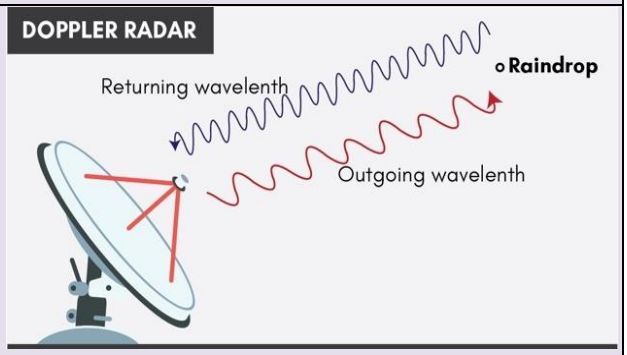
- It occurs when the **sun is directly over Tropic of Cancer (between June 20-22),** resulting in **longest day of the year in Northern Hemisphere.**
- During this, the Earth's axis is tilted in a way that the North Pole is tipped towards the sun and the South Pole is away from it.
- Amount of incoming energy from the sun on this day is **30 per cent higher at the North Pole than at the Equator**.



XENON1T	• It is the **world's most sensitive dark matter experiment** and was operated deep underground at the INFN Laboratori Nazionali del Gran Sasso in Italy. • Everything we see – the planets, moons, massive galaxies etc – makes up less than 5% of the universe. **About 27% is dark matter and 68% is dark energy.** • While **dark matter attracts and holds** galaxies together, **dark energy repels** and causes the expansion of our universe. ○ Some other evidence of expansion are **detection of microwave in space, observation of redshift phenomenon** in space etc. 
Gamma Ray Burst (GRB)	• Recently, energy afterglow of GRB detected in space **may help in probing stellar evolution.** • GRBs are **short-lived explosions of highly energetic gamma rays** lasting from less than a second to several minutes. • GRB are thought to be **generated during the formation of black holes.** They shine about a million **trillion times as bright as the Sun.** • They are known to **occur at huge distances from Earth,** towards the limits of the observable Universe.

Enceladus	• **NASA's Cassini spacecraft has detected methane (CH4)**, along with other compounds like **dihydrogen** (H2) and **carbon dioxide during flybys** of Saturn's moon **Enceladus**.
	  ○ This suggests that the moon has **deep-sea hydrothermal vents** producing these compounds- the **same environment that may have been life's cradle here on Earth.**
	  ○ Saturn's other moon **Titan**, also **has methane** in its atmosphere.
	• Earlier in 2005, Cassini had **discovered geysers blasting particles of water ice** into space from fractures near **Enceladus' south pole that feeds Saturn's ring.**

International Space Station (ISS)	• **Recently, Nauka** (meaning science in Russian) a **space module, is launched by Russia** to replace its existing module at ISS to serve as a research facility.
	• **About ISS**
	  ○ ISS is a **low-earth orbit space station**, launched in 1998, **with five participating space agencies as**- NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe) and CSA (Canada).
	  ○ It **helps in carrying long-term research on human health under microgravity** along with physical, material and space science.
	  ○ The **ownership and use** of the space station is established **by intergovernmental treaties and agreements.**
	  ○ The space station **orbits in Low Earth Orbit** at an average altitude of 227 nautical miles/420 kilometers above Earth.
	  ○ ISS orbits the **Earth every 90 minutes.**

Doppler Radar (DR)	• Recently, the **Indian Meteorological Organisation's** (IMD) only DR in Mumbai, which surveys weather patterns and forecasts, **had stopped working.**
	• **Working procedure:**
	  ○ **Observing the time required for the beam to be transmitted and returned to the radar allows** weather forecasting departments **to "see" raindrops in the atmosphere, and measure their distance from the radar.**
	 
	• Doppler radar is special as it can **provide information on both the position of targets as well as their movement.**
	  ○ This makes it possible to tell whether the precipitation is moving toward or away from the radar.

Space Rice	• China harvested its first batch of "space rice" from seeds that **returned from a lunar voyage (Chang'e-5 lunar probe) last year.**
	  ○ The country has been taking seeds of rice and other crops to space since 1987.
	• **Significance of farming in space**
	  ○ After being **exposed to cosmic radiation and zero gravity, some seeds can mutate and produce higher yields when planted back on Earth.**

	○ **contribute to China's hybrid rice breeding** by providing more and better genetic sources to expand the seed bank.
Cryogenic-Electron microscopy (Cryo-EM) facilities to boost research	• **With ongoing development of four new** Cryo-EM facilities, **India aims to take lead instructural biology, enzymology, ligand/drug discovery**. • Cryogenics is the science that addresses the production and effects of **very low temperatures**. • Apart from its use in Cryo-EM for **high-resolution structure determination** of biomolecules in solution, it is commonly used: ○ To understand **materials behaviourat low temperatures** (e.g. reduction in resistance); ○ In **Space technology** (use liquid oxygen and Hydrogen); ○ **Preservation** of foods, human bodies for restoration (cryonics) or livestock semen, tissues etc.

4.11.2. SPACE OBJECTS

Blue straggler	• Indian researchers have carried out the first-ever comprehensive analysis of blue stragglers. • Blue stragglers are **bigger and bluer star formed when one star eats up another.** ○ These stars are primarily present in the **older and massive star clusters.** • More than 54% of blue stragglers are formed through **mass transfer from a close binary companion star**, 30% are likely formed through **collisions of 2 stars**, and 10-16% are formed through **interactions of more than 2 stars.**
Magnetars	• Scientists traced first **clue to understand transient high energy pulses from magnetars.** • **A magnetar is a type of neutron star.** In a typical neutron star, magnetic field is trillions of times that of the Earth's magnetic field; however, in a magnetar, magnetic field is another 1000 times stronger. ○ Neutron stars are **formed when a massive star** (with a core between 1 and 3 solar masses) **runs out of fuel and collapses,** crushing together every proton and electron into a neutron. ○ **Stars with higher masses** will continue to **collapse into stellar-mass black holes.** • **Magnetars suffer violent eruptions that are still little known** due to their unexpected nature and short duration, of barely tenths of a second. • It is believed that **eruptions in magnetars may be due to instabilities in their magnetosphere or to a kind of earthquakes** (starquakes) produced in their crust. ○ These triggers **create waves** (**called Alfvén waves**) in magnetosphere of the magnetars and while **interacting with each other wavesdissipate energy**
Wolf-Rayet stars	• **Massive stars** which are at an **advanced stage of stellar evolution** and **losing mass at a very high rate** are known as Wolf-Rayet stars. • With **masses typically greater than 25 times that of the Sun**, they have brief lifetimes and are therefore quite rare objects. • **Wolf-Rayet stars are hot** (25-50,000+ degrees K). • **These are divided into 3 classes based on their spectra**: WN stars (nitrogen dominant, some carbon), WC stars (carbon dominant, no nitrogen), and the rare WO stars with C/O < 1.
White dwarf Star	• A white dwarf star, named LAMOST J024048.51+195226.9 — or J0240+1952, that **completes a full rotation once every 25 seconds is the fastest spinning confirmed white dwarf**, according to a team of astronomers. • A white dwarf is a **star that has burnt up all of its fuel and shed its outer layers, now undergoing a process of shrinking and cooling over millions of years.**
Asteroid Ryugu	• Recently, **NASA received its first sample of asteroid Ryugu,** which was **returned to Earth last December** by Japan Aerospace Exploration Agency's (JAXA) **Hayabusa2 spacecraft.** • Ryugu, diamond-shaped space rock, **is orbiting the sun between Earth and Mars** and occasionally crosses Earth's orbit (therefore classified as potentially hazardous). • Ryugu is **classified as a carbonaceous, or C-type asteroid**, which means it contains a lot of carbon and water. • Studying asteroids like Ryugu could help in answering **questions about origins of solar system and where molecules like water came from.**
Ganymede	• Using **datasets** from **NASA's Hubble Space Telescope (Collaboration of NASA and European Space Agency)**, scientists for the **first time have discovered evidence of water vapour in the atmosphere of Jupiter's moon Ganymede**. • Ganymede, the **largest moon in the solar system**, contains **more water than all of Earth's oceans.** However, temperatures there are so cold that water on the surface is frozen solid. • Right now, **NASA's Juno mission is taking a close look at Ganymede and Jupiter.**
'Hycean' planets	• According to researchers, extra-terrestrial life could thrive on major Hycean exoplanets.

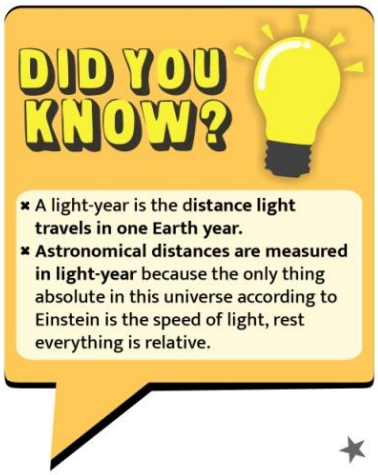
	• Hycean planets are up to **2.6 times bigger than Earth**, with large oceans and hydrogen rich atmosphere.
	  ○ **Hycean planets aren't rocky** like Earth.
	  ○ They appears to be incredibly abundant throughout the Milky Way galaxy.

Magnetic field on an Exoplanet	• Researchers have identified the **first signature of a magnetic field surrounding an Exoplanet HAT-P-11b** (123 light-years from Earth). • **Earth's magnetic field acts as a shield against energetic particles from the sun** known as the solar wind. ○ Magnetic fields **could play similar roles on other planets.**

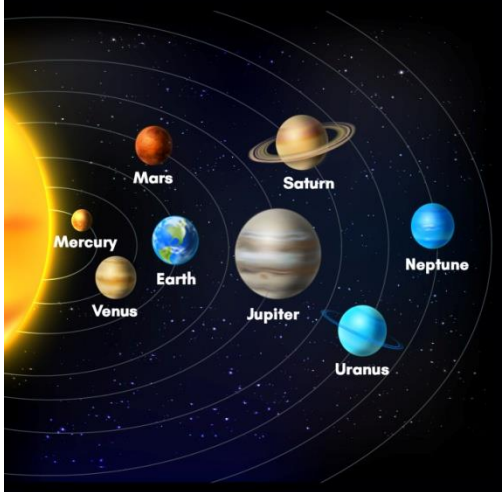
New Exoplanet-TOI 1789b or HD 82139	• Ahmedabad-based Physical Research Laboratory (PRL), has discovered a new exoplanet with a mass **of 1.5 times that of Sun** and located 725 light years away.
	  ○ This is second such exoplanet known **as TOI 1789b or HD 82139b**.
	  ○ The first such exoplanet**K2-236b**, was discovered in 2018.
	• Such close-in exoplanets around stars **with masses between 0.25 to a few Jupiter mass are called "Hot-Jupiters".**

Planet Nine	• It is a **massive, hypothetical object in an elliptical orbit far beyond Pluto.** • It is believed that Planet Nine has a **mass of 6.2 (+2.2/-1.3) Earth masses**. • A study published in 2018 in The Astronomical Journal, on the other hand, cited fresh evidence for the existence of Planet Nine. ○ It noted that a **trans-Neptunian object called 2015 BP519 had an unusual trajectory because it was affected by Planet Nine's strong gravity**.
Atacama Large Milimeter Array (ALMA)	• Using the **ALMA,** scientists for the first time have spotted a **moon-forming region around the exoplanet**. • ALMA is a radio telescope system located on the **Chajnantor plateau in Chile's Atacama Desert.** ○ The radio telescope is an international partnership operated by the **U.S. National Radio Astronomy Observatory, the European Southern Observatory, and the National Astronomical Observatory of Japan.**
Kamo'oalewa	• It is a **quasi-satellite**- a near-Earth object that orbits the Sun and yet remains close to the Earth. ○ It was discovered in 2016 by **Hawaii's Pan-STARRS 1 telescope.** • Because of its small size (about 50 metres wide), **Kamo'oalewa has been difficult for scientists to study.** • Recently, scientists **offered insights into where this satellite could have come from.**

Active Galactic Nuclei (AGN)	• Researchers from the Indian Institute of Astrophysics have observed **three supermassive black holes** from three galaxies **merging to form a triple AGN.**
	• **About AGN:**
	  ○ Many galaxies have **very bright nuclei**, so bright that the **central region can be more luminous than the remaining galaxy light**. These nuclei are called AGN.
	  ○ Based on X-ray (and other) observations, a **good guess is that the power source in AGN is a supermassive black hole.**
	  ○ Much of the energy output of AGNs is of a **non-thermal (non-stellar)** type of emission, with many AGN being **strong emitters of X-rays, radio and ultraviolet radiation**, as well as optical radiation.



Various Space Missions



Planet	Organisation/ Country	Missions
Mercury	NASA	Messenger
	ESA	BepiColombo
Venus	NASA	Magellan, DAVINCI+, VERITAS
	ISRO	Shukrayaan
	ESA	EnVision, Venus Express
Mars	NASA	InSight, Odyssey, Pathfinder, MAVEN, Viking, Perseverance
	ISRO	Mangalyaan
	CHINA	Tianwen-1
	UAE	Hope
	ESA	ExoMars, Mars Express
Jupiter	NASA	Voyager 1, Voyager 2, Juno, Europa Clipper
	ESA	Juice
Saturn	NASA	Voyager 1, Voyager 2, CASSINI
	ESA	Huygens
Uranus	NASA	Voyager 2
Neptune	NASA	Voyager 2

Sun

Organisation/ Country	Missions
NASA	Parker, MUSE and HelioSwarm, Heliophysics, Solar Orbiter (With ESA)
ISRO	Aditya-L1

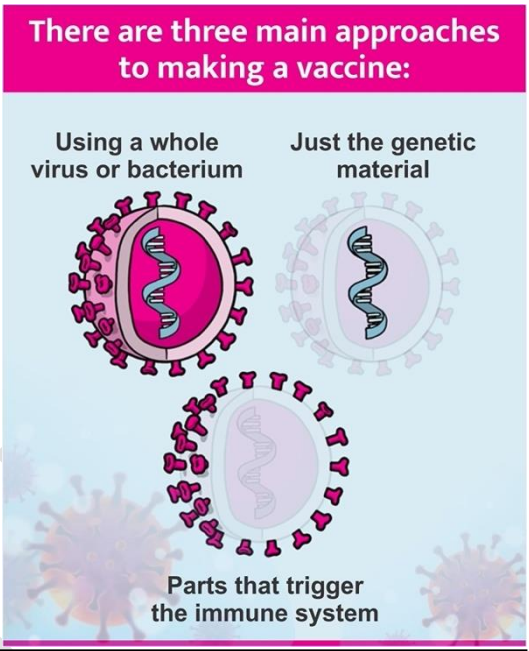
5. HEALTH

5.1. VACCINES

5.1.1. NUCLEIC ACID VACCINES

Why in News?

Recently, Zydus Cadilla, a pharmaceutical company, received **emergency use approval for ZyCov-D, its plasmid DNA vaccine against COVID-19**



More on News

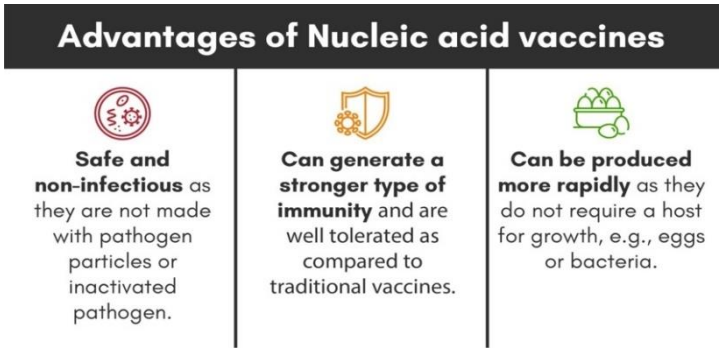
- This **would be the world's first DNA vaccine against COVID-19.**
- Both **DNA and RNA are types of Nucleic acid vaccines** (also known as gene-based vaccines).

About Nucleic Acid vaccines

- Instead of injecting a weakened form of a virus or bacteria into the body, Nucleic acid vaccines **use genetic material from a disease-causing virus or bacterium** (a pathogen) **to stimulate an immune response** against it.
  - That **immune response, which produces antibodies,** is what protects us from getting infected if the real virus enters our bodies.
- Depending on the vaccine, the **genetic material could be DNA or RNA.**
  - DNA and RNA are the instructions our cells use to make proteins. In our cells, DNA is first turned into messenger RNA (m RNA), which is then used as the blueprint to make specific proteins.
  - **mRNA teaches cells how to make a protein** that triggers an immune response inside human bodies.
    - ✓ **Transcriptome refers to the full range of mRNA** molecules expressed from the genes of an organism.
- In the case of DNA vaccines, **a piece of DNA encoding the antigen is first inserted into a bacterial plasmid.**
  - A plasmid is a small, **often circular DNA molecule** found in bacteria and other cells. They generally carry only a small number of genes, notably some associated with antibiotic resistance.
- DNA plasmids carrying the **antigen are usually injected into the muscle and then driven into cells** with the help of technologies like electroporation (short pulses of electric current are used to create temporary pores in patients' cell membranes).
- **RNA vaccines encode the antigen of interest in mRNA.**
- The RNA can be injected by itself, encapsulated within nanoparticles (as Pfizer's mRNA-based Covid vaccine is), or driven into cells using some of the same techniques being developed for DNA vaccines.
- Unlike mRNA vaccines, **DNA based vaccines don't require ultra-cold storage systems** and are said to be more cost effective.

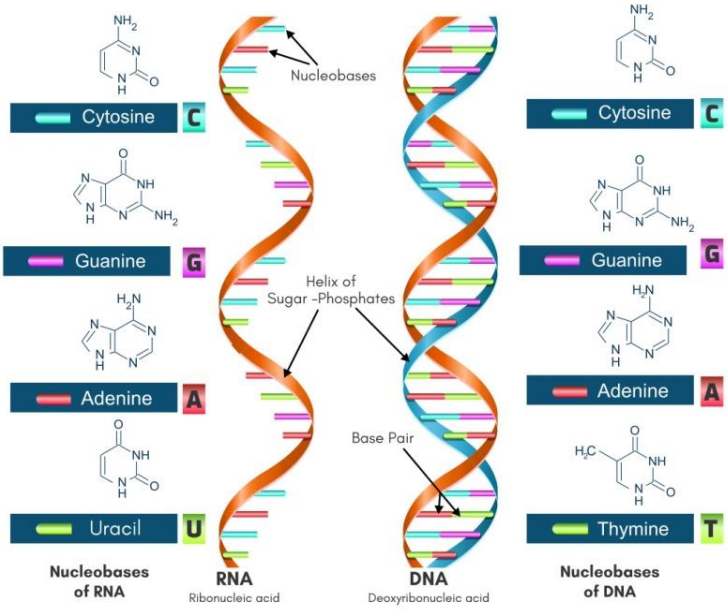
About Zycov-D

- It is the **first indigenously developed COVID vaccine.**
- It has been developed in partnership with the Department of Biotechnology **under the 'Mission COVID Suraksha'.**
- This DNA-based vaccine in **can be administered without a needle.**
- It can be administered **to adults as well as those 12 and above.**



Other approaches to make a Vaccine		
Whole-microbe approach	• **Inactivated vaccine by** taking the disease-carrying virus or bacterium, or one very similar to it, and inactivating or killing it using chemicals, heat, or radiation.	• This is the **way the flu and polio vaccines are made** – and vaccines can be manufactured on a reasonable scale. • **Requires special laboratory facilities** to grow the virus or bacterium safely, can have a **relatively long production time,** and will likely require two or three doses to be administered
	• **Live-attenuated vaccine** uses a living but weakened version of the virus or one that's very similar.	• **Examples are** measles, mumps and rubella (MMR) vaccine and the chickenpox and shingles vaccine. • Vaccines like this **may not be suitable for people with compromised immune systems.**
	• **Viral vector vaccine** uses a safe virus to deliver specific sub-parts – called proteins – of the germ of interest so that it can trigger an immune response without causing disease. ○ This has the advantage of triggering a strong **cellular immune response by T cells as well the production of antibodies by B cells.**	• **Ebola vaccine is a viral vector vaccine** and this type can be developed rapidly.
Subunit approach	• **Only uses the very specific parts** (the subunits) of a virus or bacterium that the immune system needs to recognize. ○ The subunits **may be proteins or sugars.**	• **Most of the vaccines on the childhood schedule are subunit vaccines,** protecting people from diseases such as whooping cough, tetanus, diphtheria and meningococcal meningitis.

Deoxyribonucleic Acid (DNA) & Ribonucleic Acid (RNA)



- They are two main **types of nucleic acids** responsible for the storage and reading of genetic information that underpins all life.
- **Three types of RNA**
  - **Messenger RNA (mRNA)** copies portions of genetic code, a process called transcription, and transports these copies to ribosomes, which are the cellular factories that facilitate the production of proteins from this code.
  - **Transfer RNA (tRNA)** is responsible for bringing amino acids, basic protein building blocks, to these protein factories, in response to the coded instructions introduced by the mRNA. This protein-building process is called translation.
  - **Ribosomal RNA (rRNA)** is a component of the ribosome factory itself without which protein production would not occur.

Ribonucleic Acid (RNA)	Deoxyribonucleic Acid (DNA)
RNA **converts the genetic information contained within DNA** to a format used to build proteins, and then moves it to ribosomal protein factories.	DNA **replicates and stores genetic information**. It is a blueprint for all genetic information contained within an organism
RNA only has one strand, but like DNA, is made up of nucleotides.	**DNA consists of two strands**, arranged in a double helix.
RNA contains ribose sugar molecules, without the hydroxyl modifications of deoxyribose.	**The sugar in DNA is deoxyribose**, which contains one less hydroxyl group than RNA's ribose.
RNA shares Adenine ('A'), Guanine ('G') and Cytosine ('C') with DNA, but contains Uracil ('U') rather than Thymine.	The bases in DNA are Adenine ('A'), Thymine ('T'), Guanine ('G') and Cytosine ('C').

RNA forms in the nucleolus, and then moves to specialised regions of the cytoplasm depending on the type of RNA formed.	**DNA is found in the nucleus**, with a small amount of DNA also present in mitochondria.
RNA is more resistant to damage from UV light than DNA.	DNA is vulnerable to damage by ultraviolet light.

5.1.2. PNEUMOCOCCAL VACCINE

Why in News?

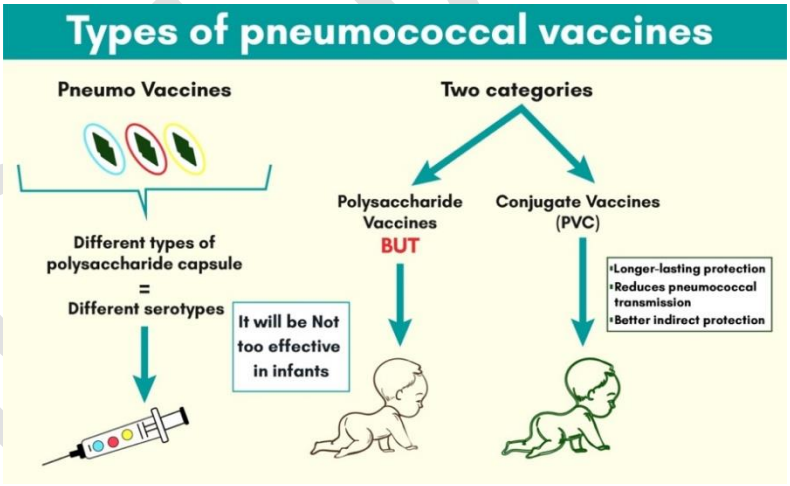
Recently, Union Minister for Health and Family Welfare launched the **nationwide expansion of Pneumococcal Conjugate Vaccine (PCV)** under the **Universal Immunization Programme (UIP).**

About UIP

- It is one of the largest public health programmes **targeting close to 26.7 million newborns and 29 million pregnant women annually.**
- Under UIP, immunization is being provided free of cost **against 12 vaccine preventable diseases:**
  - **Nationally against 10 diseases:** Diphtheria, Pertussis, Tetanus, Polio, Measles, Rubella, severe form of Childhood Tuberculosis, Rotavirus diarrhea, Hepatitis B and Meningitis & Pneumonia caused by Haemophilus Influenzae type B;
  - **Sub-nationally against 2 diseases** - Pneumococcal Pneumonia and Japanese Encephalitis; of which Pneumococcal Conjugate vaccine is nationally expanded today (earlier in select districts **of Bihar, Himachal and to be expanded in phases**), while **JE vaccine is provided only in endemic districts.**

About Pneumococcal disease

- It is the name given to **a group of diseases caused by a bacterium called Streptococcus pneumoniae (also known as pneumo-coccus).**
  - Pneumococcal disease can occur in **multiple organ systems, causing pneumonia, meningitis, bacteraemia/sepsis, sinusitis, bronchitis** and middle ear infection**.**
- Pneumococcal infection is **transmitted by direct contact with respiratory secretions** from patients and healthy carriers.
  - **Children** under 5 years of age and especially those under 2 years of age **are the most at risk** of developing and dying from the disease.
  - **Elderly and immunocompromised** people are also at risk.



- PCV gives **prevention against pneumococcal diseases** and can potentially **reduce the dependence on antibiotics.**
  - PCV can **have side effects** ranging from fever, loss of appetite to headache, fussiness

Types of Pneumococcal Vaccines

- **Pneumococcal vaccines are derived from sugars** (polysaccharides) from the capsule of the bacterium Streptococcus pneumoniae.
- They **may or may not be attached to the carrier protein** (proteins that carry substances from one side of a biological membrane to the other).
- **Based on the presence of carrier protein, two broad categories** of pneumococcal vaccines are available in market:
  - Polysaccharide vaccines (with no carrier) and
  - Conjugate vaccines (with protein carrier)
    - ✓ A conjugate vaccine is a type of vaccine which **combines a weak antigen with a strong antigen** (a substance that causes immune system to produce antibodies against it) **as a carrier** so that the immune system has a stronger response to the weak antigen.

5.1.3. BCG (BACILLUS CALMETTE-GUERIN) VACCINE

Why in News?

It has been 100 years since the BCG vaccine was first used in humans in 1921 against tuberculosis (TB).

More on News

- It was developed by two Frenchmen, **Albert Calmette and Camille Guerin,** by modifying a strain of Mycobacterium bovis that causes TB in cattle.
- In India, BCG was first introduced in a limited scale in 1948 and became a part of the **National TB Control Programme in 1962.**

About Tuberculosis (TB)

- TB is caused by a bacterium called Mycobacterium tuberculosis, belonging to the **Mycobacteriaceae family** consisting of about 200 members, some of which cause diseases **like TB and leprosy in humans** and others **infect a wide range of animals.**
- According to the WHO's Global TB Report, 10 million people developed TB in 2019 with 1.4 million deaths. India accounts for 27% of these cases.
- India is committed to eliminate TB as a public health problem by 2025.
- Indian Council of Medical Research is undertaking clinical trial of two vaccines against TB- a **recombinant BCG called VPM 1002 and Mycobacterium indicus pranii (MIP).**

About BCG

- Currently**, BCG is the only licensed vaccine available for the prevention of TB.**
- The **efficacy of BCG is higher** in geographic locations **farther from the equator.**
  - This may be because **regions near the equator also have a higher prevalence of environmental mycobacteria** which may interfere with the protective effect against TB.
- The **protective effect** of the vaccine against severe forms of TB **appears to wane with age.**
- BCG is also used against **respiratory and bacterial infections of the newborns**, and other **mycobacterial diseases like leprosy and Buruli's ulcer** and as an **immunotherapy agent in cancer of the urinary bladder and malignant melanoma.**

Related News

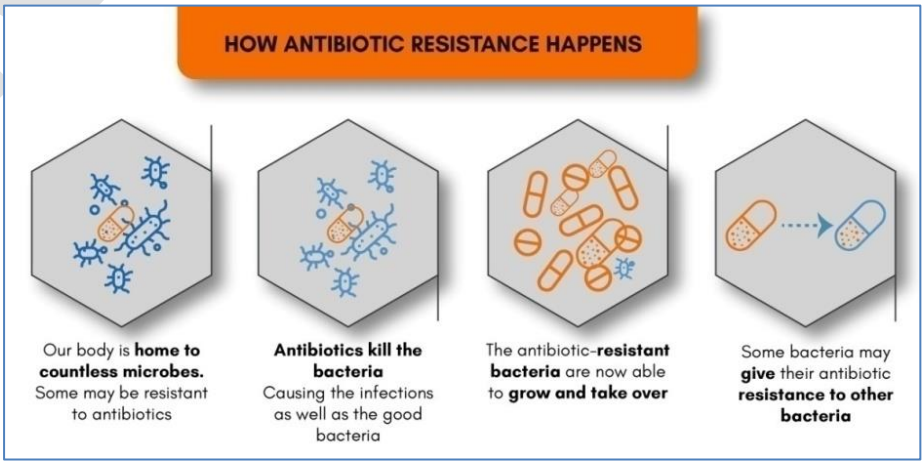
Recently, the Union Ministry of Agriculture and Farmers Welfare notified the **draft order on 'Prohibition of Streptomycin and Tetracycline in Agriculture'.**

- The antibodies, Streptomycin and Tetracycline are important medicines used in the treatment of tuberculosis in human beings.
  - The **use of antibiotics leads** directly to the **development and spread of resistance.**
  - It was also observed that the **overutilization of the TB antibodies on crops is not healthy for human beings, plants, and the soil.**
- According to the draft Order
  - **No person shall import, manufacture, or formulate Streptomycin and Tetracycline for use in agriculture** in India with effect from February 1, 2022.
  - There will be a **complete ban on the use of Streptomycin and Tetracycline in agriculture from January 1, 2024.**
- The draft Order also stated that every S**tate government shall take all steps necessary for the execution of the Order in their State**, under the provisions of the Insecticides Act, 1968 and rules framed there under.
  - **The Insecticides Act, 1968** is **to regulate the import, manufacture, sale, transport, distribution and use of insecticide** with a view to prevent risk to human beings or animals and for matters connected therewith.

5.2. ANTIMICROBIAL RESISTANCE

Why in news?

According to a study by Lancet, Antimicrobial resistance (AMR) is now the leading cause of death across the world.



Key Facts/Findings regarding AMR

- **Young children were found to be particularly affected by AMR.** In 2019, 1 in 5 deaths attributable to AMR occurred in children under the age of five.
- While resistance levels continue to grow, **antibiotic development has not.**
  - While 63 new antibiotics were approved between 1980 and 2000, **only 15 new drugs have been approved between 2000 and 2018.**

- Out of the seven deadliest drug-resistant bacteria, **vaccines are only available against bacteria causing pneumonia and tuberculosis.**

About Antimicrobial Resistance (AMR)

- **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.
- WHO has declared that AMR is one of the top 10 global public health threats facing humanity.
- Antibiotic resistance has been **found in all regions of the world**.

Causes of AMR

- **Poor hygiene** and infection prevention and control.
- **Overuse of antimicrobials**
- **Over prescription by** doctors and **Non-prescription purchase** in many countries.
- If a person **does not complete a course of antimicrobial drugs,** some microbes may survive and develop resistance to the drug.
- Practice of **adding antibiotics to agricultural feed** promotes drug resistance.
- **Environment** plays a significant role wherein **waste from farms, factories, community (such as mass bathing) and healthcare settings** can contribute to AMR through environmental routes.

Global efforts

- **Global Action Plan (GAP) 2015** on AMR during the 2015 World Health Assembly and committed to the development and implementation of multisectoral national action plans.
- **WHO launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS)** in 2015 to continue filling knowledge gaps and to inform strategies at all levels.
- **WHO is working closely with Food and Agriculture Organization (FAO) and World Organisation for Animal Health (OIE) in a 'One Health' approach** to promote best practices to reduce the levels of AMR and slow its development.
  - An **international 'Go Blue for AMR' colour campaign** has been launched this year by the **AMR tripartite organisations(WHO, FAO and OIE)** to help spread awareness about antimicrobial resistance.
- **Global Antibiotic Research and Development Partnership (GARDP),** a joint initiative of WHO and the Drugs for Neglected Diseases INITIATIVE (DNDI), to encourage research and development through public-private partnerships.
  - By 2025, the partnership aims to develop and deliver five new treatments that target drug-resistant bacteria identified by WHO as posing the greatest threat.

Impacts of AMR: Inability to treat common infections, increased threat to medical procedures such as organ transplantation, adverse impact on animal health, Endangers SDGs etc.

Initiative taken in India

- **National programme on AMR containment was launched** during 12th FYP in 2012-17. Under this programme, AMR Surveillance Network has been strengthened by establishing labs in State Medical Colleges.
- **National Action Plan on Antimicrobial Resistance (NAP-AMR)** to establish and strengthen governance mechanisms, change prescription practices and consumer behaviour and to scale up infection control and antimicrobial surveillance.
- **Red Line campaign** demands that prescription-only antibiotics be marked with a red line, to **discourage the over-the-counter sale of antibiotics**.
- **National Health Policy, 2017** terms antimicrobial resistance as one of the key healthcare issues and prioritizes the development of guidelines regarding antibiotic use and check on restricting the growth of antibiotics.
- ICMR has undertaken a project on an **"Integrated One Health Surveillance Network for Antimicrobial Resistance"** in collaboration with Indian Council of Agriculture research (ICAR) to assess the preparedness of Indian Veterinary laboratories to participate in integrated AMR surveillance network.

Related development

Researchers from Indian Institute of Science (IISc) are working on **two approaches to tackle AMR -**

- Use **bacteriophages, or 'phages', to kill bacterial cells**.
  - Bacteriophages are viruses that infect bacteria.
- **Block the transporters that 'throw out' antibiotics** from bacterial cells.
  - Transporters help move nutrients from the environment into cells and remove toxic metabolites.
  - **Multi-drug resistant pathogens have evolved transporters** that are capable of moving out (or 'effluxing') antibacterial compounds from bacterial cells and membranes, **thereby protecting pathogens (bacteria).**
  - Researchers are **developing certain type of antibody that could inhibit the transporters** in bacteria.

- ICMR has also created veterinary standard operating procedure (Vet-SOPs) for enabling comparison of antimicrobial resistance patterns in animals and humans.

- **FSSAI has set certain guidelines limiting the antibiotics in food products** such as fish and honey.
- In 2012, India's medical societies adopted the **Chennai Declaration,** a set of national recommendations to promote antibiotic stewardship.
- A **separate Schedule H-1** has been incorporated in Drug and Cosmetic rules to regulate the sale of antimicrobials in the country.

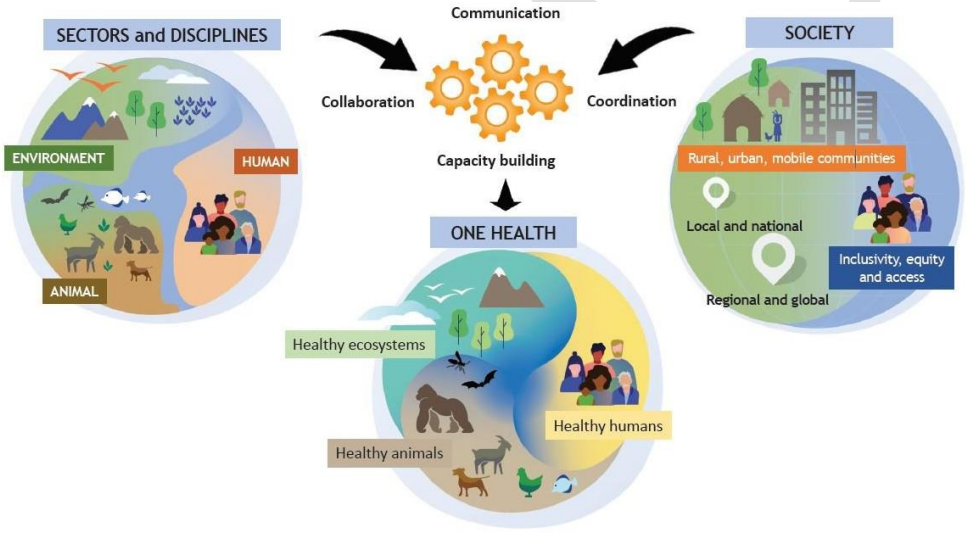
Related News
Report finds positive associations between antimicrobial use in animals and AMR in humans

- The report **by EU Centre for Disease Prevention and Control and others**, analysed **six classes of antibiotics**- cephalosporins, fluoroquinolones, polymyxins, aminopenicillins, macrolides and tetracyclines.
  - These are part of **WHO's AWaRe (Access, Watch, Reserve) classification.**
  - Data on AMR in *E. coli, K. pneumoniae,S. aureus and C. jejuni* were included in report.
    - ✓ While *E. coli* and *K. pneumonia* are common **infection causing bacteria**, *S. aureus* and *C. jejuni*are**food-borne bacteria.**

5.2.1. ONE HEALTH

Why in News?

FAO, the World Organisation for Animal Health (OIE), WHO and UNEP welcomed the newly formed operational definition of "OneHealth" by One Health High Level Expert Panel (OHHLEP).



About OHHLEP

- **OHHLEP** is made up of **26 independent experts** selected by **these four international organisations.**
- These 4 organizations are **working together to mainstream One Health** so that they are better prepared to prevent, predict, detect, and respond to global health threats and promote sustainable development.

About One Health

- One Health is an **integrated, unifying approach** that aims to sustainably balance and **optimise the health of people, animals and ecosystems**.
- It **recognizes the health of humans, domestic and wild animals, plants,** and **wider environment** (including ecosystems) are closely linked and interdependent.
- The approach **mobilises multiple sectors,** disciplines and communities at **varying levels of society to work together** to foster well-being and tackle threats to health and ecosystems.
- It addresses the **collective need for clean water, energy and air, safe and nutritious food,** taking action on climate change, and contributing to sustainable development.

Benefits of One Health:

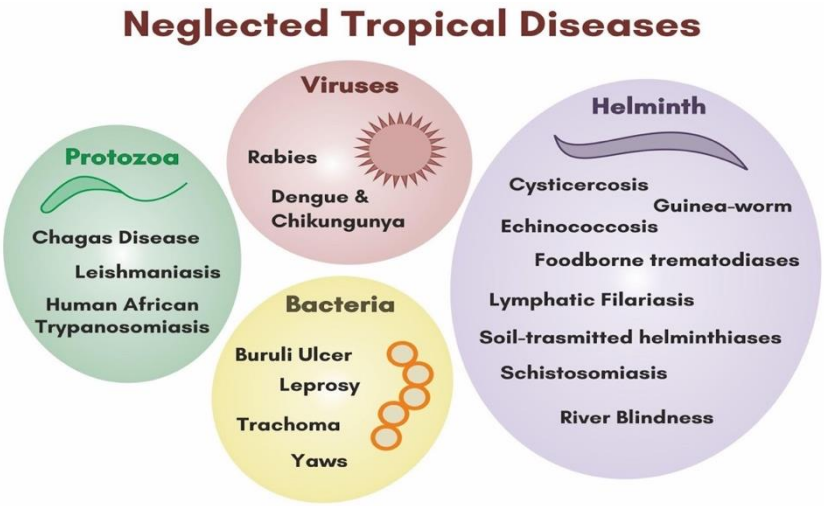
- **Promote coherence** in action across sectors and areas of expertise in health sector.
- Address the full spectrum of disease control - **from disease prevention to detection, preparedness, response, and management**.

5.3. NEGLECTED TROPICAL DISEASES

Why in News?

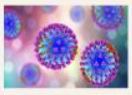
Accepting the proposal of the United Arab Emirates (UAE), 74th World Health Assembly declared January 30 as 'World Neglected Tropical Diseases (NTD) Day'

About Neglected Tropical Diseases (NTD)



- NTD are communicable diseases that **prevail in tropical and subtropical countries** and affect more than one billion people.
- Populations living in **poverty, without adequate sanitation** and in close contact with infectious vectors and domestic animals and livestock are those worst affected.
    - Worldwide, around 149 countries and territories are affected by at least one NTD.
    - India experiences the **world's largest absolute burden of several major NTDs,** though India has already **eliminated several NTDs, including guinea worm, trachoma, and yaws.**

Types of Pathogens

Bacteria	Viruses	Fungi	Protozoa	Helminths
				
• Bacteria are **tiny, single-celled organisms** that get nutrients from their environments. • They are **free-living as well as parasites.** • They are **autotrophs as well as heterotrophs.** • Bacteria **lack a nucleus** and other membrane-enclosed organelles.	• Viruses are even smaller than bacteria. They **aren't even a full cell.** • They are simply genetic material **(DNA or RNA) packaged inside of a protein coating.** • They need to **use another cell's structures to reproduce.**	• Fungi are **multicelled, plant-like organisms.** • A fungus **gets nutrition from plants, food, and animals** in damp, warm environments. • They **reproduce by vegetative, asexual and sexual** reproduction.	• Protozoa are **unicellular eukaryotes.** • They **lack a cell wall.** • They are **heterotrophs.** • They are either **free-living or parasitic.**	• Helminths include **multicellular parasitic worms, such as roundworms,** tapeworms, etc. • They are **invertebrates characterized by elongated, flat or round bodies.** • Helminths are **transmitted to humans through food, water and soil, arthropod and** molluscan vectors.

Impact of NTDs

- **NTDs overload already stretched health systems in developing countries.**
- Some disease **impair physical and cognitive development amongst children** as infection leads to malnutrition, cognitive impairment, stunted growth, and the inability to attend school.
- Some diseases with **cutaneous manifestations are disfiguring, particularly for women,** because they delay health-seeking behaviour, diagnosis and treatment.
- **Challenges in tackling NTD:** little attention from policy-makers, lack of priority within health strategies, inadequate research, limited resource allocation and few interventions etc.

Related News

Lymphatic filariasis or elephantiasis

- Maharashtra government has flagged off its **mass drug administration drive** for the elimination of lymphatic filariasis.
    - Mass drug administration is one of the **two pillars of the National Programme for Elimination of Lymphatic Filariasis,** under which anti-filaria drugs are administered to the eligible population once a year.
- Lymphatic filariasis is a neglected tropical disease that occurs when **filarial parasites are transmitted to humans through mosquitoes.**
- Symptoms include swelling of legs, and hydrocele and can cause a raft of societal stigma.

Visceral Leishmaniasis/Kala- Azar

- Indian researchers have developed a **non-invasive, easy to administer, cost-effective, and patient compliant** potential therapeutic strategy against Visceral Leishmaniasis.

- The conventional treatment therapy of VL mainly involves **painful intravenous administration**, which imposes many treatment complications, including **prolonged hospitalization, high cost, and high risk of infection.**
- **About Visceral Leishmaniasis (VL):**
  - It is a complex infectious disease transmitted by the **bite of female PHLEBOTOMINE sandflies**.
  - Leishmaniasis is a disease **caused by protozoan parasites of the Leishmania genus.**
  - It is a **vector-borne disease and transmitted through sand flies**
  - It is a **neglected tropical disease** that affects millions annually, making it the **second most common parasitic killer after malaria**.
  - **It is endemic to the Indian subcontinent** (in Nepal, Bhutan, Bangladesh and India)**. India accounts for half the global burden of the disease.**

National Action Plan for dog mediated Rabies Elimination (NAPRE) launched

- **Prepared by National Centre for Disease Control,** in association with the Ministry of Fisheries, Animal Husbandry, and Dairying, **NAPRE targets to end rabies by 2030 through One health Approach.**
  - Earlier, a National Rabies Control Program was launched during 12th Five-year Plan
- Rabies is a **vaccine-preventable, zoonotic, viral disease.** Once clinical symptoms appear, **rabies is virtually 100% fatal.**
  - **Rabies is one of the NTD** that predominantly affects poor and vulnerable populations who live in remote rural locations.
  - In up to 99% of cases, **domestic dogs are responsible for rabies virus transmission to humans.**
  - Rabies is present on all continents, **except Antarctica.**

5.4. MUCORMYCOSIS

Why in News?

As cases of Mucormycosis or Black Fungus cases had started rising some states **declared it as epidemic** under Epidemic Diseases Act 1897.

Other types of Fungal Infection

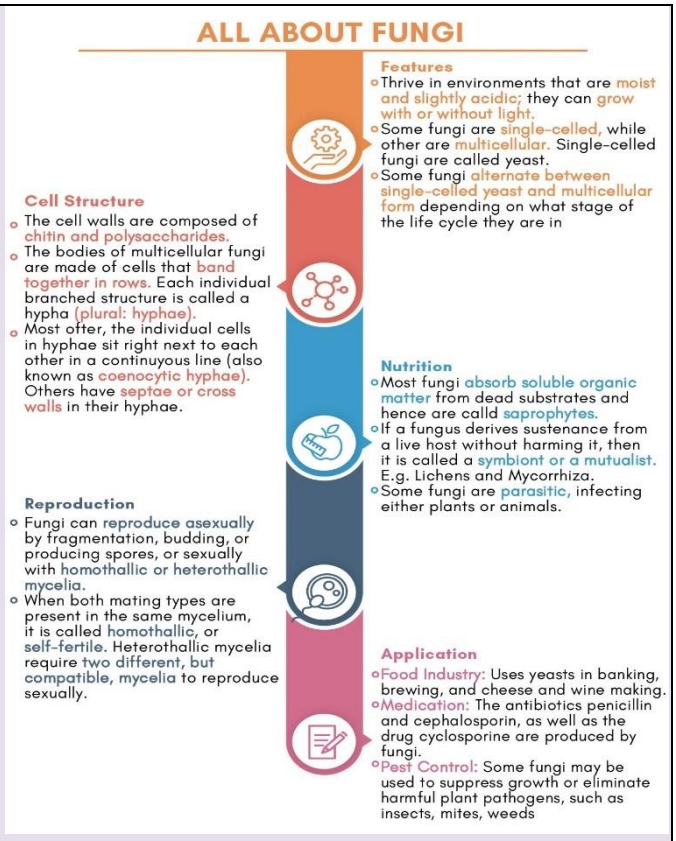
- **White Fungus or Candidiasis** (caused by fungus called **Candida**).
- When fungus attacks private parts, there is **white colour discharge**, thus the **name white fungus**.
- **Yellow Fungus** (caused by moulds (a type of fungi) in the environment).
- Because of **Yellow colour pus** that is formed in the area wounded by the fungus, it has been **called Yellow Fungus.**
- **Aspergillosis** (caused by a common mould, Aspergillus)

About Mucormycosis

- Mucormycosis is a **fungal infection that mainly affects people who are on medication for other health problems** that reduces their ability to fight pathogens.
- It has been **commonly called as black fungus** because it causes the tissue affected to necrose and **turn into black.**
- Previously called zygomycosis, it is a **serious but rare fungal infection** caused by a group of molds called **mucormycetes.**
  - These molds live throughout the environment, particularly in **soil and in decaying organic matter, such as leaves, compost piles, or rotten wood.**
- **Examples of fungi** that most commonly cause mucormycosis are: Rhizopus species, Mucor species, Rhizomucor species, Syncephalastrum species etc.
- **Most people come in contact with microscopic fungal spores every day** but it mainly affects people with weakened immune system. Person can get infected through **inhalation, inoculation or ingestion** of fungal spores.
- Mucormycosis **isn't contagious**, so one can't get it from an infected person. It can't spread **between people and animals.**
- **Symptoms** include: Sinusitis, nasal blockade, blackish or bloody nasal discharge, blackish discolouration over bridge of nose or palate, blurred vision, etc.
- **Prevention:** Maintaining **personal hygiene**, **Aggressive monitoring of blood sugar** etc.
- **Treatment:** Mucormycosisneeds to be treated with prescription **antifungal medicine**, usually amphotericin B, posaconazole, or isavuconazole. Often, mucormycosis requires surgery to cut away the infected tissue.

Fungi

- Fungi (singular: Fungus) are **eukaryotes** which are responsible for decomposition and nutrient cycling through the environment.
  - **Eukaryote** refers to any of the single-celled or multicellular organisms whose cell contains a **distinct, membrane-bound nucleus.**
  - Fungi are **classified as a separate kingdom,** along with other eukaryotic kingdoms like Plantae, Animalia and Protista (see infographic).
- **Common examples** of fungi are: yeasts, rusts, truffles, moulds, mildews and mushrooms.



CHARACTERISTICS OF THE FIVE KINGDOMS

Characteristics	Five Kingdoms				
	Monera	Protista	Fungi	Plantae	Animalia
Cells Type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid)	Present is some	Present with chitin	Present (cellulose)	Absent
Neclear Membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/loose tissue	Tissue/organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosynthetic and photosynthetic and photosynthetic) and Heterotrophic (saprophytic/ parasitic)	Autotrophic (photosynthetic Heterotrophic	Heterotrophic (Saprophytic Parasitic)	Autorophic (Photosynthetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

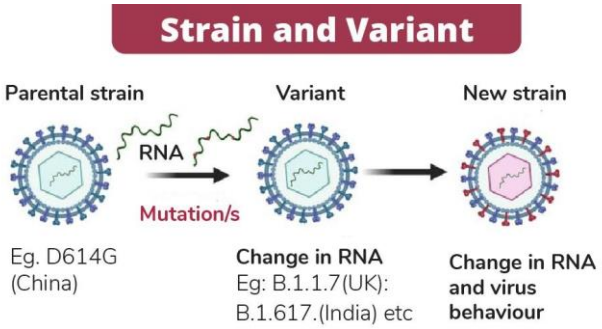
5.5. CORONAVIRUS MUTATION

Why in News?

WHO designated New Coronavirus Strain as 'variant of concern' and named it 'Omicron'.

More on News

- This Variant, **B.1.1.529 was first reported from South Africa** and is being considered potentially more dangerous than the Delta variant.
  - It comes with a **"very unusual constellation" of mutation** and can even infect fully vaccinated people**.**



About virus mutations

- **Viruses, like all living things, go through mutations** throughout their lifespan.
  - A mutation is a **subtle change in the genes of the virus** using host body itself.
  - This may make the **virus more unstable and more vulnerable.**
- At times **mutation may result in major changes in the structure of a virus**.
  - In this case, virus could be difficult to detect with existing tests, respond differently to treatments and **become unrecognizable to antibodies developed after an infection or vaccination.**
- When a **new variant shows functional properties different from the original virus** and becomes established in a population, it is referred to as a **new strain** of the virus. A strain **behaves differently from its parent virus**.
  - **All strains are variants** but **not all variants are strains**.

WHO Classification of COVID-19 variants	
Variant of Concern	• It is a variant that results in **rise in transmissibility, increase in fatality** and a significant **decrease in effectiveness of vaccines**, therapy and other health measures. • The **Alpha, Beta, Gamma and Delta** variants fall under it.
Variant of Interest	• It is a variant with a genetic capability that **affects characteristics of virus such as disease severity, immune escape, transmissibility and diagnostic escape**, and causes a **consequential volume of community transmission**. • The Eta, Iota, Kappa and Lambda fall under it.
Variants Under Monitoring (VUM)	• It is a **variant with genetic changes that are suspected to affect virus characteristics** but evidence of phenotypic or epidemiological impact is currently unclear**.** • It may pose a **future risk.**

WHO announced labels of SARS-CoV-2 variants:

- WHO has assigned simple, easy to remember and non-stigmatising labels for key variants of SARS-CoV-2 **using letters of the Greek alphabet:**

SARS-CoV-2 Variants	WHO label	Earliest documented samples
B.1.1.7	Alpha	United Kingdom
B.1.351	Beta	South Africa
P.1	Gamma	Brazil
B.1.617.2	Delta	India
B.1.1.529	Omicron	South Africa

5.5.1. OTHER COVID RELATED DEVELOPMENTS IN NEWS

Global Initiative on Sharing Avian Influenza Data (GISAID)	• A research team that found a new strain of Covid-19 Deltacron (that combines **Delta and Omicron**) in **Cyprus** has shared findings with **GISAID.** • **About GISAID:** o Launched in **2008**, Initiative promotes the **rapid sharing of data from all influenza viruses and the coronavirus causing COVID-19.** o Data includes: ✓ **Genetic sequence and related clinical and epidemiological** data associated with human viruses, and ✓ **Geographical as well as species-specific data** associated with avian and other animal viruses.
Global COVAX Alliance	• Recently, Punjab Cabinet decided to join the **Global COVAX Alliance**, as first Indian state to do so because of **vaccine shortage** **About COVAX Alliance** • COVAX, short for **COVID-19 Vaccines Global Access**, is a worldwide initiative co-led by **Coalition for Epidemic Preparedness Innovations (CEPI), Gavi and the World Health Organization (WHO),** alongside key delivery partner **UNICEF** • It **coordinates international resources to enable equitable access** to COVID-19 tests, treatments, and vaccines **COVAX No-Fault Compensation Program** • No Fault compensation program **is the world's first and only international vaccine injury compensation mechanism.** o It provides fair, no-fault, lump sum compensation **to eligible individuals who suffer certain serious adverse events after receiving a COVID-19 vaccine** distributed through the COVAX Facility.

	○ It helps to **deliver safe and effective COVID-19 vaccines to the high-risk and vulnerable populations in 92 low- and middle-income countries** including India.
Global Hub for Pandemic and Epidemic Intelligence	• **WHO and Germany** will establish a new global hub for pandemic and epidemic intelligence as part of WHO's Health Emergencies Programme (HEP). ○ **HEP** was **established in 2016 to deal with emergency health needs related to disease outbreaks, disasters and conflicts**. • The hub will create a shared network access to vital multi-sectoral data that will **drive innovations in data analytics to predict, prevent, detect, prepare and respond to worldwide health threats.** ○ It will strengthen the global early warning surveillance system to identify pandemic and epidemic risks. ○ It will help in **developing tools and models** for risk analysis and monitor disease control measures and infodemics.
WHO'S "Solidarity" Clinical Trial for COVID-19	• India was rolled out the next phase of World Health Organization's Solidarity trial - **Solidarity PLUS - which aims to assess the effectiveness of new drugs** in treating hospitalised Covid-19 patients. ○ **India is among the 52 countries** taking part in WHO's Solidarity PLUS trial. ○ In 2020 WHO initiated the Solidarity trial. • India trial will study **two drugs - Imatinib and Infliximab**. ○ Imatinib is used for **treating certain cancers** while infliximab is used for **diseases of the immune system,** including Crohn's disease and rheumatoid arthritis.
India SarsCov2 Genome Consortium (INSACOG)	• After **steady decline** in new Covid-19 infections, INSACOG has prioritized **developing and expanding** a SARS CoV2 **sewage surveillance program.** • INSACOG is jointly initiated by the **Union Health Ministry of Health, and Department of Biotechnology** with Council for Scientific & Industrial Research and Indian Council of Medical Research. ○ It is **a consortium of National Laboratories to monitor the genomic variations in the SARS-CoV-2.** ○ The network carries out **whole genome sequencing of SARS-CoV-2 virus across the nation**, aiding the understanding of how the virus spreads and evolves, and provides information to aid public health response.
Neo Cov	• A new kind of coronavirus, NeoCov, is found among bats in **South Africa**. • NeoCov virus shares **85% similarity to Middle East respiratory syndrome coronavirus (MERS-CoV)** in genome sequence which enters cells via DPP4 receptors. ○ MERS-CoV is a viral disease that was first identified in Saudi Arabia in 2012. • NeoCov is **not SARS-CoV-2**. ○ NeoCoV is a **bat coronavirus** that was first identified in 2011. ○ It was identified in a species of bats known as **Neoromicia**. ○ NeoCov can use **ACE2 receptors of bats** but **they can't use human ACE2 receptor unless a new mutation occurs.**
Monoclonal Anti-Body Therapy	• **Monoclonal antibody therapy** is the use of monoclonal antibodies to specifically target cells. It has been suggested for treating COVID-19 in 'high-risk' patients. • Monoclonal antibodies are **artificially created in the lab** and are **similar to antibodies naturally created by immune system** of humans. ○ **Antibody**, also called **immunoglobulin**, is a **protective protein** produced by the **immune system** in response to the presence of a **foreign substance**, called an **antigen**. • **Casirivimab** and **Imdevimab** are monoclonal antibodies that are specifically directed against the **spike protein of SARS-CoV-2**, designed to block the virus' attachment and entry into human cells. • Earlier also, monoclonal antibodies have been used to treat other viral infections such as **Ebola and HIV**.
2-deoxy-D-glucose (2-DG)	• Drugs Controller General of India (DCGI) has approved **anti-COVID oral drug2-DG developed by** the **Institute of Nuclear Medicine and Allied Sciences (INMAS),** a leading laboratory of DRDO, in collaboration with Dr. Reddy's Laboratories (DRL) in Hyderabad. ○ It **accumulates in the virus-infected cells** and prevents virus growth by stopping viral synthesis and energy production. Its selective accumulation in virally infected cells makes this drug unique. ○ The **basic mechanism of the drug involves inhibiting glycolysis,** or one of the way in which cells break down glucose from energy. ○ It helps in **faster recovery** of hospitalised patients and **reduces supplemental oxygen dependence.**

Corbevax Vaccine	• Corbevax Vaccine is based on **recombinant protein platform,** based on **Recombinant DNA technology,** in which cloned spike proteins are created in a lab setting through bioprocessing. o For example, use of **E. coli** as host for recombinant proteins offers benefits of low cost, well-known biochemistry and genetics, rapid growth, and good productivity. • It offers benefits like **low price** and **easy to scale up production** as compared to other vaccines which instructs human body cells to create spike proteins. • **Recombinant DNA technology allows genes to be transferred**across different species of plants, from animals to plants, from microorganisms to higher organisms. o **Recombinant subunit vaccine** causes the immune response of the human body by **directly injecting the subunit of the pathogen into the body.** ✓ **Genetic engineering is applied** in the development of these vaccines. ✓ It exposes the body to proteins made by a virus or bacteria, are **often made by using weakened or inactive versions of that virus or bacteria.**
Intranasal Covid vaccine- BBV154	• It is developed by **Bharat BioTech.** o It is a **novel adenovirus vectored** vaccine. ✓ Adenoviruses are **common viruses that cause a range of illness**. They can cause cold-like symptoms, fever, sore throat, bronchitis, pneumonia, diarrhea, and pink eye (conjunctivitis). ✓ Adenoviruses **have double stranded DNA genomes.** Viruses of the family Adenoviridae **infect vertebrates,** including humans • **Benefits** o Other vaccines only produce antibodies, Intranasal vaccine **produce antibodies as well as reduce risk of transmission.** o **Easy delivery** – cut down syringe, needles etc. o **Additional immune response-** addition to the immunity in blood, it activates immunity of the cells founds in the tissues lining the nose and mouth and lungs. o Only **small volume** typically 0.1 ml **will be required.**
ACE2 protein	• The ACE2 protein in humans is where the **coronavirus latches on to, in order to enter the cell.** o However, it is a **plant-grown protein** and **can be manufactured using a patented plant-based production system**. • Researchers are working on creating a **chewing gum laced with ACE2 protein which can serve as a "trap" for the virus and ultimately reduce transmission load.**
SPOT (Scalable and Portable Testing)	• The US scientists have developed a new SPOT system **to detect COVID-19** easily **from saliva samples.** • It uses **Reverse Transcriptase-Loop Mediated Isothermal Amplification (RT- LAMP),** a one-step nucleic acid amplification method. o It **does not need complex machinery** or expertise. o It can be completed **more quickly and is more accurate** than most antigen tests. o The **only difference** between RT-PCR and RT-LAMP **is that RT-LAMP uses four LAMP Primers**. Primers are short fragments of nucleic acids.
Enzyme-linked immunosorbent assay (ELISA) Test	• ELSA is a **labeled immunoassay** that is considered the gold standard of immunoassays. • This immunological test is very sensitive and is used to **detect and quantify** substances, including **antibodies, antigens, proteins, glycoproteins, and hormones** in the blood sample**.** • Recently, **a start-up funded by the Department of Science and Technology (DST) has developed** first of its kind, semi-quantitative **Electrochemical ELISA test** that would help rapid & accurate estimation of total antibody concentration of COVID-19.
Jivan Vayu	• It is India's **low-cost first of its kind CPAP device** developed by IIT Ropar. o CPAP (Continuous Positive Airway Pressure) is **a treatment method used for patients having breathing problemslike sleep apnea** or other lung limitations like lack of full development or lung damage like Covid-19. • It **functions even without electricity** and is adapted to both kinds of oxygen generation units, i.e. O2 cylinders and oxygen pipelines in hospitals.
Project O_2 for India	• It is to enable stakeholders working **to augment the country's ability to meet this rise in demand for medical oxygen.** • Under this, a **National Consortium of Oxygen is enabling the national level supply of critical raw materials** such as zeolites, setting up of small oxygen plants, manufacturing compressors, final products, i.e. concentrators, and ventilators. • It is launched **by Office of Principal Scientific Adviser (PSA).** o PSA was set up (1999) to advice PM and cabinet on matters related to science, technology and innovation

Liquid Medical Oxygen (LMO)	• Medical oxygen **means high-purity oxygen, which is used by hospitals and clinics** in the treatment of various illnesses that cause oxygen saturation levels in the body to drop. o It generally comprises of **minimum 90% oxygen (O2) with 5% nitrogen and 5% argon.** • One of the ways how this oxygen **can be supplied is through Liquid Medical Oxygen (LMO).** o Liquification enables storage in larger volumes and easier transportation. • Most common method to produce LMO is **separation of oxygen in what are known as Air Separation Units or ASUs.** • ASUs **use a method called Fractional Distillation Method** to produce pure oxygen from atmospheric air. o In this method, **gases from the air are separated into various components** after cooling them into a liquid state and then liquid oxygen is extracted from it.
Pressure Swing Adsorption (PSA) Oxygen Plants	• Recently, PM dedicated 35 PSA Oxygen Plants, **established under PM CARES, across 35 States/UTs.** o PM also stated that **all districts now have commissioned PSA Oxygen Plants**. • PSA **refers to an adsorption–desorption cycle** that is driven by drop in sorbent carrying capacity with decreasing pressure. • PSA oxygen generating plants are a **source of medical-grade oxygen.** o In these plants. **ambient air passes through an internal filtration system,** which has a large enough total surface area **to separate nitrogen from air, concentrating the remaining oxygen to a known purity.**
National Oxygen Stewardship Programme	• Union government has launched an initiative to **train health care workers in rational utilisation of medical oxygen** to prevent wastage. • **About National Oxygen Stewardship Programme** o As part of the programme, **at least one oxygen steward will be identified and trained in each district** across the country. o These trained professionals would be responsible for **leading the training on oxygen therapy and management** in their respective districts. o They will also support **audit of oxygen delivery and preparedness** for a surge scenario.
i-Drone (ICMR's Drone Response and Outreach for North East)	• It is **a delivery model,** launched by Ministry of Health and Family Welfare, **to facilitate vaccine delivery to hard-to-reach terrains of India.** • i-Drone will overcome these challenges **by deploying Unmanned Aerial vehicles (UAV) / drones to remote areas.** o Currently, the project has been granted permission for implementation in Manipur and Nagaland, as well as Andaman and Nicobar Islands.

5.6. ANTI-DOPING BILL

Why in News?

Recently, the government introduced National Anti-Doping Bill, 2021 in Lok Sabha.

About doping

- **Doping is the consumption of certain prohibited substances by athletes to enhance performance.**
  - When the drug is consumed by the athlete, he gets an unfair advantage over the clean athlete, thereby banning such drugs shall propagate level playing field and equality among the athletes.
- **World Anti-Doping Agency (WADA) monitors doping** in all kinds of competitive sports.
  - WADA was established in 1999 as an international independent agency (under **Lausanne Declaration** in **Switzerland)** composed and funded equally by the sport movement and governments of the world.
  - Its **key activities include** Scientific research, Education, Development of anti-doping capacities, and **Monitoring of the World Anti-Doping Code**– the document harmonizing anti-doping policies in all sports and all countries.
  - The WADA **periodically updates its list of Prohibited Substances and Methods.** This includes steroids, anabolic agents, stimulants, and gene doping.
    - ✓ Some components such as narcotics are permanently banned.
    - ✓ Some, like alcohol, are banned only in-competition.
  - At the national level, there is the **National Anti-Doping Agency (NADA)**, an independent body under Union **Ministry of Sports**.
- **WADA monitors doping in sport based on the World Anti-Doping Code.** The Code provides a framework for anti-doping policies, rules, and regulations for sport organizations and public authorities.

- Any sportsperson competing in national or international events can be asked to give his/her blood and/or urine samples at any point of time by anti-doping agency or sports events committee during the event. Testing can be conducted in-competition and out-of-competition.

- The **WADA doesn't directly conduct tests**. It gives accreditation to laboratories which adheres to the mandatory International Standard for Laboratories.
- In the latest report published by **the World Anti-Doping Agency, 152 (17% of the world total) Anti-doping Rule Violations (ADRVs) were reported in India in 2019.**
  - **India ranks third in the list** with the maximum dope offenders (Russia topped the list followed by Italy) coming from bodybuilding (57).

National Dope Testing Laboratory (NDTL)

- NDTL has regained **the WADA accreditation.**
  - The restoration of accreditation is a boost to India's efforts to achieve the **highest global standards of excellence in sport.**
- NDTL was established with an aim to **get permanently accredited by International Olympic Committee (IOC) and WADA** to do the testing for the banned drugs in human sports.

Key features of the Bill

- Bill **prohibits athletes, athlete support personnel and other persons from engaging in doping in sport.**
  - ✓ **Anti-doping rule violation** may result in disqualification of results, Ineligibility to participate for a prescribed period, financial sanctions etc.
  - ✓ **Exemptions:** If any athlete requires a prohibited substance or method due to a medical condition, they may apply to the NADA for a therapeutic use exemption.
- **National Anti-Doping Agency:** Bill seeks **to provide statutory framework for the functioning of NADA,** empowering it to conduct raids besides strengthening measures to tackle drug abuse in Indian sports.
  - NADA established as societies under Societies Registration Act, will be dissolved and reconstituted. It will be **headed by a Director General appointed by the central government.**

Significance of the Bill

- It will **strengthen doping control programme** as currently NADA had no authority to conduct raids.
- It will also give **effect to UNESCO's International Convention against Doping in Sport.**
  - India ratified the convention in 2007.

- **National Board for Anti-Doping in Sports:** to make recommendations to the government on anti-doping regulation and compliance of international commitments on anti-doping.
  - The Board will **consist of a Chairperson and two members appointed by the central government.**
- **Disciplinary and Appeal Panels:** The Board will constitute a **National Anti-Doping Disciplinary Panel for determining consequences of Anti-Doping Rule Violations**.
  - This Panel will consist of a **Chairperson and four Vice-Chairpersons** (all legal experts), **and ten members** (medical practitioners and retired eminent athletes).
- **Dope Testing Laboratories:** The existing **National Dope Testing Laboratory (NDTL) will be deemed to be the principal dope testing laboratory.** The Union Government may establish more NDTL.
  - **Recently, NDTL has regained the WADA accreditation** which was suspended in 2019, based on non-compliances which were observed during on-site assessment of the Laboratory.

Related News

WADA approved dried blood spot (DBS) testing technique for the Tokyo Olympics.

- DBS is an innovative **method of screening for banned substances** in which **few drops of blood is taken and put on a kind of blotting paper (dry matrix).**
- The sample is analysed using an **appropriate solvent which extracts the biological material** that is required for the test.
- It is **less invasive method than current urine and blood collection** and therefore, a better athlete experience.

5.7. WORLD MALARIA REPORT 2021

Why in news?

Recently, the **World Health Organization (WHO) has released the World Malaria Report 2021** edition that assesses the actions taken by states in response to Malaria in the backdrop of COVID 19 pandemic.

Key findings of the report

- **Malaria cases and deaths**
  - An estimated **241 million malaria cases** were **reported in 2020** in 85 malaria-endemic countries, increasing from 227 million in 2019.

- **Sub-Saharan Africa** continues to carry the **heaviest malaria burden,** accounting for about 95% of all cases and 96% of deaths in 2020.
- **Malaria deaths increased by 12% globally** in 2020 compared with 2019.

- **India related findings**
  - India accounted for **83% of cases** in the **WHO South-East Asia Region.**
  - **India was the only high-burden country to record progress** by sustaining a reduction in malaria burden between 2019 and 2020.
- **Globally, 40 countries and territories** have now been granted a **malaria-free certification from WHO** – including, most recently, China, El Salvador, Argentina and Uzbekistan.
  - Certification of **malaria elimination is granted by WHO** when a country has proven, beyond reasonable doubt, that the chain of indigenous **transmission has been interrupted nationwide for at least the previous three consecutive years**

About Malaria

- It is a life-threatening **mosquito borne blood disease** caused by **plasmodium parasites,** and spread through the bites of infected **female Anopheles mosquitoes**.
- There are **5 parasite species** that cause malaria in humans, and 2 of these species – **P. falciparum** (African continent) and **P. vivax** (outside of sub-Saharan Africa) – pose the greatest threat.
- It is **preventable as well as curable**.
- **Malaria Vaccine**
  - WHO has recommended broad use of the **RTS,S/AS01 (RTS,S) malaria vaccine** among children living in regions with moderate to high P. falciparum malaria transmission.
  - Known by its **brand name Mosquirix**, this recombinant protein vaccine has been shown to significantly **reduce malaria, and deadly severe malaria** among young children, and also reduced the overall hospital admissions.

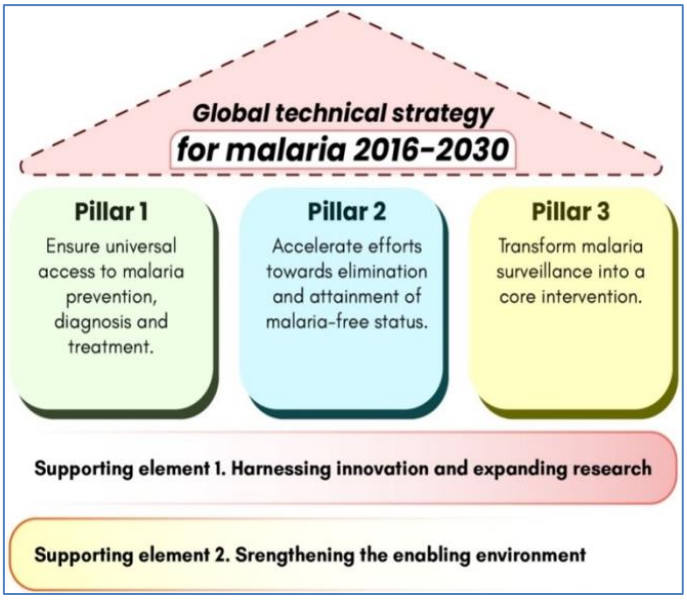
Measures taken to eliminate Malaria

- **WHO Global Malaria Programme (GMP):** Its work is guided by the **Global technical strategy (GTS) for malaria 2016–2030** adopted by the World Health Assembly in May 2015 and updated in 2021.

Goals, milestones and targets for the Global technical strategy for malaria 2016-2030

GOALS	MILESTONES		TARGETS
	2020	2025	2030
1.Reduce malaria mortality rates globally compared with 2015	At least 40% 18% raduction achieved 22% off track	At least 75%	At least 90%
2. Reduce malaria case incidence globally compared with 2015	At least 40% 3% raduction achieved 37% off track	At least 75%	At least 90%
3. Eliminate malaria from countries in which malaria was transmitted in 2015	At least 10 countries On track	At least 20 countries	At least 35 countries
4. Prevent re-establishment of malaria in all countries that ore malaria- free	Re-establishment prevented On track	Re-establishment prevented	Re-establishment prevented

- **Malaria Elimination Research Alliance (MERA)- India:** Its purpose is to identify, articulate, prioritise and respond to the research needs of the country to eliminate malaria from India by 2030.
- **E-2025 initiative:** Under this, WHO has identified group of 25 countries with the potential to eradicate malaria by 2025.
- **High Burden to High Impact (HBHI) initiative:** In 2019,WHO has initiated the HBHI initiative in 11 high malaria burden countries, including **India** (West Bengal and Jharkhand, Chhattisgarh and Madhya Pradesh).
- **National Strategic Plan for Malaria Elimination (2017-22):** It gives year wise



elimination targets in various parts of the country depending upon the endemicity of malaria in the next 5 years.

- **Ministerial Declaration on Accelerating and Sustaining Malaria Elimination in South-East Asia Region (SEAR):** India is a signatory to it.
- **National Task Force on Malaria Elimination:** to promote inter sectoral cooperation and engagement of all stakeholders.
- **Parliamentary and Legislative Forum on Malaria Elimination** was formed.

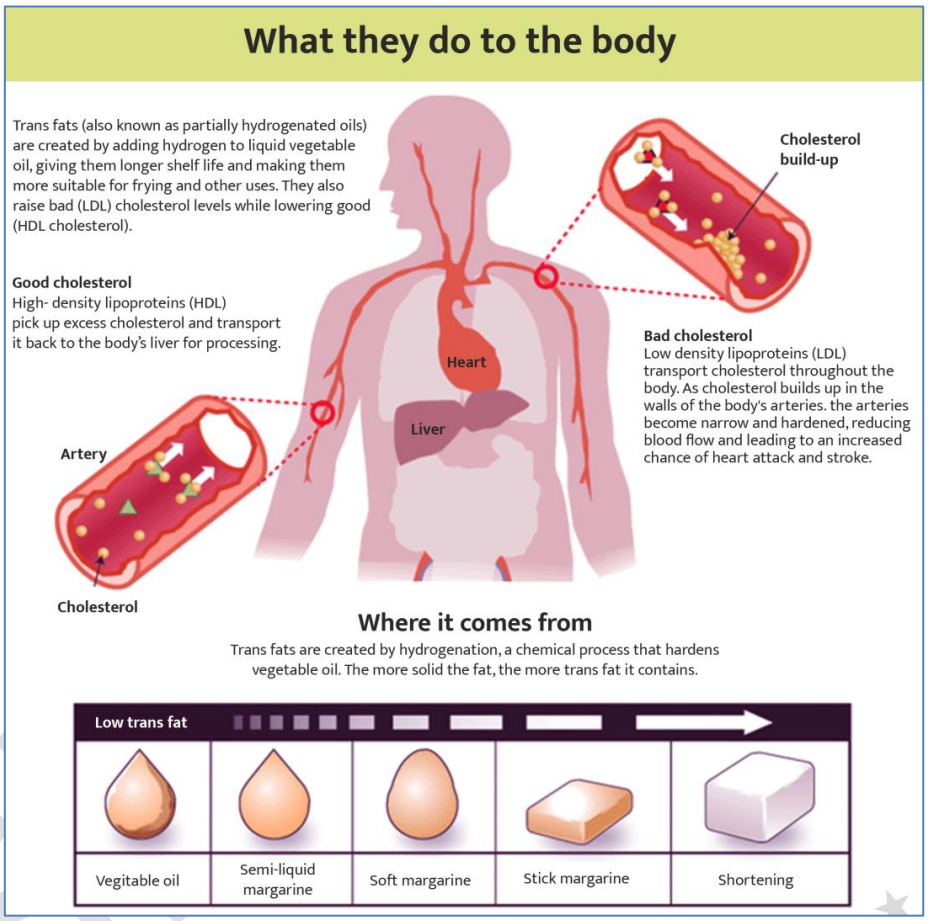
5.8. TRANS FATS

Why in news?

World Health Organisation (WHO) released the third progress report on Global trans-fat elimination 2021 titled 'Countdown to 2023'.

Key highlights of the report

- **Progress in efforts worldwide:** Since May 2020, there has been significant progress in TFA elimination around the world.
  - Mandatory Trans Fatty Acids (TFA) elimination policies are currently in effect in 57 countries.
- **Best performers:** India and the Philippines became the first and second lower-middle-income countries to pass a best-practice policy.



About Trans Fatty Acid (TFA)

- Trans fat, or trans-fatty acids, are **unsaturated fatty acids** that come from either natural or industrial sources:
  - **Naturally occurring trans-fat** come from ruminants (cows and sheep).
  - **Industrially produced trans-fat** are found in hardened vegetable fats such as margarine and are often present in snack foods, baked goods and fried foods.
    - ✓ Industrially produced trans-fats are **formed in a process that adds hydrogen to vegetable oil converting the liquid into a solid**, resulting in "partially hydrogenated" oil (PHO).
    - ✓ Manufacturers often use them as they **have a longer shelf life and are cheaper** than other fats.
- **Health Impacts:** Intake of TFA is associated with **increased risk of heart attacks and death from coronary heart disease.**
  - Approximately **540,000 deaths each year globally and 60,000 in India** can be attributed to intake of industrially produced TFA.

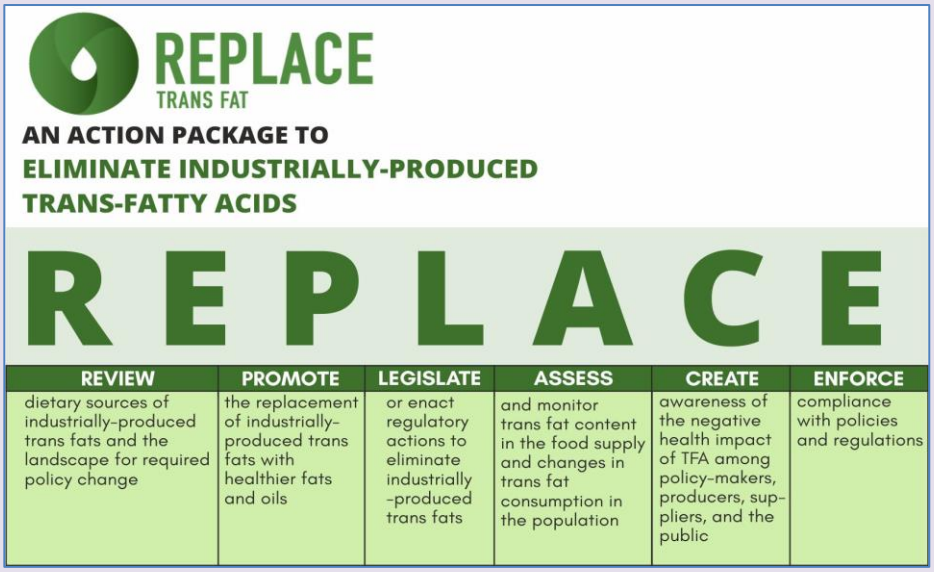
Steps taken by WHO to eliminate Trans Fats from food supplies

WHO identified **TFA elimination as one of the priority targets** in its 13th General Programme of Work (GPW13). In 2018, WHO called for the **global elimination of industrially produced TFA by 2023.**

- **REPLACE action framework:** It provides a roadmap for countries to eliminate industrially produced TFA from their food supplies.

- WHO recommends that **trans-fat intake be limited to less than 1% of total energy intake** i.e., less than 2.2 g/day with a 2,000-calorie diet.

- **Additional resources to support country actions:** This includes six REPLACE implementation modules and a live policy tracking map – the **TFA Country Score Card**– to monitor global progress towards the 2023 target.
- **TFA indicator** that records whether countries have adopted WHO best-practice policies for eliminating industrially produced TFA.
  - This is one of the indicators in the WHO Triple Billion Indicators, an ambitious initiative to improve the health of billions of people by 2023.



- **WHO Certification Programme for Trans Fat Elimination:** The programme aims to accelerate progress towards the 2023 goal for global elimination by recognizing countries that have eliminated industrially produced TFA from their national food supplies. It also establishes country accountability.
  - To qualify for certification, countries must demonstrate that a best- practice TFA policy has been implemented.

Following steps have been taken by India in recent times for TFA elimination:

- In 2018, India called for action **to make the country TFA free by 2022,** a year ahead of the WHO global target of 2023.
  - Target is **to reduce TFA in all food products containing oils and fats to less than 2%** in a phased manner: to not more than 3% from 1 January 2021 and not more than 2% from 1 January 2022.
- Food establishments can display the **"Trans Fat Free" logo** in their outlets and on their food products if the food contains less than 0.2 g of TFA per 100 g or 100 mL and if edible oils or fats contain less than 1 g of TFA per 100 g or 100 mL.
- **Multilingual Mass media campaign,** "Heart Attack Rewind" was launched to create a demand for healthier alternatives to Partially hydrogenated oils.

What are fats and fatty acids?

- Fats are a **group of chemical compounds that contain fatty acids.**
- Fats are the **sources of energy and also act as main constituents of cellular membranes** assuring the fluidity, flexibility, permeability of the membrane.
- The terms fat and fatty acids are frequently used interchangeably.

What are the different types of fatty acid?

- All fatty acids are **chains of carbon atoms with hydrogen atoms** attached to the carbon atoms.
- There are two main types of fatty acids: **saturated and unsaturated.**
  - **Saturated fatty acid** has the maximum possible number of hydrogen atoms attached to every carbon atom. It is therefore said to be "saturated" with hydrogen atoms, and all of the carbons are attached to each other with single bonds.
  - **Unsaturated fatty acid:** If the carbon chain has fewer hydrogen atoms, it is said to be unsaturated. These are further divided into **monounsaturated and polyunsaturated** depending on the nature and number of bonds between carbon atoms.

SATURATED	UNSATURATED
H H | | -C-C- | | H H	H H | | -C-C-
Carbon-Carbon Single Bond	Carbon-Carbon Double Bond

  - **Omega 3 fatty acids** are polyunsaturated fatty acids (also termed as essential fatty acid) with a double bond at the third carbon atom from the end of the carbon chain.Marine algae and phytoplankton are primary sources of omega-3 fatty acids.

Are all food fats bad for the body?

- The fat in **foods contains a mixture of saturated, monounsaturated and polyunsaturated fatty acids.** In foods of animal origin, a large proportion of fatty acids are saturated. In contrast, in foods of plant origin and some seafood, a large proportion of the fatty acids are monounsaturated and polyunsaturated.
- **Saturated and Trans fats raise LDL** (or "bad") cholesterol levels in the blood, thereby **increasing the risk of heart disease.Unsaturated fats,** such as monounsaturated and polyunsaturated, **do not raise LDL cholesterol and are beneficial** when consumed in moderation.

5.9. FOODBORNE DISEASES

Why in News?

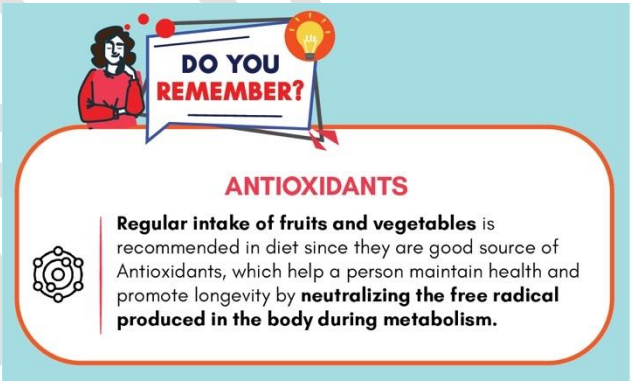
World Health Organization (WHO) calls for intensified efforts to prevent food-borne diseases (FBD).

More on News

- On World Food Safety Day (June 7), **WHO South-East Asia Region has called for an intensified whole-of-society effort** to prevent, detect, and manage the risk of FBD, which affects 600 million people globally.
  - Region contributes a **quarter of the global burden of FBD morbidity** and nearly 42% of FBD mortality.
  - FBD are **costing India almost 15 billion USD annually**.

Classification of food-borne diseases

- **Food-borne infections** – caused by consuming foods or liquids contaminated with bacteria, viruses, or parasites. **These pathogens cause infection by:**
  - Invading and multiplying in the lining of the intestines and/or other tissues
  - Invading and multiplying in the intestinal tract and releasing a toxin (bacteria only)
- **Food-borne intoxications** – caused by consuming foods or beverages already contaminated with a toxin. **Sources of toxins are as follows:**
  - Certain bacteria (pre-formed toxins)
  - Poisonous chemicals
  - Natural toxins found in animals, plants, and fungi.



About FBD

- FBD are **caused by contamination of food** and occur at any stage of the food production, delivery and consumption chain.
  - Factors responsible for FBD include **environmental contamination, unsafe food storage and processing, complex food chains etc.**
  - FBD encompass a wide range of illnesses **from diarrhoea to cancers.**

Steps taken by Food Safety and Standards Authority of India (FSSAI)for food safety:

- **Eat Right Movement** to cut down negative nutritional trends.
- **Blissful Hygienic Offering to God (BHOG)** to encourage food safety and hygiene at Places of Worship.
- **Hygiene Rating Scheme** to allow consumers to make informed choices about the places where they eat out.
- **Food Safety Compliance System (FoSCoS),** one-stop point for all regulatory and compliance engagements of FSSAI.

5.10. FOOD FORTIFICATION

Why in News?

Department of Food and Public Distribution (DFPD), under the Consumer Affairs Ministry **had issued uniformspecifications for fortified rice kernels (FRK) for Grade A and common rice for procurement** of fortified rice stocks, wherein 1% of FRK should be blended with normal rice.

More on News

- Fortified rice is to be **distributed under** various government schemes including **public distribution system and midday meals in schools by 2024.**
- According to the FSSAI norms, 1 kg **fortified rice shall contain iron** (28mg-42.5mg), **folic acid** (75-125 microgram) and **Vitamin B-12** (0.75-1.25 microgram).

- In addition, rice may also be fortified with **micronutrients such as zinc, Vitamin A, Vitamin B1, Vitamin B2, Vitamin B3** and **Vitamin B6**.

Concerns raised over Food fortification

- **Can do more harm:** A group of health experts have recently argued that **India's programme on fortification of rice** to address chronic anaemia and micro-nutrient **deficiency ignores the central role of balanced and diverse diet.**
  - They have cautioned **specifically against iron supplementation.** Consumption of **excess iron by pregnant women** can adversely affect foetal development and birth outcomes.
- **Difficult to withdraw:** Mandatory fortification **will create markets that will be hard to withdraw** when we have achieved the target of reduced micronutrient deficiency. These foods can contribute to **nutrient overdoses.**
- **May be misused to promote junk food:** It may be applied to junk foods, effectively **making unhealthy foods look better** than they are.

About Fortification

- WHO defines Fortification as the practice of **deliberately increasing the content of an essential micronutrient,** i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.
- Fortification has been **particularly successful for iodized salt:** 71 percent of the world's population has access to iodized salt and the number of **Iodine-deficient countries has decreased from 54 to 32 since 2003.**
- Other common examples of fortification include **adding B Vitamins, Iron, and/or Zinc to wheat flour and adding Vitamin A to cooking oil and sugar.**
- **Food fortification can take several forms like:**

Mass fortification: Addition of one or more micronutrients to foods commonly consumed by the general public, such as cereals, condiments and milk.	**Targeted fortification:** Foods aimed at **specific subgroups of the population** are fortified, thereby increasing the intake of that particular group rather than that of the population as a whole.	**Market-driven fortification:** Situations whereby a **food manufacturer takes a business-oriented initiative** to add specific amounts of one or more micronutrients to processed foods.

Benefits of food fortification

- **Addressing Hidden hunger:** WHO defines 'hidden hunger' as a **lack of vitamins and minerals.** Over 70% of the Indian population consumes **less than half the daily recommended dietary allowance** of micronutrients a day.
  - It helps in providing better immunity, growth and development, better eyesight etc.
- **Safe method:** The addition of micronutrients to food does not pose a health risk to people.
- **Other Benefits:**
  - It does not require any changes in food habits of people. It is a **socio-culturally acceptable** way to deliver nutrients to people.
  - It **does not alter the characteristics** of the food—the taste, the feel, the look.

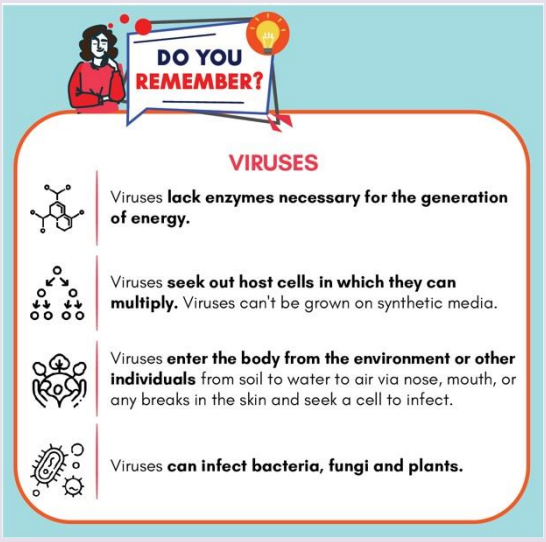
Steps towards fortification in India

- The journey with **food fortification in India began in the 1950s** with vegetable oil fortification and salt iodization. Other commodities such as rice and wheat flour were finally **introduced in the 2000s**.
- India's **10th, 11th ,12th Five Year Plans, POSHAN Abhiyan** (National Nutrition Mission) and **Anaemia-Mukt Bharat Mission** recommend food fortification as an important strategy to tackle micronutrient malnutrition.
- In 2016, FSSAI had come out with **regulations on fortification for staples** like wheat flour, maida, rice, double fortified salt, milk and oil.
- **Other Steps taken by FSSAI include:**
  - A dedicated unit called the **Food Fortification Resource Centre has been set up** for all **end-to-end technical and advocacy support** to both States/UTs as well as the open market.
  - Contributed towards various **capacity building trainings and developed Information Education & Communication (IEC) material** specifically for **POSHAN Maah.**
  - Further, one of the key messages in the **Eat Right India movement** is consumption of fortified foods.

- In 2019, **Centrally Sponsored Pilot Scheme** on **'Fortification of Rice and its Distribution under Public Distribution System'** was approved for a period of three years with focus on 15 districts.
  - Government has also decided to scale up the scheme to cover the **Integrated Child Development Scheme (ICDS) and Mid-Day Meal (MDM) scheme** in 'aspirational districts'.
- Food Corporation of India (FCI) has made it mandatory for the rice millers in all states to **install blending infrastructure for the production of fortified rice.**

5.11. DISEASES

5.11.1. VIRAL DISEASES

Zika Virus	• **Kerala has reported cases of Zika virus** (ZV) for the first time.
	• ZV spreads mostly by the **bite of an infected Aedes mosquito**, which bites during the day (the same mosquito that **transmits dengue, chikungunya and yellow fever**).
	  ○ The virus can be **passed from a pregnant woman to her fetus** and can **cause infants to be born with microcephaly** (birth defect where a baby's head is smaller than expected), **congenital malformations, etc.**
	  ○ **It can also be sexually transmitted as well.**
	• Presently, there is **no specific treatment or vaccine** for the ZV
	 

Nipah Virus	• Recently, Kerala reported the death of a child due to Nipah Virus. • Nipah Virus (NiV), a **zoonotic virus**, is a type of RNA virus transmitted in humans through its natural hosts- **fruit bats** (**Pteropodidae Family**), or through **direct contact** with infected people or contaminated food. ○ Presently, it **lacks any treatment or vaccine** with support care as only primary treatment.

Marburg Virus Disease (MVD)	• MVD is a **highly virulent disease that causes haemorrhagic fever**, with a fatality ratio of up to 88%.
	• Marburg and Ebola viruses are both **members of the Filoviridae family (filovirus).** Though caused by different viruses, the **two diseases are clinically similar.**
	  ○ Virus family Filoviridae includes three genera: **Cuevavirus, Marburgvirus, and Ebolavirus.**
	  ○ MVD can spread through **human-to-human transmission.**
	• MVD was **initially detected in 1967** in Marburg and Frankfurt (Germany); and in Belgrade (Serbia).
	  ○ Recently, MVD was **confirmed in Guinea** (West Africa's first ever case).
	• Humans catch this infection **through prolonged exposure to mines or caves inhabited by Rousettus bats.**
	• It can **spread through human-to-human transmission** via direct contact of infected people, and with contaminated surfaces and materials.

Ebola Virus	• Recently, **Ivory Coast recorded its first Ebola Virus case in nearly 3 decades.** • Ebola Virus Diseases, also known as Ebola Haemorrhagic fever, is a severe, often fatal illness affecting humans and primates. • First discovered in 1976, **Ebola is a zoonotic disease spreading from wild animals to human and through direct human population contact.**

Monkey B virus (BV)	• China has reported the **first human infection case** with Monkey BV.
	• About **Monkey B virus (BV)**
	  ○ The virus, initially isolated in 1932, is **an alphaherpes virus in macaques** of the genus Macaca.
	  ✓ Alphaherpes viruses are pathogens that invade the nervous systems of their mammalian hosts.
	  ○ The infection **can be transmitted via direct contact and exchange of bodily secretions** of monkeys.
	  ○ Currently, **there are no vaccines** that can protect against Monkey B virus infection.

Avian flu	• **India has reported possibly the first case of human death** due to bird flu, the strain of influenza virus that primarily affects birds. • Bird flu or avian influenza is a disease caused by avian influenza **Type A viruses found naturally in wild birds worldwide.** ○ This year, **H5N8 and H5N1 avian influenza have been reported in birds from across India** • Person-to-person spread of bird flu is not common. Those **who work in close contact with infected birds, dead or alive, or eat uncooked or half-cooked poultry products are at risk.**
Norovirus	• As per reports, several people have been found infected with **Norovirus in Kerala's Wayanad district.** • Norovirus is a **highly contagious animal-borne disease** that can be transmitted through contaminated water and food. • Norovirus **causes gastrointestinal illness,** including inflammation of the lining of the stomach and intestines, severe vomiting and diarrhea.
Canine Parvovirus (CPV)	• **Pet and stray dogs in Amravati city were affected** by CPV. • It is a **highly contagious viral disease that can also be life-threatening** in puppies and dogs. • It **spreads through direct contact with an infected dog** or by indirect contact with a contaminated object. • Parvovirus **has no cure and inoculating a puppy or a dog gives them a fighting chance** against the infection. • **Parvovirus B19 infects only humans.**

Dengue	• Dengue is a **mosquito-borne tropical disease** caused by the **dengue virus (Genus Flavivirus)** and **spread to people through the bite of an infected Aedes species** mosquito.
	  ○ These mosquitoes also spread Zika, chikungunya, and other viruses.
	• The first dengue vaccine **Dengvaxia was approved by the US Food & Drug Administration in 2019.**
	  ○ Dengvaxia is a **live, attenuated virus vaccine.**
	• Recently, Researchers at **IIT Delhi have developed a handheld Surface Enhanced Raman Spectroscopy (SERS)**-based platform for early diagnosis of dengue.
	• SERS is a **technique for molecular detection and characterization that relies on the enhanced Raman scattering of molecules** that are adsorbed on, or near, SERS-active surfaces, such as nanostructured gold or silver.
	• **Sir C.V. Raman discovered 'Raman Effect'** for which he was **awarded Nobel Prize in 1930.**

Scrub typhus	• Recently, a mystery fever was reported from parts of Uttar Pradesh. This viral fever was identified as Scrub typhus. • Scrub typhus **also known as bush typhus is an infectious disease** with symptoms similar to any viral fever. • It is **caused by a mite-borne bacterium called Orientia tsutsugamushi,** which is transmitted by the bite of infected mite larvae in soil containing scrub vegetation. • It can also be transmitted by lice, ticks and fleas. It **can impact everyone from infants to adults.**

HIV (human immunodeficiency virus)	• According to research, Increased **Hydrogen sulphide** was found to **have a direct effect on reducing the rate at which virus multiplies in HIV-infected human immune cells.**
	  ○ **HIV** is a virus that attacks the body's immune system. If HIV is not treated, it can lead to AIDS (acquired immunodeficiency syndrome).
	  ✓ HIV is **called a retrovirus** because it works in a back-to-front way.
	  ✓ Unlike other viruses, **retroviruses store their genetic information using RNA instead of DNA,** meaning they need to 'make' DNA when they enter a human cell in order to make new copies of themselves.
	• Presently, **current state-of-the-art combined antiretroviral therapy (cART) is used as a therapy,** but it has the **following disadvantages.**
	  ○ **Build-up of toxic molecules** leading to 'oxidative stress' **and loss of function in the mitochondria.**
	  ○ **Can fail** even when patients fully follow their drug regimen.
	• Recently, the Food and Drug Administration (FDA) **approved the world's first injectable medication** for reducing the risk of acquiring HIV. **The name of the drug is Apretude.**

5.11.2. OTHER DISEASES

Dementia	• As per a Lancet report, number of dementia cases in India is **expected to almost double by 2050.** ○ The study attributes the increase of dementia cases to three risk factors: **high body-mass index, high fasting plasma glucose, and smoking.**

	• Dementia is a general term for **loss of memory, language, problem-solving and other thinking abilities** that are severe enough to interfere with daily life. ○ **Alzheimer's disease** is the most common type of dementia. • WHO has brought a **Global Action Planon the Public Health Response to Dementia 2017-2025** that aims to improve the lives of people with dementia.
Havana Syndrome	• A **US intelligence officer reported symptoms of Havana syndrome** while he was in India. • Havana Syndrome refers to **a set of mental health symptoms that typically involves hearing certain sounds without any outside noise being present**, nausea, vertigo and headaches, memory loss and issues with balance. ○ It was **first reported by officials based in the U.S. embassy in Cuba** in 2016. • A US National Academy of Sciences panel found that the **most plausible theory is that "directed, pulsed radio frequency energy" causes the syndrome.**

Asperger's syndrome	• Tech billionaire **Elon Musk** announced that he has **Asperger's syndrome**.
	  ○ It is a **disorder where people have trouble in social relationships**.
	  ○ It belongs to the **autism spectrum** which can severely **inhibit aperson's mental and social development**.
	  ○ The disorder is named after German doctor Hans Asperger, who first described it in 1944.
	• In 2013, it became part of one umbrella diagnosis of **autism spectrum disorder (ASD)** in the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5).

Gestational diabetes mellitus(GDM)	• **GDM** is defined as any **degree of glucose intolerance** with onset or first recognition during pregnancy. • Government has Guidelines on Diagnosis and Management of GDM in pregnant women as per which testing has been **included in essential ante natal care package for all pregnant women**.

5.12. OTHER IMPORTANT NEWS

SWASTIIK' technology for disinfecting water	• **Developed by:** CSIR-NCL Pune, with support from the Water Technology Initiative of the Department of Science and Technology (DST) • SWASTIIK (Safe Water and Sustainable Technology Initiative from Indian Knowledgebase) is a **hybrid technology that combines Modern technology and Indian traditional knowledge to bring safe & healthy drinking water**. • The technique used ---**hydrodynamic cavitation combines chemistry, biology, and chemical engineering along with natural resources in the form of natural oils and plant extracts.** • Disinfection of water is essential for removing pathogenic microorganisms that are responsible for causing a number of water-borne diseases. ○ However, the common drawbacks of chemical **methods such as chlorination include formation of harmful/ carcinogenic disinfection by-products.**
Wolbachia Bacteria	• Recently, an Indonesian research showed **reduction in dengue cases** (as much as 77%) **after breeding dengue mosquitoes with Wolbachia Bacteria.** • Wolbachia **are common bacteria that occur naturally in almost 60% of insect species,** including some mosquitoes, fruit flies, moths, dragonflies and butterflies. **Wolbachia are safe for humans.** • Wolbachia **does not occur naturally in Aedes aegypti mosquito species** that spreads dengue and other diseases such as chikungunya, Zika and yellow fever. ○ When Aedes aegypti mosquitoes carry Wolbachia, **bacteria compete with viruses like dengue, Zika etc and make it harder for viruses to reproduce** inside the mosquitoes.
AmbiTag	• IIT Ropar developed a device - AmbiTag that **records real-time ambient temperature during the transportation** of perishable products, vaccines and even body organs and blood. • This device **will help to know that the item transported from anywhere in the world is still usable or perished** because of temperature variation

Protein–antibody conjugates (PACs)	• This approach **combines concepts of biologics and antibody–drug conjugates** to produce PACs that can be used for targeted drug delivery.
	  ○ Biologics approach of drug delivery **targets a defective protein in the system** by delivering proteins to it.
	  ○ The other concept is of using antibodies for drug delivery. **Drug molecules can be attached to the antibody, forming drug–antibody conjugates.**
	• However there are **diseases where researchers know what to target but do not know how** to design drugs that will bind.
	• **PACs is like an addressed envelope containing the drug.** The antibody plays the role of the address and indicates the cell where the drug should precisely be delivered.

WHO BioHub Initiative	• **WHO and Switzerland signed a MoU** to launch a BioHub facility **to allow rapid sharing of pathogens between laboratories and partners to facilitate safe storage, better analysis, sequencing** and preparedness against them. • Presently, **pathogens are shared bilaterally between countries.** • The initiative will **enable member states to share biological materials** with and via the BioHub under pre-agreed conditions, including biosafety, biosecurity, and other applicable regulations. • The move would further contribute to the establishment of an international exchange system for novel coronavirus SARS-CoV-2 and other emerging pathogens.

Global Sodium Benchmarks for Different Food Categories	• WHO has **established global benchmarks for sodium levels** in foods across different food categories.
	• WHO **recommended daily intake** of salt or sodium is **5 gm,** but most people around the world **consume more than double this amount.**
	• **Sodium is necessary to maintain normal cell metabolism,** healthy plasma, and improves the health of the nervous system.
	  ○ It is **found naturally in a range of foods** like meat and dairy.
	  ○ However, it is **present in very high amounts** in processed foods, like snacks, bread, or condiments.
	• Excess dietary sodium intake increases **blood pressure** and consequently increases the risk of **cardiovascular diseases.**

6. DEFENCE

6.1. HYPERSONIC MISSILE TECHNOLOGY

Why in News?

India is expected to have Hypersonic weapon systems (HWS) within four years, with medium- to long-range capabilities.

More on News

- DRDO has successfully tested a **Hypersonic Technology Demonstrated Vehicle (HSTDV) in September 2020,** and demonstrated its hypersonic air-breathing scramjet technology.
    - The significance of developing the technology has come in the **backdrop of development strides made by China, Russia and US in the domain.**

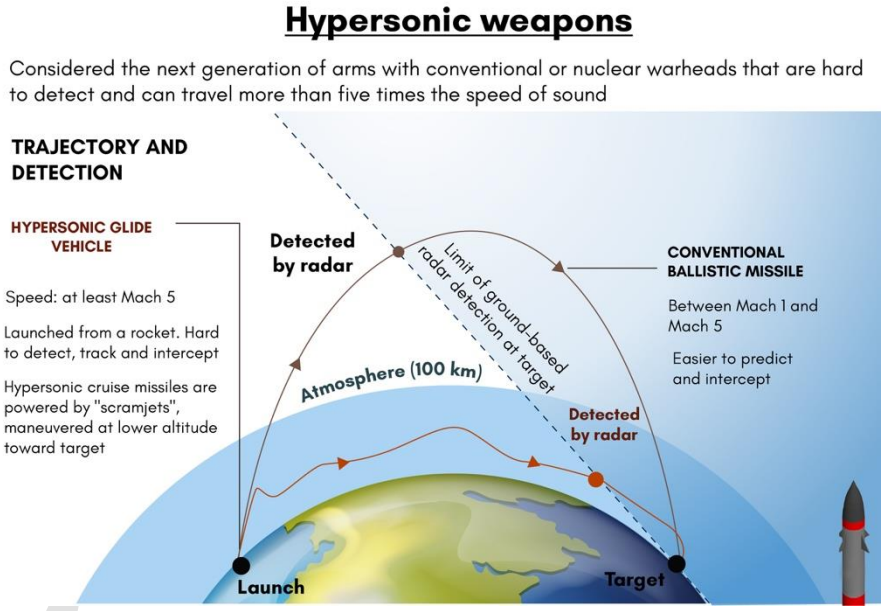
Mach Number

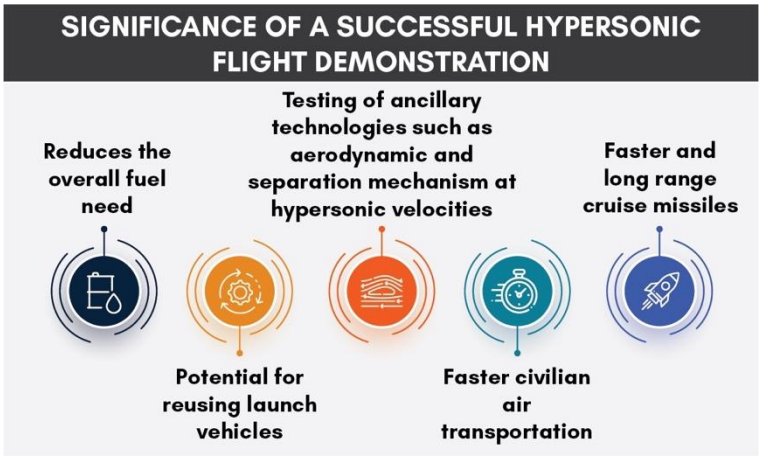
- Mach number expresses the **speed of an object in air relative to the speed of sound.** For example, Mach number 6 here implies that the vehicle was moving at **six times the speed of sound.**
- Velocity zones according to Mach numbers:

Velocity Zone	Mach number
Subsonic	Mach < 1.0
Transonic	Mach ~ 1.0
Supersonic	Mach > 1.0
Hypersonic	Mach > 5.0

About Hypersonic missile technology

- Hypersonic defines speed of **about Mach 5 or at least at 1.6 km per second.**
- **Ballistic missiles, though much faster, follow a fixed trajectory** and travel outside the atmosphere to re-enter only near impact.
    - **For ex:** Prithvi I, Prithvi II, Agni I, Agni II are some operational ballistic missiles in Indian defence forces.
- On the contrary, **hypersonic weapons travel within the atmosphere and can manoeuvre midway** which combined with their high speeds makes their detection and interception extremely difficult.
    - This means that **radars and air defences cannot detect them till they are very close** and little time to react.
- They **use scramjet technology**, which is a **type of Air Breathing propulsion System.**
- **2 Types of hypersonic platforms:**
    - **Hypersonic cruise missiles: Use rocket or jet propellant** through their flight and are regarded as being faster versions of existing cruise missiles.
    - **Hypersonic Glide Vehicle (HGV):** These missiles first go up into the atmosphere on a conventional rocket before being launched towards their target.





Air-breathing engines: How they work?

- The basic difference between air-breathing systems and others is the **material that plays the role of oxidiser** (used to support the combustion of a rocket propellant).
- Generally, launch vehicles use combustion of propellants consisting of oxidiser and fuel for deriving the energy.
- **Air breathing propulsion systems use atmospheric oxygen,** which is available up to about 50 km of earth's surface to burn the fuel stored on-board thereby making the system much lighter, more efficient and cost effective.

Types of air-breathing systems: Ramjet, Scramjet and Dual Mode Ramjet

- **Ramjet Engine:** A ramjet is a form of air-breathing jet engine that uses the vehicle's forward motion to compress incoming air for combustion **without a rotating compressor**. Fuel is injected in the combustion chamber where it mixes with the hot compressed air and ignites.
  - A ramjet-powered vehicle **requires an assisted take-off** like a rocket assist to accelerate it to a speed where it begins to produce thrust.
  - Ramjets work most efficiently at **supersonic speeds around Mach 3**. However, the ramjet efficiency starts to drop when the vehicle reaches hypersonic speeds.
- **Scramjet Engine:** A scramjet engine is an improvement over the ramjet engine as it efficiently operates at hypersonic speeds and allows supersonic combustion. Thus it is known as Supersonic Combustion Ramjet, or Scramjet.
  - The Scramjet engine designed by ISRO uses Hydrogen as fuel and the Oxygen from the atmospheric air as the oxidiser.
- **Dual mode ramjet**: It is a type of jet engine where a ramjet transforms into scramjet over Mach 4-8 range, which means it can efficiently operate both in subsonic and supersonic combustor modes.

6.2. OTHER IMPORTANT NEWS

6.2.1. MISSILES

Agni Prime	• DRDO successfully tested the new missile Agni Prime, **advanced version of the 'Agni-1' missile.**
	• Agni Prime' is a **short-range (surface to a surface) ballistic missile** that will have a range of 1000 km to 1500 km and will have advanced features in agility and road mobility.
	  ○ It can carry a payload of around 1,000 Kg or a nuclear warhead.
	• It is a **two-stage canisterised solid propellant ballistic missile** with dual redundant navigation and guidance system.
	  ○ Since the missile is canisterised, **it can be launched from rail and road and stored for a longer period** and transported all across the country as per operational requirements.
	• The double stage missile **will be lighter and much sleeker than its predecessor 'Agni-1'.**
	  ○ **Agni-1 is a short-range (surface to a surface) nuclear capable ballistic missile.**

Agni-5	• Recently, a **successful launch of the Surface to Surface Ballistic Missile**, Agni-5, was carried out. • The missile, which **uses a three-stage solid fuelled engine,** is capable of striking targets at **ranges up to 5,000 kilometres** with a very high degree of accuracy. • It is a **"canisterised" missile.** • **Other missiles in Agni series:Agni-1** (700 km range), **Agni-2** (2,000 km range), **Agni-3 and Agni-4** (2,500 km to more than 3500 km range).
HELINA (Helicopter based NAG)	• HELINA has completed all the trials. • It is a **third-generation fire and forget class anti-tank guided missile (ATGM)** system mounted on the Advanced Light Helicopter (ALH). • It is being inducted into the **Indian Army** and its variant called **DHRUVASTRA is being inducted into theIndian Air Force.** • **Features:** All weather day and night capability. It can defeat battle tanks with conventional armour as well as explosive reactive armour. • A **minimum range of 500 m** and a maximum range of 7 km.

Stand-off Anti-tank (SANT)	• DRDO and Indian Air Force (IAF) flight-tested the **indigenously designed and developed Helicopter launched** SANT Missile.
	• The missile is **equipped with a state-of-the-art MMW seeker** which provides high precision strike capability from a safe distance.
	  ○ Millimetre-Wave Seeker (MMW) is **capable of working under all weather conditions, day and night,** and has attracted increasing popularity
	  ○ The weapon can **neutralizetargets in a range of up to 10 km.**

New Generation Akash Missile (Akash-NG) and Man Portable Antitank Guided Missile (MPATGM)	• DRDO tested two missile systems- MPATGM and a **new variant of the Akash Surface-to-Air Missile** called **Akash-NG**. o MPATGM is an indigenously developed low-weight, **fire-and-forget missile incorporated with state-of-the-art miniaturized infrared seeker** with advanced avionics. o Akash-NG is a **medium-range mobile surface-to-air missile**defense system. It has a **range of 60 km** and speed of **2.5 Mach.** ✓ **Improvements over Akash Missile:** two-pulse, solid rocket motor and new seeker head that locks onto the enemy aircraft and continuously guides the Akash-NG.
Akash Prime Missile	• A **new version of the Surface to Air Akash Missile – 'Akash Prime'** has been successfully flight tested from Integrated Test Range (ITR), Chandipur, Odisha. • In comparison to existing Akash System, Akash Prime is **equipped with an indigenous active Radio Frequency (RF) seeker for improved accuracy**. o Other improvements include **more reliable performance under low temperature environments** at higher altitudes. • **Akash missile** is **India's first indigenously produced medium range Surface to Air missile** that can engage multiple targets from multiple directions. • **It can be launched from mobile platforms** like battle tanks or wheeled trucks.
Vertical Launch Short Range Surface to Air Missile (VL-SRSAM)	• **India successfully test-fired the missiles for the second time from Chandipur off** the coast of Odisha. o Launches were carried out for **demonstration of vertical launch capability.** • It is meant for **neutralising aerial threats at close ranges, including sea-skimming targets.** o Sea skimming targets are those assets that **fly as close as possible to sea surface to avoid being detected by the radars**onboard warships. • It is **indigenously designed and developed by DRDO for the Indian Navy**.
S-400 Triumf surface-to-air missile system	• Russia started delivery of S-400 missile system to India. • S-400 is **among the most advanced air-defence systems** in the world. o **Equipped with four different missiles, it can engage** enemy aircraft, ballistic missiles, and Airborne Warning And Control System (AWACS) planes **at 400km, 250km, medium-range 120km and short-range 40km.** • It has the capability to engage 80 targets at one time with a **response time of 9-10 seconds.**
'Pralay' missile	• **Launched by DRDO,** maiden flight test of Pralay missile was successfully conducted. • **About Pralay** o Indigenously developed **surface-to-surface missile**. o Has a **range of 150-500 kilometres** with an accuracy of less than 10 metres. o Has a guidance system that includes **state-of-the-art navigation mechanisms** and integrated avionics.
Supersonic Missile Assisted Torpedo (SMART)	• Recently, **DRDO** tested a **long-range SMART** from Wheeler Island in Odisha. • SMART is a next-generation missile-based standoff **torpedo delivery system.** • It has been designed to **enhance anti-submarine warfare capability** far beyond the conventional range of the torpedo.

6.2.2. SUBMARINES, SHIPS AND AIRCRAFT CARRIER

Project 75 (India) [P-75(I)]	• India's Defense Ministry issued First P-75(I) Submarine Tender. • Project-75(I) **envisages indigenous construction of six modern conventional submarines** with contemporary equipment, weapons &sensors including Fuel-Cell based AIP (Air Independent Propulsion Plant) etc. o AIP technology **allows conventional diesel-electric submarines to remain underwater for longer**, enhancing its lethality. o Other countries to have an AIP system include **China, Germany, Sweden, France, Spain and Russia.** • P-75(I) submarine project **is the first acquisition India has undertaken through its Strategic Partnership procurement model**.
Vela	• It is the **fourth submarine** (Kalvari, Khanderi, and Karanja are other three) **of the Project-75 that was delivered** to the Indian Navy recently. • Project-75 includes **construction of six submarines of Scorpene design.** o Scorpene submarines **can undertake multifarious types of missions**i.e Anti-Surface warfare, Anti-Submarine warfare, Intelligence gathering, Mine Laying, Area Surveillance etc.

	• These submarines are **being constructed at Mazagon Dock Shipbuilders Limited** (MDL) Mumbai.
Y 12704 (Visakhapatnam)	• It is the **lead ship of the Project-15B** state-of-the-art stealth guided missile destroyers. o It is **equipped with BrahMos**supersonic cruise missiles **and medium range Surface-to-Air missiles.** • Contract for four ships of **Project 15B** was signed in 2011. • Four ships **are christened after major cities** viz. Visakhapatnam, Mormugao, Imphal and Surat. • India's **indigenous Destroyer construction programme** commenced in the late 1990s with the **three Delhi class** (P-15 class) warships and this was followed by **three Kolkata class** (P-15A) destroyers commissioned a decade later.
INS Vikrant- First Indigenous Aircraft Carrier (IAC)	• INS Vikrant is likely to be commissioned in 2022. o India currently **operates a solitary aircraft carrier, INS Vikramaditya.** • **Vikrant, a STOBAR** (short take-off but arrested landing) aircraft carrier, has an **indigenous content of 76%.** o Designed by the Indian Navy's Directorate of Naval Design, Vikrant has been **built at the state-owned Cochin Shipyard Limited.** • Apart from **India, only US, UK, Russia, France and China** have the **capability to build aircraft carriers.** • It will **operate MiG-29K fighter aircraft**, **Kamov-31 Air Early Warning Helicopters,** the soon-to-be-inducted **MH-60R multi-role helicopter**, and the indigenously manufactured **Advanced Light Helicopters.** o It will provide the ability to project air power over long distances, airborne anti-submarine warfare and airborne early warning etc.
Sarthak	• Recently, Indigenously built **Indian Coast Guard Ship (ICGS) Sarthak was dedicated to the nation.** o ICGS Sarthak **will be based at Porbandar (Gujarat)** and operate on India's Western Seaboard. • ICGS Sarthak is **4th in the series of five offshore patrol vessel** (OPVs) being built by Goa Shipyard Limited.
Tushil	• It is a **Krivak or Talwar-class stealth frigates,** being built in Russia, which **was launched recently.** • It is **part of four frigates contracted by India from Russia,** of which two are being built by Russia and two are under construction in India through technology transfer. o These feature **stealth technology in terms of low radar and underwater noise signatures.** o These ships are **being equipped with major Indian supplied equipment** such as Surface to Surface Missiles, Sonar system, Surface Surveillance Radar etc.

6.2.3. AIRCRAFTS, DRONES AND HELICOPTERS

P-8I patrol aircraft	• Recently, US Approved Proposed Sale Of Six P-8I Patrol Aircraft To India. • P-8I is a **long-range, multi-mission maritime patrol aircraft** offered by Boeing **for the Indian Navy**. • **P-8I replaced** the ageing fleet of the **Indian Navy's Tupolev Tu-142 aircraft.** • It can conduct **anti-submarine warfare (ASW), anti-surface warfare (AsuW), intelligence, maritime patrol,** and surveillance and reconnaissance missions.
Light Combat Aircraft (LCA)Tejas	• It is **half-indigenous, single engine, multi-role fighter jet** designed by Aeronautical Development Agency (ADA) and produced by Hindustan Aeronautics Limited (HAL). • It was **conceptualised in the year 1984.** • Its **reach is up to 400-km** and will be mainly used for close air-to-ground operations. • It is pegged as the **world's smallest and lightest supersonic fighter aircraft** in its class. • It is equipped with state-of-the-art Satellite aided Inertial Navigation System • Variety of LCA larger aircraft LCA MK-2 **to roll out by year end or early 2023.**
DRDO's Abhyas	• **ABHYAS- High-speed Expendable Aerial Target (HEAT)** was successfully flight-tested by DRDO. o It is a **drone that will be used as a target** for various missile systems. o Designed and developed by DRDO's **Aeronautical Development Establishment (ADE),** Bengaluru **for autonomous flying**. • Performance of target aircraft was **monitored through telemetry** and various tracking sensors including **Radars and Electro Optical Tracking System (EOTS).**

	• **Powered by a small gas turbine engine** and has MEMS (Micro-electromechanical) based Inertial Navigation System (INS).
Controlled Aerial Delivery System-500 (CADS-500)	• DRDO's Aerial Delivery Research and Development Establishment (ADRDE) in Agra conducted a flight demonstration of its CADS-500. • CADS-500 can be used for **precise delivery of payloads up to 500 kilograms at a predetermined location** by making use of manoeuvrable capabilities of **Ram Air Parachute (RAP).** • It **autonomously steers its flight path** using waypoint navigation towards target location by operating controls.
MQ-9 Reaper or Predator B armed drones	• Recently, India moved a step ahead on the acquisition of **30 predator drones** from the USA. • Developed by **General Atomics Aeronautical Systems Inc (GA-ASI)** of USA, these are **turboprop, multi-mission drones** with **long-endurance** • It can remain in the air for over **27 hours at a maximum altitude of 50,000 feet** and is armed with **AGM-114 Hellfire missiles** for armed reconnaissance. • It will add the ability to carry out **long-range precision air strikes** by Armed forces.
Heron-I Unmanned Aerial Vehicles (UAVs)	• In a boost to **Army surveillance in eastern sector**, the **Army Aviation Brigade** (raised in **March 2021 at Missamari in Assam**) has taken control of the **Heron-I UAVs** from Artillery. • Heron-I UAVs are developed by **Israel Aerospace Industries** with a **Medium Altitude Long Endurance** (MALE) Unmanned Aerial System for **all weather strategic missions**.

6.2.4. DEFENCE SYSTEMS

Smart anti-airfield weapon (SAAW)	• Indian Air Force and DRDO successfully tested SAAW. • SAAW is **indigenously designed smart weapon, with 100 km range,** that can target enemy airfield assets such as radars, bunkers, taxiways and runways. ○ **Electro optical seeker based flight test** of this class of bomb has been **conducted for the first time in the country.** • It has been **equipped with Imaging Infra-Red Seeker technology** to enhance precision strike capability.
Long Range Reconnaissance and Observation System (LORROS)	• It is being reported that **to prevent frequent security breaches**, India will further enhance LORROS along borders with China and Pakistan. • LORROS is a sensor system which **provides long-range day-time and night-time surveillance.** ○ It has been found to be **very effective in countering infiltration.** • Earlier, DRDO handed **Border Surveillance System (BOSS), an all-weather electronic surveillance system** to Indian Army.
Indrajaal	• It is an **autonomous defence weapon** system, developed by Hyderabad-based Grene Robotics company, that uses technologies such as AI and robotics **to identify and counter threats.** ○ It is capable of protecting a large area of 1,000-2,000 sq km per system against threats **such as Unmanned Aerial Vehicles (UAVs), incoming weapons (missiles), loitering munitions and Low-Radar Cross Section (low flying) targets**. • Indrajaal came in the **backdrop of possible use of drones** in recent attack in J&K.

Advanced chaff Technology (ACT)	• DRDO has developed an **ACT to safeguard fighter aircraft from enemy radar threats.**
	• **About Chaff Technology:**
	  ○ It is primarily an **electronic counter-measure technology used to protect high-value targets** such as fighter jets or naval ships from radars and radio frequency (RF) guiding mechanisms of the enemy missiles.
	  ○ The chaff deployed in the air **reflects as multiple targets** for the missile guidance systems, thus misleading the enemy radars or deflecting adversary missiles.

Iron Dome aerial defence system (ADS)	• This **ADS of Israel** intercepted a Hamas Unmanned Aerial Vehicle (UAV) that crossed from Gaza. • It is a **multi-mission system capable of intercepting** rockets, artillery, mortars and Precision Guided Munitions like very short range air defence (V-SHORAD), aircraft, helicopters and UAV **over short ranges of up to 70 km.** • It is an **all-weather system and can engage multiple targets** simultaneously. It can be deployed over **land and sea.**

6.2.5. MISCELLANEOUS

Army Secure IndiGeneous Messaging Application(ASIGMA)	• **Launched by:** Indian Army. • **Developed entirely in-house** by a team of officers of the Corps of Signals of the Army • It is **an in-house messaging service** to meet real time data transfer and messaging requirements of the Army. ○ It is being deployed on the Army's internal network **as a replacement of Army Wide Area Network** (AWAN) messaging application. • It has a variety of contemporary features including **multi-level security, message prioritisation and tracking, dynamic global address book** and various options to meet the Army's requirements.
Operation SamudraSetu-II	• It is **launched by Indian Navy** to augment ongoing national mission to **meet the country's oxygen requirements**. • Warships have been deployed to **carry liquid oxygen-filled cryogenic containers and associated medical equipment** to India amid its worsening COVID-19 pandemic. ○ All such containers carried on aircraft around country are empty because **oxygen-filled tanks cannot be transported by air.**
Stockholm International Peace Research Institute (SIPRI) Arms Sales Report	• As per report,**3 Indian companies** (Hindustan Aeronautics Limited, Indian Ordnance Factories, and Bharat Electronics Limited)has**1.2% share of global arms sale** in 2020. ○ USA companies top at **$285 billion or 54%**, followed by China (13%) and UK (7.1%). • In 2020, India announced a phased ban on imports of more than a hundred different types of military equipment **to support domestic companies and enhance self-reliance** in arms production • SIPRI is an **independent international institute** dedicated to research into conflict, armaments, arms control and disarmament.

Defence India Startup Challenge 5.0	• Launched under **Innovations for Defence Excellence - Defence Innovation Organisation (iDEX-DIO)**
	• iDEX aims to **achieve self - reliance and foster innovation and technology development in Defence and Aerospace by engaging Industries** including MSMEs, start-ups, individual innovators, R&D institutes and academia.
	  ○ **DIO is a "not for profit" company** to administer the iDEX framework.
	  ○ Department of Defence Production (DDP) will release funds to DIO for setting up and managing the iDEX network.

Project Seabird	• Defence Minister reviewed the progress of ongoing **infrastructure development under 'Project Seabird'.** • The largest naval infrastructure project for India, **Project Seabird involves creation of a naval base at Karwar (Karnataka)** on the west coast of India. • Upon completion, this will provide the Indian Navy with its **largest naval base on the west coast and also the largest naval base east of the Suez Canal.**
Indian Ocean Naval Symposium (IONS)	• **7th edition of IONS Conclave of Chiefs** was hosted by French Navy at Paris. • IONS **was conceived by the Indian Navy** in 2008 as a forum which seeks **to enhance maritime co-operation among Navies** of the littoral states of the Indian Ocean Region. • It provides an open and inclusive **platform for discussions on regionally relevant maritime issues.**

National Maritime Security Coordinator (NMSC)	• Two decades after the recommendation by the Kargil Review Committee, the government is set to appoint a NMSC with the objective of enhancing India's security architecture and energy security.
	• **About NMSC**
	  ○ **Interface between the civilian and military maritime** domains.
	  ○ Will work **under the National Security Adviser (NSA).**
	  ○ It will be the **principal advisor** to the government on maritime security domain.
	  ✓ Maritime security is a general term for the p**rotection of vessels both internally and externally**.
	• The areas from which ships and maritime operations need protecting include **terrorism, piracy, robbery, illegal trafficking of goods and people, illegal fishing and pollution.**

Direct-Ascent Anti-Satellite (DA-ASAT) test	• As per reports **Russia has carried out DA-ASAT test by shooting down an old satellite** which has created huge debris in the low earth orbit. ○ While **Russia has previously tested ASAT weapons,** the DA-ASAT is more advanced. • **ASAT weapon gives the capability to destroy satellites in orbit** disrupting the communications and surveillance capabilities of adversaries.

	• So far **only China, India** (under Mission Shakti)**, Russia and U.S have successfully demonstrated** ASAT capability.
Laser weapons	• U.S. Navy **tested a laser weapon** in Gulf of Aden (separates East Africa from the Arabian Peninsula). • By focusing a powerful beam of light steadily on an object, the **laser can burn through and destroy a range of objects,** from small drones to flying missiles. ○ Such weapons are **also known as Directed energy weapons** that travel at the speed of light with unprecedented accuracy • DRDO has also developed a **vehicle-mounted high-power laser-directed energy system** for use against drones.

7. ALTERNATIVE ENERGY

7.1. COAL BASED HYDROGEN

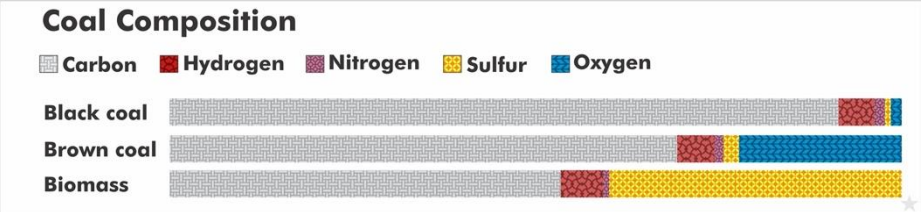
Why in news?

Recently, the **Ministry of Coal** constituted a **Task Force and Expert Committee** to prepare the roadmap for Coal based Hydrogen production.

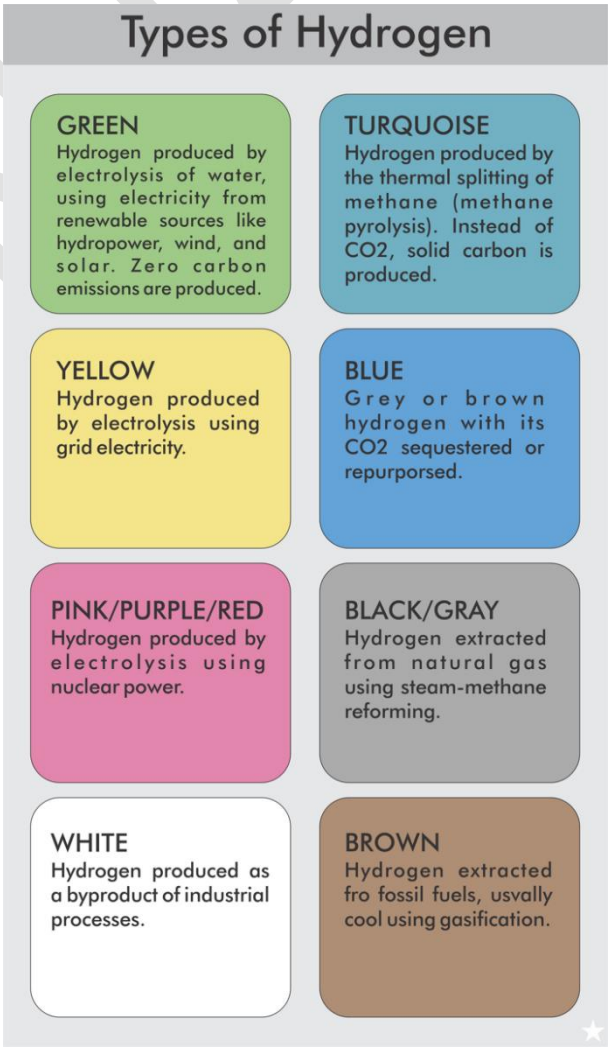
Global status of Hydrogen

- At present, the current global demand for hydrogen is **70 million metric tons**, most of which is being produced from fossil fuels– **76% from natural gas** and **23% from coal** and **remaining from the electrolysis of water**.
- Much of the hydrogen produced is used for **oil refining,ammonia,methanol production, steel production.**

What is Coal based Hydrogen?



- Hydrogen is considered a secondary source of energy, commonly referred to as an energy carrier. It can be stored physically as a gas or liquid.
- Coal is a **mixture of two components** i.e., **Carbon-based matter** (the decayed remains of prehistoric vegetation), and **Mineral matter** (which comes from the ground from which the coal is dug).
  - The **carbon-based matter** is composed of five main elements i.e., **carbon, hydrogen, oxygen, nitrogen, and sulfur.**
  - Among Black Coal, Brown coal and Biomass, **Black Coal has the highest carbon content** and Biomass has the highest sulfur content
- Coal is one of the important sources of **hydrogen making (Brown Hydrogen)** apart from **Natural Gas (Grey hydrogen)** and **renewable energy (Green Hydrogen)through electrolysis**. In case of renewable energy (Green Hydrogen) surplus solar power is used to electrolyze water into hydrogen and oxygen.
- The **global emphasis is on substituting liquid fuels with hydrogen** (as fuel in vehicles), storage of surplus renewable power as hydrogen (as power cannot be stored at a cost effective price), and cutting down emission.



How is Coal based Oxygen produced?

The **partial oxidation process** is used to **produce hydrogen from coal**, which means some air is added to the coal, which generates carbon dioxide gas through traditional combustion. **(refer infographic for the process of coal based hydrogen)**

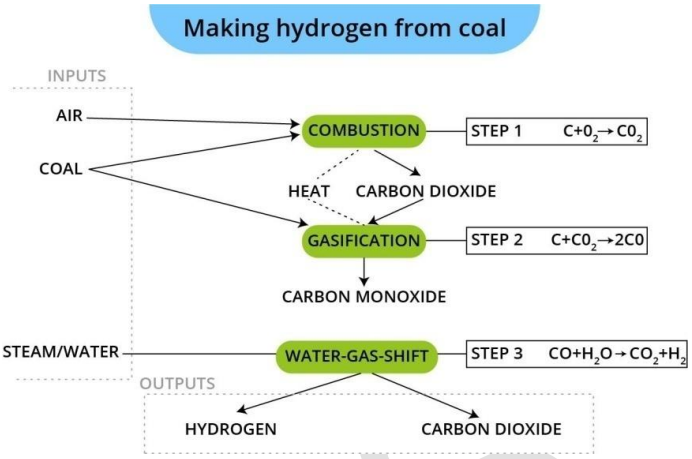
- The **partial oxidation also makes its own gasification agent**, carbon dioxide.
- Carbon dioxide reacts with the rest of the carbon in the coal to form carbon monoxide (this is the **endothermic gasification reaction**, which needs heat input).
- Carbon monoxide in the gas stream is now further reacted with steam, generating hydrogen and carbon dioxide.

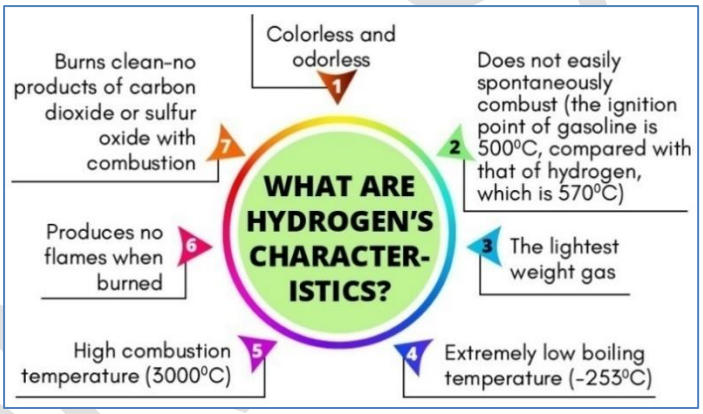
How does the picture look for India in this sector?

- In industry, **steel and ammonia will drive growth in hydrogen demand,** followed by refineries and methanol.
- **Almost 100% of Hydrogen produced in India is through Natural Gas** (Grey Hydrogen).

In this context, pursuing Coal based hydrogen could enable following for India-

Benefits of Coal Based Hydrogen	Challenges of Coal Based Hydrogen
• Since India has the world's fourth-largest coal reserves, **Cost of Hydrogen produced from coal can be cheaper and less sensitive to production** through electrolysis and Natural Gas respectively. • Effective way to **develop clean energy.**	• **Higher rate of carbon dioxide emissions.** • Safety and storage problem. • **Issue of building much-needed infrastructure** and developing consumer markets (that is, hydrogen fuel cell vehicles).





Related News
Reactors for green hydrogen

- If India is to achieve 'net-zero' emissions by 2070, many more nuclear plants would be needed **to increase the capacity from 15,000 MW at present to 22,480 MW by 2031.**
  - Heating water using **high-temperature reactors (HTRs)** and then splitting the water into **hydrogen and oxygen** in an electrolyser is a cost effective way to provide energy.
- Indian HTR development programme**had two elements:**
  - A 100 kW (thermal), 1,000 degrees C **portable 'compact high-temperature reactor' (CHTR)** for technology demonstration; and,
  - A 600 MW (thermal), 1,000 degrees C **'Indian high-temperature reactor-hydrogen'**, or IHTR-H.

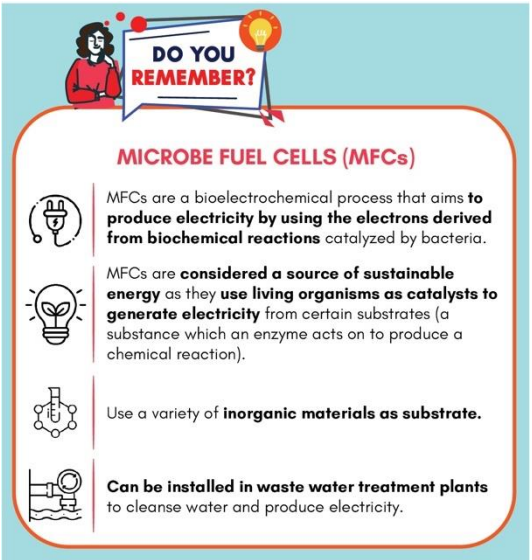
7.2. SOLID STATE LITHIUM-METAL BATTERY (SSLMB)

Why in News?

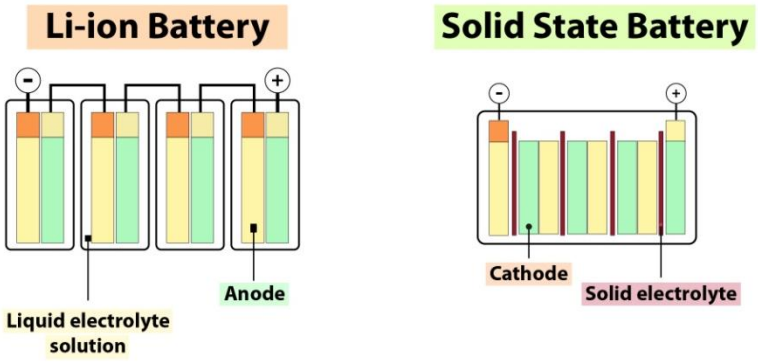
Volkswagen (in partnership with QuantumScape) is aiming for **production of Solid State lithium-metal battery (SSLMB) by 2025.**

About SSLMB

- A solid-state battery **replaces polymer separator** used in conventional lithium-ion batteries **with a solid-state separator.**
  - **Lithium-ion batteries use aqueous electrolyte solutions** to keep anode (negative electrode generally made of graphite) and cathode (positive electrode made of lithium) apart.
  - On the other hand, **solid-state battery uses solid electrolyte** that plays the role of a separator as well.



- Replacement of the separator **enables carbon or silicon anode used in conventional lithium-ion batteries to be replaced with a lithium-metal anode.**
    - **Lithium metal anode is more energy dense** than conventional anodes, allowing battery to store a greater amount of energy in the same volume.



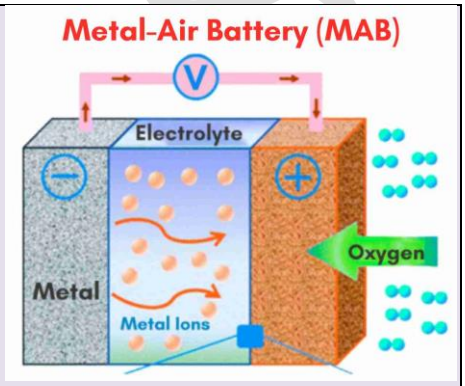
Advantages of SSLMB

- **Higher cell energy density** (by eliminating the carbon anode);
- **Lower charging time** and Ability to undertake more charging cycles and thereby a **longer life;**
- **Improved safety.**

Related Concepts

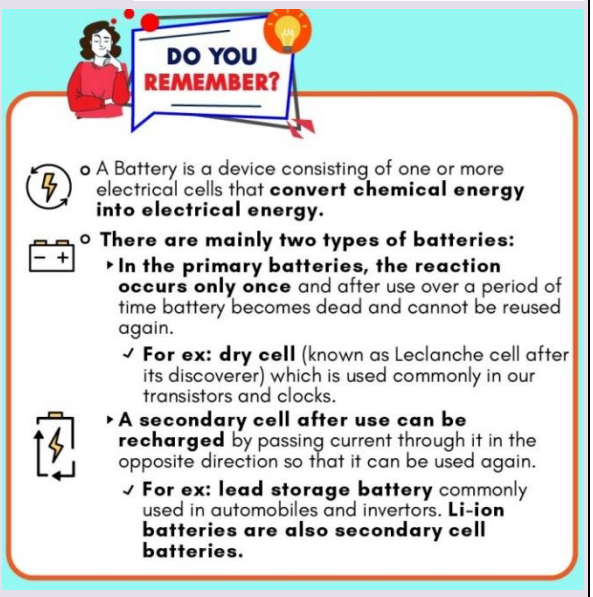
Metal-air battery (MAB)

- International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) developed **a cost effective catalysis for MAB.**
    - ARCI is an autonomous R&D Centre of Department of Science and Technology.
- **MAB is an electrochemical cell that has a metal negative electrode,** an air positive electrode, and an electrolyte.
    - Metal used include **sodium (Na), potassium (K), zinc (Zn), magnesium (Mg) and aluminium (Al).**
- **Advantage of MAB:** high energy density, expected to offer much greater range of 400 km or more per battery, metals used can be recycled and traded directly for industrial uses etc.
- **Potential applications:** power sources for portable electronics and electric vehicles, energy storage devices to manage energy flow among renewable energy generators etc.



Iron-Air battery

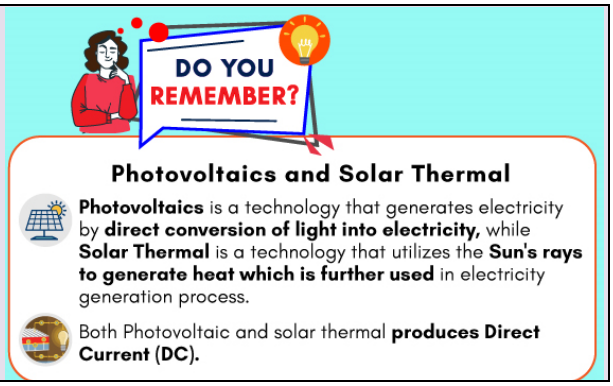
- In July 2021, **American company Form Energy Inc. announced a rechargeable iron-air battery** capable of delivering electricity for 100 hours.
- The Iron-Air battery **leverages the concept of 'reversible rusting'.**
    - It **uses oxygen from the air and converts iron metal to rust while discharging,** and while charging, the application of an electrical current transforms the rust back to iron and the battery releases oxygen back into the air.
- **Active components** of the iron-air battery system are some of the safest, cheapest, and most abundant materials on the planet — **low-cost iron, water, and air.**
- **It uses a water-based, non-flammable electrolyte,** similar to the electrolyte used in AA batteries.



Related News

ARCI signed an agreement with a private firm to set up Lithium ion (Li-ion) batteries fabrication lab in Bangalore.

- **About Lithium ion (Li-ion) batteries**
    - A lithium-ion battery is a type of rechargeable battery that is charged and discharged by **lithium ions moving between the negative (anode) and positive (cathode) electrodes.**
    - **Applications:** consumer electronics such as smartphones and PCs, industrial robots, production equipment and automobiles.



- **Advantages of Li-ion batteries over other batteries** include higher energy densities of any battery technology today, higher voltage, long life cycle, low self-discharge rate, low maintenance and environment friendly as they do not contain toxic cadmium.
- **Disadvantages include** tendency to overheat, and can be damaged at high voltages, and are costlier in comparison to other batteries.

7.3. OTHER IMPORTANT NEWS

Perovskite-based devices	• Recently, IIT Guwahati has found a way to make solar panels more efficient, cheaper and recyclable — by **stabilising hybrid perovskite-based solar or photovoltaic devices** to produce electricity. • Perovskite-based devices are considered **heavily used semiconductor materials** as they are affordable and easy to manufacture. ○ The perovskite materials are **extremely unstable towards ambient (humidity and oxygen) conditions** that restrict their commercialisation.
Bio-Jet Fuel Technology	• CSIR-IIP Dehradun's **home-grown technology to produce bio-jet fuel**, formally approved for use on military aircraft of the Indian Air Force. ○ **Bio-jet fuel can be produced from used cooking oil, tree-borne oils, short gestation oilseed crops,** and waste extracts from edible oil processing units. • Earlier, AN 32 (transportation plan) **and commercial plan (Spice jet) was flown in 2018** using the bio-jet fuel.

8. IPR

8.1. IPRS (INTELLECTUAL PROPERTY RIGHTS)

Why in News?

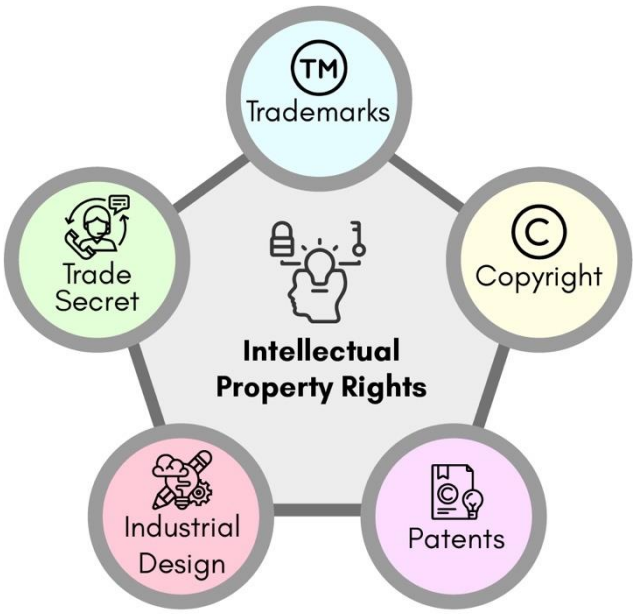
Recently, Patent for black pepper micronutrient foliar formulation and Trademark for Tumor Antigen SPAG9 were awarded.

More on News

- The **Indian Council of Agricultural Research (ICAR)**-Indian Institute of Spices Research (IISR) has received a patent for black pepper micronutrient foliar formulation.
  - The micronutrient mixture for black pepper **maintains an optimal ratio of secondary micronutrients** like magnesium, zinc and boron in the leaf.
- TheSPAG9 antigen has received the **trademark ASPAGNII**. This antigen was **developed in 1998 by the National Institute of Immunology**, the Department of Biotechnology (DBT).
  - Currently, ASPAGNII™ is being used in **dendritic cell (DC) based immunotherapy in cervical, ovarian cancer and will also be used in breast cancer.**

Office of Controller General of Patents, Designs and Trade Marks (CGPDTM)

- CGPDTM **supervises** the working of the **Patents Act, 1970, Designs Act, 2000** and **Trade Marks Act, 1999.**
- It **functions** under the **Department of Promotion of Industry and Internal Trade (DPIIT)**, Ministry of Commerce & Industry.



What are IPRs (Intellectual Property Rights)?

- IPRs are the **rights given to persons over the creations of their minds.** They usually give the creator an exclusive right over the use of his/her creation for a certain period of time.
- It can include creations such as a **newdrug composition, business module, product, software** and so on.

Types of Intellectual Property	Definition	Works Covered	Validity in India
Copyright	• Copyright is a legal term used to describe the **rights that creators have over their literary and artistic works.**	• Range from **books, music, paintings, sculpture and films, to computer programs, databases, advertisements, maps and technical drawings.**	• The **general rule is that copyright lasts for 60 years.** In the case of original literary, dramatic, musical and artistic works the 60-year period is counted from the year following the death of the author.
Patents	• A patent is an **exclusive right granted for an invention.** • It provides the patent owner with the right to decide how - or whether - the invention can be used by others. • Patents should be obtained in each country where the applicant requires protection of his invention.	• The **product or process should provide in general, a new technical solution** to a problem of any field. • An **invention relating either to a product or process** that is new, involving an inventive step and capable of industrial application **can be patented.**	• The **term of every patent in India is twenty years** from the date of filing the patent application.
Utility Model	• A Utility Model just **like a Patent also protects**	• A product or process which is Novel and Industrial	• The **term of protection for utility models**

	inventions/innovations but for a shorter period. • The main difference between a Patent and Utility Model is that the requirements for granting a Utility Model are less stringent than for Patents.	applicable passes for Utility Model, **inventive step is not a requirement.**	**is shorter than for patents,**(usually between 6 and 15 years).
Trademarks	• A trademark is a sign capable of **distinguishing the goods or services of one enterprise from those of other enterprises.**	• A trademark can be **any distinctive word, symbol, slogan, logo, brand label, name, signature, letter, numeral or any combination of them.**	• **The trademark is initially registered for a period of 10 years,** which is calculated from the date of filing of the application.
Industrial Design	• An industrial design **constitutes the ornamental or aesthetic aspect of an article.**	• A design **may consist of three-dimensional features,** such as the shape or surface of an article, **or of two-dimensional features,** such as patterns, lines or color.	• In India the **maximum validity of a registration under the (Indian) Designs Act, 2000 can be 15 years.**
Geographical Indications	• **Signs used on goods that have a specific geographical origin** and possess qualities, a reputation or characteristics that are essentially attributable to that place of origin.	• Most commonly, a geographical indication **includes the name of the place of origin of the goods.**	• **It is registered for a period of 10 years** and the registration may be renewed from time to time for a period of 10 years at a time.
Trade secrets	• Trade secrets are **IP rights on confidential information which may be sold or licensed.**	• Examples include **formulae, recipes, pattern, technique, compilation, method, program, process, device or product mechanism.**	• Trade secret remains **valid as long as one does not discover it independently.**

Some terms associated with IPRs

- **Ever-greening of patent:** Section 3(d) Indian Patent Act doesn't allow the renewal of patent over a product by introducing minor changes to it. It has been an issue of concern for pharmaceutical companies (Ex: Novartis issue on the issue of patent of cancer drug Glivec).
- **Compulsory Licensing (CL):** It enables a competent government authority to license the use of a patented invention to a third party or government agency without the consent of the patentholder.
    - **Section 92 of the Patent Act, 1970, provides for issuing CL** by the central government (permitted under the WTO's TRIPS (IPR) Agreement) in circumstances of **"national emergency or in circumstances of extreme urgency or in case of public non-commercial use".**

Related Info

- **As per the Patents Act, 1970 - "plants and animals in whole or any part thereof** other than microorganisms but including seeds, varieties and species and essentially biological processes for production or propagation of plants and animals" **are inventions not patentable.**

Related News

India records 572% growth in grants for patents in last 7 years

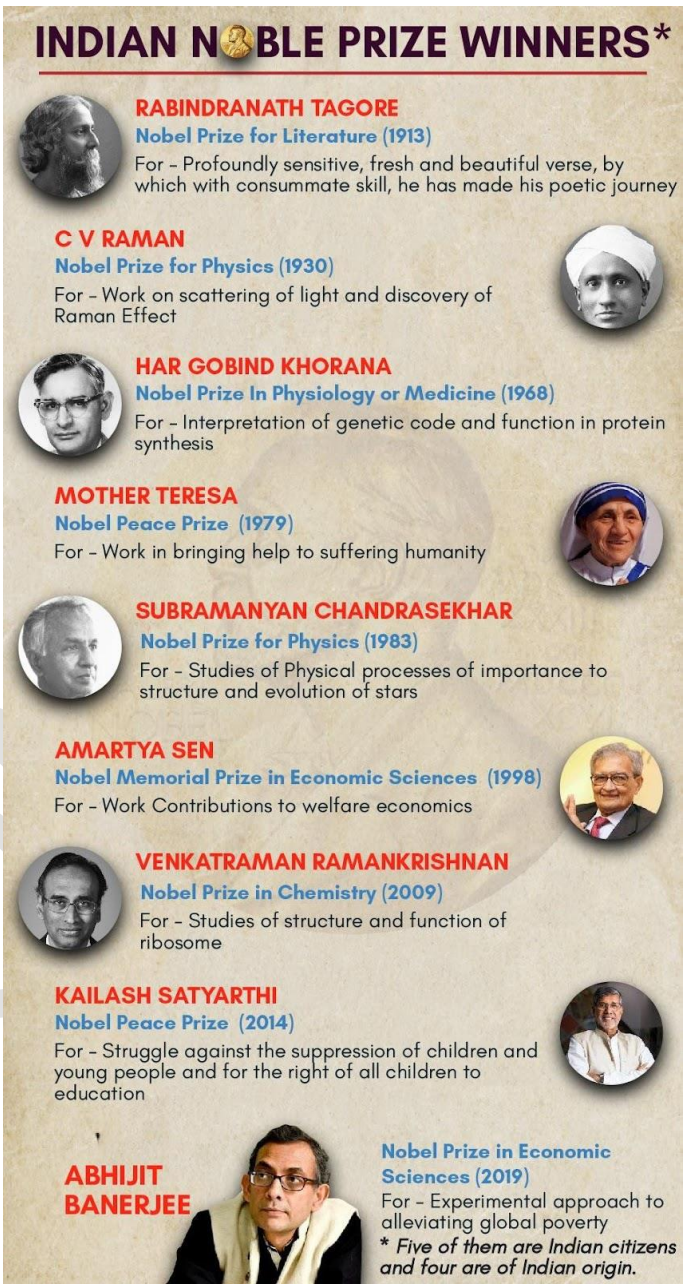
- A total of 28,391 patents were granted in 2020-21 as compared to 4,227 grants during 2013-14.
- **Measures taken by government to encourage innovation.**
    - **80% fee reduction to all Recognized Educational Institutions (Govt/Aided/Pvt) applying for patents,** whether in India or abroad.
        - ✓ Earlier it was available only to recognised educational institutions owned by the government.
    - **Expedited Examination System of patents**
    - **Improved access and transparency for dissemination of information** through real-time basis status of IP applications, Indian Patent Advanced Search System (InPASS), SMS Alert etc.

9. AWARDS

9.1. NOBEL PRIZES

Why in news?

The Nobel Assembly and the Royal Swedish Academy of Science have **announced the winners** of Medicine, Physics and Chemistry **Nobel** for the year 2021.



About Nobel Prize

- The Nobel Prize is an **international award** administered by the Nobel Foundation in **Stockholm, Sweden,** awarded to people "who have conferred the **greatest benefit to humankind**" in the previous 12 months.
- They are awarded **annually from a fund that Alfred Nobel** (Swedish inventor and entrepreneur) set aside in his **1895 will** for this purpose.
    - Alfred Nobel is known for **inventing dynamite and is holder of 355 patents.**
- **Categories:** Instituted **in 1901,** Prizes were **initially awarded in five categories**: **Physics, Chemistry, Physiology or Medicine, Literature and Peace**. A sixth award, the **Nobel Prize in Economic Sciences was instituted in 1968** by the Royal Bank of Sweden and was **first awarded in 1969.**
    - Since the start, in 1901, **there are some years when the Nobel Prizes have not been awarded.**
- **What do the winners receive?** The recipient of each prize receives **three things**:
    - A Nobel **diploma**, each of which is a unique work of art;
    - A Nobel **medal**;
    - A **cash prize** of 10m Swedish krona (£836,000; $1.1m). They have to **deliver a lecture** to receive the money.
        - ✓ **In no case** may a prize amount be **divided between more than three persons.**
- **Who awards the prizes?** The **Royal Swedish Academy** of Sciences awards the Nobel Prize in **Physics**&**Chemistry** and the Nobel prize in Medicine is awarded by **Nobel Assembly at Karolinska Institutet, Stockholm, Sweden**.
- Prize winners are called **laureates,** to signify the **laurel wreath given to victors** of contests in ancient Greece. More than one, but **no more than three**, people **can win each prize.**
    - **Malala Yousafzai (Peace)is the youngest** and **John B. Goodenough (Chemistry)** is the **oldest laureate.**

9.1.1. THE NOBEL PRIZE IN PHYSICS 2021

Prize awarded for: Ground-breaking contributions to our understanding of **complex physical systems**.

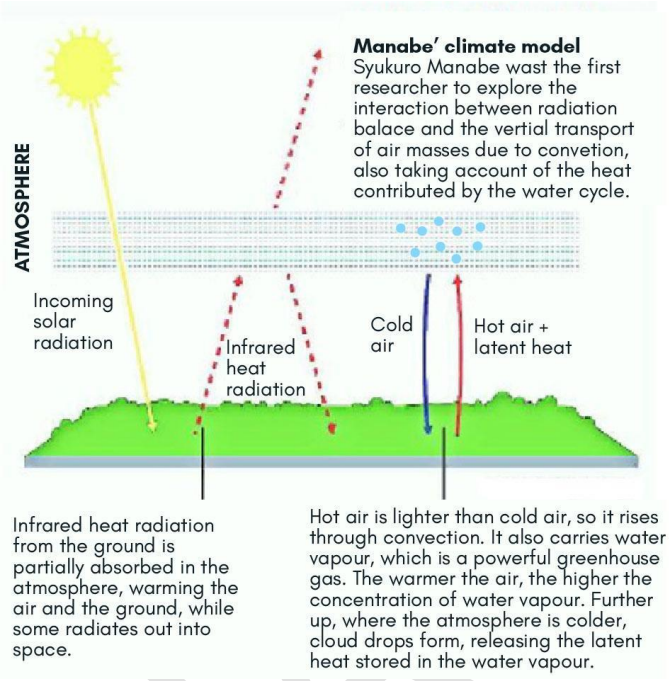
Awardees

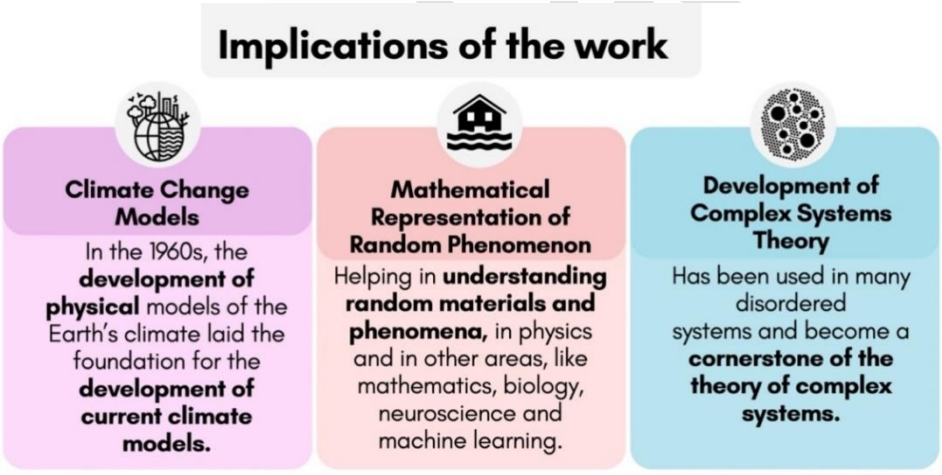
- One half of the prize was awarded to **Syukuro Manabe and Klaus Hasselmann for their work in the physical modeling of Earth's climate,** quantifying variability and reliably predicting global warming.

- Second half was awarded to **Giorgio Parisi for the discovery of the interplay of disorder and fluctuations in physical systems** from atomic to planetary scales.

About complex physical systems and the work of Nobel laurates

- **Complex systems** are characterised by **randomness and disorder** and are difficult to understand. They can be difficult to **describe mathematically** – they may have an enormous number of components or be governed by chance. The Prize recognizes **new methods** for describing them and predicting their **long-term behaviour.** The **Earth's climate** is one of many examples of complex systems.
- **Syukuro Manabe** demonstrated how **increased levels of carbon dioxide** in the atmosphere lead to **increased temperatures** at the surface of the Earth**.**
- **Giorgio Parisi** discovered **hidden patterns** in disordered complex materials with his **spin glass experiments (refer infographic).** With this, he discovered hidden structures within the systems and represented them mathematically.





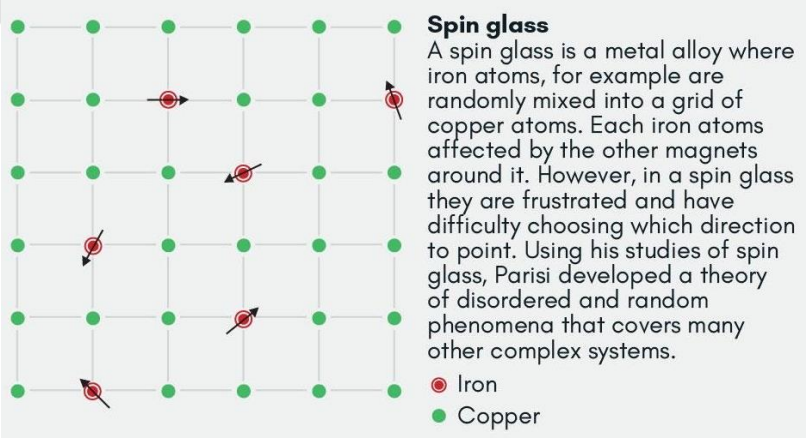
9.1.2. NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

Prize awarded for: discoveries of **receptors for temperature and touch.**

Awardees

The 2021 Nobel Prize in Physiology or Medicine was jointly awarded to **David Julius and ArdemPatapoutian**.

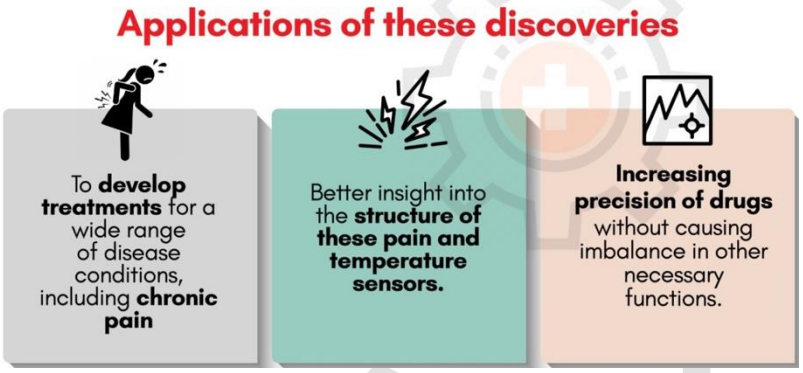
About the receptors and work of Nobel laurates



- In the human body, all the molecules are **not sensitive to heat or mechanical pressure.** Only very specific are, and it is their job to **relay this signal to the nervous system**, which then triggers an appropriate response.
- David Julius utilized **capsaicin, a pungent compound from chili peppers** that induces a burning sensation, to identify a **sensor in the nerveendings** of the skin that responds to heat.
- He and his team looked for a **gene that could induce a response** to capsaicin in cells that usually wouldn't react to it. They found one in a **novel ion channel protein, later called TRPV1,** where TRP stands for **transient receptor potential,** and VR1 is **vanilloid receptor1.**

- They were part of a **super family of TRP,** and it was found that TRPV1 was activated when **temperatures were greater than 40 degrees Celsius**, which is close to the body's pain threshold.

- ArdemPatapoutian used **pressure-sensitive cells** to discover a **novel class** of sensors that respond to **mechanical stimuli in the skin and internal organs.**
- Patapoutian and his colleagues identified **72 potential genes** that could encode an ion channel receptor and **trigger sensitivity** to mechanical force, and it emerged that one of them coded for a **novel ion channel protein, called Piezo1.**
  - Via Piezo1, a **second gene** was discovered and named **Piezo2.** Sensory neurons were found to express **high levels of Piezo2** and further studies firmly established that Piezo1 and Piezo2 are ion channels that are directly activated by the **exertion of pressure on cell membranes.**



  - Later it was demonstrated that the Piezo2 ion channel is essential for the **sense of touch**. Moreover, Piezo2 was shown to play a key role in **proprioception as well as regulate blood pressure, respiration, and urinary bladder control.**
- **Both David Julius and ArdemPatapoutian also** identified another **new receptor called TRPM8**, a receptor that is activated by cold.

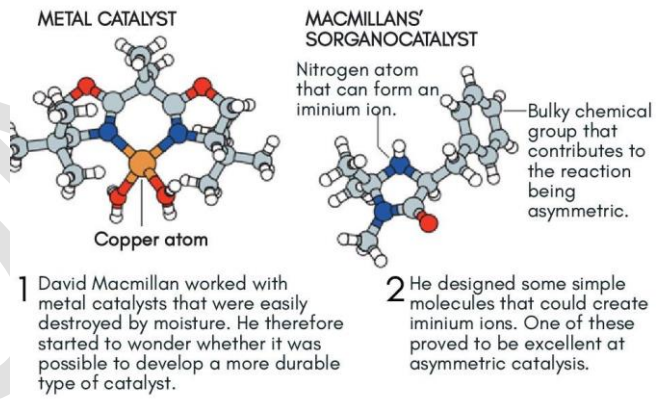
9.1.3. NOBEL PRIZE IN CHEMISTRY

Prize awarded for: development of a **precise new tool** for molecular construction: **organocatalysis.**

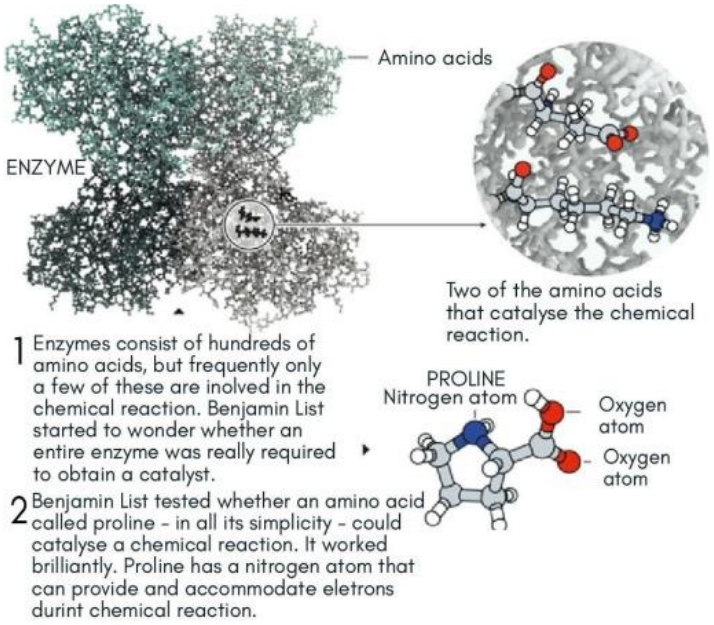
Awardees

The Nobel Prize in Chemistry 2021 was awarded to **Benjamin List and David MacMillan.**

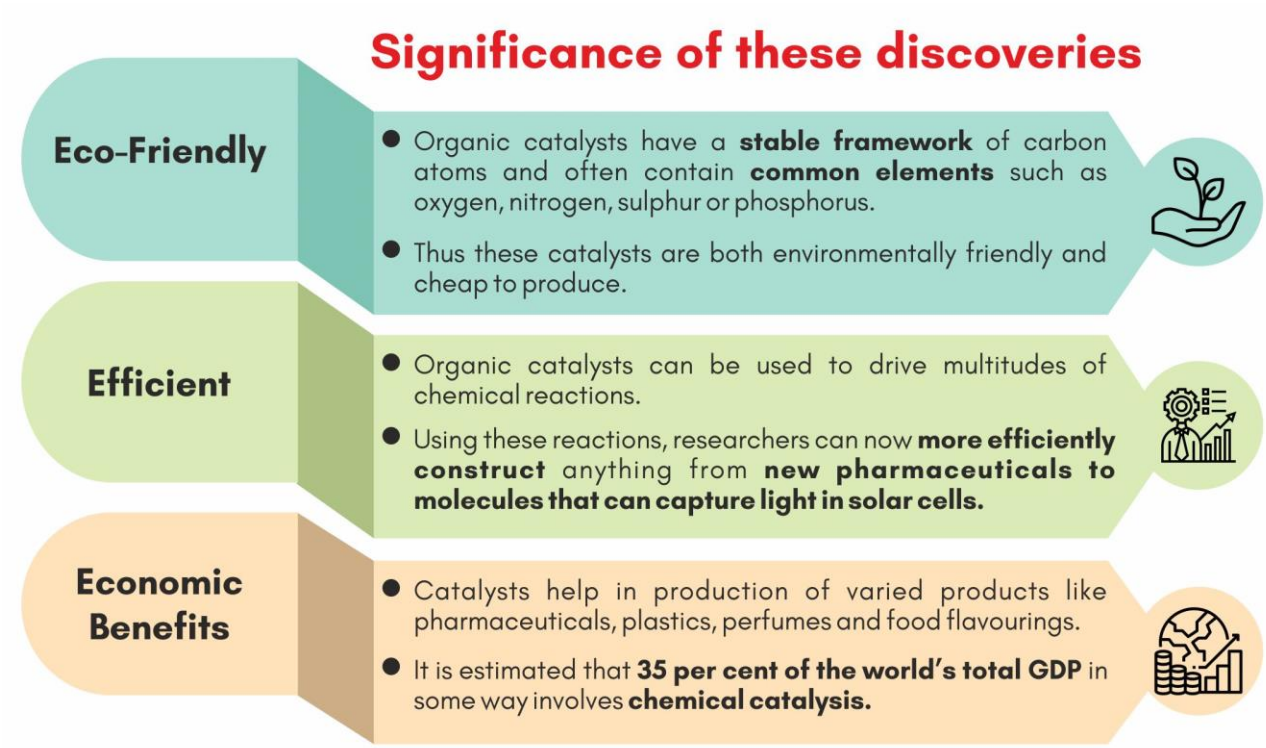
About Catalysts, catalysis and organocatalysis and the work ofNobel laurates



- Catalysts are substances that **control and accelerate chemical reactions**, without becoming part of the final product.
  - For example, catalysts in catalytic converters of cars **transform toxic substances** in exhaust fumes to **harmless molecules.**
- Researchers long believed that there were, in principle, **just two types of catalysts available:metals**, mainly heavier metals; and **enzymes, naturally occurring** heavy molecules that facilitate all life-supporting biochemical processes. Both these **had limitations:**
  - Heavier metals are **expensive** and **toxic** to humans and the environment. Also, metals required an environment **free of water and oxygen,** which was difficult to ensure on an industrial scale.



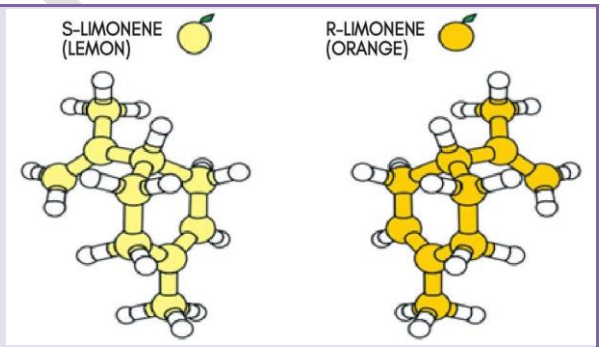
  - Enzymes on the other hand, **work best when water is used** as a medium for the chemical reaction. But that is **not an environment suitable for all kinds of chemical reactions.**



Benjamin List and David MacMillan, independent of each other, developed a **third type of catalysis**. It is called **asymmetric organo catalysis** and builds upon small organic molecules.

Asymmetric Catalysis

During chemical construction a situation often arises in which two molecules can form, which – just like our hands – are **each other's mirror image**. Chemists often **just want one of these mirror images,** particularly when producing pharmaceuticals, but it has been difficult to **find efficient methods** for doing this.

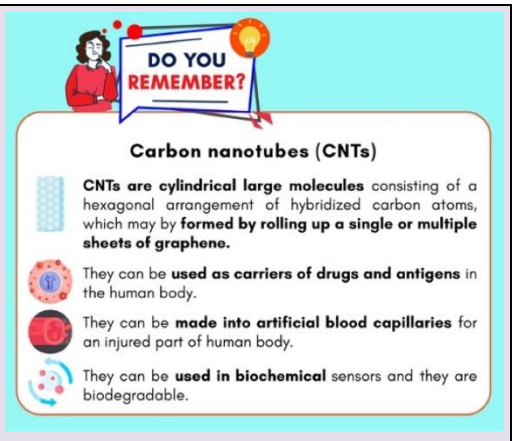


- List and MacMillan discovered that by using a natural compound like an amino acid as a catalyst, they were obtaining **only one specific mirror image** of the end-product. This was later named **asymmetric catalysis.**
- They experimented with **simple organic compounds**. Organic compounds are **mostly naturally-occurring substances,** built around a framework of carbon atoms and usually containing hydrogen, oxygen, nitrogen, sulphur, or phosphorus.
    - Life-supporting chemicals like **proteins**, which **are long chains of amino acids** (carbon compounds containing nitrogen and oxygen) are organic.

9.2. OTHER AWARDS IN NEWS

International Eni Award 2020

- Bharat Ratna Professor C.N.R. Rao has **received the International Eni Award 2020** also called the Energy Frontier award.
    - Eni Award is considered to be the Nobel Prize in Energy Research.
    - It has got **recognition by the President of the Italian Republic**.
- The Energy Frontiers award has been conferred **for his work on metal oxides, carbon nanotubes (CNTs), and other materials** and two-dimensional systems, including graphene, boron-nitrogen-carbon hybrid materials, and molybdenum sulfide (Molybdenite - MoS_2) for energy applications and green hydrogen production.



Shanti Swarup Bhatnagar (SSB) Prize	• SSB Prizes are **awarded annually for outstanding research**, applied or fundamental, in **following disciplines:** Biological Sciences, Chemical Sciences, Earth, Atmosphere, Ocean and Planetary Sciences, Engineering Sciences, Mathematical Sciences, Medical Sciences and Physical Sciences. • **Eligibility:** Any Citizen of India, Overseas citizen of India working in India (up to the age of 45 years). • Dr Shanti Swarup Bhatnagar was the **Founder Director of Council of Scientific & Industrial Research** (CSIR). o He was the **first Chairman of University Grants Commission (UGC).** o He was awarded the Padma Vibhushan in 1954.
Ramanujan Prize for Young Mathematician	• **Professor Neena Gupta** has been awarded the 2021 Ramanujan Prize for her **outstanding work in affine algebraic geometry and commutative algebra.** • AWard is **administeredby** the Abdus Salam International Centre for Theoretical Physics (ICTP) jointly with the Department of Science and Technology (DST) Government of India and the International Mathematical Union (IMU). • Award is **given annually to an eminent Mathematician who is less than 45 years of age** on 31 December of the year of the award.

10. MISCELLENAOUS

10.1. LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY (LIGO) PROJECT

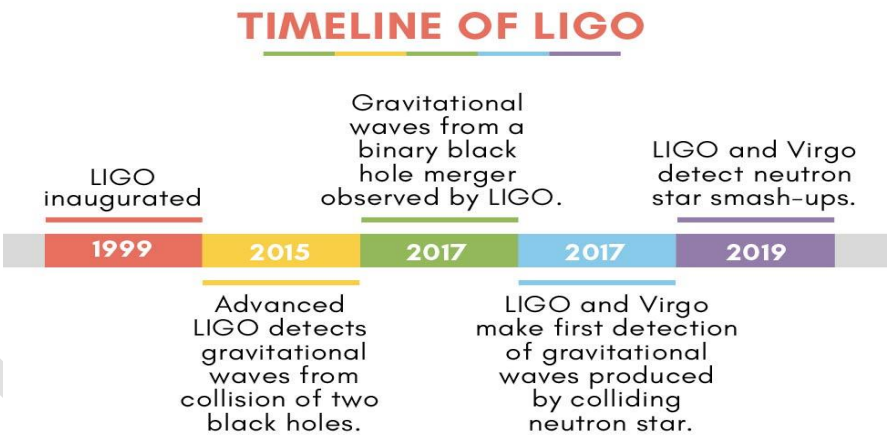
Why in News?

Hingoli revenue department (Maharashtra) has handed over land for Laser Interferometer Gravitational-Wave Observatory (LIGO) project **for setting up a laboratory** along with some other related infrastructure.

More on News

- In 2016, **central government had given approval to LIGO-India** (a Joint India-US detector) for research on gravitational waves.
  - **It is collaboration between the LIGO Laboratory (operated by Caltech and MIT) and three Institutes in India:**the Raja Ramanna Center for Advanced Technology (Indore), the Institute for Plasma Research (Ahmedabad), and the Inter-University Centre for Astronomy and Astrophysics (Pune).
- Technology being developed includes **design and fabrication of ultra stable laser, quantum measurement techniques,** handling of complex control system for enforcing precision control, large-scale ultra-high vacuum technology, **data analysis and machine learning.**
- Project will be built by **Department of Atomic Energy (DAE) and Department of Science and Technology (DST).**

About LIGO



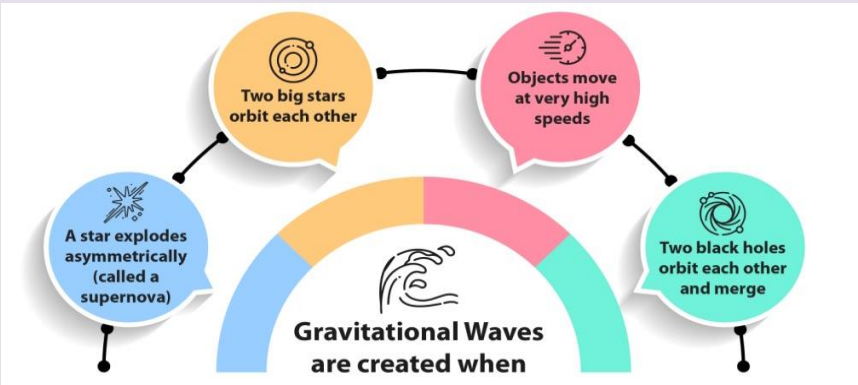
- It was **designed for direct detection of gravitational waves** predicted by Einstein's General Theory of Relativity.
- It is **being operated at two sites in US** (Washington and Louisiana).
  - Also, there are **3 LIGO's sisters' facilities:** Virgo in Italy, GEO600 in Germany and KAGRA (Kamioka Gravitational-wave Detector) in Japan **and LIGO- India.**
- Data LIGO collects may have **far-reaching effects on many areas of physics including gravitation, relativity, astrophysics, cosmology, particle physics,** and nuclear physics.
- **LIGO use laser interferometry** to measure the minute ripples in space-time caused by passing gravitational waves from cataclysmic cosmic events such as colliding neutron stars or black holes, or by supernovae.
  - Interferometers are **investigative tools that work by merging two or more sources of light** to create an interference pattern, which can be measured and analyzed.
  - They are **often used to make very small measurements** that are not achievable any other way.
- **It is different from other observatories as**
  - **LIGO is blind:** Unlike optical or radio telescopes, LIGO does not see electromagnetic radiation (e.g., visible light, radio waves, microwaves) as gravitational waves are not part of the electromagnetic spectrum.
  - **LIGO isn't round** and can't point to specific locations in space: Since LIGO doesn't need to collect light from stars, it doesn't need to be round or dish-shaped.

Significance of detection of Gravitational Waves by LIGO

- Test of **Einstein's theory of general relativity under extreme conditions of gravity** where it has never before been tested.
- **Information about** the unimaginably dense form of matter that makes up **neutron stars.**
- Tell us about how many objects like **black holes and neutron stars exist in the Universe.**
- Insight into what **happens during some of the Universe's most violent explosions.**

About Gravitational Waves

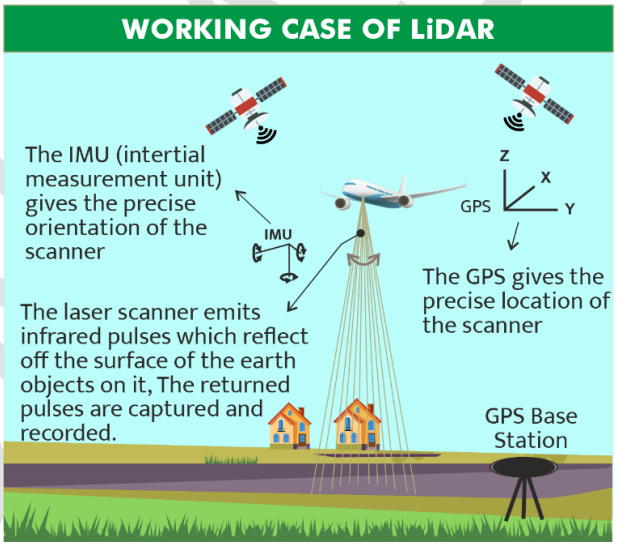
- They are **'ripples' in space-time** travelling at speed of light caused by some of most violent and energetic processes in Universe.
- They carry with them **information about their cataclysmic origins, as well as invaluable clues to nature of gravity itself.**
- **Different types of gravitational waves are**
  - **Continuous gravitational waves:** thought to be produced by a single spinning massive object like a neutron star.
  - **Compact binary inspiral gravitational waves:** produced by orbiting pairs of massive and dense ("compact") objects like white dwarf stars, black holes, and neutron stars.
  - **Stochastic Gravitational Waves:** are smallest and most difficult gravitational waves to detect and are passing by from all over the Universe all the time and are mixed together at random.



10.2. LIDAR SURVEY REPORTS

Why in News?

Recently, Ministry of Environment, Forest and Climate Change released LiDAR (light detection and ranging) based reports mapping out the water requirement within forest areas in 10 states.



More on News

- **Project was awarded to WAPCOS,** a public sector unit under the Ministry of Jal Shakti.
  - Surveys were carried out at forest areas in **Assam, Bihar, Chhatisgarh, Goa, Jharkhand, Madhya Pradesh, Maharashtra, Manipur, Nagaland, and Tripura.**
- WAPCOS **followed the Ridge to Valley approach of watershed management** for this survey.
- **LiDAR technology was used to create 3-D images** of the project areas to recommend soil and water conservation structures.
- State forest departments **will use Compensatory Afforestation Fund Management and Planning Authority (CAMPA) funds** towards implementation of these projects.
- The **survey would help in:**
  - **Identifying areas** which need groundwater recharge.
  - **Reducing human-animal conflict** by reducing water scarcity.

About LiDAR technology

- LiDAR is a **remote sensing technology** that uses light in the form of a pulsed laser to measure ranges (distances) to a target.
  - These light pulses—combined with other data recorded by the airborne system— **generate precise, three-dimensional information about the shape of the Earth** and its surface characteristics.
  - It is similar to **radar and sonar** (that use radio and sound waves, respectively).
- A LiDAR instrument principally consists of a **laser, a scanner, and a specialized GPS receiver**.
  - Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas.
- **There are following two types of LiDAR:**
  - **Topographic:** typically uses a near-infrared laser to map the land.
  - **Bathymetric:** uses water-penetrating green light to also measure seafloor and riverbed elevations.
- **Applications**: Land management and planning efforts, including hazard assessment, forestry, agriculture, geologic mapping, and watershed and river surveys etc.

10.3. FLEX-FUEL ENGINES

Why in News?

Government issued advisory to carmakers to introduce flex-fuel engines in vehicles.

About Flex Fuel Vehicle (FFV)

- It is a **modified version of vehicles that could run both on gasoline and blended petrol** with different levels of ethanol blends.
  - These are currently being used successfully in Brazil, **giving people the option to switch fuel** (gasoline and ethanol).
  - Flex-fuel, or flexible fuel, is an **alternative fuel** made of a combination of gasoline and methanol or ethanol.

Advantage of FFV

- Provides **option for using bio-fuels,** which are better than petrol (are import substitute, cost effective, pollution-free and indigenous).
  - Target date for achieving **20% ethanol-blending with petrol has been advanced by five years** to 2025.
  - Flex-fuel engines are **capable of running on 100 percent petrol or ethanol.**
- Help in **addressing the problems of surplus food grains** (can be used in making ethanol).
- **Reduce dependence on oil imports**.

Challenges in adopting FFV

- Require **additional investment from auto companies** in production lines and technology transfers.
- Ethanol can also cause **corrosion and damage to the engine.**
- Ethanol is also **not as economical as gasoline** as it does not provide the same level of fuel efficiency.

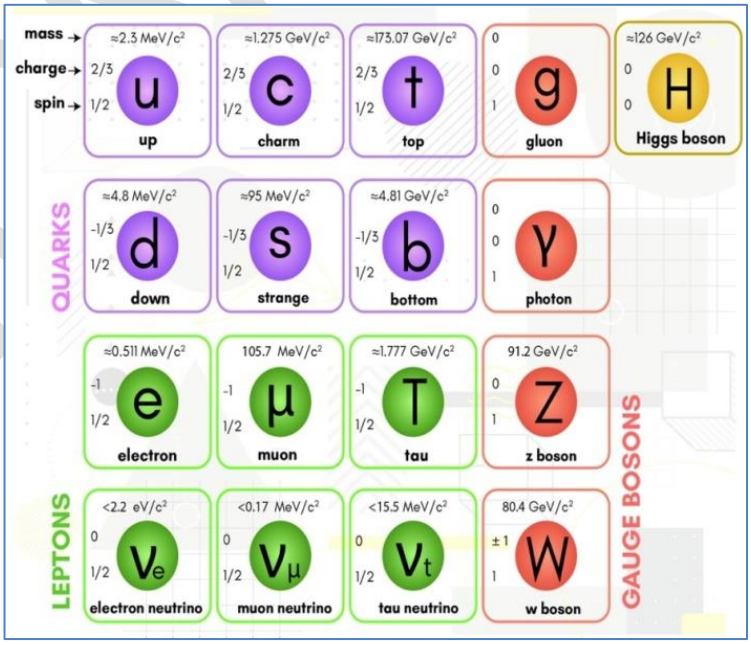
10.4. MUON G-2

Why in News?

Fermilab, which houses the American particle accelerator, has **released the first results** from its 'muon g-2' (pronounced gee minus two)experiment.

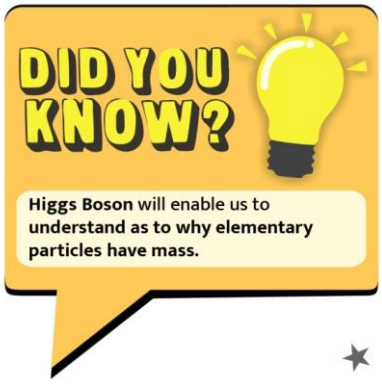
More on News

- Muon g-2 experimenters **examine the precession of muons that are subjected to a magnetic field.**
- The **main goal is to test the Standard Model's predictions of this** value and if there is an inconsistency, it could indicate the Standard Model is incomplete and in need of revision.

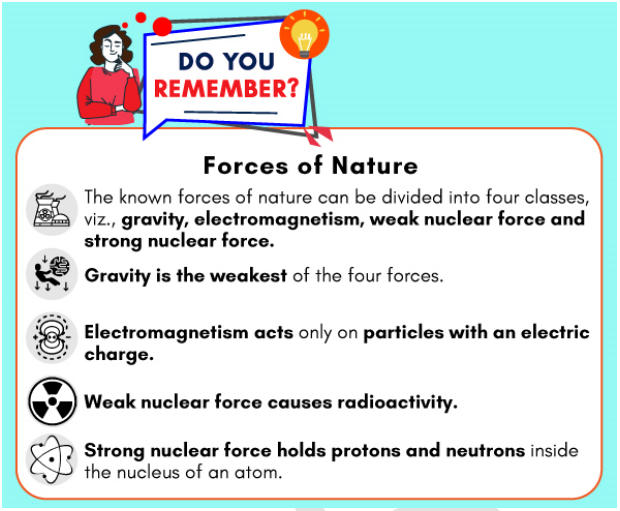


About Muon

- **Muon is sub atomic particle** and is classified as one of the leptons (elementary particles).
- It is **about 200 times more massive than electron** and much more unstable, surviving for a fraction of a second.
- Muon, like its relative the electron, is **a point-like particle, meaning that it has no composite parts.**
  - the energy of a composite particle, such as a proton, is really the sum of the energies of its constituent parts, **the energy of the simple muon is all its own.**



- Muon g-2 experiment showed that behaviour of muons is **different from what is predicated in the Standard Model** of particle physics.
- The Standard Model is a rigorous theory that lays out the **rules for six types of quarks, six leptons, the Higgs boson, three fundamental forces,** and how the subatomic particles behave under the influence of electromagnetic forces.
  - **Quarks are elementary subatomic particles** that interact by means of the strong force and are believed to be among the **fundamental constituents of matter.**
  - **There are six types of quarks** that differ from one another in their mass and charge characteristics that are grouped in three pairs: **up and down, charm and strange, and top and bottom.**



10.5. OTHER IMPORTANT NEWS

Xenobots	• Recently, Scientists developed **first living robots that can reproduce.**
	• World's first living robots, called **Xenobots, were formed from the stem cells of the African clawed frog** (Xenopus laevis) from which it takes its name.
	  ○ Xenobots are **less than a millimeter wide and could move, work together in groups** and self-heal.
	  ○ Stem cells are **unspecialized cells that have the ability to develop into different cell types.**
	• Now, scientists have **discovered an entirely new form of biological reproduction**(using Artificial Intelligence) different from any animal or plant **to create first-ever, self-replicating living robots.**
	  ○ **Unlike in cloning,** where DNA from one individual is used to grow identical copies of that individual, **these cells are harvested from different embryos,** and used to create organisms that don't resemble their parent species.
	• **Potential Applications of Xenobots**
	  ○ Could be organized to **form lenses to restore vision.**
	  ○ To clean up plaque that **causes heart blocks or brain damage.**
	  ○ Could be **programmed to attack/remove cancer cells,**
	  ○ To **clean up plastic pollution** etc.

Bose Einstein condensation (BEC)	• Recently physicists **observed a new phase in BEC** of light particles.
	• Sometimes referred to as the **'fifth state of matter'** (other four are solids, liquids, gases and plasma), a BEC is **a state of matter created when particles, called bosons, are cooled to near absolute zero** (-273.15 degrees Celsius).
	  ○ **At such low temperatures there is insufficient energy for the particles to move** into positions that might cause their distinct quantum characteristics to interfere with one another.
	  ○ Hence, these particles in this state **behave like a single giant superparticle.**
	• Existence of **BEC was predicted by Albert Einstein and Indian mathematician Satyendra Nath Bose** in early 1920s.
	• **BECs are extremely fragile** and the slightest interaction with the external world is enough to warm them past their condensation threshold.
	• **Nobel Prize in Physics 2001** was awarded jointly to Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman **for their BEC related achievement.**

India Innovation Graphene Centre (IIGC)	• India's first graphene innovation center to be established in **Thrissur, Kerala.** • **Graphene** is the **thinnest and strongest material** in the world and has **good chemical stability, high electrical conductivity** and a large surface area while being transparent and lightweight. ○ It is **two-dimensional form** of crystalline carbon. • **Applications**: Anti-corrosion coatings and paints, efficient and precise sensors, faster and efficient electronics, flexible displays, efficient solar panels, faster DNA sequencing, drug delivery, conducting electrode for touch screen, LCDs etc and more.
UNESCO Science Report 2021	• Report **monitors trends in science governance worldwide** and explores how countries are using science to realize a digitally and ecologically smart future.

	• **Key highlights**
	  ○ **Countries of all income levels are prioritizing their transition to digital and green economies.**
	• **India specific Findings**
	  ○ Average gross domestic expenditure on research and development (GERD) over past two decades is **0.75% of GDP, lowest among BRICS** (Brazil, Russian Federation, India, China and South Africa).
	  ○ **Number of start-ups is almost doubling each year since 2016** (17,390 start-ups in 2019), however most are in the services sector.
	  ○ **Employability increased** from 34% in 2014 to almost 47% in 2019, meaning that **one out of two graduates is still not employable.**
	  ○ As a share of total installed capacity for electricity generation, **green energy sources** (wind, solar, biofuels and small hydro-electricity generators) **rose from 13% in 2015 to 22% in 2018.**

Science and Engineering Research Board-Fund for Industrial Research Engagement (SERB-FIRE)	• It is a **research initiative launched by SERB** (statutory body of Department of Science and Technology) **in collaboration with Intel India.** • FIRE is a joint government-and-industry initiative with a co-funding mechanism **to promote innovative technology solutions and strengthen academic research** through collaboration with key research and development (R&D) organisations in India. ○ The new initiative aims to utilize the expertise available in academic institutions and national laboratories **to solve industry-specific problems for the larger benefit of society.**

Indian Science Technology and Engineering Facilities Map (I-STEM) Enters Phase-II	• I-STEM is the **national web portal for sharing R&D facilities.**
	• It was launched in **2020 as an initiative of Office of Principal Scientific Adviser to Govt. of India** under aegis of **Prime Minister Science, Technology and Innovation Advisory Council mission.**
	  ○ **Its goal is to strengthen R&D ecosystem** by connecting researchers with resources and by supporting researchers by enabling them access to existing publicly funded R&D facilities.
	• Under Phase II, portal will host **indigenous technology products and will also provide platform for City Knowledge and Innovation Clusters.**
	• **Also,** in a related development, I-STEM portal will now help **users to access COMSOL Multiphysics software.**
	  ○ COSMOL group (in Sweden), is used as a **tool for computer simulations for R&D,** learning and instruction.

DRDO develops critical near isothermal forging technology for Aeroengines	• Isothermal forging is **a hot working process to work on super alloys that have low forge ability**. Here the workpiece is maintained at its maximum elevated temperature throughout the entire operation.
	  ○ This technological **breakthrough involves developing complex titanium and nickel based alloys** that can withstand temperatures exceeding 1000 degrees Celsius.
	  ○ It would help in India in developing **jet engines with thrust to power a combat fighter.**

Artificial Snow	• For the first time in the history of the Winter Olympics, **athletes will compete on 100% artificial snow** in Beijing. • Artificial snow is **small particles of ice that are used to increase the amount of snow available** for winter sports such as skiing or snowboarding. ○ It is **produced by a machine that uses a high-pressure pump to spray a mist of water into the cold air.** The water **droplets subsequently crystallize** to form fake snow.
Magnetic Levitation Technology	• After successful trials, China rolled out its **high speed Maglev train** with a top speed of **600 kmph.** • Maglev, short for **Magnetic Levitation**, is a system in which the **vehicle runs levitated from the guide way** (corresponding to the rail tracks of conventional railways) by using electromagnetic forces between superconducting magnets onboard the vehicle and coils on the ground. • Because of no contact (or friction) between vehicle and guideway, it can reach **high speeds** along with other benefits such as **higher efficiency** and **low noise**.

Artificial Moon	• **China has built an artificial moon facility** that will simulate lunar conditions **to train astronauts, test new rovers and technologies** for future missions.
	  ○ Facility has been **made with rocks and dust that are as light as those on moon.**
	  ○ It will **use powerful magnetic field** to make gravity disappear.
	• China has **already developed an artificial sun** to replicate nuclear fusion process that occurs naturally in the sun and stars to provide almost infinite clean energy.

Heartiest Congratulations to all successful candidates

10 IN TOP 10 SELECTIONS IN CSE 2020

FROM VARIOUS PROGRAMS OF VISION IAS

1 AIR — SHUBHAM KUMAR

2 AIR — JAGRATI AWASTHI

3 AIR — ANKITA JAIN

4 AIR — YASH JALUKA

5 AIR — MAMTA YADAV

6 AIR — MEERA K

7 AIR — PRAVEEN KUMAR

8 AIR — JIVANI KARTIK NAGJIBHAI

9 AIR — APALA MISHRA

10 AIR — SATYAM GANDHI

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