VISIONIAS
INSPIRING INNOVATION

SCIENCE & TECHNOLOGY

Classroom Study Material

April 2022 - December 2022

8468022022, 9019066066

DELHI JAIPUR HYDRABAD BHOPAL GUWAHATI RANCHI LUCKNOW PUNE AHMEDABAD CHANDIGARH PRAYAGRAJ

enquiry@visionias.in /c/VisionIASdelhi /Vision_IAS vision_ias www.visionias.in /VisionIAS_UPSC

SCIENCE AND TECHNOLOGY

Table of Contents

NOTE:

Dear Students,

PT 365 documents comprehensively covers 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:

Summarised Infographics:
- Complex concepts and processes related to science and technology
- Important technologies and their developments

have been summarised and added in form of interactive infographics to improve ease of understanding, provide for smoother learning experience and ensure enhanced retention of the content.

Organization infographics: Prelims oriented information for key organizations have been consolidated alongside the respective articles for quick revision.

Know the term: They have been added to clarify important concepts and terms.

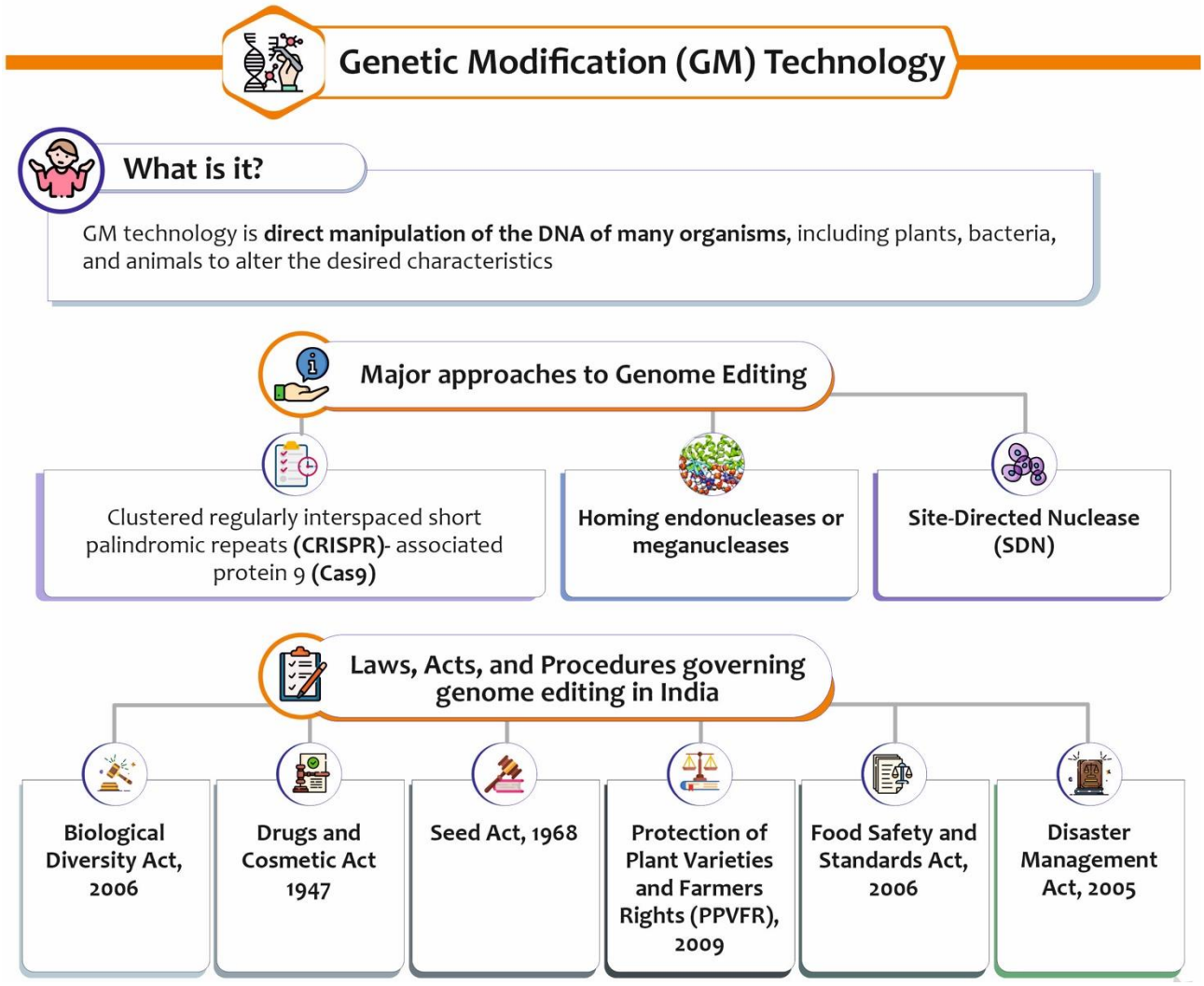
Quiz: QR based Smart quiz has been added to test the aspirant's learnings and understanding.

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. GENETIC MODIFICATION (GM) TECHNOLOGY



1.2. GENOME EDITING

1.2.1. GENETICALLY MODIFIED (GM) CROPS

Why in news?

Recently the Department of Biotechnology (DBT) issued **Guidelines for Safety Assessment of Genome Edited Plants, 2022** easing norms for research into genetically modified (GM) crops.

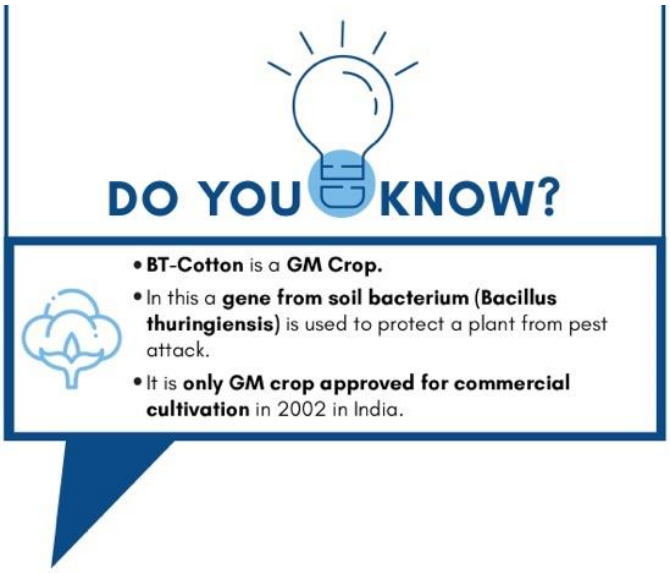
More on News

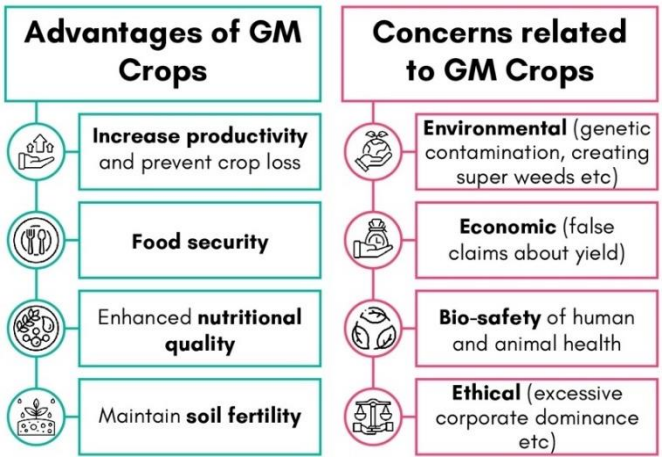
- Guidelines **exempts Genome Edited plants falling under** the **categories of Site directed nuclease (SDN)1 and SDN2**, from Manufacture, Use, Import, Export and Storage of hazardous Microorganisms/ Genetically Engineered Organisms or Cells, Rules, 1989, under the Environment (Protection) Act (1986).

- It is **based on an earlier exemption by the Ministry of Environment, Forest and Climate Change** to avoid a long process for approval of GM crops through GEAC.

Guidelines for Safety Assessment of Genome Edited Plants, 2022

- **Aim:** Provides regulatory framework and scientific guidance on data requirement in context of research & development of Genome Edited Plant.
- **Scope of Guidelines:** Limited to plants and products thereof developed using genome editing techniques employing site-directed nucleases (SDN).
- **Guidelines Notified by:** Ministry of Environment, Forest and Climate Change under the Environment (Protection) Act, 1986.
- **Exemption:** Researchers who use **gene-editing technology to modify plant genome** from seeking approvals from Genetic Engineering Appraisal Committee (GEAC).
  - **All requirements** to develop transgenic seeds **will apply to gene-edited seeds except clauses requiring GEAC permission**.
- **Significance of guidelines:** Accelerate genetic improvement of crops, increasing farmer's income, roadmap for sustainable use of genome editing.
- **Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cells, Rules, 1989:** Regulates all activities related to Genetically Engineered organisms or cells and hazardous microorganisms and products thereof.





About GM Crops

- **Genetic modification in plants:** Cells are grown in **tissue culture** which develop into plants and seeds produced by these plants will **inherit the new DNA**.
- Indian Council of Agricultural Research **(ICAR) promotes the science-based innovative technology including research on GM crops.**
  - **Network Project on Functional Genomics and Genetic Modification in Crops** was launched by ICAR in 2005.

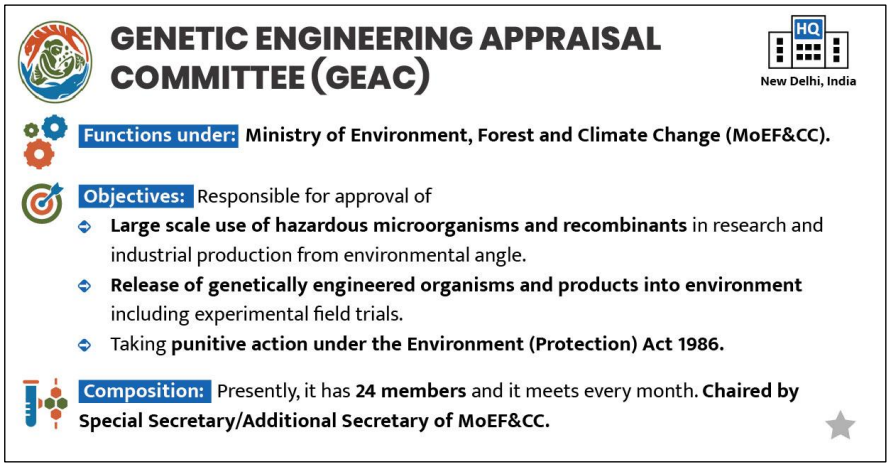
Genome editing technology and Transgenic Technology

- **Both can alter the genome of an organism.** However, there is a **difference between the two** as:
  - **Genome editing is manipulation of genome of organism itself** by knocking out or replacing targeted gene which resulting in individuals with intentionally selected and desired traits.
  - **In Transgenic technology** genome of an organism is **altered by introduction of** one or more **foreign DNA sequences from another species** by artificial means.

Various bodies on GM crop regulation

- **Recombinant DNA Advisory Committee (RDAC):** Monitors the developments in biotechnology at national and international levels. It functions in DBT.
- **Institutional Biosafety Committee (IBSC):** Approves low-risk experiments and ensures adherence to prescribed safety guidelines. It functions from DBT.
- **Review Committee on Genetic Manipulation (RCGM):** Reviews all ongoing projects involving high-risk and controlled field experiments. It functions from DBT.

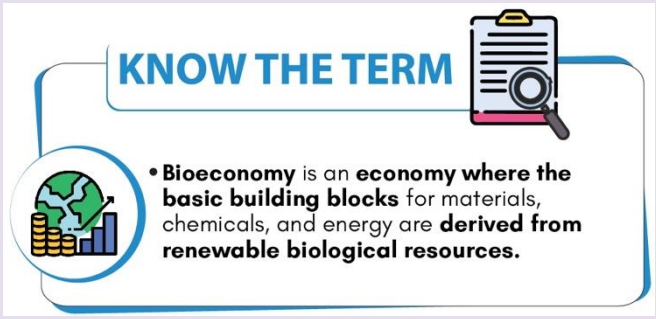
- **State Biotechnology Coordination Committee (SBCC):** Acts as State level nodal agency to assess the damage due to release of GMOs and to take on-site control measures.
- **District Level Committee (DLC):** Acts as nodal agency at District level to reports to SBCC or the GEAC about compliance or non-compliance of regulatory guidelines.



Related News

GEAC has recommended the environmental release of transgenic hybrid mustard Dhara Mustard Hybrid-11 (DMH-11).

- **Commercial use:** under **Indian Council of Agriculture Research (ICAR) supervision** and will be **subject to Seed Act, 1966.**
- **About DMH-11**
  - **Developed by:** Delhi University's Centre for Genetic Manipulation of Crop Plants.
  - **Process used:** Crossing **Indian mustard variety 'Varuna' (barnase line)** with an **East European 'Early Heera-2' mutant (barstar)**
  - **Contains two alien genes** isolated from a soil bacterium called **Bacillus amyloliquefaciens.**
    - ✓ **First gene ('barnase') codes** for a protein that impairs pollen production and renders the plant into incorporated male sterile.
    - ✓ Second is the **'barstar' gene that blocks the action of the barnase gene.**
    - ✓ Resultant progeny is **both high-yielding and capable of producing seed/ grain.**



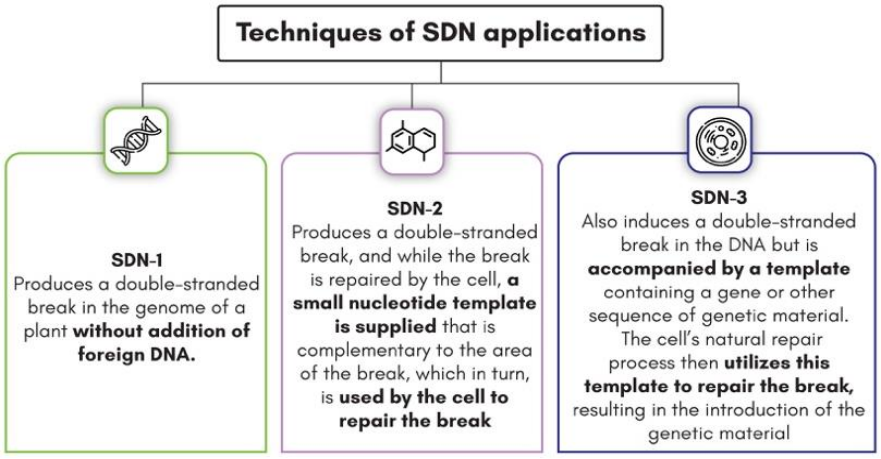
Related News

- **Haryana government issued NOC to conduct field trials on BG-2 RRF,** herbicide-tolerant and insect resistant **variety of BT cotton.**
  - So far, **India has allowed commercial use of BG-1 and BG-2 GM cotton** while BG-2 RRF approval is pending at various stages.
  - **BG-2 RRF can provide protection against pest attack** such as American Bollworm.

1.2.2. SITE-DIRECTED NUCLEASE (SDN) TECHNOLOGY

Why in news?

Department of Biotechnology revised guidelines for plants and products thereof developed using genome editing techniques employing site-directed nucleases (SDN).



About site-directed nucleases (SDN)

- **SDN or sequence specific nuclease (SSN)** refers to the practice of cleaving DNA strands to affect the subsequent genome editing.
  - SDN technology **takes advantage of targeted DNA break** and **host's natural repair mechanisms** to introduce specific small changes at the site of the DNA break.
- **Main SDN technologies:** Zinc-Finger Nucleases (ZFNs) and Transcription Activator Like Effector Nucleases (TALENs).

- **Depending on the nature of the edit,** the process is **divided into three categories** — SDN 1, SDN 2 and SDN 3 (refer infographic).
  - **Both SDN1 and SDN 2 do not involve alien genetic material** and the result is indistinguishable from conventionally bred crop varieties.
  - **SDN3** process **involves genes of foreign origin.**
- **SDN-1 and SDN-2** do not produce new plant varieties that fall under the scope of the GMO legislation.
- **In SDN-3, the newly developed plant falls under GMO legislation** only if foreign DNA exceeding 20 base pairs is inserted.

1.2.3. CRISPR-CAS 9

Why in the news?

It's been ten years since microbiologist Emmanuelle Charpentier and biochemist Jennifer Doudna published research that paved way for CRISPR-Cas9 gene editing (Both awarded Nobel Prize for the same in 2022).

About Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-Cas 9

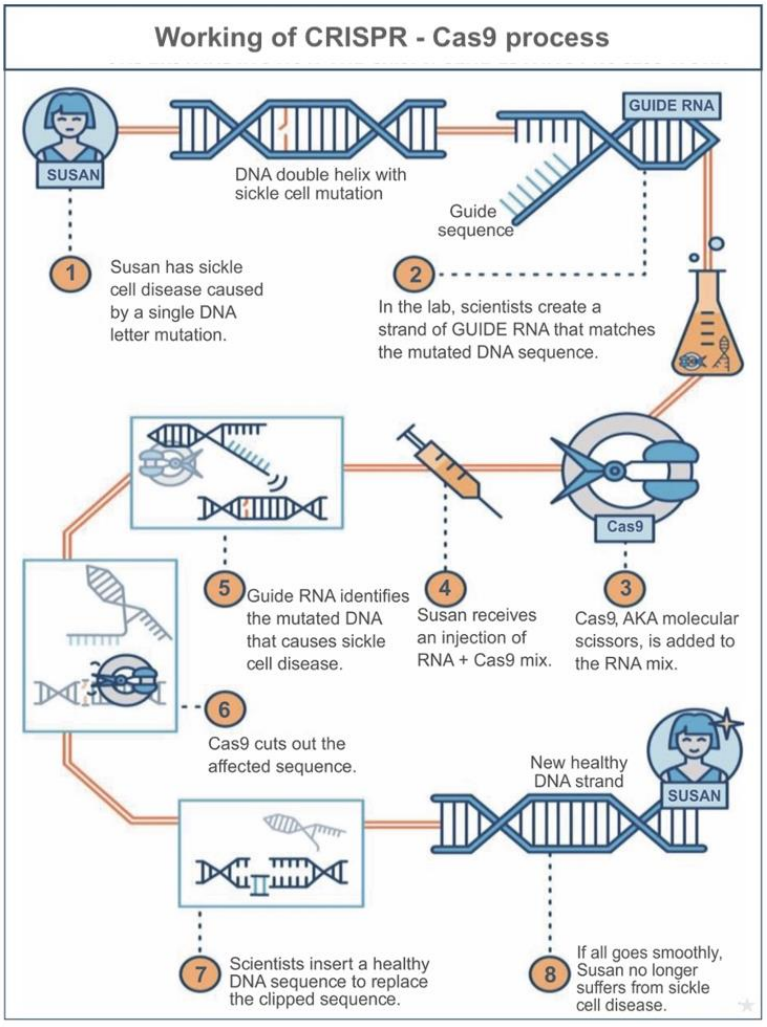
- CRISPR is a **genetic code or sequence found in bacteria.**
  - **Formed due to** the activity of the **previous bacteriophages** that had infected them.
- **Bacteria uses CRISPR sequence to remember** each specific virus that attacks them by **incorporating virus DNA into their own bacterial genome.**
- This **gives the bacteria protection when a specific virus tries to attack** again.
- **CRISPR-associated protein 9 (Cas9):** A bacterial RNA-guided endonuclease that **once activated will make special enzymes** that seem to have co-evolved with CRISPR.

How does CRISPR work?

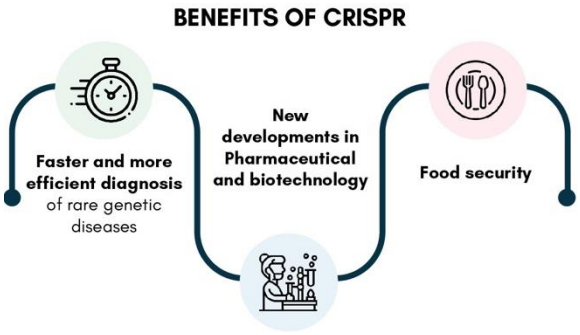
- **There are the 3 key elements of CRISPR-Cas9 work:**
  - **Guide RNA:** A piece of RNA that locates the targeted gene. This is engineered in a lab.
  - **Cas9:** The "scissors" that snip the undesired DNA out.
  - **DNA:** The desired piece of DNA that is inserted after the break.
- **Challenges:** Ethical challenges (concerns over 'Designer Babies'), ecological impacts (genes with negative traits throughout a population).

KNOW THE TERM

- **DNA:** DNA, or deoxyribonucleic acid, is the **hereditary material in most of living beings.**
- **RNA:** RNA or Ribonucleic acid molecules are **single-stranded nucleic acids.** They are **hereditary material in some viruses.**
- **Genes:** A gene is a **'specific' section of DNA.** It is involved in making RNA (transcription) or protein (translation).
- **Genome:** A genome is **an organism's complete set of DNA.** It **includes all chromosomes,** which house the DNA, and genes.
- **Molecular scissors** act as the scissors that **cut out the unwanted DNA.** They are **also called Restriction Enzymes** because of their ability to restrict the unwanted genes at the site identified by the Guided RNA.



- **Advancement in India:** study for treating sickle cell anemia, researchers at National agri-food biotechnology edited the banana genome to improve its nutritional quality and pathogen resistance etc.



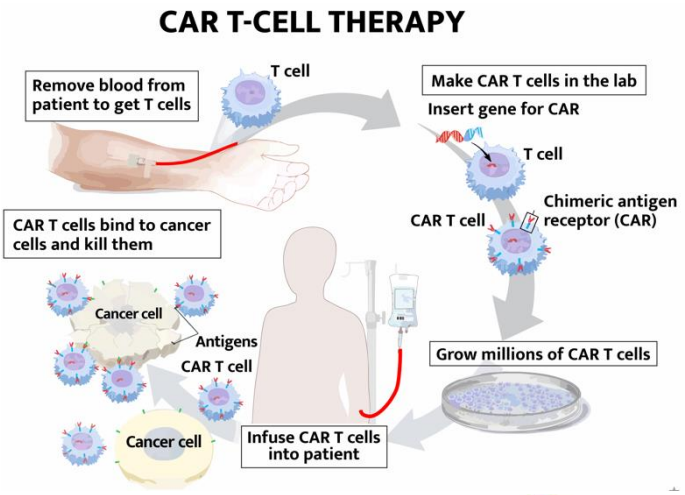
1.2.4. CHIMERIC ANTIGEN RECEPTOR T (CAR-T) CELL THERAPY

Why in the news?

This is the first time that CAR-T therapy, indigenously developed by IIT Bombay and Tata Memorial Centre, was tested on patients in India.

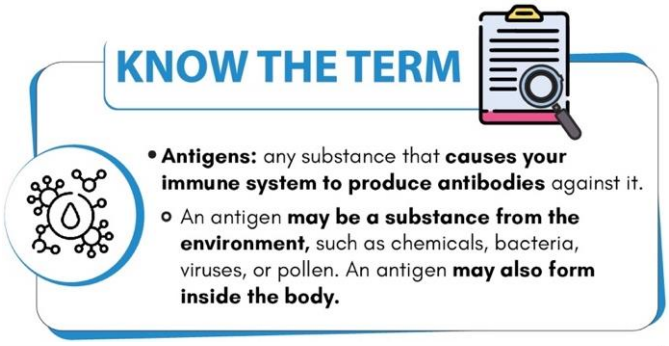
More about the news

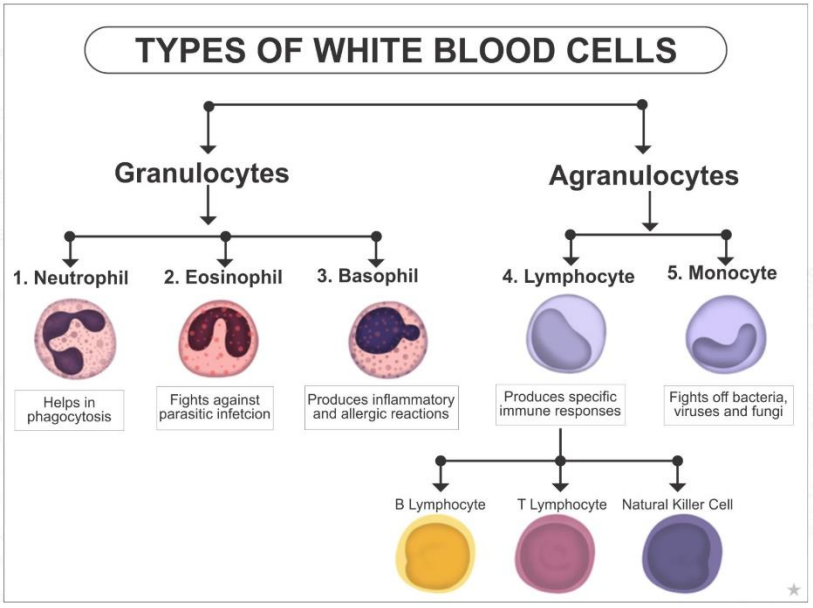
- **Research is funded under National Biopharma Mission (NBM)** by Biotechnology Industry Research Assistance Council (BIRAC).
  - BIRAC is **a Public Sector Enterprise**, set up by **Department of Biotechnology (DBT)** as an Interface Agency **to strengthen emerging Biotech enterprise**.



About CAR-T therapy

- It is a **way to get immune cells called T cells to fight cancer by editing them in the lab.**
  - **T cells are a type of white blood cell** that attacks foreign pathogens.
- T cells are **taken from patient's blood** and are edited by **adding a gene for a man-made receptor** (called CAR).
  - CAR is **special receptor,** created in the laboratory, that is **designed to bind to certain proteins on cancer cells.**
  - CAR is then **added to T cells.** This **helps them better identify specific cancer cell antigens.**
  - These **changed T cells called CAR- T cells.**
- CAR-T cells are **then given back to the patient.**
- **Benefits of CAR-T therapy**
  - While existing treatments work towards increasing life of patients, **CAR-T technology holds promise of curing certain types of cancers.**
  - Unlike chemotherapy, CAR-T is **administered only once to a patient.**
  - **Short treatment time** needed and **more rapid recovery.**





Related Concept
T and B Cells

- **Immune system cells:** innate and acquired.
- **Innate immune cells:** Body's first line of defense that quickly respond to fight infection.
- **Acquired immunity:** Also called adaptive immunity—**uses T-cells and B-cells** when invading organisms slip through first line of defence.
  - **T-cells and B-cells** evolve from learned experiences so **take longer to develop.**
  - **Tend to live longer** than innate cells.
- **B-cells and T-cells are also called lymphocytes** (a type of white blood cell that is part of the immune system).
  - **B cells produce antibodies** that are used **to attack invading bacteria, viruses, and toxins.**
    - ✓ These antibodies are Y-shaped proteins that are specific to each pathogen.
  - **T cells are direct fighters of foreign invaders and also produced cytokines,** which are biological substances that help activate other parts of the immune system.
    - ✓ **T cells destroy body's own cells** that have been **taken over by viruses** or become cancerous.

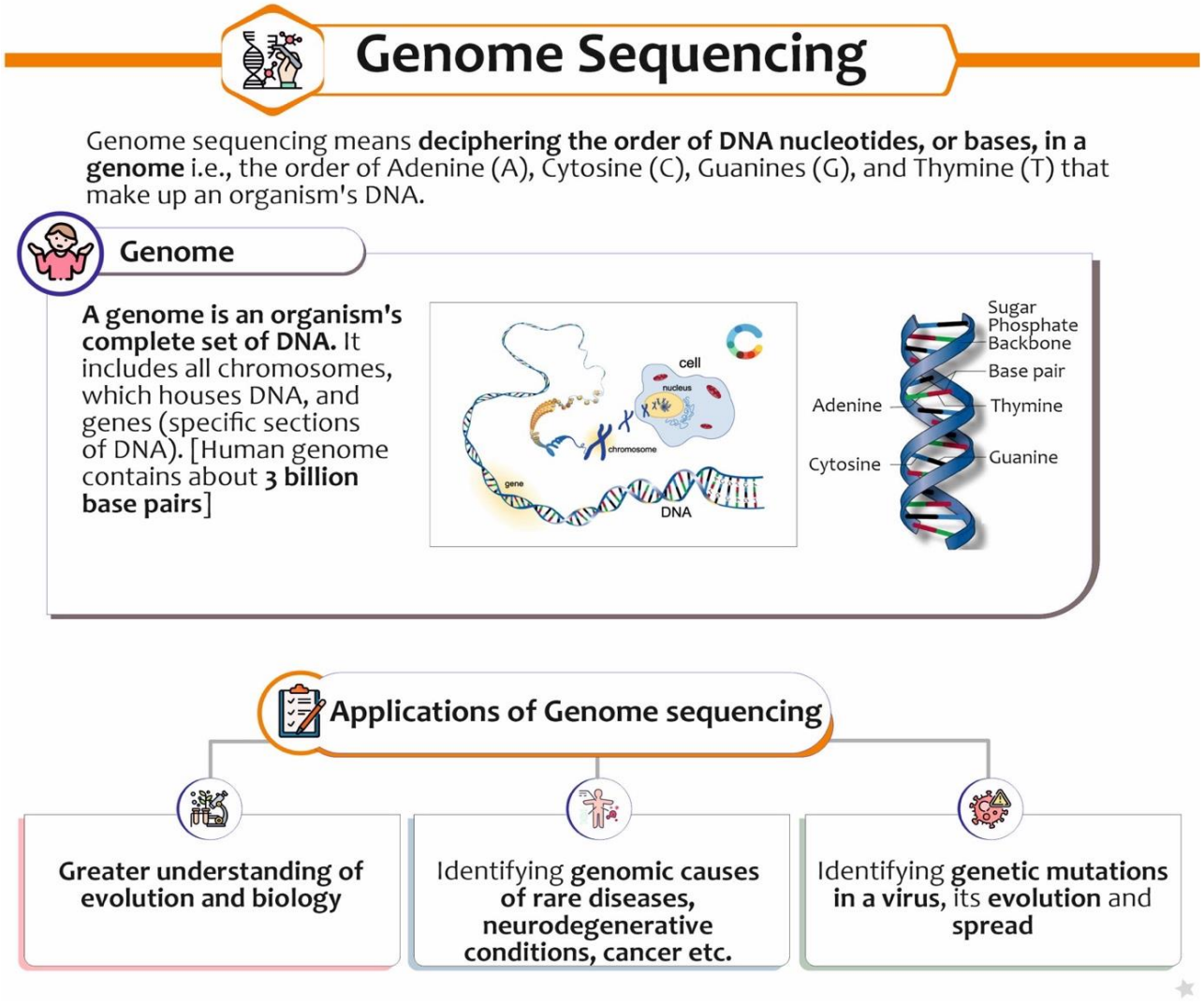
1.3. GENOME SEQUENCING

Why in News?

In a recently published research, an international team described the **first-ever sequencing of a complete human genome.**

More about News

- **Previous effort** of sequencing was incomplete as DNA sequencing technologies **couldn't read about 8% of the genome.**



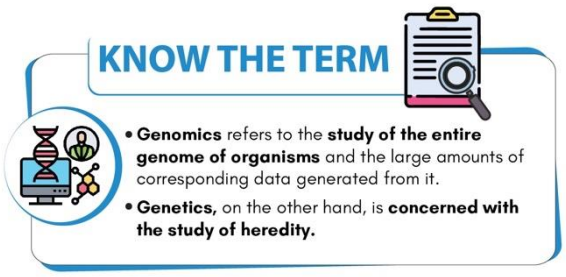
Various Initiatives taken for Genome Sequencing

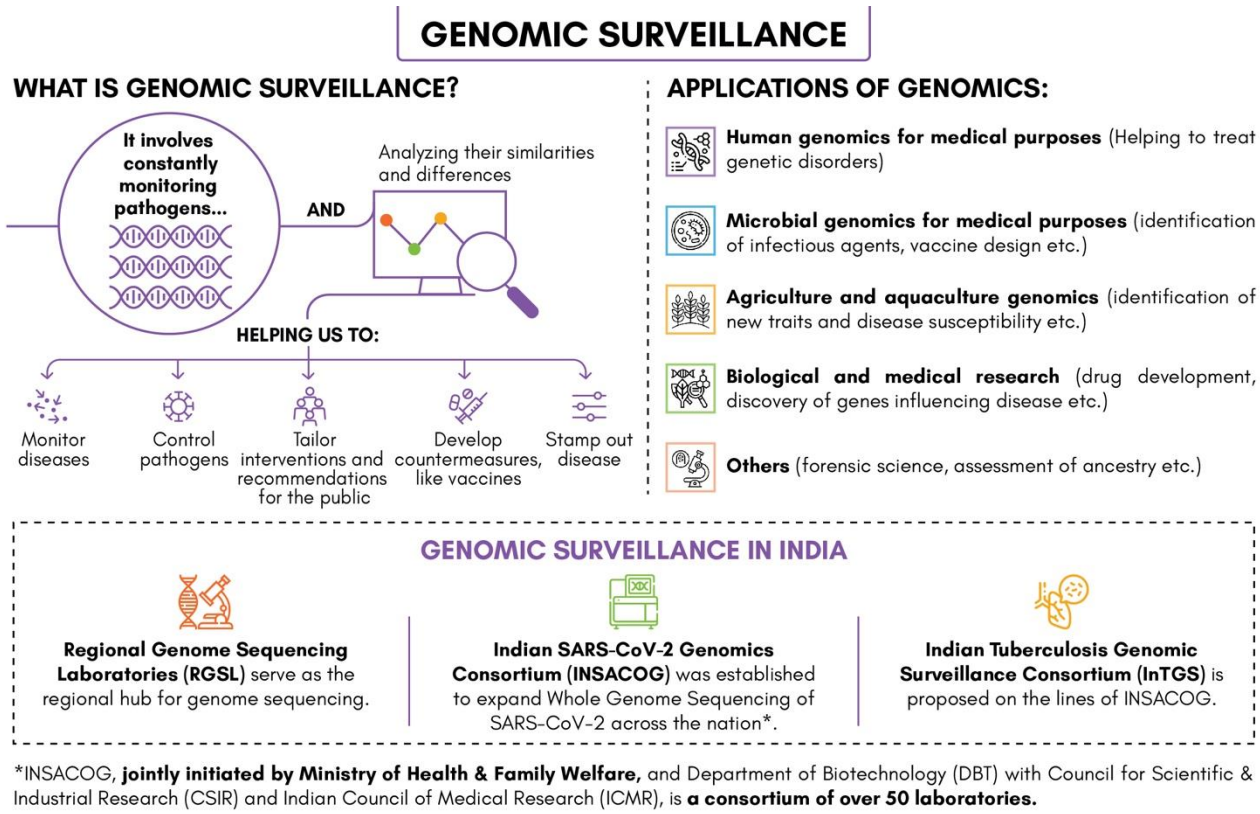
- **IndiGen programme**
  - Aims to undertake whole **genome sequencing of 1000 Indian individuals** representing diverse ethnic groups from India.
  - Funded by **Council of Scientific and Industrial Research** (CSIR).
- **Genome India Project**
  - Aims to **collect 10000 genetic samples from citizens across India** to build a reference genome.
  - By **Department of Biotechnology**.
- **Human Genome Project**
  - **International research effort** to determine the **DNA sequence of the entire human genome.**
  - It began in 1990 and **completed in 2003.**
  - It was coordinated by **National Institutes of Health, USA and Department of Energy, USA**.

1.4. GENOMIC SURVEILLANCE

Why in News?

With outbreaks of several pathogens and their variants, including COVID-19, monkeypox, etc, in recent years, the need to build a sustainable system for genomic surveillance is felt.





*INSACOG, **jointly initiated by Ministry of Health & Family Welfare,** and Department of Biotechnology (DBT) with Council for Scientific & Industrial Research (CSIR) and Indian Council of Medical Research (ICMR), is **a consortium of over 50 laboratories.**

Related News

- **WHO's Science Council** (SC) **issued its first report on accelerating access to genomics for global health,** arguing that it is not justifiable ethically or scientifically for less-resourced countries to gain access to such technologies long after rich countries do.
  - **SC was established** (2021) by the Director General of WHO **to provide guidance on the science and research strategy** of the organization.

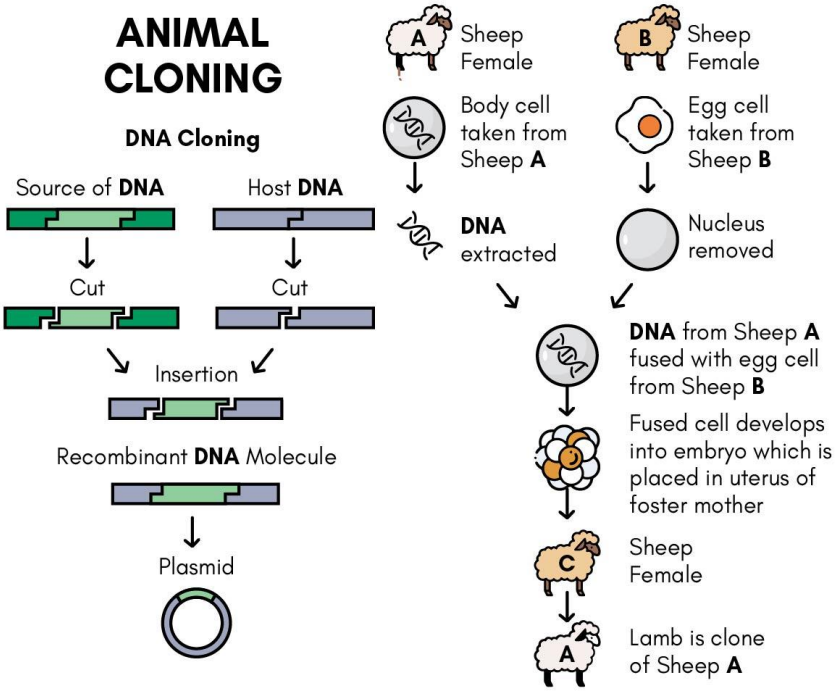
1.5. CLONING

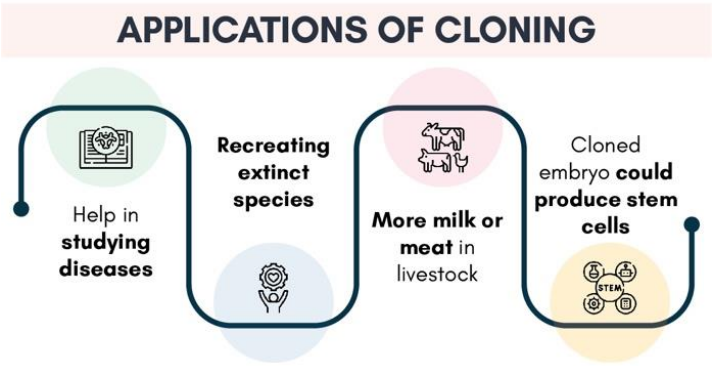
Why in news?

Recently, China has successfully cloned a **wild Arctic wolf** for the first time in the world.

About Cloning

- **Clone: Copied material, which has the same genetic makeup as the original,** is referred to **as a clone.**
- **Cloning:** Process of producing **genetically identical copies of a biological entity** (genes, cells, tissues, and even entire organisms), either by natural or artificial means.
- **Not identical:** Despite having the same genetic material **clones do not always look identical** as **environment also plays a role in deciding the physical feature** of an organism.
- In mammals including humans, **identical twins** (monozygotic twins) **are natural clones.**
  - **These twins are produced** when a **fertilized egg splits,** creating two or more embryos that carry almost identical genetic material**.**





Three different types of artificial cloning

- **Gene/DNA cloning: Transfer of a DNA fragment** from one organism to a self-replicating genetic element, such as a bacterial plasmid.
- **Reproductive cloning:** Transferring nuclear material isolated from a somatic cell into an enucleated oocyte (egg cell).
  - Then **this oocyte is stimulated to divide,** forming an embryo with the same genome as the nuclear donor. This process is called **Somatic Cell Nuclear Transfer (SCNT).**
  - This process was **used to create Dolly sheep**, the first mammal cloned.
- **Therapeutic cloning** is like reproductive cloning till the production of the embryo. The **produced embryo is then grown in the laboratory.**

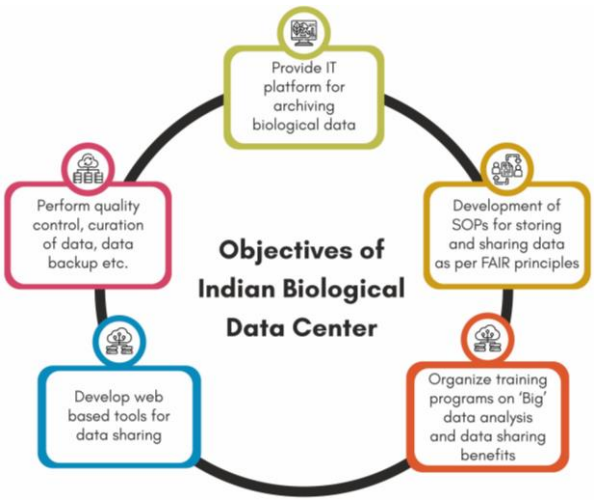
1.6. INDIAN BIOLOGICAL DATA CENTER

Why in news?

Recently, **Indian Biological Data Center (IBDC) was inaugurated at Faridabad, Haryana**.

About IBDC

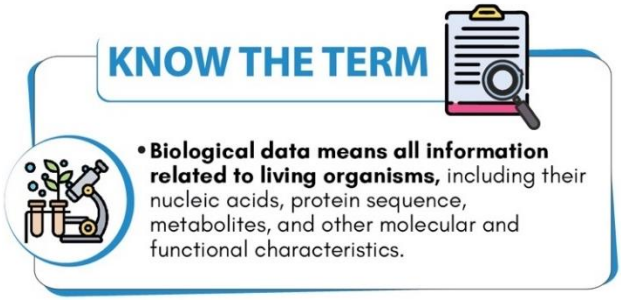
- **First national repository for life science data** in India.
  - Also, as per the **Biotech-PRIDE guidelines,** released last year, IBDC is **mandated to archive all life science data** generated from publicly-funded research in India.

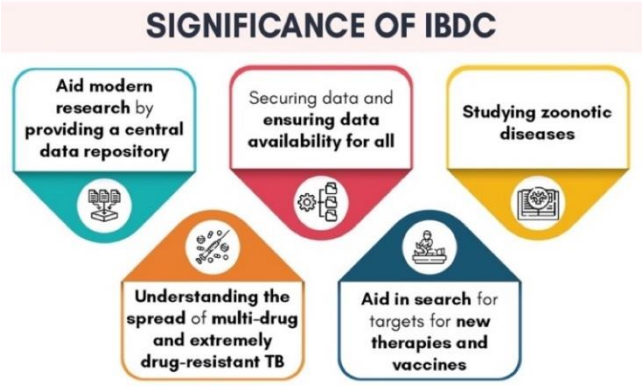


- **Established at**: Regional Centre of Biotechnology, Faridabad in collaboration with National Informatics Centre (NIC).
- **Storage:** Digitised data will be stored on a four-petabyte **supercomputer 'Brahm'**.
- **Supported by**: Department of Biotechnology (DBT).
- **Data sharing:** As per FAIR (Findable, Accessible, Interoperable and Reusable) principle.
  - **FAIR Data Principles** were proposed by a consortium of scientists and organizations **to support the reusability of digital assets.**
- **Also contains genomes sequenced by the Indian Sars-CoV-2 Genomic Consortium (INSACOG).**
- Under IBDC, currently, **two sections have been developed.** These include:
  - **Indian Nucleotide Data Archive (INDA)** shall archive data generated from publicly funded research projects in India and provide internationally accepted data accession numbers (digitised genetic makeup of humans, plants, animals, and microbes).
  - **Indian Nucleotide Data Archive – Controlled Access** (INDA-CA).
- **Data access types of IBDC**: Open access/time-release access and Restricted access.

Biotech PRIDE (Biotech Promotion of Research and Innovation through Data Exchange) Guidelines 2021

- Released by: **Department of Biotechnology (DBT)**
- These guidelines **enable exchange of information** to promote research and innovation in different research groups across the country.
- These Guidelines are **applicable for all biological data** generated through research conducted within the country.





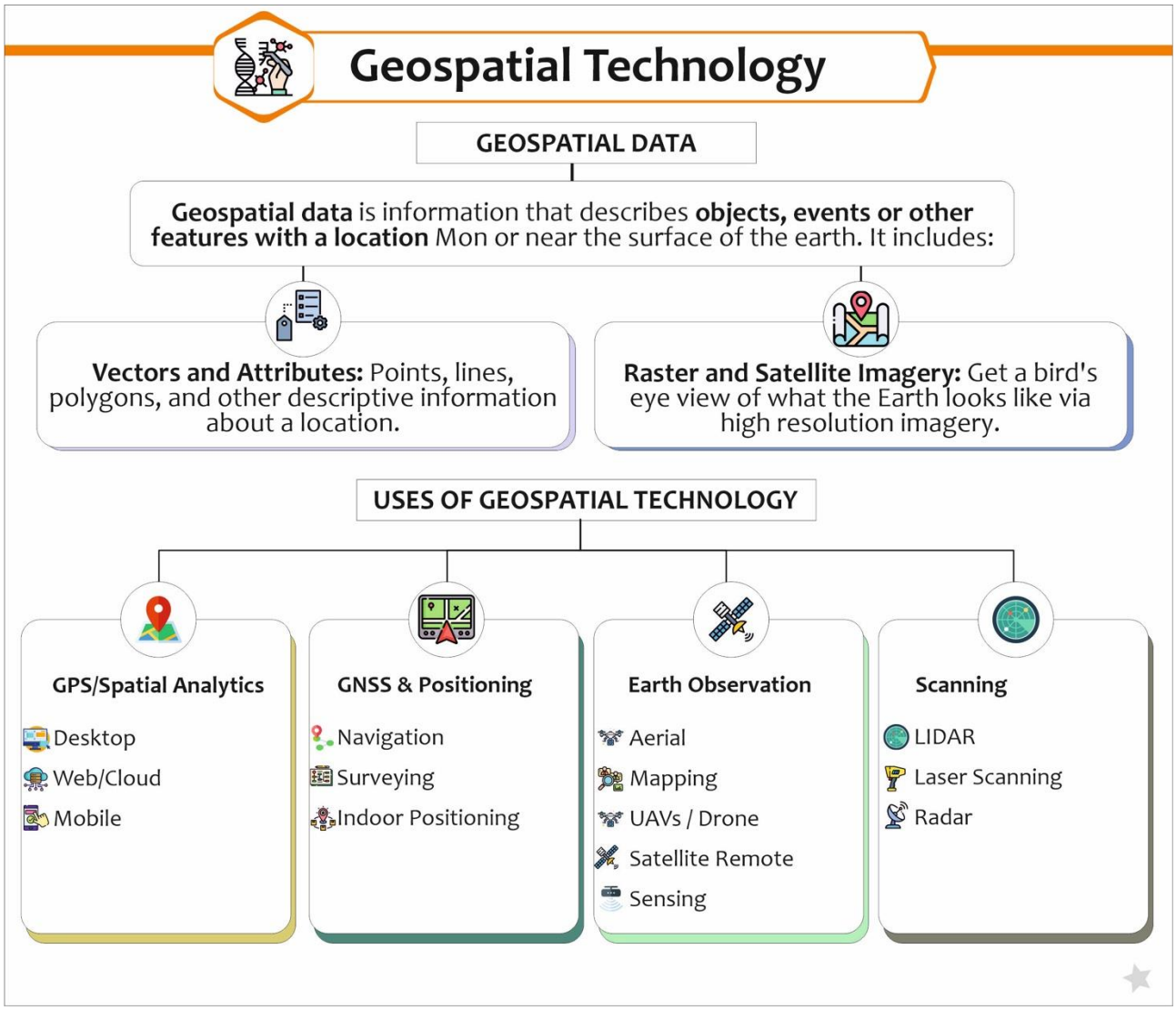
Related News
Maharashtra Cabinet approved the Gene Bank Project

- It is a **type of biorepository to preserve plants** (by collecting seeds, plants, tissue cultures) **and animals** (by collecting sperm and eggs).
- **At National level**, several such **facilities are established such as**:
  - **National Gene Bank** at National Bureau of Plant Genetic Resources, Pusa (It is **world's 2nd largest** refurbished gene bank).
  - **National Animal Gene Bank** at National Bureau of Animal Genetic Resources, Karnal.
  - **Indian Seed Vault** at Chang La (Ladakh).

1.7. OTHER IMPORTANT NEWS

Biological Research Regulatory Approval Portal (BioRRAP)	• **Department of Biotechnology has developed** BioRRAP **to track the regulatory approvals** for a research proposal on a single portal. • BioRRAP **provides a single route to direct the applicant to regulatory agencies** providing requisite approval relevant to the biological research. ○ **BioRRAP ID generated** through this portal **is linked with the portals of various regulatory agencies.** • This will provide **more credibility to such biological research** and will **strengthen interdepartmental synergies and increase efficacy** in functioning of agencies regulating various aspect of biological research.
Molecular motor	• Scientists have built a **molecular-scale motor using the DNA origami method** (involves folding of DNA to create 2D and 3D objects at nanoscale). • Molecular motors are a **class of proteins that drive intracellular movement** by converting chemical energy to mechanical work. • Some of the examples of **molecular motor's role in our bodies are muscle contraction, mitosis** (cell division) etc.

2. IT AND COMPUTER



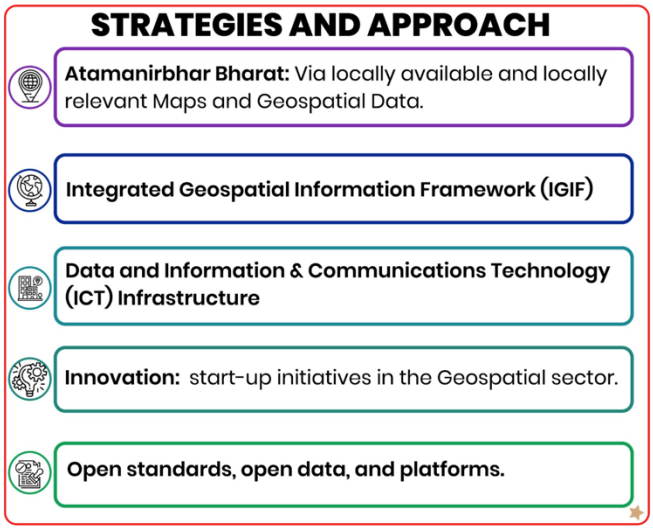
2.1. NATIONAL GEOSPATIAL POLICY

Why in news?

The Ministry of Science and Technology has notified a citizen-centric **National Geospatial Policy (NGP) 2022.**

Vision and Goals

- To make India a **World Leader in Global Geospatial space.**
- **Integrated Policy to move towards a digital economy** and improve services to citizens.
- **Better utilization of data.**
- Encouraging **participation of the private sector**

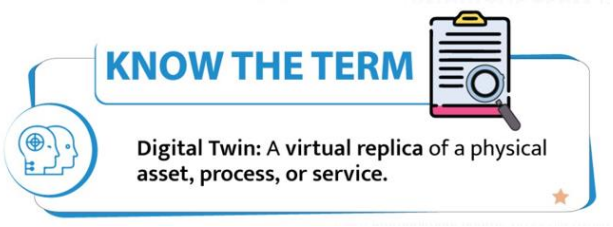


Institutional framework

- **Geospatial Data Promotion and Development Committee (GDPDC):** At national level, an apex body for formulating and implementing appropriate guidelines, strategies, and programs.
  - **GDPDC would replace** National Spatial Data Committee (NSDC) and Geospatial Data Promotion and Development Committee.

- **Role of Department of Science & Technology (DST):** Continue to be nodal Department and GDPDC shall make suitable recommendations to DST.

Strengthening Geospatial Infrastructure

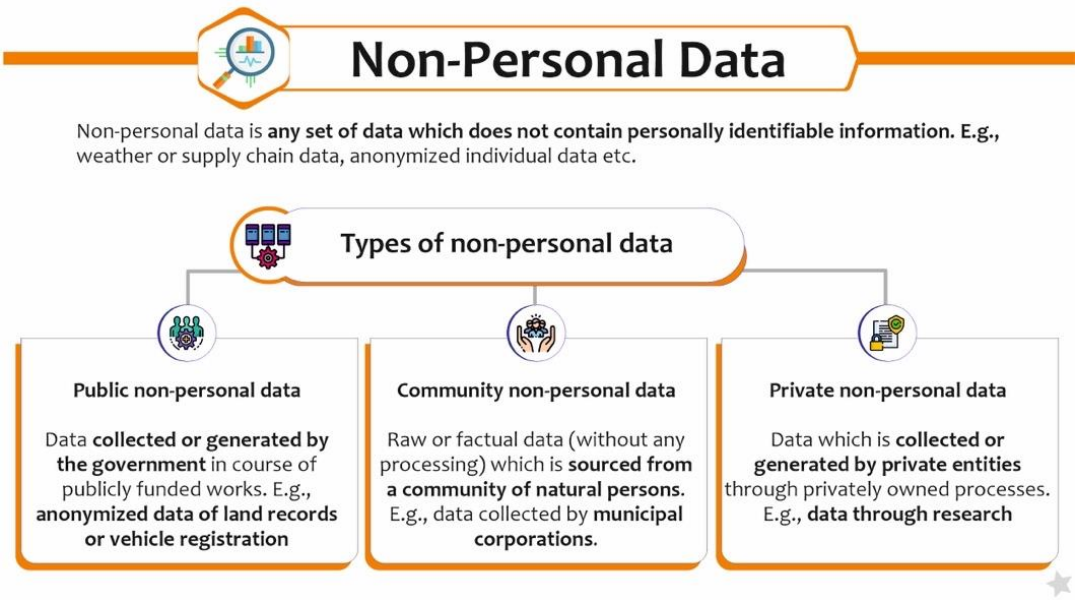


- **Geospatial Data Infrastructure**
  - GDPDC will **develop 14 global geospatial data themes** recognized by **United Nations Statistics Division**.
    - ✓ It **will also develop Sectoral Geospatial Data Themes** for various sectors.
  - **National Geospatial Data Registry (NGDR):** Accessible by all stakeholders.
  - **Unified Geospatial Interface (UGI):** To provide consumer-oriented products and solutions using Geospatial data.
  - **Survey of India (SoI):** Will help in developing NGDR and UGI in collaboration with Bhaskaracharya National Institute for Space Applications and Geo-informatics (BISAG-N)-under MeitY, private sector etc.
- **Mapping infrastructure:** Policy shall replace the National Map Policy, 2005.
- **Geospatial Knowledge Infrastructure (GKI)**: Will be enabled by the integration of Geospatial data with Fourth Industrial Revolution technologies and the growing digital infrastructure.
- **Geospatial Education and Skill Development:** National Institute for Geo-informatics Science and Technology (NIGST), Indian Institute of Remote Sensing (IIRS), and/or any suitable institute(s), public or private, will be developed into Centre(s) of Excellence.
- **Geospatial Industrial Development Board (GIDB): Advisory body** under GDPDC.

2.2. DRAFT NATIONAL DATA GOVERNANCE FRAMEWORK POLICY

Why in news?

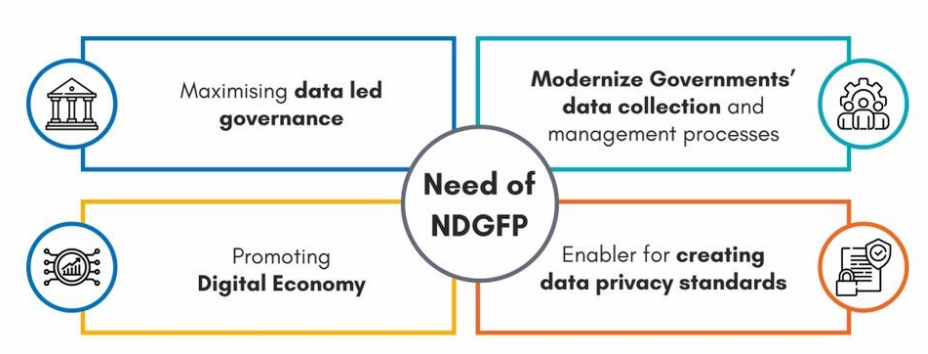
The Ministry of Electronics and Information Technology released a revised Draft National Data Governance Framework Policy (NDGFP).



About National Data Governance Framework Policy

It is the **revised version of Draft India Data Accessibility and Use Policy, 2022.**

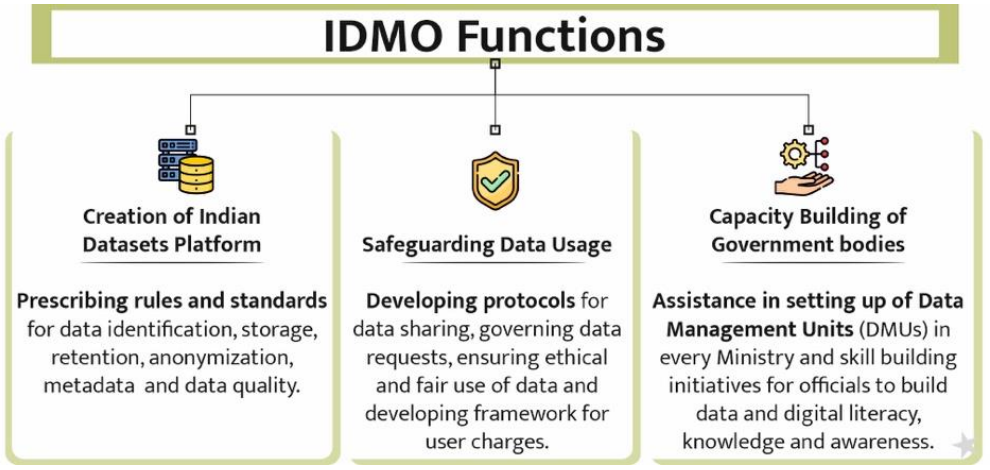
- **Aim:** To **enhance access, quality, and use of data,** in line with the current and emerging technology needs.
- **Objectives:** To accelerate Digital Governance**,** have standardized data management and security standards.



- **Applicability:** All Government departments and entities; all non-personal datasets and data and platform; rules, standards governing its access and use by researchers and Start-ups.

Components under NDGFP

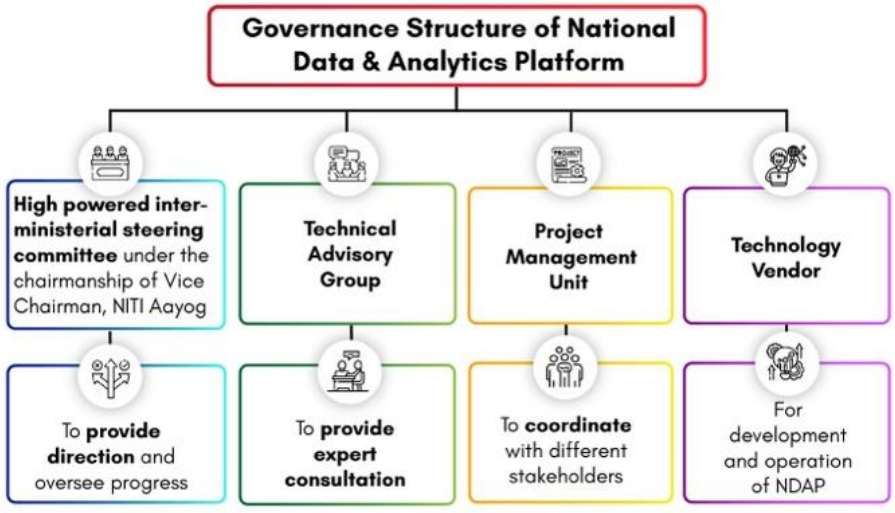
- **Indian Datasets Platform:** Consisting of anonymized non-personal datasets from Government entities collected from Indian citizens or those in India.
  - It will **provide datasets access to Indian researchers and startups.**
  - **NDGFP does not apply to the private players,** but they can voluntarily contribute their datasets.
  - N**o provision for monetization of such data.**
- **Indian Data Management Office (IDMO)** (refer infographic).
- **India Data Management Office (IDMO):** Will be set up under Digital India Corporation (DIC), under MeitY.
  - **Data Management Units (DMUs):** In every Ministry/Department to work closely with IDMO for ensuring implementation of the Policy.



Related News

NITI Aayog launched the National Data & Analytics Platform (NDAP) for open public use

- **About NDAP:** A user-friendly web platform accessible to all users.
- **Function:** Hosts **foundational datasets from various government agencies,** presents them coherently, and provides tools for **analytics and visualization.**



Related News

Bank for International Settlements (BIS) has **endorsed India's Data Empowerment Protection Architecture (DEPA)**

- **About DEPA:** A **joint public-private effort for an improved data governance** approach.
  - **DEPA forms the final layer of India Stack,** a set of APIs that allows various stakeholders **to utilise a unique digital infrastructure** aimed at presence-less, paperless, and cashless service delivery.
- **Function:** Creates a digital framework that **allows users to share their data on their own terms** through a third-party entity, Consent Managers.
- **Application:** DEPA's **first application has been in the financial sector.** It is being **tested in the health sector**, as well as others.

Yotta D1

- It is country's biggest and North India's **first hyperscale data centre that was recently inaugurated in** Greater Noida **Uttar Pradesh.**
- **About Data Centre:** Dedicated secure space within a centralized location where computing and networking equipment is concentrated for collecting, storing and processing large amounts of data.
- **Components: Network infrastructure** (connects servers etc. to end-user locations); **Storage infrastructure; and Computing resources** (provide processing, memory, etc. that drive applications).

2.3. FIFTH GENERATION (5G)

Why in news?

Recently, Prime Minister inaugurated the country's first 5G testbed.

More about news

- The 5G testbed has been developed as a **multi-institute collaborative project** by eight institutes led by IIT Madras.
- It is the **Country's first 5G testbed** to enable startups and industry players to test and validate their products locally.

About 5G technologies

3G vs 4G vs 5G vs 6G

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

5G is the Fifth generation of cellular networks.

5G Spectrum Types

5G Spectrum	Features
Low-band	Lower than 1 GHz on the spectrum chart. Wider coverage but limited improvement in speed and latency. For thinly populated areas and provides indoor coverage in built-up areas.
Mid-band	1 GHz - 6 GHz range. Ideal for 5G because it can carry plenty of data while also traveling significant distances.
High-band	24 GHz band and higher. It delivers super-fast speeds over short distances.

- **5G is an amalgamation of various technologies** such as:
  - **Massive multi-user MIMO** (Multiple input multiple output) enabled network.
  - **Small cell stations** to connect the base stations and users seamlessly.
  - **Mobile Edge Computing** that brings cloud computing closer to the user.
  - **Beamforcing** a laser beam between transmitting entity and the user.
- **5G operates at higher frequencies** and is **designed to connect virtually everyone and everything together** including machines, objects, and devices.
- Have an **enhanced throughput to handle more simultaneous connections** at a time.

Other Steps taken by Government to boost 5G Tech

- **Cellular Operators Association of India** (COAI) has **formed the 5G India Forum (5GIF).**
- **National Digital Communication Policy-2018** lays out the objectives with respect to 5G services in India.

KNOW THE TERM

Network slicing

- Network slicing is a **network configuration that allows multiple networks** (virtualized and independent) to be created on top of a common physical infrastructure.
- This configuration has become an **essential component of the overall 5G architectural landscape.**
- Each "slice" or portion of the network **can be allocated based on the specific needs** of the application, use case or customer.

KNOW THE TERM

- **Fiberisation:** Process of **connecting radio towers with each other** via optical fiber cables.
  - **Connects core of network to edge** facilitating large amounts of data used in **5G services.**
  - **Provides additional bandwidth** and stronger backhaul support.
  - In India, **currently only 33% of towers are fiberised,** compared to 80%-90% in U.S., Japan and China.

- **5G Vertical Engagement and Partnership Program (VEPP) initiative:** Department of Telecommunications (DoT) has invited Expression of Interest for initiative to enable close collaboration between User verticals and 5G Tech stakeholders.

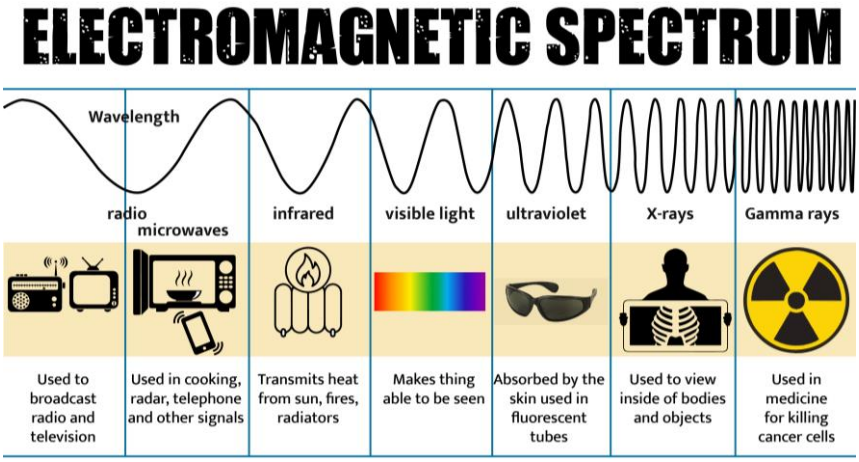
Related News
5G Airwave Interference
- Directorate General of Civil Aviation (DGCA) flagged **concerns over likely interference of 5G C-Band spectrum with aircraft radio altimeters** as both operate in mid C-Band frequency range.
  - A radio altimeter **provides direct height-above-terrain information** to various aircraft systems and use of altimeters in **C- band ensures highly precise measurements** of plane's altitude.
  - **For telecom service providers, C-Band ensures coverage as well as high bandwidth**, resulting in faster internet speeds, **for rolling out 5G services.**

Private captive 5G networks
- **Union Cabinet has allowed private captive 5G telecom network** in India.
- A private captive 5G network is a **network set up by a private entity for the use of enterprise concerned, and no one else.**

2.3.1. 5G SPECTRUM AUCTION

Why in News?

A record over ₹1.5 lakh crore worth of 5G telecom spectrum was sold in recently held auction.



About 5G spectrum

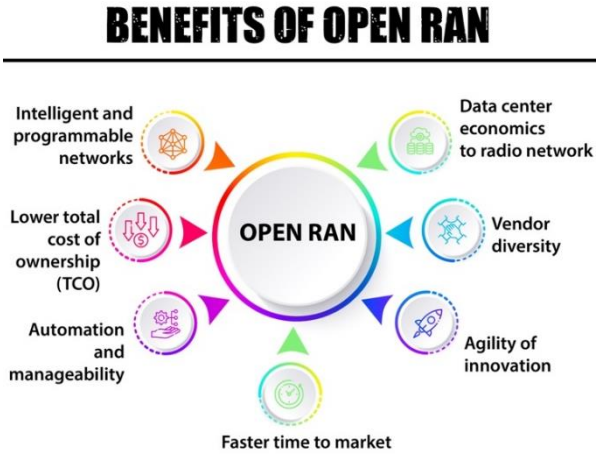
- Spectrum relates to the **radio frequencies allocated to the mobile industry and other sectors for communication** over the airwaves.
- **Spectrum is a sovereign asset.**
- Operators are most likely going to **use a mix of low-band, mid-band, and high-band spectrum** to deliver the type of 5G experience that their customers demand.

Related Information
E-Band
- Broadband and WiFi players **opposes giving E band exclusively to Telcos**.
- **E band** is the **range of radio frequencies from 60 GHz to 90 GHz** in the electromagnetic spectrum.
- E-band is a major **solution of 5G's microwave transmission.**

2.3.2. 5G OPEN RADIO ACCESS NETWORK (RAN)

Why in News?

Centre for Development of Telematics (C-DOT), WiSig Networks Private Limited and VVDN Technologies Private Limited have signed an **agreement for developing 5G Open RAN** and other products together.



About RAN

- RAN is **part of network** that **connects the main network infrastructure to end-users**.
  - It **connects individual devices to other parts of a network** through radio connections.
- It **provides the critical technology to connect users to the mobile network** over radio waves.
  It acts as a **bridge to access all the key applications on the web**.
  - Current RAN technology is **provided as an integrated platform of both hardware and software.**
  - Therefore, it is **difficult to mix vendors for its different units**.

- Idea of **Open RAN is to enable operators to mix and match components** from different vendors.
  - Open RAN **will create a multi-supplier RAN solution** that allows for the separation between hardware and software with open interfaces.

Related Information

- **Standalone (SA) 5G:** A telecom network where both core network and radio access network (RAN) are upgraded to 5G.
  - It **replaces the LTE network** 4G wireless communications standard and allows **completely independent operation** of a 5G service **without any interaction with an existing 4G core.**
- **Non-standalone 5G:** In this, only RAN part of the network is upgraded.
  - It is **built over an existing 4G network.**
- **Advantage of SA over NSA:** superior voice quality, significantly more speed, lower latency etc.
- **Challenges of SA 5G:** not all phones will have support for SA 5G, will cost more etc.

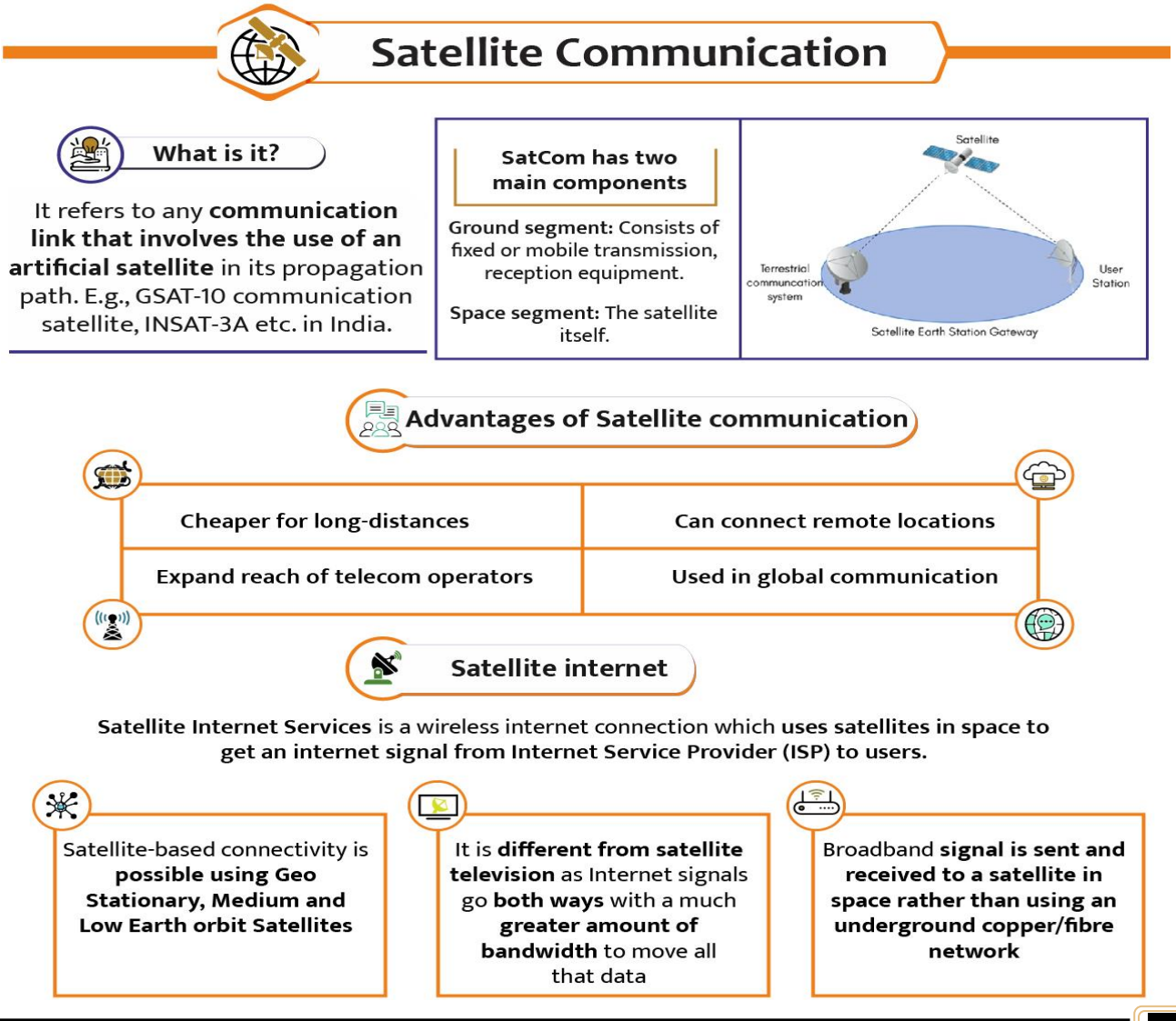
2.4. SATELLITE COMMUNICATION

Why in News?

Recently TRAI releases recommendations on 'Licensing framework for Establishing and Operating for Satellite Earth Station Gateway (SESG).

More about the news

- SESG, also known as **Gateway Hub**, acts as a **bridge between space-based communication network** and **terrestrial communication network.**
  - It houses the equipment that **convert Radio Frequency (RF) signal to an Internet Protocol (IP) signal** for terrestrial connectivity.



2.4.1. OTHER COMMUNICATION NETWORKS

Wi-Fi	• **RailTel**, a mini Ratna PSU under Ministry of Railways, **has launched PM-WANI scheme based access to its Public Wi-Fi** services **across 100 railway stations.**
	  ○ Wi-Fi network **can also be accessed through Mobile App 'Wi-DOT'**, built by **RailTel** and **C-DOT.**
	  ○ PM-WANI, by Department of Telecommunications, **aims to elevate wireless internet connectivity** in the country **through Public Wi-Fi Hotspot** providers.
	• **Wi-Fi**, or **Wireless Fidelity**, is a **wireless networking technology** that gives **internet access to devices** like desktop computers, laptops, mobile phones, smart TVs etc.
	• It uses **radio frequencies**, or **radio waves**, in frequency **bands 2.4GHz to 5GHz** to communicate between devices.

Splinternet	• **Russia-Ukraine war has threatened to splinter the internet.** • Splinternet refers to '**Internet that is increasingly fragmented** due to **nations filtering content or blocking it entirely for political purposes'. For Example:** ○ **China's 'Great Firewall'** keeps American tech giants out while pushing online services developed indigenously. • **Russia, in 2019, passed the sovereign internet law** — or the online Iron Curtain — that enabled the country to disconnect its internet from the rest of the world.

GigaMesh	• GigaMesh is an **innovative wireless network solution** that can give **fibre-like bandwidth internet services** to suburban and rural areas.
	  ○ It aims to **address congestion issues in 4G infrastructure** and provide high-tech and affordable internet connectivity.
	• **Developed by:** Astrome, a deep-tech startup.
	  ○ Astrome is **supported by Technology Innovation Hub** at the Indian Institute of Science.

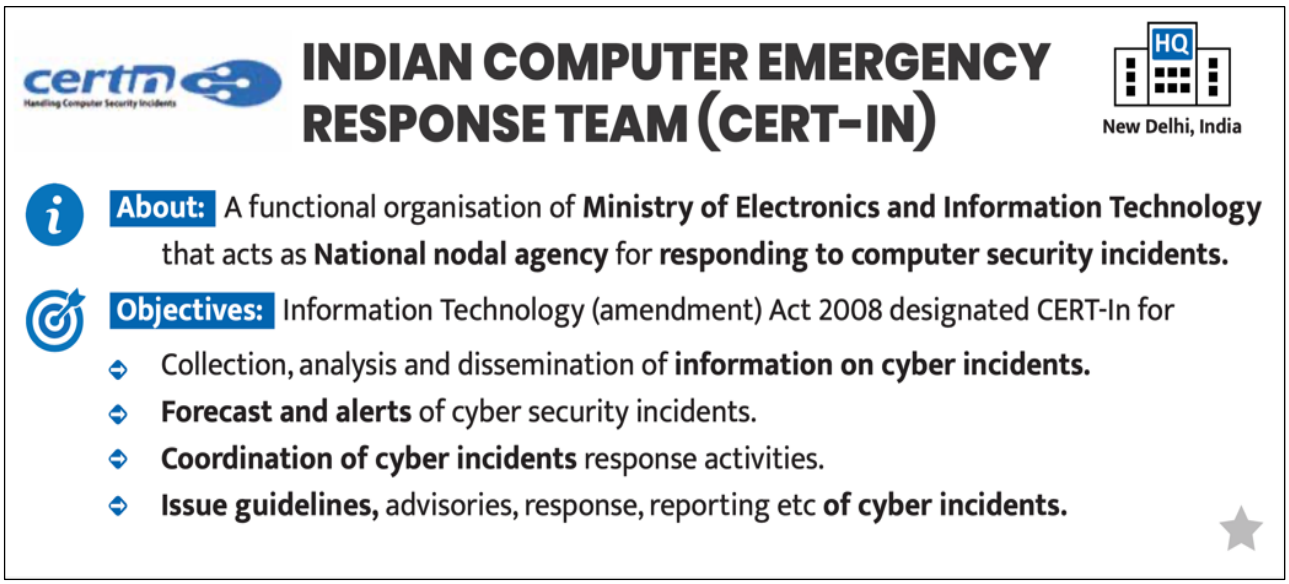
2.5. VIRTUAL PRIVATE NETWORK (VPN)

Why in news?

Recently, the **Central government has asked virtual private network (VPN) companies** to keep a record of their logs of customer information as directed by Indian Computer Emergency Response Team (CERT-In).

About CERT-In guidelines

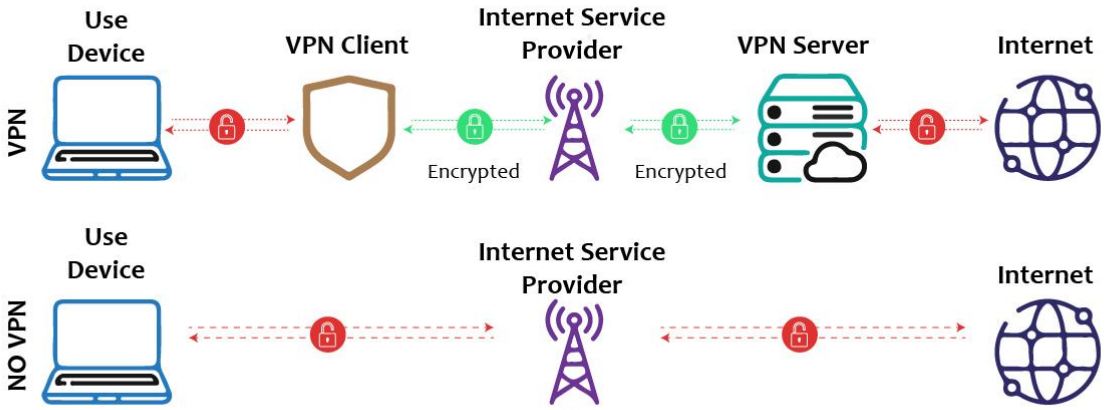
- New directives by CERT-In under **Information Technology Act, 2000** state that:
  - All cloud service and VPN providers to **maintain a series of extensive customer information for at least five years**, even after cancellation or withdrawal of the registration.
  - **Data centre companies and cryptocurrency exchanges** are also asked to collect and store user data.



Virtual Private Network

What is it?

VPN is an **encrypted connection** over the Internet from a device to a network **in real time**



Types of VPN

Secure Sockets Layer (SSL) VPN

It enables individual users to **access an organization's network** and client-server applications **without the need for specialized software**

Site-to-site VPN

A **private network designed to hide private intranets** and allow users of these secure networks to access each other's resources.

Client-to-Server VPN

User is not connected to the internet via his own ISP (internet service provider), but establishing **a direct connection through VPN provider.**

Benefits of using a VPN

Encryption of IP address and protocols (prevents third parties from gaining access to confidential information).

Issues associated with using a VPN

Jurisdiction (The country where your VPN is located affects how secure your VPN is)

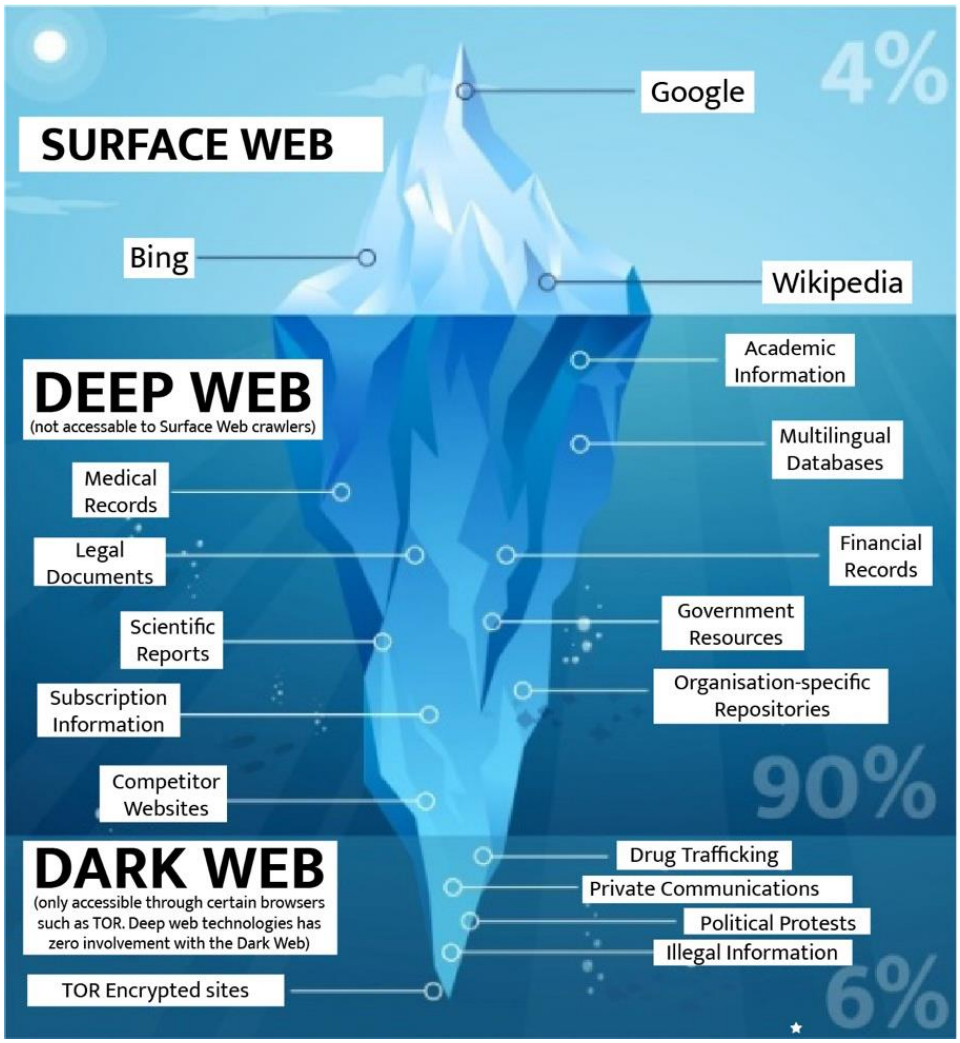
Data leaks and cybersecurity issues.

2.6. DARKNET

Why in News?

Germany has shut down Russia-linked 'Hydra Market'- considered as world's **biggest and oldest DarkNet marketplace** of illegal items and services.

About DarkNet



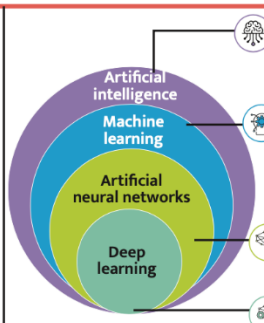
- **Also known as Dark Web,** it is that **part of the Internet which cannot be accessed through traditional search engines** like Google nor is it accessible by normal browsers like Chrome or Safari.
    - It **generally uses non-standard communication protocols** which make it inaccessible to internet service providers (ISPs) or government authorities.
    - **Content on Dark Net is encrypted and requires a specific browser such as TOR** (The Onion Ring) to access those pages.
- **Dark Net itself is only a part of the Deep Web,** which includes sites that are protected by passwords.
    - **Part of the internet that is readily available** and searchable on standard search engines **is called as Surface Web.**
- **Application: Used by journalists and citizens working in oppressive regimes** (to communicate without any government censorship), **researchers and students** to do research on sensitive topics, law enforcement agencies, etc.
- **Concerns over its use:** Anonymity, Haven for illicit activity, Privacy and ethical concerns, drug dealing, communication by terrorists, etc.

2.7. ARTIFICIAL INTELLIGENCE

Artificial Intelligence

What is AI?

- Field of computer science that **focuses on the creation of intelligent machines that can perform tasks that typically require human intelligence** like visual perception, speech recognition and language translation.
- **Enable computers to learn from experience, adjust to new inputs and perform human-like tasks.**



Artificial intelligence (AI)
Any techniques that enable machines to solve a task in a way like humans do.

Machine learning (ML)
Algorithms that allow computers to learn. from examples without being explicitly programmed.

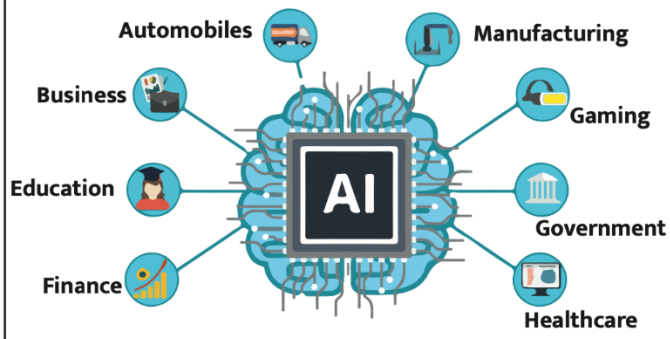
Artificial neural networks (ANN)
Brain-inspired machine learning models.

Deep learning (DL)
A subset of ML which uses deep artificial neural networks as models and automatically builds a hierarchy of data representations.

Types of AI

- **Artificial Narrow Intelligence** (or weak AI) Ability of a computer system to outperform humans in a narrowly defined task.
- **Artificial General Intelligence** (also called strong/human-level AI) Ability of a computer system to outperform humans in any intellectual task.
- **Artificial Super Intelligence** Computer system that would outperform humans in almost every field, including scientific creativity, general wisdom and social skills

Applications of Artificial Intelligence



2.7.1. GENERATIVE ARTIFICIAL INTELLIGENCE

Why in News?

Recently, Tech companies around the world are harnessing Generative AI for various use cases.

Related News
LaMDA (Language Models for Dialog Applications)

- LaMDA is a **machine-learning language model** created by **Google as a chatbot** that is supposed to **mimic humans in conversation.**
  - Like BERT, GPT-3 and other language models, **LaMDA is built on Transformer**, a **neural network architecture** that Google invented and open-sourced in 2017.
  - It is designed to be **able to engage in free-flowing conversations** about virtually endless number of topics.

More about News

- There has been **increasing popularity of generative AI programs,** such as **OpenAI's ChatGPT, Google's BARD AI,** DALL-E, Codex, GPT-3 etc.
- These programs are a **conversational AI language based on deep learning model built on the transformer architecture.**
  - It **uses a deep neural network** and is trained on corpus of text data from the internet, allowing it to generate human-like text and to perform various tasks like question answering, and conversation.

Generative artificial intelligence (AI)

- Describes **algorithms that can be used to create new content** like audio, code, images, text, simulations, and videos.
- **Achieved by** training machine learning models on large amounts of data using neural networks and then using these models to generate new, synthetic data, like already existing data.
- **Prominent frameworks or models of generative AI** like **Generative adversarial networks (GANs), Transformer-Based Models (TBMs)** and **Variational AutoEncoders (VAEs).**

2.7.2. GLOBAL PARTNERSHIP ON AI (GPAI)

Why in News?

India took over the Chair of Global Partnership on AI (GPAI) from France.

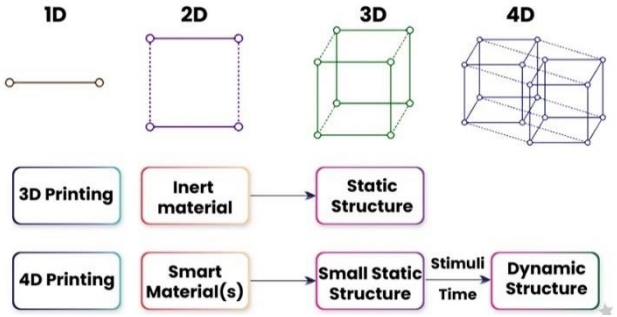
Related News
Responsible AI for Youth 2022

- National E-Governance Division of **Ministry of Electronics & IT in collaboration with Intel India** launched 'Responsible AI for Youth 2022' program.
- Program is aimed at **enabling school students with Artificial intelligence (AI) skills** in an inclusive manner through exclusive hands-on learning and mentorship opportunities.
  - It is open to **all school students studying in classes 8-12 across India**.

2.8. 4 D PRINTING

Why in news?

In recent years, 4D printing technology has enhanced the potential of cancer therapeutics such as surgery, hyperthermia, chemotherapy, therapeutic devices etc.



About 4-D printing

- **A renovation of 3D printing** wherein special materials is used to print objects that change shape post-production.
- **Need Stimuli or triggers to start transformation:** Such as moisture, temperature, light, electrical current, stress, pH etc.
- **Materials used:** Hydrogels, Thermo-responsive, Photo and magneto responsive, Piezoelectric materials, pH-responsive etc.
- **Properties:** Self-assembly, self-adaptability, self-healing, shape memory, self-capability etc.
- **Printing techniques:** Similar to ones used in 3D such as fused deposition modelling (FDM), jet 3D printing (3DP), selective laser melting (SLM), direct ink writing (DIW), electron beam melting (EBM), etc.
- **Applications:** Medical, biotechnology, robotics, automobiles, aerospace, textiles, flexible electronics, construction etc.

Related Concept
Additive manufacturing or 3D printing

- Technology that **constructs a three-dimensional object from a digital 3D model or a Computer-aided design** (CAD) model by adding material layer by layer.
  - 3D printing is the **opposite of subtractive (traditional) manufacturing** which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.
- It allows **creation of lighter, more complex designs** that are too difficult or too expensive to build using traditional dies, milling and machining.

2.9. QUANTUM KEY DISTRIBUTION (QKD)

Why in News?

Bengaluru-based start-up QNu labs recently innovated advanced secured communication through quantum key distribution (QKD) systems.

More about News

- **Developed By:** QNu Labs under aegis of Innovation for Defence Excellence (iDEX).
  - iDEX is **operational framework of Defence Innovation Organization** (DIO), a special purpose vehicle under Ministry of Defence.

- **Objective of iDEX:** To create an ecosystem to foster innovation, entrepreneurship, and technology development, specifically in Defence and Aerospace sector.

About Quantum Technology

Quantum technology **seeks to harness laws of quantum physics,** which describe the behaviour of matter and energy at the **atomic and subatomic level.**
This is unlike classical physics, in which an **object can exist in one place at one time.** E.g. classical computers operate using binary physical state (1 and 0).

Potential applications of Quantum technology

Quantum Computing: Uses qubits (typically subatomic particles) as its the basic unit of information instead of binary bits.

Quantum communication: Uses quantum bits, typically photons of light, for transmitting data along optical cables. Includes technologies like- Quantum key distribution and Quantum Random Number Generation (QRNG).

Quantum simulation: Specially designed quantum computer constructed for the purpose of simulating materials or chemical reactions of the physical world.

Quantum sensing and metrology: Uses individual particles such as photons and electrons as highly sensitive sensors in current technologies related to measurements of forces, gravitation, electric fields etc.

About quantum key distribution (QKD)

- QKD is a secure **communication technology that uses quantum physics** to construct a cryptographic protocol.
  - It **allows two parties to generate a shared secret key** that can be used to encrypt and decrypt messages.
- **In traditional cryptography,** security is usually because an **adversary is unable to solve a certain mathematical problem** while in QKD, **security is achieved through laws of quantum physics.**
- Two such laws are **Superposition and Entanglement.**

KNOW THE TERM

- **Superposition:** Ability of a quantum particle to be in multiple states at the same time until it is measured.
- **Entanglement:** A situation in which two or more quantum particles are linked in such a way that it is impossible for them to be described independently but measurements from one particle can be used to instantly draw conclusions about the others.

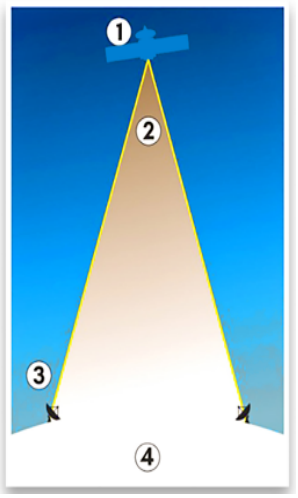
Related News
Quantum Internet

- **Researchers have successfully teleported quantum information across a basic network.**
- **Quantum internet:** Based on the theoretical use of quantum computers to construct a new kind of network.
- In contrast to **traditional internet which operates through the use of binary signals** (represented by 0's or 1's) in data packets, **quantum internet would utilize quantum bits, or qubits,** to encode information as 0's, 1's, or both at same time.

How does Quantum Key Distribution works?

Quantum key distribution allows user to agree on a way of transmitting their data without the worry that someone is listening in

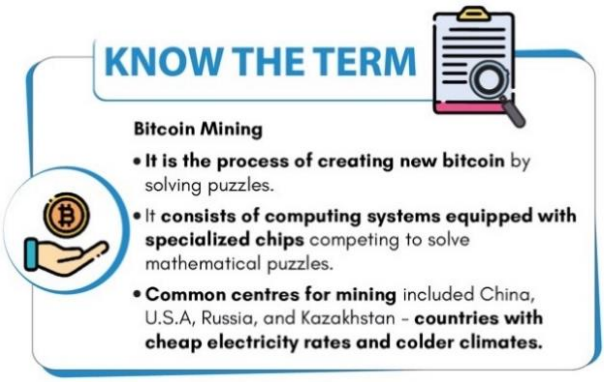
- Sender instructs satellite to generate 2 entangled photons of particular quantum state
- Photons are beamed to both ground stations
- Sender and receiver compare the quantum states of the photons to check if they have been intercepted. If not they use the photons to create a code to encrypt the date
- Encrypted data can then be sent securely via conventional means



2.10. PROOF-OF-STAKE TECHNOLOGY

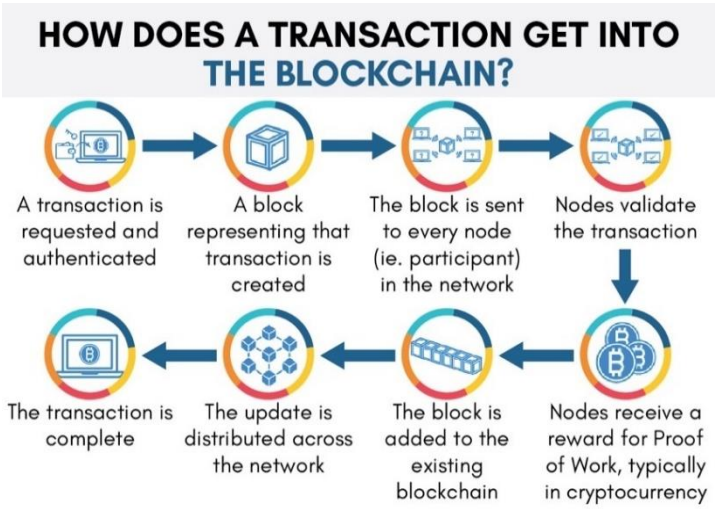
Why in News?

Ethereum blockchain platform switched to Merge software mechanism that uses 'proof-of-stake' (PoS) mechanism.



About Merge and Proof-of-Stake

- Ethereum is **a decentralised blockchain platform used to build decentralised apps** (dApps) and smart contracts among others.
- **Merge is a software**, aimed at slashing energy consumption, **to the way transactions are validated on Ethereum** blockchain.
    - Blockchain is **a distributed or decentralised ledger technology** which was first introduced in the design and development of cryptocurrency.
- Merge uses the **process of shifting the consensus mechanism** of the blockchain **from proof-of-work (PoW) to proof-of-stake (PoS).**
- **Importance of new consensus mechanism:** Less impact of crypto mining on local communities: Environmentally conscious move, better security, Ripple effect on the direction in which the crypto and broader Web3 industry contribute to positive climate action.



Related Concept
Non-fungible tokens (NFT)

- NFT is a **digital object** that can be a drawing, animation, piece of music, photo, or video **with a certificate of authenticity created by blockchain technology.**
    - **Tokenizing** these assets allows them to be bought, sold, and traded **more efficiently while reducing the probability of fraud.**
    - **Fungibility** refers to an **asset's ability to be exchanged with a similar asset** without sacrificing its value (For ex: 100 rupee note is fungible).
- **Characteristics of NFT**
    - All NFTs have a **unique quality** and a **distinct value** from any other similar token.
    - They are **digitally rare.**
    - Must **be sold or purchased as a whole** as they **cannot be divided** unlike fungible tokens.

	Proof-of-Work (PoW)	Proof-of-Stake (PoS)
About	Mechanism bitcoin uses **to regulate creation of blocks** through the process of mining.	An alternative consensus mechanism that **delegates control of the network to the owners of a given token.**
Working Mechanism	**PROOF OF WORK** To add each block to the chain, miners must compete to solve a difficult puzzle using their computers processing power. In order to add a malicious block, you'd have to have a computer more powerful than 51% of the network. The first miner to solve the puzzle is given a reward for their work.	**PROOF OF STAKE** There is no competition as the block creator is chosen by an algorithm based on the user's stake. In order to add a malicious block, you'd have to own 51% of all the cryptocurrency on the network. There is no reward for making a block, so the block creator takes a transaction fee.
Energy Consumption	**PoW consumes more energy** since it allows all miners on a network to try and validate a transaction.	**PoS replaces miners with validators** and rewards only the top stakeholders, **resulting in less energy consumption.**

2.11. FACIAL RECOGNITION SYSTEM (FRS)

Why in news?

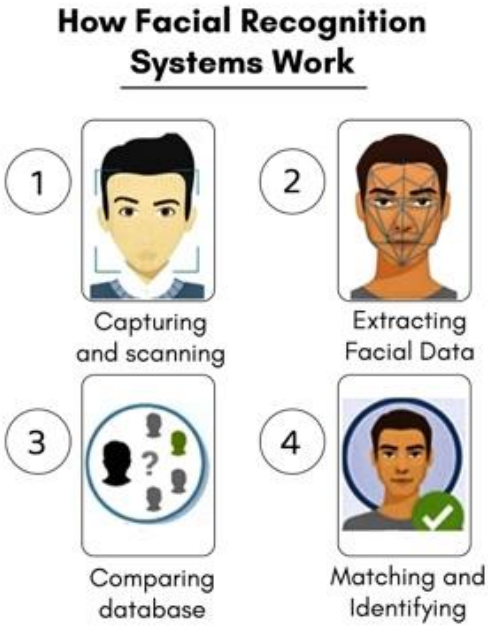
First phase of Facial Recognition System (FRS) is planned at **Kolkata, Varanasi, Pune, Vijayawada, Bangalore, Delhi and Hyderabad Airports** by March 2023.

More on News

- FRS is **part of the Digi Yatra initiative** (Ministry of Civil Aviation) **to promote seamless and hassle-free experience at airports** and simultaneously **improving the security.**
  - Government is looking to make **ticket booking, airport entry and boarding pass security check-in digital.**
- **Digi Yatra Foundation (DYF)** has been set up as a joint venture company for **creating the Digi Yatra Central Ecosystem.**

About Facial Recognition System

- FRS 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.
  - For verification or identification, **system compares faceprint generated with a large existing database** of faceprints.

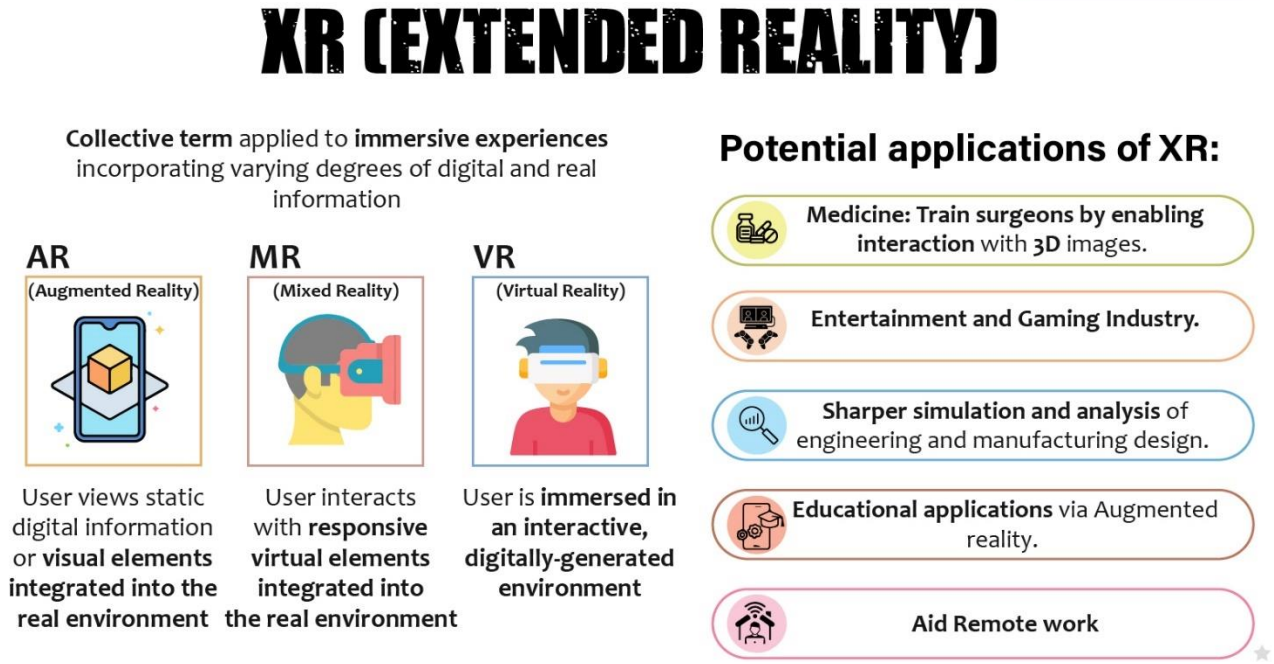


Applications of Facial Recognition System	Concerns against use of Facial Recognition System
Automated processing at checkpoints like Entry Point, Security check etc.	Can be used for **state-sponsored mass surveillance.**
Facilitates crime investigation and provide information for easier and faster analysis	**Privacy Concerns**
Identification of criminals, missing children/persons, unidentified dead bodies etc.	Potential vitiation of due process in **absence of a data protection law.**

2.12. EXTENDED REALITY

Why in news?

Ministry of Electronics and Information Technology (MeitY) Startup Hub and Meta collaborate to accelerate XR technology start-ups in India.



2.13. RADIO FREQUENCY IDENTIFICATION (RFID)

Why in News?

Delhi airport has become the first Indian airport to introduce Radio Frequency Identification (RFID)-enabled tag to track check-in luggage.

Various Types of Wireless Technologies

	Radiofrequency Identification (RFID) 	Quick Response (QR) code 	Near Field Communication Technology (NFCT) 
About	• **A wireless system** comprised of two components: **tags and readers.**	• A **two-dimensional version of a barcode that can be read easily by a digital device**	• A **short-range wireless connectivity technology** that allows NFC-enabled devices to communicate with each other and **transfer information quickly and easily with a single touch**
Working Range	• **Read distance depends upon the frequency** (Ranging from 300 gigahertz to as low as 9 kilohertz) used	• Ideal scanning **size to distance ratio is 1:10.**	• NFC-enabled devices must be **either physically touching or within a few centimeters from each other** for data transfer.
Other Key Information	• **Do not require a direct line of sight** to be read. • Data stored in an RFID tag **can be updated in real-time.**	• **Require a line of sight** to scan. • **No real-time tracking.**	• **Transfer information quickly and easily** with a single touch.

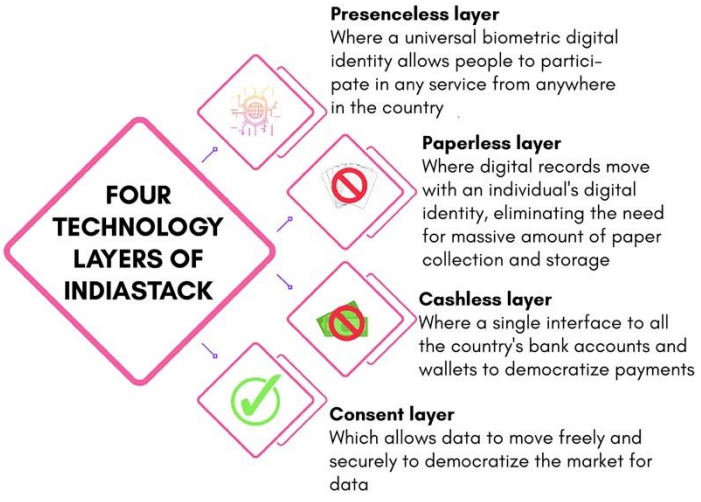
2.14. INDIASTACK

Why in News?

IndiaStack Knowledge Exchange 2022 held recently.

More on News

- Earlier, India also launched **Indiastack. global** - a **single repository** of all major projects on **IndiaStack**.
  - **Indiastack. global** allows to contribute towards the **Global Digital Public Goods** repository.



About IndiaStack

- A collection of open APIs and digital public goods.
  - API stands for **Application Programming Interface**. It allows two applications to talk to each other.
  - IndiaStack includes **APIs of Aadhaar, Unified Payment Interface (UPI), Co-Win, DigiLocker, Aarogya Setu, eSanjeevani, UMANG, DIKSHA**, etc.
- **Aim:** To unlock the economic opportunities of **identity, data**, and **payments** at population scale.

2.15. OTHER IMPORTANT NEWS

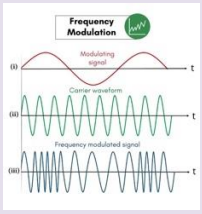
2.15.1. INITIATIVES/GUIDELINES/PROGRAMS/FORUMS

Global Declaration on	• **India stays out of global declaration** on future on Internet. • It is a **political commitment** that aims **to keep Internet open, free, and neutral.** ○ US, European Union, UK, Canada etc signed the declaration.

future on internet	○ **India, China, and Russia** are **not part** of this declaration. • India also **did not sign the Budapest Convention on Cybercrime,** 2001. ○ **Data sharing** provisions of Budapest Convention infringes on **national sovereignty**. ○ Presently, it is the **only legally binding multilateral convention** on cybercrime and electronic evidence.
Internet Governance	• **India Internet Governance Forum (IGF) 2022 was held recently.** ○ It is an **initiative associated with UN Internet Governance Forum**, a multi-stakeholder platform to discuss public policy issues related to Internet. • Internet Governance is **development and application** by Governments, private sector, and civil society, of **decision-making procedures** and programs **that shapes use of Internet**. ○ It includes **Physical Infrastructure layer, Code or Logical layer, Content layer and Security**. ○ It **involves IP Addressing, Domain Name System (DNS), Routing,** Technical Innovations, Standardization, Security, Privacy etc. • **No single organization in charge of Internet.** • **Major actors:** Internet Corporation for Assigned Names and Numbers (ICANN), IGF, Internet companies, NGOs etc. • **India also supports a multi-stakeholder approach** in matters on Internet Governance.
National Internet Exchange of India (NIXI)	• **NIXI has established two new Internet Exchange Points** (IXP) in West Bengal **under Digital India Vision**. ○ IXP is a **physical network access point** through which primary network providers connect their networks and exchange traffic. • **About NIXI: A not-for-profit organization,** established in 2003, **that facilitates exchange of domestic internet traffic** between peering **ISPs** (internet service providers) members. • **It also functions as:** ○ **.in registry** (India's **Country Code Top Level Domain**), and • **Indian Registry for Internet Names and Numbers:** allocating and registering **Internet Protocol Addresses (IPv4 and IPv6)**.
2Africa Pearls	• Facebook parent Meta **will partner with Bharti Airtel to expand 2Africa Pearls to India**. • 2Africa Pearls is **one of world's longest subsea cable systems** that will ultimately **interconnect countries in Africa, Asia, and Europe**. • 2Africa Pearls **will improve connectivity of fixed-line broadband** internet **in India.**
Global Lighthouse Network (GLN)	• Recently, **World Economic Forum announced addition of three Indian factories** to its GLN. • **GLN is a World Economic Forum initiative in collaboration with McKinsey & Company.** ○ It is a **community of over 100 manufacturers** that are showing **leadership in applying Fourth Industrial Revolution technologies** such as artificial intelligence, 3D-printing and big data analytics.
ITU's- Regional Standardization Forum (RSF)	• **Ministry of Communications hosted the International Telecommunication Union's (ITU) RSF** for Asia and Oceania region. • RSF is a **platform for exchange of ideas, discussing standardization topics** like Sustainable Digital Transformation and **Role of ITU Standards,** evolving Data Value Chain etc. 
DigiLocker	• **Ministry of Electronics & IT (MeitY)** has **enabled DigiLocker to store and access health records** of individuals pertaining to **Ayushman Bharat Digital Mission.** • DigiLocker **is a flagship initiative of MeitY** under Digital India program. ○ It is a **platform to issue/store and digitally verify government documents** and certificates. ○ Documents in DigiLocker system are deemed to be **at par with original physical documents** under **Information Technology Rules, 2016**. ○ Digital Locker is **aimed at minimising the usage of physical documents** and enable **sharing of e-documents across agencies.**
Roadmap to promote IPR in telecom sector	• Department of Telecommunications (DoT) debates a **strategy roadmap to promote IPR** in the telecom sector. • **Road map proposed** ○ **Sovereign Patent Fund: To aggregate patents** from home-grown firms and offer them as a bouquet abroad **and procuring patented licensing** for key technologies such as 5G and 6G, etc.

	○ **Bharat Technology Bank**: To offer **Indian patents to needy countries** at nominal fee for creating diplomatic goodwill and helping Indian companies access new markets. ○ **Digicom Intellectual Property Management Board**: To facilitate IPR licensing, IP management and arbitrate on issues related to standard essential patent (SEP) in India. ✓ SEPs **protect the telecom industry's core technology** like Wi-Fi, Bluetooth, GPS, etc.

2.15.2. TECHNOLOGIES/CONCEPTS

Frequency Modulation (FM) 	• Government has **approved amendments in FM Radio Phase-III policy** guidelines to simplify eligibility criteria. • FM, (**88** to **108 MHz**), refers to modulation process in which **frequency of carrier wave** (**radio wave**) is modulated while keeping **phase and amplitude constant**. ○ In **Amplitude Modulation (AM)** (**535** to **1700 KHz**), carrier wave amplitude is altered, keeping others constant. ○ In **Phase Modulation (PM)**, carrier phase angle is altered. • **Advantages of FM:** Resilience to interference, Easy to Modulate etc. • **Disadvantages:** Poor spectral efficiency, requires more complicated demodulator. • **Uses:** Broadcasting, Audio Transmission on TV.
Embedded SIM (e-SIM) 	• Telecom Regulatory Authority of India (TRAI) has released **consultation paper on e-SIM for M2M (machine-to-machine) Communications**. • **e-SIM is a form factor** that is **physically integrated into device,** mostly by soldering to device printed circuit board (PCB). ○ It **cannot be easily removed** in the field. ○ It **requires remote provisioning which is ability to remotely select SIM profile** deployed on a SIM without physically changing SIM card. • It supports **multiple applications unlike regular SIMs** and can be modified (as per requirements) remotely.
ARYABHAT-1 	• Indian Institute of Science have built a prototype of an **analog chipset called ARYABHAT-1** (Analog Reconfigurable Technology and Bias-scalable Hardware for AI Tasks). • It will be **faster** and **require less power than the digital chips** found in **most electronic devices.** • It would be helpful for **Artificial Intelligence (AI)-based applications like object or speech recognition e.g., Alexa or Siri.** • **Different machine learning architectures** can be programmed on it and operate across a wide range of temperatures.

2.15.3. CYBERSECURITY

Cybersecurity Guidelines	• **Indian Computer Emergency Response Team (CERT-In)** has **issued directions** relating to information security practices and **reporting of cyber incidents.** ○ These are released under provisions of **Information Technology (IT) Act, 2000.** • **Key guidelines** ○ All government and private agencies will **mandatorily have to report all cyber breach incidents to CERT-In** within **six hours**. ○ All service providers, intermediaries, data centres, and government organisations shall **mandatorily enable logs of all their ICT systems** and **maintain them securely for a rolling period of 180 days** and same shall be **maintained within Indian jurisdiction**. ○ Virtual private server (VPS) providers, cloud service providers need to **register accurate information related to subscriber names,** customer hiring services, etc and **maintain them for five years or longer duration as mandated by law**.
Cryptojacking	• Cryptojacking is a **cyber-attack that is hard to detect,** wherein a computing device is hacked by the attacker, and its resources are used to illicitly coin mining of cryptocurrency. • Coin mining is a **legitimate, competitive** process used to **release new crypto** coins into **circulation** or to **verify new transactions.** ○ It involves **solving complex computational problems** to generate **blocks of verified transactions** that get added to the blockchain.
Bluebugging	• It is a form of hacking that lets attackers **access a device through its discoverable Bluetooth connection.** • Once a **Bluetooth connection is established,** hackers use brute force attacks to bypass authentication. • Once a device is blue bugged, a hacker can **listen to the calls, read and send messages and steal and modify contacts.**

	• **To prevent:** Turning off Bluetooth when not in use, updating the device, limited use of public Wi-Fi, etc.
Hermit	• Hermit is a **new spyware** with capability **to affect both Android and iOS devices.** • Hermit is a **commercial spyware** known to be used by **governments** with victims in Kazakhstan, Italy and northern Syria. • Spyware is a **malicious software** or **malware** installed on a computing device to **steal sensitive information through covert data transmission.**

2.15.4. OTHERS

PARAM PORUL	• PARAM PORUL is a **state-of-the-art Supercomputer at NIT Tiruchirappalli** under Phase 2 of **the National Supercomputing Mission (NSM).** • Majority of the components used to build **PARAM PORUL have been manufactured and assembled within the country.** • It is **based on Direct Contact Liquid Cooling technology** to obtain a high-power usage effectiveness and thereby reducing the operational cost. • Under NSM, **till date 15 supercomputers** have been installed across the nation with a computing capacity of 24 petaflops. ○ **PARAM Shivay was the first Supercomputer** assembled indigenously.

True Random Number Generator (TRNG)	• Indian Institute of Science has developed a TRNG that **can improve data encryption and provide improved security for sensitive digital data** (credit card details, passwords, etc.).
	• **Encrypted information can be decoded** only by authorised users who have **access to a cryptographic 'key'** (unpredictable and randomly generated to resist hacking)**.**
	  ○ 'Key' generated by computers using **pseudorandom number generators** (rely on re-programmed tables to produce numbers) appear random but are not.
	  ○ A **TRNG extracts random numbers from inherently random physical processes** (using the random motion of electrons)**,** making it more secure.

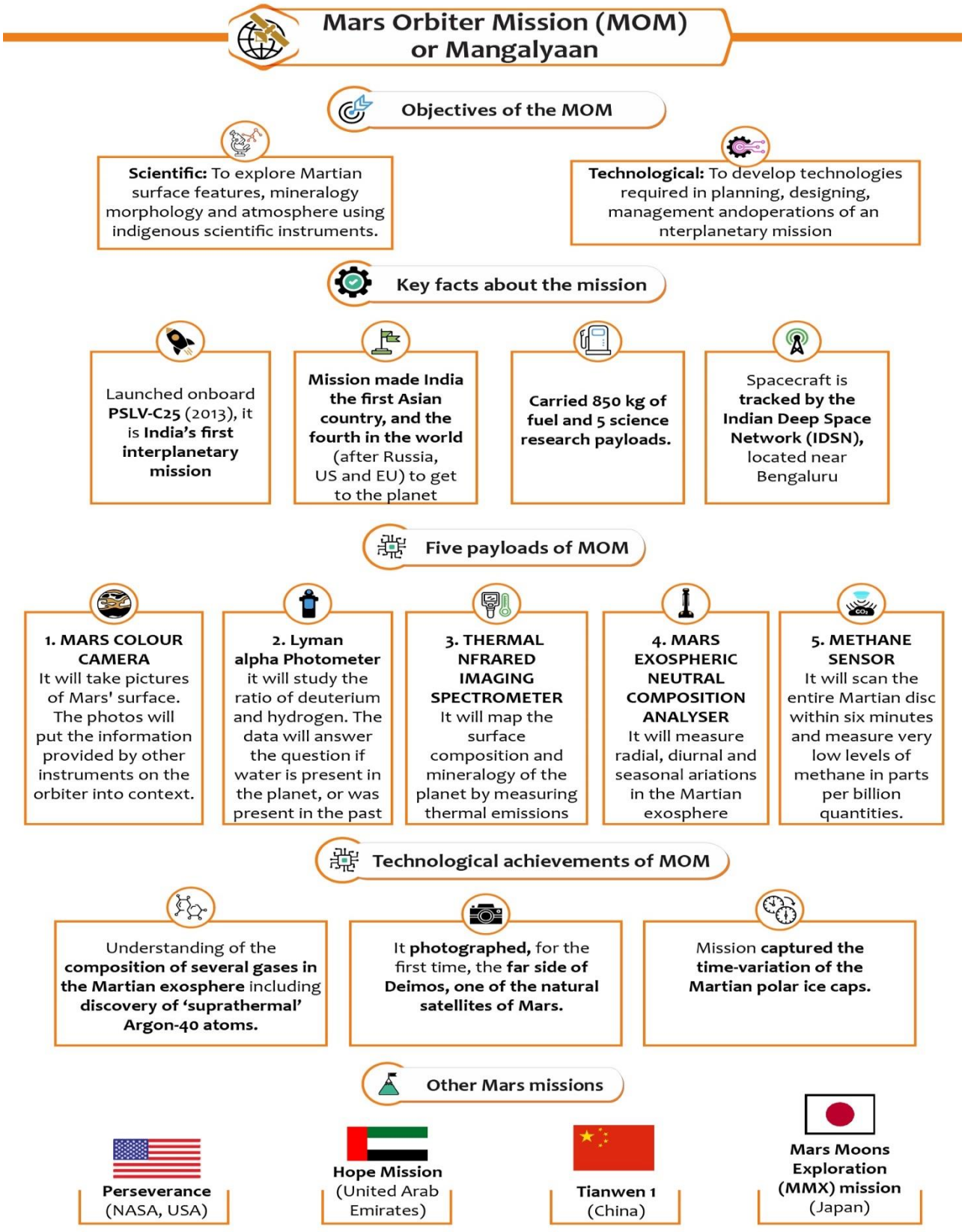
TiHAN (Technology Innovation Hub on Autonomous Navigation)	• TiHAN, **India's first Autonomous Navigation facility** (for both ground and aerial vehicle testing)**, was inaugurated at IIT Hyderabad.** • TiHAN (by Ministry of Science & Technology) is a **multidisciplinary initiative** to make India a global player **in futuristic and next generation 'smart mobility' technology.** • **It will provide** industries, research and development labs, and academia **a platform for research in autonomous navigation.** • It is one of the **25 technology innovation hubs** under **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS).**

3. SPACE TECHNOLOGY

3.1. MARS ORBITER MISSION

Why in news?

India's Mars Orbiter Mission (MOM) spacecraft has lost communication with the ground stations, bringing an end to its life after eight long years.



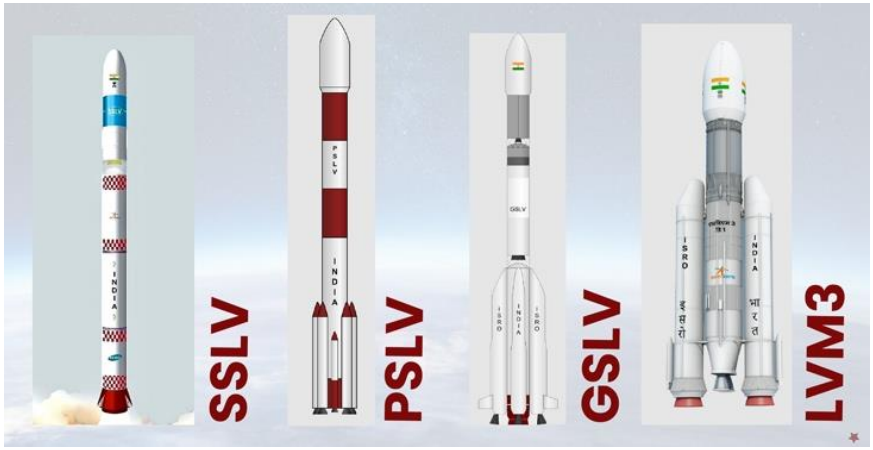
Related News
NASA's Perseverance Rover

- Perseverance rover mission is **part of NASA's Mars Exploration Program,** a long-term effort of robotic exploration of Mars.
- Recently, it placed a **titanium tube containing a rock sample** on the surface of Mars.
  - **Igneous rock** sample was **collected from Mars Jezero Crater** called **South Séítah.**
  - Samples are being **placed at a location called "Three Forks,"** first such **sample depot on another world**.
  - **Depot will serve as a backup** if Perseverance can't deliver its samples and **subsequent NASA missions would return these samples to Earth.**
- Recently, it also **captured the solar eclipse on Mars** featuring Phobos, one of Mars' two moons (other is Deimos).
- In a related news, **Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE)** has **produced oxygen at Mars** with components **from the planet's atmosphere.**
  - **MOXIE was sent** (by Massachusetts Institute of Technology) **with NASA's Perseverence rover.**

3.2. POLAR SATELLITE LAUNCH VEHICLE (PSLV)

Why in News?

PSLV on its 55th mission (PSLV-C53) **successfully launched three Singaporean satellites** in the **second commercial mission of New Space India Limited (NSIL).**



More about News

- Besides placing satellites in orbit, **ISRO also achieved successful launch of PSLV Orbital Experimental Module (POEM),**
  - **About POEM:** A platform which **allows in-orbit scientific experiments using the final (fourth) stage** of PSLV.
  - **Dedicated Navigation Guidance and Control system:** Act as platform's brain to stabilize it with specified accuracy.
  - **Power source:** Mounted solar panels and a Li-Ion battery.

ISRO's Launch Vehicles		
Launch Vehicle	**Stages**	**Payload capacity and Orbits**
Small Satellite Launch Vehicle (SSLV)	**3 stage Launch Vehicle** (Three Solid Propulsion Stages and liquid propulsion-based Velocity Trimming Module as a terminal stage.)	Mini, Micro, or Nanosatellites (10 to 500 kg mass) to **a 500 km orbit.**
Polar Satellite Launch Vehicle (PSLV)	**Four-stage launch vehicle** (1st & 3rd stage: Solid; 2nd & 4th: Liquid)	Up to 1,750 kg to **Sun-Synchronous Polar Orbits,** 1,425 into **Geosynchronous and Geostationary orbits**
Geosynchronous Satellite Launch Vehicle (GSLV) Mark II	**Three-stage launch vehicle** (1st: Solid, 2nd: Liquid; 3rd: Cryogenic Upper Stage)	Up to 2,250 into **Geosynchronous Transfer Orbits,** up to 6 tonne in **Low Earth Orbits**
Geosynchronous Satellite Launch Vehicle Mk-III (LVM3)	**Three-stage launch vehicle** (1st: Liquid, 2nd: Solid; 3rd: Cryogenic Upper Stage)	Up to 4 tonne into **Geosynchronous Transfer Orbits,** 8 tonne into **Low Earth Orbits**

Different Types of Orbits

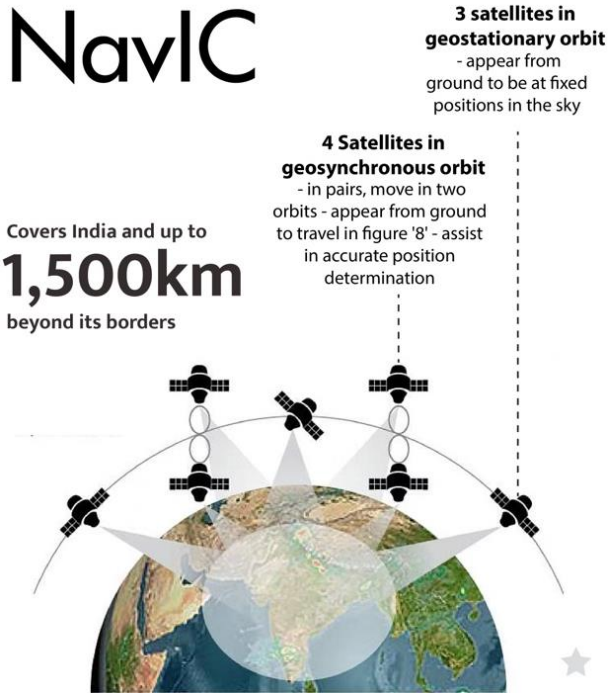
Geostationary orbit (GEO)	Satellites in GEO **circle Earth above the equator from west to east** following Earth's rotation. This makes satellites in GEO appear to be 'stationary' over a fixed position.
Low Earth orbit (LEO)	An orbit that is **relatively close to Earth's surface.** It is normally at **an altitude of less than 1000 km** but could be **as low as 160 km** above Earth.
Polar Orbit	Satellites in polar orbits **usually travel** past Earth **from north to south** rather than from west to east, passing roughly over Earth's poles.
Sun-synchronous orbit (SSO)	It is a particular **kind of polar orbit.** Satellites in SSO, travelling over the polar regions, **are synchronous with the Sun.**

3.3. NAVIC (NAVIGATION WITH INDIAN CONSTELLATION)

Why in News?

Centre is pushing smartphone makers to **enable support for its NavIC navigation system in new devices from next year.**

About NavIC (Navigation with Indian Constellation)



- **Independent stand-alone navigation satellite system** developed by **Indian Space Research Organisation (ISRO).**
  - **Earlier known as IRNSS** (Indian Regional Navigation Satellite System).
- **Coverage:** It **consists of 7 satellites** and covers the whole of India's landmass and **up to 1,500 km** from its boundaries.
- **Forthcoming change:** To add the **L1 Spectrum band** into NavIC which is **part of GPS** and is the most **used for civilian navigational use.**
  - Expansion will help **to increase its use in civilian sector and ships, aircraft travelling** far from the country's borders.
- **Application:** Public vehicle tracking in India, providing emergency warning alerts to fishermen, tracking, and providing information related to natural disasters.
- **Other Global Navigation satellite systems:** GPS from U.S., GLONASS from Russia, Galileo from European Union, and BeiDou from China.
  - In addition, there are **2 regional systems** viz., **NavIC** from India and **QZSS** from Japan.

Related News

Airports Authority of India (AAI) successfully conducted **flight trials using GAGAN** based LPV approach procedure.

- **India is the first country in the Asia Pacific Region to achieve such a landmark** in field of Air Navigation Services (ANS).
  - **LPV** (Localizer Performance with Vertical Guidance) **permits aircraft guided approaches** that are operationally nearly equivalent to Category 1- Instrument Landing System (Cat-1 ILS), **without the need for ground-based navigational infrastructure.**
- **About GAGAN (GPS Aided GEO Augmented Navigation)**
  - GAGAN is an **Indian Satellite Based Augmentation System (SBAS)** jointly developed by **AAI and ISRO** for India and neighbouring countries in the equatorial region.
  - It is one among the **only four Space-Based augmentation systems** available in the world which also includes US(WAAS) Europe (EGNOS) and Japan (MSAS).
- **Benefits of GAGAN: A**ir traffic control, manage road and railways transport, help farmers in crop spraying etc.

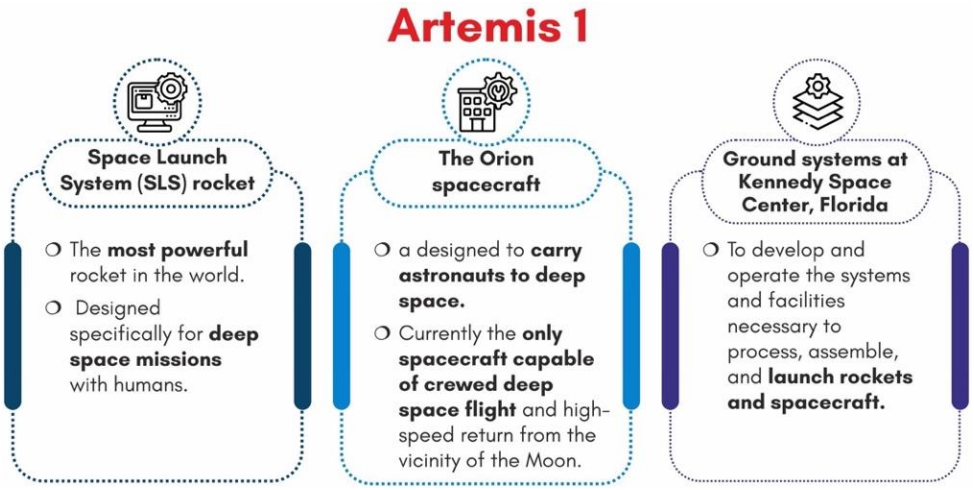
3.4. ARTEMIS I

Why in news?

Recently, NASA's Artemis 1 mission successfully lifted off from the Kennedy Space Centre.

About Artemis I mission

- **Aim:** To build a **long-term human presence at the Moon.**
- **Mission specifications:** An uncrewed flight test that will provide a foundation for human deep space exploration.
  - **With Artemis,** NASA is planning to land the **first woman** on the Moon.
- **First integrated test of NASA's deep space exploration systems,** which include (refer image).
- **Future Missions:** Artemis I will be **followed by Artemis II** (Planned for 2024) **and Artemis III** (Planned for 2026)



DO YOU KNOW?

- From 1969 through 1972, the **NASA Apollo program took humans to the moon.**
- **Artemis** is the **twin sister of Apollo** & the **goddess of the moon in Greek mythology.**

Artemis I mission objectives:

- Demonstrate **Orion's heat shield can withstand the high speed and high heat conditions** when returning through Earth's atmosphere.
- **Study the radiation environment of deep space** that is present for missions to the Moon and beyond.
- **Retrieving Orion after splashdown** will provide information to engineers for future missions.
- Accomplish flight test objectives like **certifying Orion's optical navigation system,** deploying Cube Sats.
- **Study the Moon** to learn more about the origin and history Earth, the Moon, and our solar system.

Major missions to the Moon

Country	Mission
USSR	**Luna 1, Luna2, Luna 3.** Luna 2 was the **first spacecraft to impact the Moon's surface.**
USA	**Lunar Orbiter 1** **Apollo 11: First humans to land** on the Moon. **Lunar Reconnaissance Orbiter (LRO)**
Japan	**Hiten**
China	**Chang'e 1**
India	**Chandrayaan-1** **Chandrayaan-2**

Related Information: Retrograde orbit

- After getting closer to the moon, the **Orion spacecraft used the gravitational kick** it receives to enter a so-called **"distant retrograde orbit."**
  - Retrograde means that **it will orbit the moon in the opposite direction** to the one in which the moon spins.
- Orion will stay in that orbit for some days. Then it **will swing back down toward the moon for another kick** to help power its **journey back to Earth.**

3.5. JAMES WEBB SPACE TELESCOPE

Why in news?

James Webb Space Telescope has provided astronomers with a **glimpse of the early universe** in a new image.

More about news

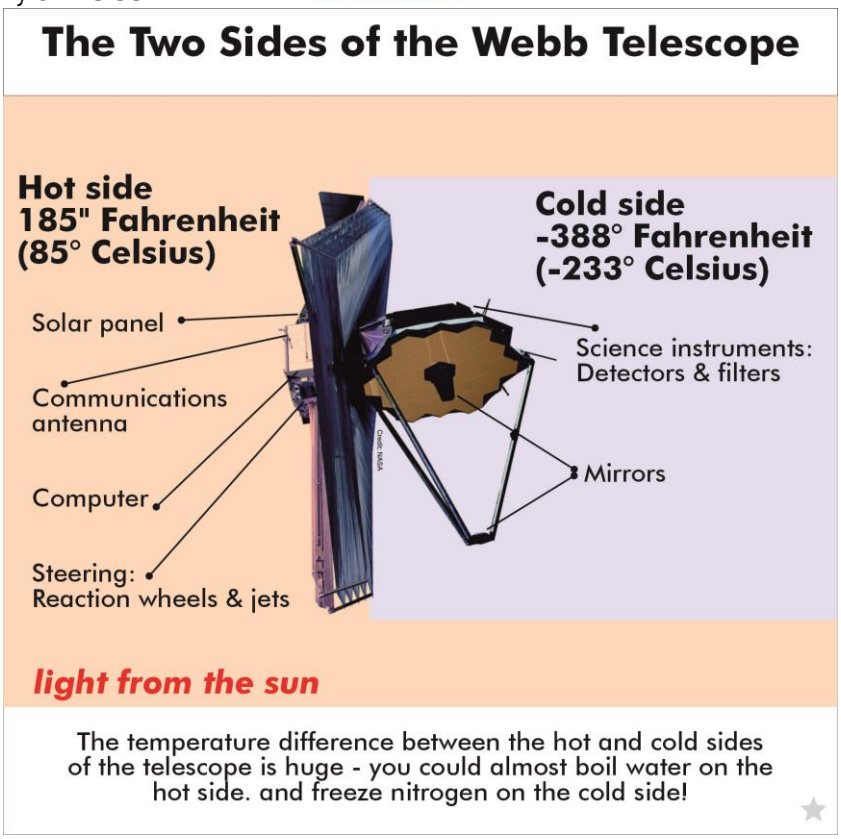
- Telescope captured an image of a **galaxy cluster called MACS0647**, as well as **distant galaxy MACS0647-JD**.
  - Scientists believe that this might be an event of a galaxy merger in the early universe.
- The **distant galaxy is visible** because of **gravitational lensing**.

KNOW THE TERM

- **Gravitational Lensing:** In this, light emitted by source is bent due to presence of another massive body between target galaxy and observer, effectively resulting in magnification of signal.

About James Webb Space Telescope

- Also called JWST or **Webb**, it is NASA's **largest and most powerful** space science telescope.
  - It was formerly known as the **"Next Generation Space Telescope" (NGST).**
- **International collaboration:** between NASA, European Space Agency (ESA), and Canadian Space Agency (CSA).



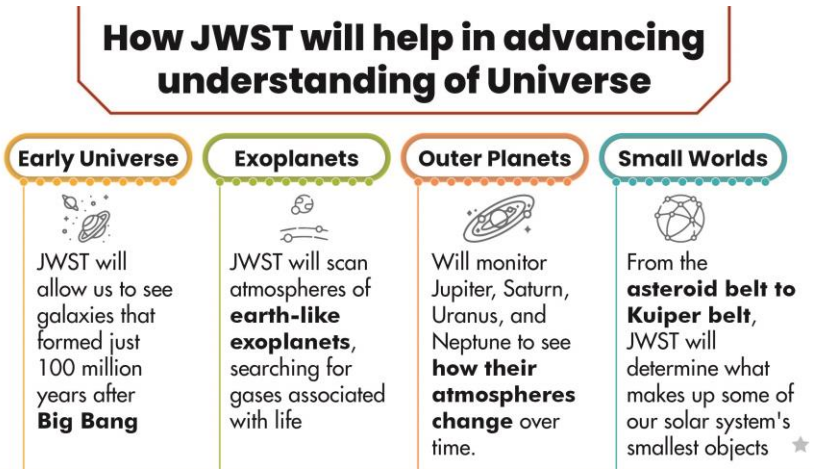
Key features of Webb

- **Visibility Spectrum:** Webb views the **universe in infrared**.
  - It will be the **only infrared-specialized telescope** in space that can see long distances.
- **Mirrors:** Its primary mirror is **6.5 metres in diameter**.
  - Larger the mirror area collecting light, **more details it can capture** of a star or galaxy.
  - Recently, a secondary mirror was also deployed, reflecting light from **primary mirror to the instruments**.
- **Location/Orbit:** It will **not be in orbit around Earth** but will **orbit Sun**, 1.5 million kilometers away from the Earth at **second Lagrange point or L2.**
  - **L2** lets telescope **stay in line with Earth** as it moves around Sun.
  - This **allows satellite's large sunshield to protect telescope** from light and heat of Sun and Earth (and Moon).

KNOW THE TERM

- **Lagrange Points:** At Lagrange points, the **gravitational pull of two large masses** precisely equals the **centripetal force required for a small object** to move with them.

- **Major instruments:** Contained within the **Integrated Science Instrument Module (ISIM)** which is one of three major elements that comprise JWST.
    - The others are **Optical Telescope Element (OTE) and Spacecraft Element (Spacecraft Bus and Sunshield).**
- **Main instruments:** ISIM is **main payload**. It houses **four main instruments:**
    - Near-Infrared Camera (NIRCam),
    - Near-Infrared Spectrograph (NIRSpec),
    - Mid-Infrared Instrument (MIRI) and
    - Fine Guidance Sensor/ Near InfraRed Imager and Slitless Spectrograph (FGS/NIRISS).



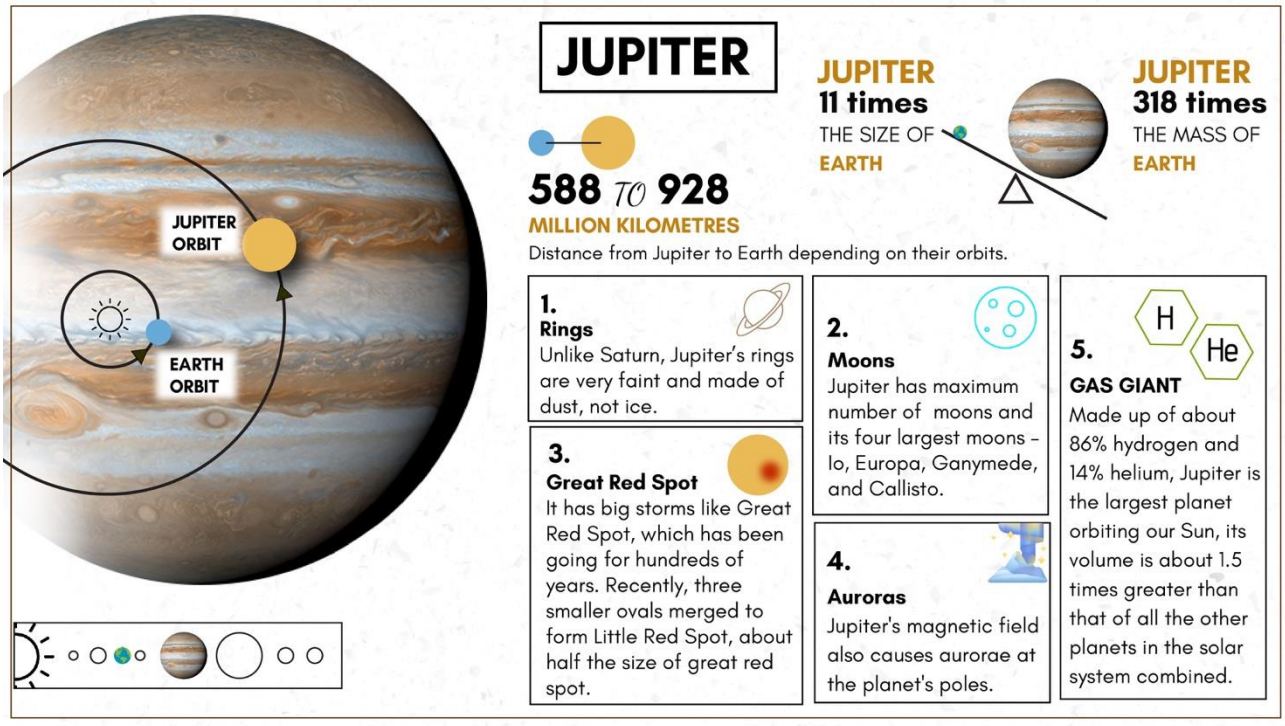
Comparison between Hubble vs. Webb vs. Herschel

	Hubble	Webb	Herschel Space Observatory
Distance from Earth	**507 Km**	**1.5 million Km** at Second Sun-Earth **Lagrange point (L2)**	Second Sun-Earth **Lagrange point (L2)**
Primary Mirror Diameter	2.4 meter	6.5 meter	3.5 meter
Searching for	**Young Galaxies** (12.5 billion years ago)	**Newborn 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 submillimeter**

3.5.1 OBSERVATIONS MADE BY JWST

New images of Jupiter

- New images of Jupiter **presented its massive storms, colourful auroras, faint rings and two small moons** — Amalthea and Adrastea (Nearer to Jupiter).



Pillars of Creation (PoC) – Formation of new stars

- James Webb Space Telescope (JWST) has captured the iconic PoC where **new stars are forming within dense clouds of gas and dust.**
  - The three-dimensional pillars are **made up of cool interstellar gas and dust** that appear – at times – semi-transparent in near-infrared light.
- PoC are **located 6,500 light years from Earth, in the Eagle Nebula of our Milky Way galaxy.**
- It will help researchers **revamp their models of star formation by identifying far more precise counts of newly formed stars,** along with the quantities of gas and dust in the region.

KNOW THE TERM

- **Kuiper Belt:** A donut-shaped region of icy bodies **beyond orbit of Neptune.** It is a region of leftovers from the solar system's early history.
- **Asteroid belt:** A region of space between the **orbits of Mars and Jupiter** where most of the asteroids in our Solar System are found **orbiting the Sun.**
- **Exoplanet:** 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.
- **Nebula:** It is a giant **cloud of dust and gas in space.** Some nebulae come from gas and dust thrown out by **explosion of a dying star,** such as a supernova. Other nebulae are regions where **new stars are beginning** to form.

Exo-Moons

- Scientists at **Indian Institute of Astrophysics** have **developed a model to trace habitable exo-moons with the help of the James Webb Space Telescope** (JWST).
- **About Exo-Moons**
  - They are **natural satellites that revolve around exoplanets** (planets orbiting stars other than the Sun).
  - So far, **5000 exoplanets have been discovered** by using several telescopes (Kepler Hubble space telescopes etc).
  - However, the **natural satellites or exo-moons around any of these planets still remain untraced.**

Other observations made from images revealed by Webb

- **SMACS 0723 (Called Webb's First Deep Field):** It is a cluster teeming with thousands of galaxies, including **the faintest objects ever observed** in the infrared.
- **WASP-96b (spectrum): Hot, puffy planet outside our solar system** reveals clear **signature of water**, along with evidence of **haze and clouds.**
- **Southern Ring Nebula**: This planetary nebula is approximately **2,000 light-years** away.
- **Stephan's Quintet**: Group of galaxies, located in **constellation Pegasus. Webb revealed velocity and composition** of gas near its supermassive black hole.
- **Carina Nebula**: Webb's look at **"Cosmic Cliffs"** in the Carina Nebula unveils the **earliest, rapid phases of star formation** that were previously hidden.
- **Einstein Ring:** Einstein Ring is visible when **light from a star or a galaxy passes another galaxy or a massive object on its way towards Earth.**

3.6. PRIVATE SECTOR IN SPACE PROGRAMME OF INDIA

Why in news?

Prime Minister recently called for higher participation of the private sector in the space programme at inauguration event of the **headquarters of the Indian National Space Promotion and Authorisation Centre (IN-SPACe) in Ahmedabad.**

INDIAN NATIONAL SPACE PROMOTION AND AUTHORISATION CENTRE (IN-SPACE)

HQ: Ahmedabad, Gujarat

About: **Autonomous nodal agency** under **Department of Space** to promote, authorize and supervise **space activities of Non-Governmental Private Entities in India.**

Composition: A **chairman, technical experts** for space activities, **safety experts, experts from Academia and Industries,** members from **Prime Minister's Office** and **Ministry of External Affairs.**

Mandate:

- **Sharing of space infrastructure** and premises under the control of ISRO.
- **Establishment of temporary facilities** within premises under ISRO.
- **Establishment of new space infrastructure and facilities.**

Other Key Information: **Decision of IN-SPACe in context of this mandate, shall be final and binding** on all stakeholders including ISRO.

Recent initiatives by Private Sector

- **Hyderabad's Dhruva Space** and **Bengaluru's Digantara** were authorized by IN-SPACe for launch of payloads onboard PSLV Orbital Experimental Module (POEM) of PSLV-C53.
- **Mission Prarambh:** Involved launch of Vikram-S (VKS), India's first privately built rocket by Hyderabad-based Skyroot Aerospace.
  - **VKS** is a **single-stage spin-stabilized** (using 3-D printed solid thrusters) **solid propellant rocket.**
  - **Payload Capacity:** 290 kg- 560 kg payloads into sun-synchronous polar orbits.
  - Launched with **support from ISRO and IN-SPACe.**
- **India's first private launch pad unveiled at Sriharikota**
  - **Designed by Agnikul** (a startup) **and executed in support of ISRO and IN-SPACe.**
  - It is specifically built **to support liquid-stage controlled launches.**

Reforms taken to promote private players in space sector

- **New Space India Limited (NSIL)**
  - It is **country's first public sector undertaking in the space sector** and **commercial arm of ISRO** aimed at production and marketing of space-based services, also empowered to own the operational launch vehicles and space assets of ISRO.
- **Indian Space Association (ISpA):** Launched in 2021, it is the apex, **non-profit industry body** exclusively working towards development of private and public Space Industry in India.
- **Antrix Corporation Limited: Marketing arm of ISRO** to handle ISRO's commercial deals for satellites **and launch vehicles with foreign customers.**
- **Space Entrepreneurship & Enterprise Development (SEED):** A competitive early-stage encouragement programme to startups and MSMEs in focus areas of interest to ISRO.

3.7. SPACE SUSTAINABILITY

Why in news?

United Nations Office of Outer **SPACE** Affairs and government of **AUSTRIA organized World Space Forum (WSF) 2022** under theme "**Sustainability in Space** for sustainability on Earth".

More about news

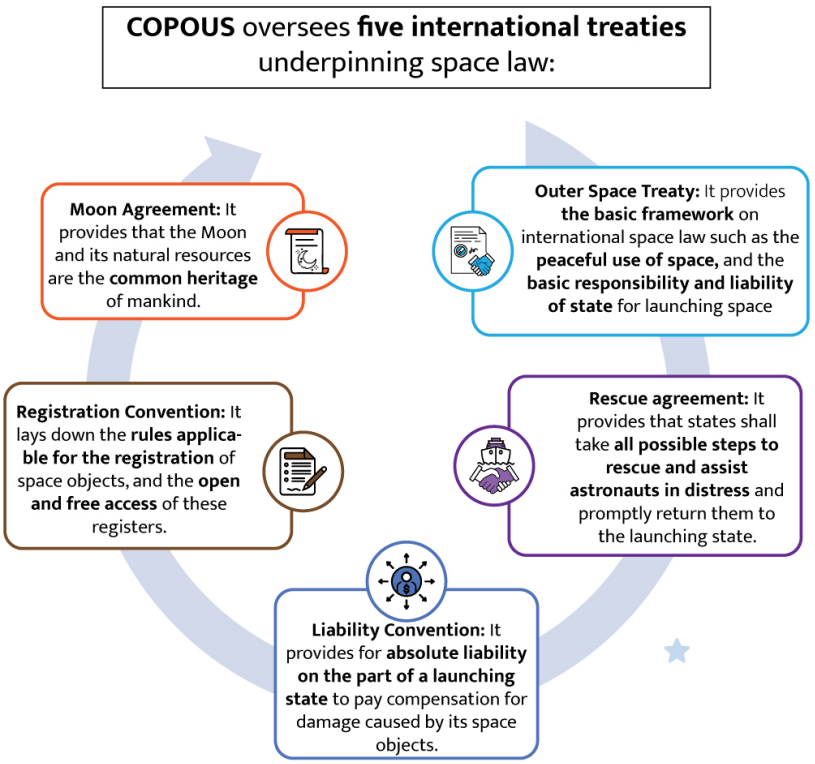
- **World Space Forum** is a platform, including governmental institutions, international organizations etc.**,** to **promote discussions** on the role of **space science and technology** in global sustainable development.

About Space sustainability

- **Space sustainability** refers to ensuring that all humanity **can continue to use outer space** for peaceful purposes and socioeconomic benefit **now and in the long term.**

Threats to space sustainability

- **Orbital crowding and Space Debris:** It poses a direct threat to **operations and safety.** Physical crowding of orbits can lead to a chain reaction called **Kessler syndrome.**
- **Militarisation and weaponisation** of the space: **Development and testing of destructive anti-satellite (ASAT) weapons** by countries like US, Russia, China, and India.

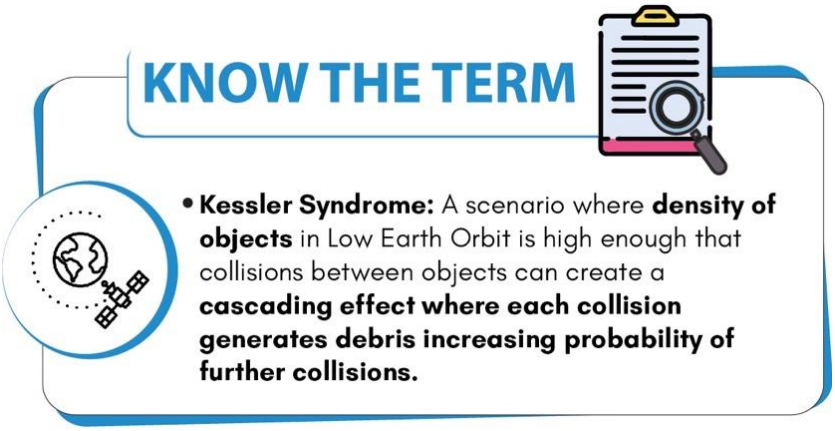


- **Rendezvous and proximity operations (RPO)**: It involves **altering the trajectory** of one or more space objects to bring them **into proximity** to each other.
- **Space weather can impact satellites** by damaging onboard electronics and disrupting communications or navigation signals.

Initiatives taken towards space sustainability

Global Initiatives

- **U.N. Office for Outer Space Affairs (UNOOSA):** It supports governments in global space activities.
- **Conference on Disarmament (CD):** It is the international forum with one of its core focus areas is the prevention of an arms race in outer space (PAROS).



- **Guidelines on space sustainability:** Adopted by U.N. Committee on the Peaceful Uses of Outer Space (COPUOS) in 2019.
- **Space Sustainability Rating (SSR):** By World Economic Forum to implement sustainable and responsible space missions.
- **ASAT test-ban resolution:** A non-binding resolution (India abstained) passed by United Nations General Assembly (UNGA) calling for a ban on kinetic ASAT tests.

Indian Initiatives

- **Project NETRA:** Initiated by ISRO to provide **first-hand information** on the status of debris.
- **Space Situational Awareness**: IIIT Delhi is currently working on a research project on SSA.
  - **Digantara,** a space sector start-up of India, is **going to set-up India's first commercial SSA observatory** in Garhwal region of Uttarakhand.
  - Further, **India and US have also signed a bilateral SSA arrangement**.
- **SPADEX:** To provide **in-orbit servicing**, ISRO is developing a space docking experiment called 'SPADEX'.

About Space Situational Awareness

- SSA refers to **knowledge of space environment, assessment of any threats to space activities** and implementation of **necessary mitigation measures** to safeguard space assets.
- **SSA covers three main areas**
  - **Space Surveillance and Tracking** (SST) of man-made objects.
  - **Space Weather** (SWE) **monitoring** and forecast.
  - **Near-Earth Objects** (NEO) **monitoring** (only natural space objects)

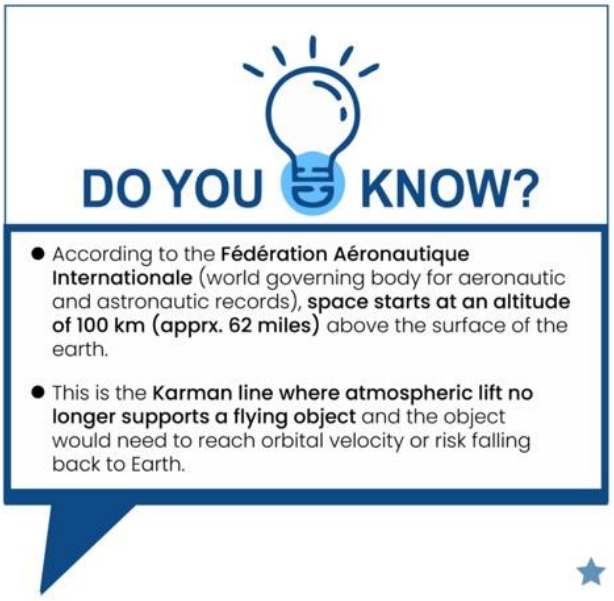
3.8. SPACE TOURISM

Why in News?

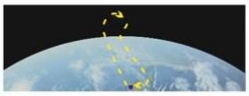
ISRO is developing capabilities towards space tourism through the demonstration of human space flight capability to Low Earth Orbit (LEO).

About Space Tourism

- A segment of space travel that **allows people to travel to space for recreational, leisure or business purposes.**
  - Blue Origin, Virgin Galactic and Elon Musk's SpaceX — **are some of the companies that have entered space tourism**.
- **Types:** Orbital, suborbital, and lunar (moon) tourism.



- **Definition of Space Tourists:** No international space law has defined. Existing space treaties such are only applicable to astronauts, envoys of mankind, or personnel of a spacecraft.
- **Concerns related to space tourism:** Impact on human health, Impact on the environment, Passenger Liability (International treaties are bereft of the provisions to handle the liability of private entities in space) and High cost.

	Suborbital tourism	Orbital tourism
Altitude	About **100 kilometres**	Over **400 kilometres**
Duration in Space	Gives passengers a **few minutes in space**	**Spend days or even more** than a week in space.
Velocity	Sub-Orbital  • **Requires much lower speeds** (than orbital) and doesn't have the power to achieve orbit. • Instead, it will **fly up to a certain height and then come back down** once its engines are shut off.	Orbital  • **Spacecraft must achieve orbital velocity** i.e. the speed that an object must maintain to remain in orbit around a planet.

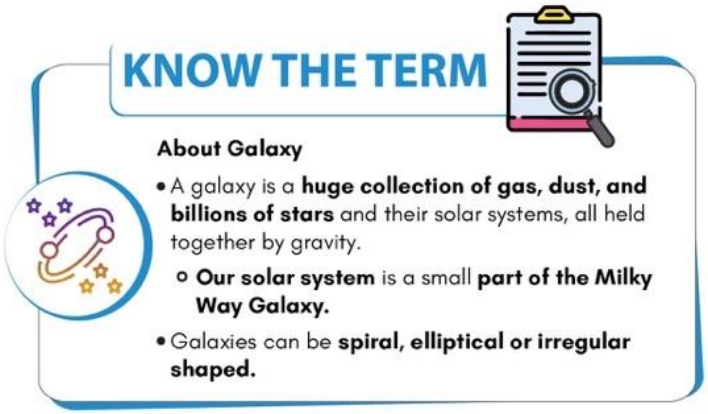
3.9. BLACK HOLES

Why in News?

The black hole at the centre of the Milky Way galaxy was photographed for the first time.

More on News

- **The first photograph of Sagittarius A*,** a supermassive black hole situated at the center of the Milky Way, **was revealed by astronomers of the Event Horizon Telescope (EHT).**
  - EHT is an **international collaboration** (of observatories) **capturing images of black holes** using a virtual Earth-sized telescope.
- **In 2019, astronomers captured the first ever photograph of a black hole M87** in a distant galaxy called Messier 87.



2020 Nobel Prize in Physics

- **One half was awarded to Roger Penrose** for the discovery that **black hole formation** is a robust **prediction of the general theory of relativity.**
- **And the other half was awarded jointly to Reinhard Genzel and Andrea Ghez** for the **discovery of a supermassive compact object** at the center of our galaxy. A supermassive black hole is the only currently known explanation.
  - They **focused on a region called Sagittarius A*** at the center of our galaxy.

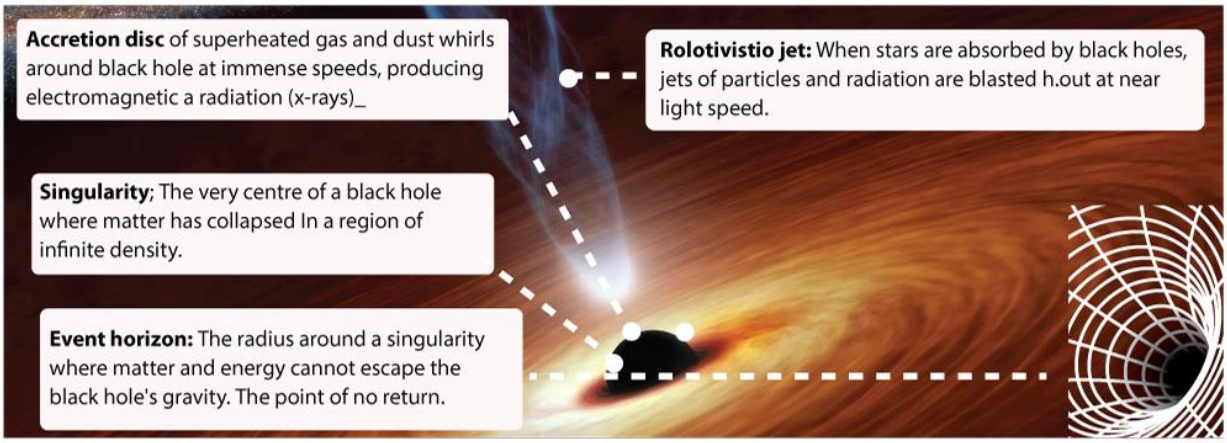
General Theory of Relativity

- 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.
  - 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.

BLACK HOLE

Basic parts of Black Hole

- **Schwarzschild Radius:** This is the event horizon's radius. It is the radius at which the escape velocity is equal to the speed of light.
- **Ergosphere:** If the black hole is rotating, then as it spins, itsmass causes the space time around the black hole to rotate as well. This region is called the ergosphere.



About Black Holes

- A place in space where **gravity pulls so much that even light cannot get out.**
- **This can happen when a star is dying.**
- Presence of black holes **can be inferred by detecting their effect on other matter nearby them.**
- **Importance of studying Black Holes:** for testing fundamental theories, understanding of gravitational force etc.

Types of Black Holes

Tiny Black Holes

- These can be **as small as one atom** but have **mass of a large mountain.**
- **Formed when universe began.**

Stellar Black Holes

- Mass up to **20 times more than mass of sun.**
- Formed **when centre of a very big star falls upon itself** or collapses.
- When this happens, it **causes a supernova.**

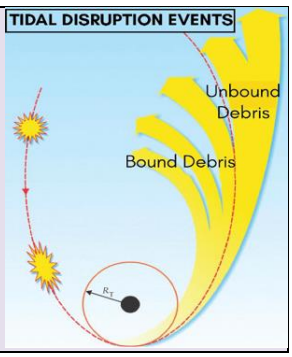
Supermassive Black Holes

- Mass **more than 1 million suns together.**
- **Formed at** the **same time as the galaxy they are in.**

Related news

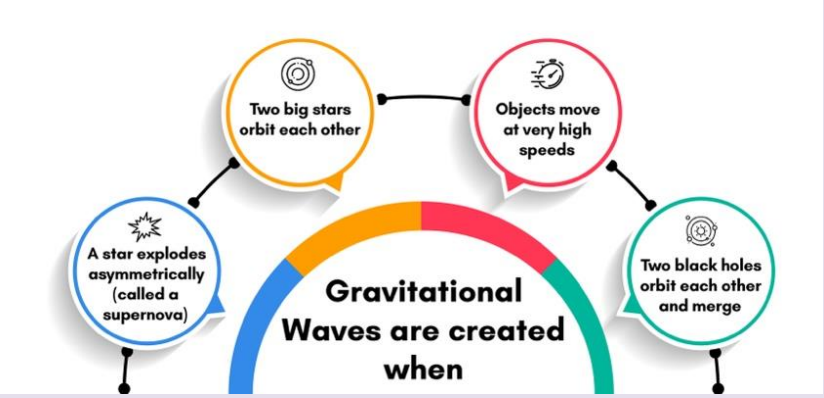
Tidal Disruption Events (TDEs)

- In 2018, **scientists observed a black hole** ripping a star into shreds because it got too close.
- TDE refers to an event when a **black hole violently rips apart stars that gets too close.**
  - When a star comes close to a black hole, **gravitational forces will stretch or "spaghettify" star** (see image)
  - Then, **elongated material spirals around black hole**, gets heated up, and **creates a flash** that can be detected by us millions of light years away.



Binary super massive black hole (SMBH)

- **About:** Binary SMBH system (system consisting of two black holes in close orbit) was discovered in gravitationally lensed blazar.
  - Blazars are among the **most luminous and energetic objects** in Universe.
- **Significance:** Help in the future detection of Gravitational Waves (GW).
- GW are **'ripples' in space-time** traveling at the speed of light caused by some of most violent and energetic processes in Universe.
  - This effect was **first predicted by Einstein's general theory of relativity.**
  - **GW were first detected in 2015** by Laser Interferometer Gravitational Wave Observatory (LIGO).



3.10. DARK MATTER

Why in News?

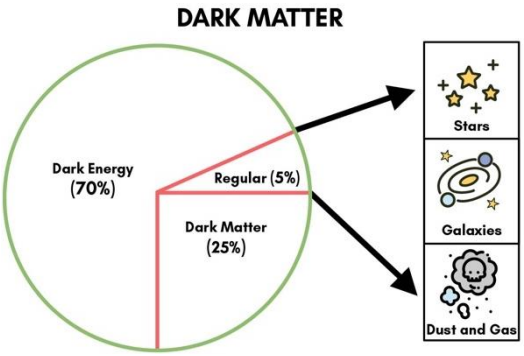
A test run of **LZ detector in** U.S. has shown it to be the **most sensitive dark matter detector** yet created.

About LUX-ZEPLIN (LZ) detector

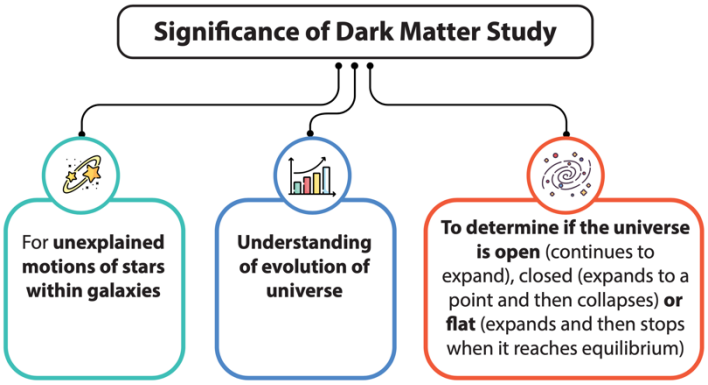
- It is designed (underground) to **capture dark matter in the form of weakly interacting massive particles (WIMPs).**
- It consists of a **huge titanium tank** filled with **extremely pure liquid xenon.**
- Centre of LZ is one of **the purest places on Earth** (free of radiation and dust).
- **Collaboration** of scientists/institutions **from U.S., U.K., Portugal, and Korea.**

About Dark Matter

- **Visible universe—**including Earth, sun, other stars, and galaxies**—is made of protons, neutrons, and electrons bundled together into atoms.**
  - This ordinary matter, also called baryonic, **makes up less than 5 percent of the mass of universe.**
  - **Rest of the universe appears to be made of** a mysterious, invisible substance called **dark matter** (~25 percent) and a force that repels gravity known as **dark energy** (~70 percent).
    - ✓ **Dark energy** is the name given to the **mysterious force that's causing the rate of expansion of our universe to accelerate** over time, rather than to slow down.



- Unlike normal matter, **dark matter does not interact with electromagnetic force.** This means it does not absorb, reflect, or emit light, **making it extremely hard to spot.**
  - Scientists study dark matter **by looking at the effects it has on visible objects.**
  - It is believed that dark matter is what **gives galaxies extra mass, generating extra gravity they need to stay intact.**



About Dark Energy

- **Universe has been known to be expanding** as a **consequence of the Big Bang** about 14 billion years ago.
- Dark Energy was **first hypothesized by Albert Einstein** in 1917 and was represented by a term, the "cosmological constant". However, he **later rejected the idea of a cosmological constant.**
  - Subsequently, **direct evidence for the existence of this component,** which was **dubbed dark energy,** was **first presented in 1998.**

- It was **discovered that this expansion is accelerating** (Nobel Prize in Physics 2011 was awarded to Saul Perlmutter, Brian Schmidt and Adam Riess for this discovery).
- **Dark energy** is the name given to the **mysterious force that's causing the rate of expansion of universe to accelerate** over time.

3.11. EARTH RECORDS SHORTEST DAY

Why in News?

According to a report, **29 July 2022 has set the record for the shortest day** as Earth completed a full spin in 1.59 milliseconds less than its standard 24 hours.

About Earth's Spin and Rotation

- **Possible reason for increased speed**: Changes in the processes in the **inner or outer layers of the core, oceans, tides,** or even **changes in climate. (Including phenomenon like Chandler Wobble)**
- **Earth's spin dynamics:** Earth's spin is slowing down but the last few years, Earth's spin has been slightly fastened.
  - **To combat the long-term slowdown in the Earth's rotation** which is caused by the constant melting and refreezing of ice caps, leap second to our calendars were added occasionally.
  - **Leap second** was **first introduced in 1972 by the International Earth Rotation and Reference Systems Service.**
  - **27 leap seconds have been added since 1972.**The last leap second added was on December 31, 2016.

About Chandler Wobble

- It is **change in the spin of Earth as it rotates on its axis**, much as a toy top wobble as it spins.
- **Discovered by:** Seth Carlo Chandler in 1890's.
- **Time Period to complete one wobble:** Around 433 days. Wobble amounts to about 20 feet at the North Pole.
- **Possible Cause:** Fluctuating pressure on the bottom of the ocean, caused by temperature and salinity changes and wind-driven changes in circulation of the oceans.

- **Negative leap seconds:** If Earth continues to rotate at an increasing rate, **negative leap seconds would need to be introduced** to keep the rate of the planet orbiting the Sun consistent with the measurement from atomic clocks.
  - Atomic clocks are **designed to measure the precise length of a second**, the base unit of modern timekeeping.
  - With an **error of only 1 second in up to 100 million years,** atomic clocks are among the most accurate timekeeping devices in history.
- **Issues with introduction of Negative leap seconds:** Can **confuse smartphones, computers, and communications systems.**

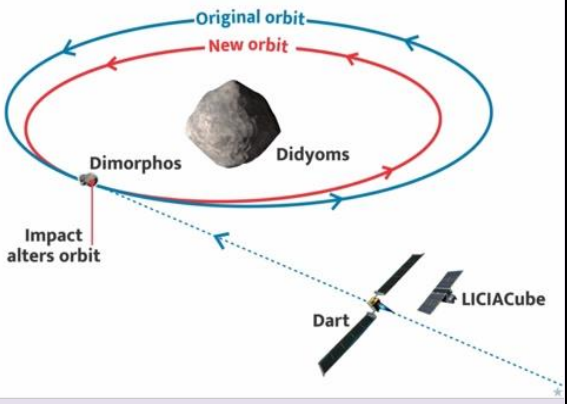
3.12. SPACE ORGANISATIONS RELATED DEVELOPMENTS

3.12.1. NASA

Double Asteroid Redirection Test (DART) Mission

- Recently, **NASA crashed DART mission** on binary asteroid system **Didymos and moonlet** to test a kinetic impactor technology.
  - **Binary asteroid system is made up by asteroid Didymos** and its small moonlet called Dimorphos and the **small moon (Dimorphos) orbits the larger body (Didymos).**
- DART is a first-of-its-kind spacecraft, which has been designed to test a **unique method to deflect an asteroid to change its motion in space through kinetic impact** and save the Earth from an incoming asteroid.
- **James Webb Space Telescope and the Hubble telescope** were used to track the spacecraft and keep an eye on the asteroid to see the impact.

Double Asteroid Redirection Test (DART) Mission



Stratospheric Observatory for Infrared Astronomy (SOFIA) mission	• **NASA** is planning to **shut down SOFIA telescope that found water on Moon.**
	• SOFIA is an **infrared telescope inside Boeing airplane**, flying at an **altitude around 40k feet above the surface.**
	  ○ SOFIA is collaboration between **NASA and German Space Agency (DLR).**
	  ○ It has been **collecting data to understand star birth and death** and **formation of new solar systems.**
	  ○ It is designed to observe **cosmic objects in far-infrared wavelengths.**
	• In 2019, **SOFIA discovered helium hydride** — first molecule formed in Universe almost 14 billion years ago.

3.12.2. INDIAN SPACE RESEARCH ORGANISATION (ISRO)

Hybrid propulsion system	• ISRO has tested **hybrid propulsion system** for the forthcoming launch vehicles.
	  ○ The motor used **Hydroxyl-terminated polybutadiene (HTPB)** as fuel and **liquid oxygen (LOX)** as the oxidizer.
	  ○ Unlike **solid-solid or liquid-liquid combinations, a hybrid motor uses solid fuel and a liquid oxidizer.**
	  ○ The use of **liquids facilitates throttling, and the control over the flow rate of LOX enables the re-start capability.**
	• **Benefits:** more efficient, greener and safer to handle.

Successful test of HS200 booster for Gaganyaan Programme	• It is the world's second largest **operational booster using solid propellants** • It is the **'human-rated'** version of the S200 rocket boosters used on **Geosynchronous Satellite Launch Vehicle Mk-III (GSLV Mk-III),** also called the LVM3. • **Gaganyaan envisages** undertaking the demonstration of indigenous capability to undertake **human spaceflight to Low Earth Orbit** (an orbit of 2,000km or less)**.** ○ Until now **only US, Russia and China** have managed to send manned missions to outer space.
Inflatable Aerodynamic Decelerator (IAD)	• **ISRO has successfully tested IAD** technology to land **missions on Venus & Mars.** • IAD is **used for aerodynamically decelerating an object descending** through the atmosphere. • **IAD has huge potential** in variety of space applications like **recovery of spent stages of rocket, for landing payloads** on to Mars or Venus and in **making space habitat for human space flight missions.** • IAD is **made of Kevlar fabric** coated with polychloroprene. ○ Kevlar has properties like **high tensile strength, toughness, thermal stability etc.**

Rohini Sounding Rockets	• **ISRO launched Rohini RH-200** sounding rocket.
	• Sounding rockets are **one or two stage solid propellant rockets** used for **probing the upper atmospheric regions** and for **space research.**
	  ○ Rohini Sounding Rockets is a **two-stage rocket capable of climbing** to a height of **70 km** bearing **scientific payloads.**
	• The **1st sounding rocket** was launched in **1963** from **Thumba** (beginning of **Indian Space Programme**).
	  ○ **ISRO started** to launch **indigenous sounding rockets in 1965.**
	  ○ **First sounding rocket** to be launched from India was **American Nike-Apache in 1963.**

RISAT-2 satellite	• ISRO's RISAT-2 satellite, has made an **uncontrolled re-entry into the Earth's atmosphere.** • **RISAT 2** is a **radar-imaging satellite** which was part of RISAT programme of ISRO. ○ **It weighs only about 300 kg** and was launched by the **PSLV-C12 launch vehicle in 2009.** • The RISAT satellites are equipped with a **synthetic aperture radar (SAR) that can take pictures of the earth during day and night,** and also under cloudy conditions. • It helps **round-the-clock border surveillance along with checking infiltration** and keeping an eye on terror or anti-national activities across the borders.
Aditya L1 mission	• It will **study about Sun's corona, solar emissions, solar winds and flares,** and **Coronal Mass Ejections (CMEs)**, and will carry out round-the-clock imaging of Sun. • Aditya 1 (meant to observe only solar corona) was **renamed as Aditya-L1 (Lagrangian Point 1).** • **Other solar missions:** European Space Agency's Solar Orbiter, NASA's Parker Solar Probe.

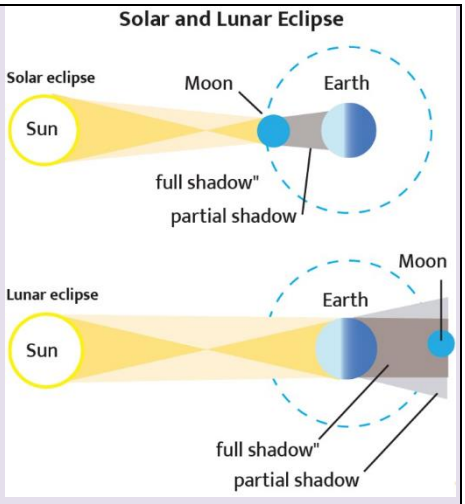
SpaceTech Innovation Network (SpIN)	• **ISRO** has signed an MoU with Social Alpha **to launch SpIN.**
	• SpIN is India's **first dedicated platform** for **innovation, curation, and venture development** for the **space entrepreneurial ecosystem.**
	  ○ It has **launched its first innovation challenge.**
	  ○ **Selected start-ups and innovators will be able to access** both Social Alpha's and ISRO's infrastructure and resources.

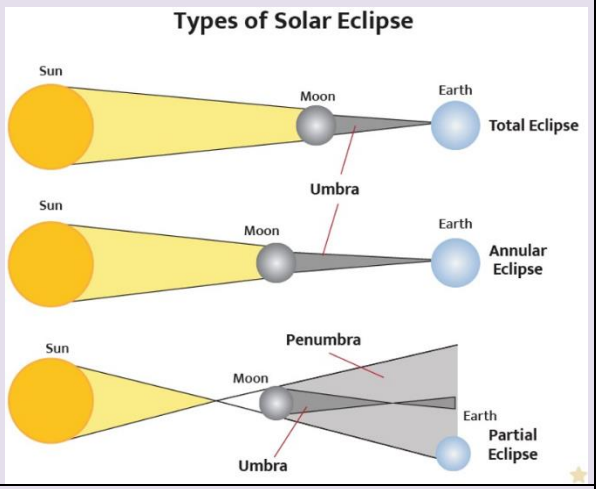
3.13. OTHER IMPORTANT NEWS

3.13.1. SPACE PHENOMENON AND EXPERIMENTS

Solar Eclipse

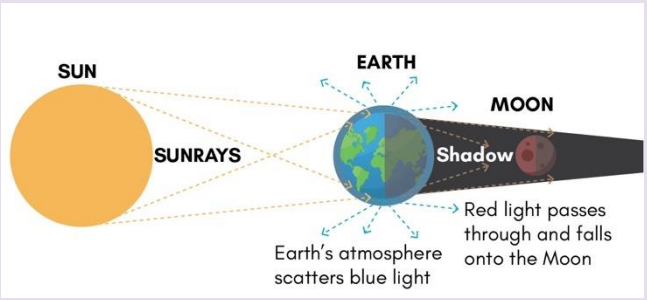
- A solar eclipse occurs when **Moon gets between Earth and Sun**, and **moon casts a shadow over Earth.**
  - Solar eclipses **happen only at the new moon phase.**
- **Different types of solar eclipses are:**
  - **Total solar eclipse:** When moon passes between Sun and Earth, **completely blocking face of Sun**. It is only visible from a small area on Earth.
  - **Partial solar eclipse:** When sun, moon and Earth are not exactly lined up. Only a part of the Sun will appear to be covered, **giving it a crescent shape.**
  - **Annular solar eclipse:** When moon is farthest from Earth. It does not block entire view of the sun. This **looks like a ring around the moon.**
  - **Hybrid solar eclipse:** Because Earth's surface is curved, sometimes an eclipse can shift between annular and total as Moon's shadow moves across the globe.





Blood Moon

- **Blood Moon was witnessed** in parts of India.
- **Blood Moon**, commonly known as **total lunar eclipse**, occurs when **moon passes through darkest part of Earth's shadow**, known as the **umbra.**
  - It is called **blood moon because of reddish hue.**
- **Other Types of Lunar Eclipse:**
  - **Partial Lunar Eclipse:** When only a part of moon enters earth's shadow.
  - **Penumbral Lunar Eclipse:** When the moon enters the Earth's penumbra.

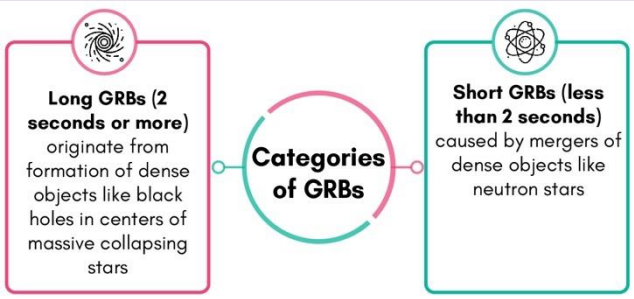
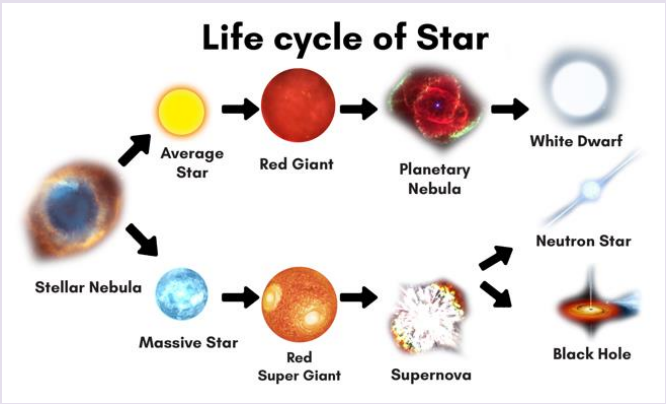


Geomagnetic Storm

- National Oceanic and Atmospheric Administration (NOAA) **has issued two geomagnetic storm** (GMS) watches.
- GMS is a **disturbance in the earth's magnetosphere**, which is the area around the planet controlled by its magnetic field.
  - **When Coronal Mass Ejections** (CME) **collide with the Earth,** it causes GMS.
  - CME is a **large expulsion of plasma and magnetic field from the sun's corona**, or upper atmosphere.
- **Impact of geomagnetic storms:** Disrupt high-frequency radio broadcasts and global positioning system (GPS) devices, damage satellite electronics, can affect power supply on earth.

Coronal Holes

- NASA's Solar Dynamics observatory observed the **phenomenon of coronal holes in ultraviolet light** as these are typically invisible to our eyes.
- **About Coronal holes**

	○ **Coronal holes** are **regions on the sun's surface from where fast solar wind gushes out into space.** ○ Because they **contain little solar material,** they have **lower temperatures** and thus **appear much darker** than their surroundings. ○ The holes are **not a unique phenomenon,** appearing throughout the sun's **approximately 11-year solar cycle.** ○ These coronal holes can **cause a solar storm on Earth** as they **release a complex stream of solar winds.**
Sunspots	• A sunspot, called AR3038, **grew to almost twice its size** in the span of 24 hours. • **Sunspots are areas that appear dark** on the surface of the Sun. They appear dark **because they are cooler than other parts of the Sun's surface.** • Sunspots are relatively cool as they **form at areas where magnetic fields are particularly strong** thus keeping some of the heat within Sun from reaching the surface. ○ **Magnetic field lines near sunspots can cause** a sudden explosion of energy called a **solar flare.**
Fast Radio Bursts (FRBs)	• Astronomers **have reported a FRB whose characteristics are different** from almost all other FRBs previously detected. • FRBs are **bright bursts of radio waves whose durations lie in the millisecond-scale,** because of which it is difficult to detect them and determine their position in the sky. ○ Radio waves can be **produced by astronomical objects with changing magnetic fields.** • **Origins of FRBs are unknown,** and their appearance is unpredictable.
Gamma Ray Bursts (GRBs)	• In a first-of-its-kind detection, astronomers recorded **binary merger emitting long GRB twinned with a kilonova emissions.** ○ Traditionally associated with short GRB, **Kilonovae occur when two compact objects, like binary neutron stars or a neutron star and a black hole, collide.**  • GRBs are **flashes of high-energy radiation arising from energetic cosmic explosions.** • GRBs are the **most powerful explosions** universe has seen **since the Big Bang.** ○ They are **brief, but intense, flashes of gamma radiation.** • They produce as much energy as **Sun will emit during its entire 10-billion-year existence.**
Betelgeuse	• It is the **bright red supergiant** on the shoulder of Orion. ○ **A red giant is a dying star** in the final stages of stellar evolution. • In late 2019, Betelgeuse star **got fainter than ever before.** • Now the researchers believe that in 2019 Betelgeuse **likely underwent an enormous surface mass ejection (SME)** where it ejected **400 billion times more mass than a typical event on other stars.**  ○ An SME happens when a star **expels large amounts of plasma and magnetic flux** into the surrounding space. However, the exact cause behind this SME is unclear.
White dwarfs	• According to a recent study by Indian scientists **study of cosmic dust from a white dwarf and companion star** could unravel mysteries behind start of life. • White dwarfs are **stars that have burned up all of** hydrogen they once used as nuclear fuel. • Cosmic dust is **made of various elements, such as carbon, oxygen, iron and other atoms heavier than hydrogen and helium.** ○ It is the stuff of which **planets and people are made, and it is essential for star formation.**
Saturn Mysterious Rings and Tilt	• A new study has suggested that a **pre-existing moon of Saturn,** named **Chrysalis,** left it with its **bright rings** and **extreme tilt.** • Saturn is the **6th planet** from the **Sun** and **2nd largest planet** of our **solar system.**

	○ Saturn has an **axial tilt** of **26.73 degrees** ○ **Saturn has 7 rings** and are **composed of water ice particles** ranging from microns to tens of meters in size**.** ○ Other planets with rings include **Jupiter, Neptune and Uranus**.
Plants in Moon soil	• Scientists have for the first time successfully **grown plants in the Moon's soil**. • This lunar soil, also called **regolith**, was brought to Earth from the Moon by the **Apollo-era astronauts.** • Researchers have grown the hardy and well-studied **Arabidopsis thaliana** in the nutrient-poor **lunar regolith**. ○ Arabidopsis thaliana, **native to Eurasia and Africa**, is a relative of **mustard greens and other cruciferous vegetables** like broccoli, cauliflower, and Brussels sprouts.

3.13.2. SPACE OBJECTS

New asteroid 2022 AP7 discovered	• **Astronomers discovered new PHA** named **2022 AP7.** ○ It is the **largest object** that is potentially hazardous to Earth to be discovered in the last eight years. ○ It **was 1.5 kilometer wide**. Any asteroid over 1km in size is considered a **planet killer.** • It will cross Earth's orbit, which makes it **potentially hazardous asteroid (PHA).** • PHA are defined based on **parameters that measure the asteroid's potential to make threatening** close approaches to the Earth.
Exoplanets	• **Scientists have now detected barium** in the upper atmosphere of two giant exoplanet (WASP-76b and WASP-121b) **for the first time.** ○ WASP-76b and WASP-121b are **Ultra-hot Jupiters, a class of hot gaseous planets that matches the size of Jupiter**. ○ But they **have short orbital periods**, unlike Jupiter. • Most of the **exoplanets discovered so far are in a relatively small region of Milky Way galaxy.**
Bernardinelli-Bernstein comet	• NASA has confirmed that Bernardinelli-Bernstein comet is indeed the **largest icy comet nucleus ever seen by astronomers**. ○ Comets are large objects made **of dust and ice** that **orbit the Sun.** • **About Bernardinelli-Berstein comet:** ○ Officially called **C/2014 UN271**, it has an estimated **diameter of almost 129 kilometres**. ○ Mass is estimated to be **around 500 trillion tonnes**. • It is believed to have originated in **the Oort cloud** (only a theoretical concept), a distant region of the solar system that is **predicted to be the source of most comets**.

3.13.3. MISCELLANEOUS

Dark SKY Reserve	• **Department of Science & Technology has announced** setting up of **India's first dark sky reserve at Hanle** in Ladakh as a part of **Changthang Wildlife Sanctuary.** ○ It will be **one of the world's highest-located sites** for optical, infra-red, and gamma-ray telescopes. • **Dark Sky Reserve is a place** that has policies to ensure that a **tract of land or region has minimal artificial light interference.** ○ **International Dark Sky Association**, a U.S.-based non-profit, **designates places** as International Dark Sky Places, parks, sanctuaries and reserves, **depending on criteria they meet.** • **Indian Astronomical Observatory (IAO)**, high-altitude station of Indian Institute of Astrophysics, **is also located** atop Mt. Saraswati in Nilamkhul Plain **in the Hanle Valley.** ○ **Other Prominent telescopes at IAO:** Himalayan Chandra Telescope, High Energy Gamma Ray telescope (HAGAR), Major Atmospheric Cherenkov Experiment Telescope (MACE), GROWTH etc.
Sampurnanand Optical Telescope (SOT)	• SOT, **located at ARIES, Manora Peak, Nainital** (Uttarakhand)**, completed 50 years of operations.** ○ Aryabhatta Research Institute of Observational Sciences (ARIES) **specializes in observational Astronomy & Astrophysics and Atmospheric Sciences.** • **SOT's major instruments:** Cassegrain plate holder, Meinel camera, photoelectric photometer, polarimeter etc. • SOT has been **used for optical observations of comets, occultation by planets and asteroids, star forming regions** and star clusters, active galactic nuclei, etc. • **Important discovery made:** discovery of rings of Neptune; contributed to detection of rings around Uranus and additional rings around Saturn; first detection of optical afterglows of

	Gamma-ray-bursts (GRBs); micro-lensing event; discovery of quakes in various stars (under Nainital-Cape Survey program) etc.
Shaped Antenna measurement of the background Radio Spectrum (SARAS 3) Telescope	• SARAS 3 has **helped determine properties of the earliest radio luminous galaxies** formed 200 million years after the Big Bang, a period known as the Cosmic Dawn. • SARAS 3 is a **precision radio telescope** to detect extremely **faint radio wave signals from Cosmic Dawn.** ○ It is the **first telescope worldwide to reach the required sensitivity.** • It is indigenously **designed and built at Raman Research Institute** (an autonomous institute of the Department of Science & Technology). • It is **deployed over Dandiganahalli Lake** and Sharavati backwaters, **in Karnataka.**
Liquid-Mirror Telescope (LMT)	• LMT, **India's first and Asia's largest liquid-mirror telescope,** is commissioned **at the Devasthal Observatory** of Aryabhatta Research Institute of Observational Sciences (ARIES) **in Nainital (Uttarakhand).** ○ ARIES is an autonomous institute under Department of Science and Technology. • LMT will **observe asteroids, supernovae, space debris** and all other celestial objects. • Built by astronomers from **India, Belgium and Canada**, LMT employs **a rotating mirror made up of a thin film of liquid mercury** (a reflective liquid) **to collect and focus light.** • LMT, having a primary mirror that is liquid, **cannot be turned and pointed in any direction** and watches the sky as the Earth rotates.

Space Bricks	• Researchers from ISRO and Indian Institute of Science (IISc) have **developed a way to make bricks of complex shapes from Martian soil** with the help of bacteria and urea.
	• First **slurry was made by mixing Martian soil with guar gum, a bacterium** called Sporosarcina pasteurii, **urea and nickel chloride ($NiCl_2$).**
	  ○ **Bacteria convert the urea into crystals** of calcium carbonate.
	  ○ These crystals, along with biopolymers secreted by microbes, **act as cement holding soil particles together.**
	• In the past, the team **had made bricks out of lunar soil** using a similar method.

Tiangong	• China successfully launched final module for Tiangong, **a space station that Chinese Manned Space Agency (CMSA) is building in low Earth orbit**. • It is set to be the **second permanently inhabited outpost in low-Earth orbit** after the **NASA-led International Space Station (ISS).** ○ **Chinese astronauts are currently excluded from ISS** because US law bans NASA from sharing its data with China. • Tiangong will be **much smaller and lighter than ISS.**

4. HEALTH

4.1. TRADITIONAL MEDICINE

Why in News?

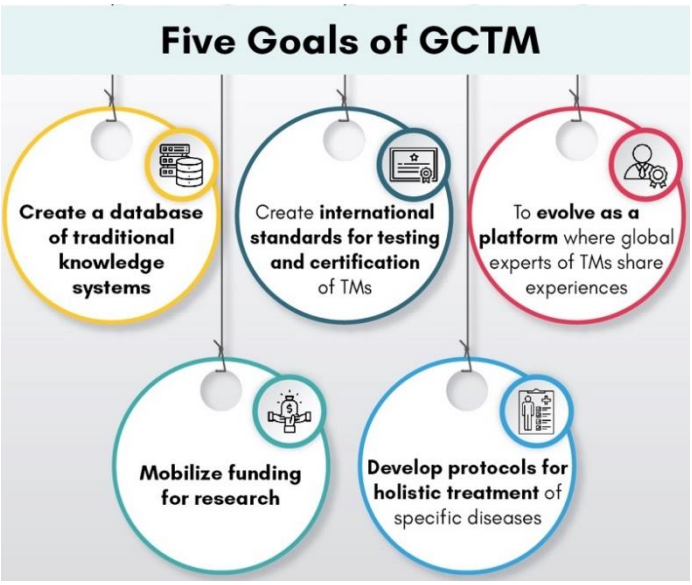
Recently, WHO Director-General laid the foundation stone for world's first and only **Global Centre for Traditional Medicine (GCTM) at Jamnagar in Gujarat.**

Initiatives by India to Promote its T&CM i.e. AYUSH system

- **National AYUSH Mission (NAM):** to promote AYUSH medical systems.
- **Champion Services Sector Scheme for Medical value Travel:** To amplify medical tourism in the field of Ayush.
- **Ayush Export Promotion Council (AEPC).**
- **The AYURSWASTHYA YOJANA:** To roll out authentic and classical Ayush Interventions.
- **AYUSH Information Cell** in several countries to disseminate authentic information about AYUSH systems.

About Traditional Medicine

- According to WTO, Traditional medicine (TM) is the **sum of the knowledge, skill, and practices** based on the theories, beliefs, and experiences **indigenous** to different cultures, **for treatment of physical and mental illness.**
  - Complementary medicine (CM) or alternative medicine refers to health care practices that are **not part of that country's own tradition or conventional medicine** and are not fully integrated into the dominant health-care system.
    - ✓ They are used interchangeably with traditional medicine in some countries.
  - India's traditional and complementary medicines (T&CM) consists of **AYUSH (Ayurveda, Yoga, Unani, Siddha and Homeopathy) and** Sowa Rigpa.
    - It is **regulated by the Ministry of AYUSH.**
- According to WHO, **170 WHO member countries** have acknowledged their **use of T&CM** since 2018.



Related News

Ministry of Ayush and **Food Safety & Standards Authority of India (FSSAI)** formulated **regulations for 'Ayurveda Aahara' products.**

- Regulations have been framed to **ensure the manufacturing of quality Ayurveda food products and to help in expanding the international market for Make-In-India products.**
- **Key highlights of the regulations**
  - Manufacturing and marketing of 'Ayurveda Aahara' products will now adhere to strict **Food Safety and Standards (Ayurveda Aahara) Regulations, 2022 rules.**
  - Prior approval for 'Ayurveda Aahara' shall be in accordance with **Food Safety and Standards (Approval for Non-Specific Food and Food Ingredients) Regulation, 2017.**
  - A **special logo has been created for "Ayurveda Aahara" category**, which will enable easier identification and reinforce quality in Ayurveda food products.
  - 'Ayurveda Aahara' **will not include Ayurvedic drugs or proprietary Ayurvedic medicines and medicinal products, cosmetics, narcotic or psychotropic substances and herbs.**

Cabinet approved widening access to Traditional Knowledge Digital Library (TKDL)

- Until now, access to **complete TKDL database is restricted to 14 Patent Offices worldwide** for purposes of search and examination.
- **About TKDL**
  - TKDL, **first of its kind globally**, is a database of **Indian traditional knowledge established in 2001**, by Council of Scientific and Industrial Research **(CSIR) and Ministry of AYUSH.**
  - It **contains information** related to **Ayurveda, Unani, Siddha, Sowa Rigpa, and Yoga in five international languages** (English, German, French, Japanese and Spanish).
  - It seeks to **prevent misappropriation of country's traditional medicinal knowledge through patenting worldwide.**

Pharmacopoeia Commission for Indian Medicine & Homoeopathy (PCIM&H)

PCIMH

HQ Ghaziabad, UP

Genesis: PCIM&H is a subordinate office **under Ministry of AYUSH.**
- It was registered **under Societies Registration Act, 1860.**

Objective: **To develop Pharmacopoeias for formulations** of and act as Central Drug Testing cum Appellate Laboratory for- Indian Medicine and Homoeopathy etc.
- It regularly updates **standards of drugs** commonly required for treatment of diseases.

Other key information:
- PCIM&H in collaboration with WHO Southeast Asia Region is **organizing training programme to maintain quality of Traditional products.**
- **Indian Pharmacopoeia Commission,** an autonomous institution under **Ministry of Health and Family Welfare, is different from above body.** ★

4.2. TUBERCULOSIS

Why in news?

Recently, World Health Organization (WHO) released new guidance to support **National Strategic Planning (NSP) for the tuberculosis (TB).**

More on news

- NSP for TB **guides how to comprehensively address TB epidemic** through goal(s), strategies, priority interventions within health and across other sectors.
  - Each goal must be defined in line with **SMART (specific, measurable, attainable, realistic, and time-bound) criteria.**
  - Current document is an **update to 2015 Toolkit to develop a NSP for TB prevention, care, and control.**

Tuberculosis

TB is **caused by bacteria (Mycobacterium tuberculosis)** and it most often **affects the lungs**

Types of TB

- **Pulmonary TB** (affects lungs)
- **Extra Pulmonary TB** (affects both lungs and other organs)

For prevention of TB

BCG (Bacille Calmette-Guérin) vaccine is used among children at the time of birth

Drug resistant TB

- **Multi- Drug Resistance TB (MDR- TB)**
  Does **not respond to at least isoniazid and rifampicin** (2 of the most powerful anti-TB drugs)
- **Extensively Drug Resistant TB (XDR- TB)**
  Does **not respond to** at least four of the core anti-TB drugs.
- **Totally drug-resistant tuberculosis (TDR-TB)**
  TB which is resistant to all the anti- TB drugs. ★

Steps taken to eliminate Tuberculosis

- **India's efforts:**
  - **National Strategic Plan (NSP), 2017-2025:** To eliminate TB by 2025, five years ahead of the SDG 2030 target.
  - **National Tuberculosis Elimination Program (NTEP):** Has expanded laboratory network as well as diagnostic facilities to cover the entire country.
    - ✓ Earlier, it was known as **Revised National Tuberculosis Control Program (RNTCP).**
  - **NIKSHAY Portal:** It is the **National TB information system** to manage patient information and monitor program activity throughout the country.
    - ✓ It provides a **National Data repository of TB information** for advanced analytics.
  - **NIKSHAY Poshan Yojana**: Provides DBT to all TB patients towards nutritional support.
    - ✓ **Scheme,** by Ministry of Health and Family Welfare**,** is **financed by Government of India,** with partial financing provided through **World Bank.**
  - **TB Free India Campaign** launched by Prime Minister to eliminate TB by 2025.
  - **'PathoDetect™ kit'**, by Pune based Mylab: India's **first indigenous TB Detection kit**-Single test can detect tuberculosis and MDR TB.
- **Global commitments and efforts taken to eliminate TB**
  - **Moscow Declaration, 2017**: To increase multisectoral action and enhance accountability towards ending TB by 2030
  - **WHO End TB Strategy:** To **reduce TB incidence by 80%, TB deaths by 90%,** and to eliminate catastrophic costs for TB-affected households by 2030.
  - **Find. Treat. All. #EndTB**: It is the joint Initiative of WHO, Stop TB Partnership, and Global Fund to **diagnose treat and report 40 million people with TB**.

Related News

Short anti-TB regimen 'BPaL' gets global nod as trials 'positive'

- **BPaL has shown favourable outcomes** in TB patients.
  - BPaL is a 6-month, **all-oral, three-drug regimen** that is used **to treat people with highly drug-resistant forms of TB.**
  - **BPaL is a combination of three newer antibiotics,** namely bedaquiline, pretomanid and linezolid.
  - **TB Alliance's** BPaL regimen **to reduce TB treatment time from 18 months to 6 months.**
  - **TB Alliance is not-for-profit organization.**

4.3. ANTIMICROBIAL RESISTANCE (AMR)

Why in News?

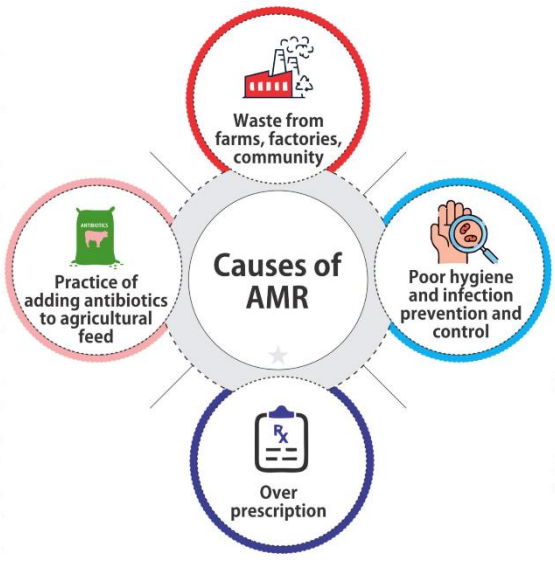
Recently, WHO released Global Antimicrobial Resistance and Use Surveillance System (GLASS) report.

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

About GLASS

- **Aim:** To provide a standardized approach to the collection, analysis and sharing of AMR data by countries.
  - **2022 GLASS Report**, for the first time, **included data on antibiotic consumption** at the **national level.**
- **Types of infection and pathogens covered in GLASS**:
- **Pathogens included in GLASS are:** Acinetobacter spp., E. coli, Klebsiella pneumoniae, Neisseria gonorrhoeae, Salmonella spp., Shigella spp., Staphylococcus aureus, and Streptococcus pneumoniae.



Initiatives taken for tackling AMR

- **Global**
  - **Global Action Plan on AMR** during the 2015 World Health Assembly.
  - **WHO** is working closely with **Food and Agriculture Organization** (FAO) and **World Organisation for Animal Health** in a **'One Health' approach** to tackle AMR.
  - **Global Antibiotic Research and Development Partnership**, a joint initiative of WHO and the Drugs for Neglected Diseases Initiative.
- **By India**
  - **National programme on AMR containment** (2012-17)
  - **National Action Plan on Antimicrobial Resistance**
  - **Red Line campaign** to discourage the over the-counter sale of antibiotics.
  - **FSSAI guidelines** limiting the **antibiotics in food products**.
  - A **separate Schedule H-1** incorporated in Drug and Cosmetic rules **to regulate sale of antimicrobials.**

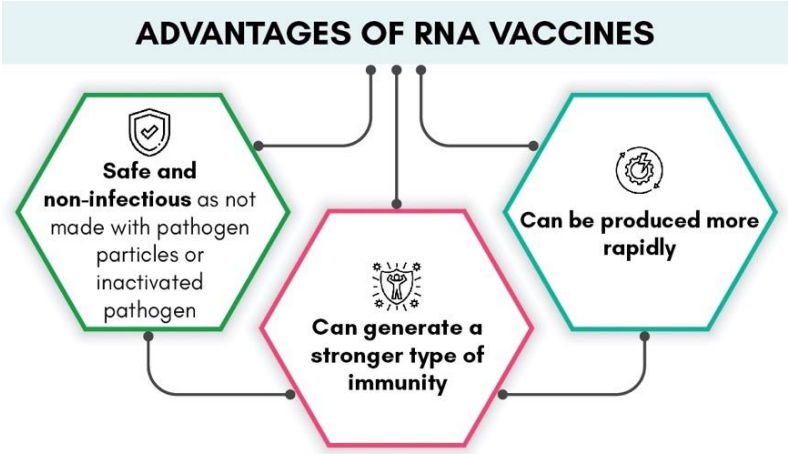
Related News

- WHO released the **first-ever report** on the **pipeline of the vaccines** to **prevent infections** by AMR bacterial pathogens.
- Vaccines are **available against four priority bacterial pathogens**: Pneumococcal disease (Streptococcus pneumonia), **Hib** (Haemophilus influenzae type b), **Tuberculosis** (mycobacterium tuberculosis), **and Typhoid fever** (Salmonella Typhi).
  - **Current BCG vaccines do not adequately** protect against TB.
  - **Remaining three** vaccines **are effective.**

4.4. SELF-AMPLIFYING MESSENGER RNA (MRNA) VACCINE

Why in News?

A Self-amplifying messenger RNA (mRNA) vaccine, ARCT-154, developed by Arcturus Therapeutics Holdings (US), showed promising results against Covid-19 .



About mRNA Vaccine

- **Unlike conventional vaccines** that inject a weakened form of a virus or bacteria into the body, **RNA vaccines use part of virus' own genes** to stimulate an immune response.
- **A conventional mRNA vaccine,** such as those from Pfizer and Moderna, **uses mRNA that encodes the spike protein of the coronavirus.**
  - **mRNA vaccines teach cells how to make copies of the spike protein** that triggers an immune response inside human bodies, when actual infection takes place.
- A self-amplifying mRNA vaccine is an **improvement over the traditional mRNA** as it **encodes four extra proteins in addition to the vaccine antigen,** and these enable amplification of original strand of RNA once inside the cell.
- **Advantage of self-amplifying mRNA vaccine** over conventional mRNA vaccine: making storage easy, minimizing dose of RNA, and lowering the cost of vaccines.

Related Information

DNA and RNA Vaccines

- In DNA vaccines, **a piece of DNA encoding the antigen** is first **inserted into a bacterial plasmid and** then these **DNA plasmids are usually injected into muscles** and then enabled to reach cells.
  - Plasmid is a **circular piece of DNA used** by a bacterium **to store and share genes** which may benefit its survival.
- Whereas, RNA vaccine **uses a copy of a natural chemical called messenger RNA (mRNA)** to produce an immune response in humans.
  - ✓ mRNA teaches cells **how to make a protein that triggers an immune response**.
- **DNA vaccine is more stable** than RNA vaccine.
- Unlike RNA vaccine, **DNA vaccines** have potential to **integrate into host cell genome.**

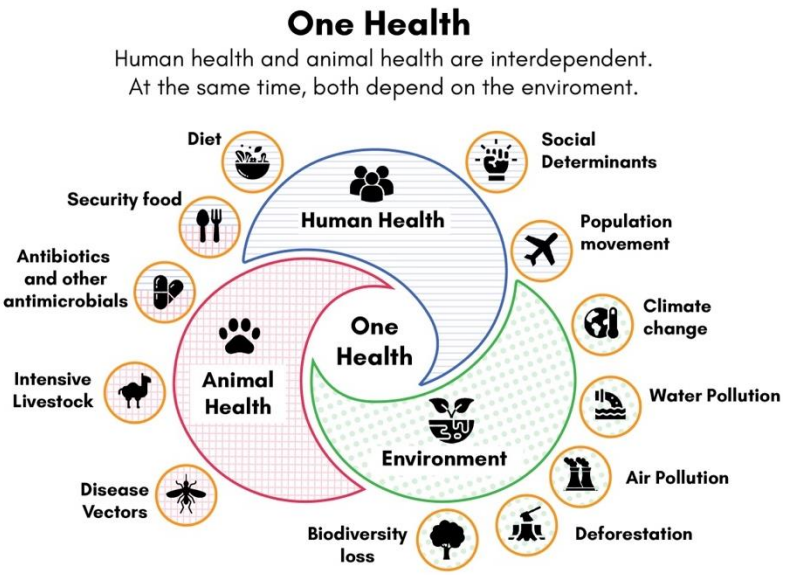
4.5. ONE HEALTH

Why in news?

Recently, four multilateral agencies have **launched a One Health Joint Plan of Action (2022-2026) (OH JPA).**

About One Health Joint Plan of Action (2022-2026) (OH JPA)

- **Launched by:** the 'Quadripartite' comprising:
  - **United Nations (UN) Food and Agriculture Organization (FAO),**
  - **UN Environment Programme (UNEP),**
  - **World Health Organization (WHO)**
  - **World Organisation for Animal Health.**



- **Aim:** Mitigating the health challenges at global, regional, and country levels by **creating a framework and integrating systems and capacity** to collectively prevent health threats.
- **Implementation:** 2022-2026

Steps taken in India to implement One health approach

- **One Health Support Unit (OHSU)** by Department of Animal Husbandry and Dairying, to develop a national **One Health Framework.**
  - The framework is **aimed at improving national and State-level resource allocation and policy ecosystem** of zoonotic diseases.
  - Under it, the **pilot project are being implemented** in states like Uttarakhand and Karnataka.
- **National Mission on Biodiversity and Human Well-being:** Launched by Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC).
- **'One Health' project:** By Department of Biotechnology to carry out surveillance of zoonotic as well as transboundary pathogens in India.

Other Global initiatives

- **The Pilanesberg Resolution, 2001:** For donors and governmental authorities to consider potential wildlife health impacts in development projects.
- **One World-One Health:** Introduced by The Wildlife Conservation Society in 2007 along with 12 recommendations (**Manhattan Principles**) to prevent epidemic disease and maintaining ecosystem integrity.
- **National Framework for One Health, 2021** by FAO guides towards overcoming the systemic barriers to implement the One Health approach.

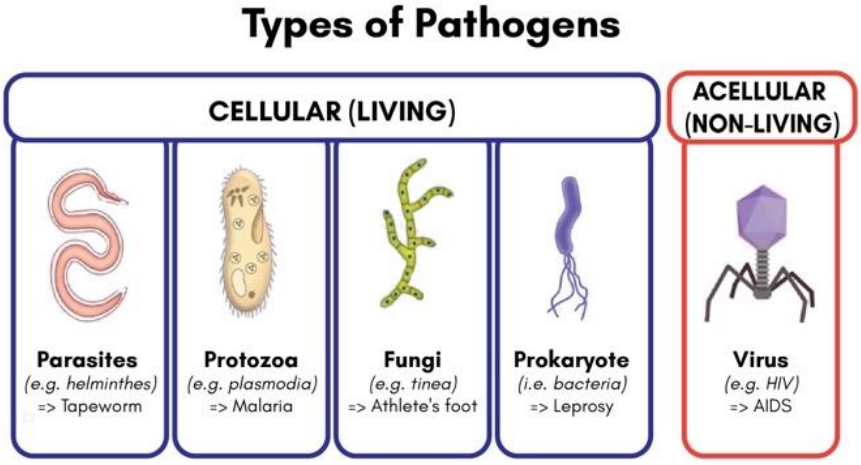
4.6. FIRST-EVER FUNGAL PRIORITY PATHOGENS LIST (FPPL)

Why in News?

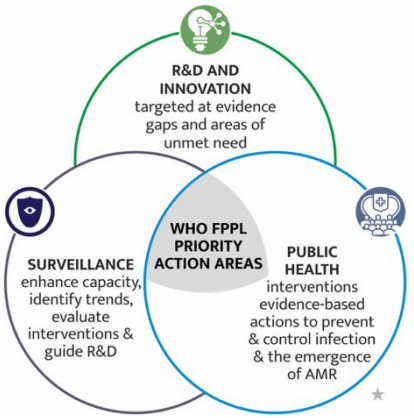
World Health Organisation (WHO) has released the first-ever fungal priority pathogens list (FPPL).

About Fungal pathogens

- **Fungal pathogens are a major threat to public health** as:
  - **Most fungal pathogens lack** rapid, sensitive, and affordable **diagnostics.**

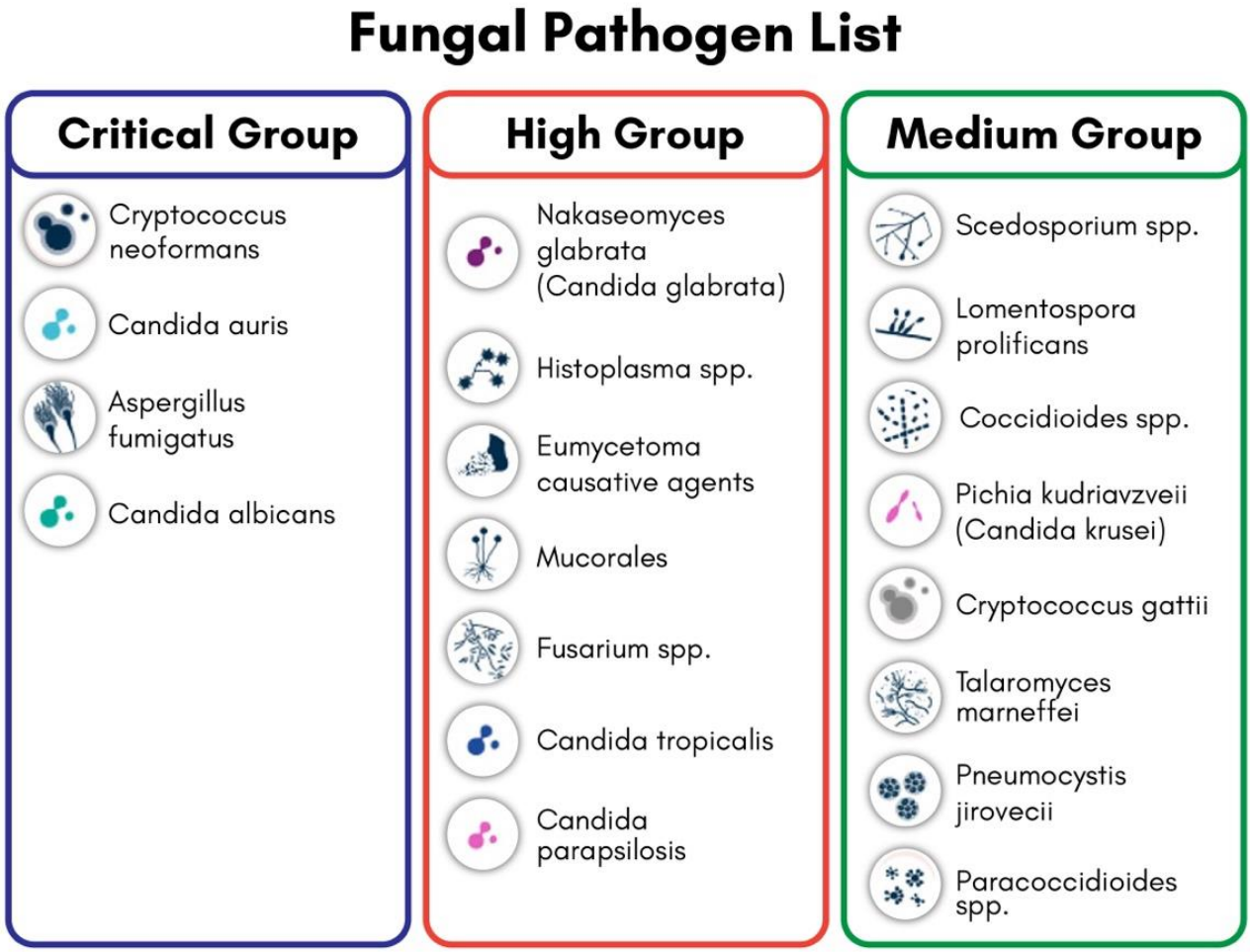


- **Only four** classes of **antifungal medicines (azoles, echinocandins, pyrimidines and polyenes)** currently available.
- **Incidence and geographic range of fungal diseases** are **expanding worldwide** due to global warming and increase of international travel and trade.
- Fungi that cause common infections become **increasingly resistant to treatment.**



About Fungal Priority Pathogens List

- FPPL includes 19 fungi categorised as critical, high, and medium priority**.**



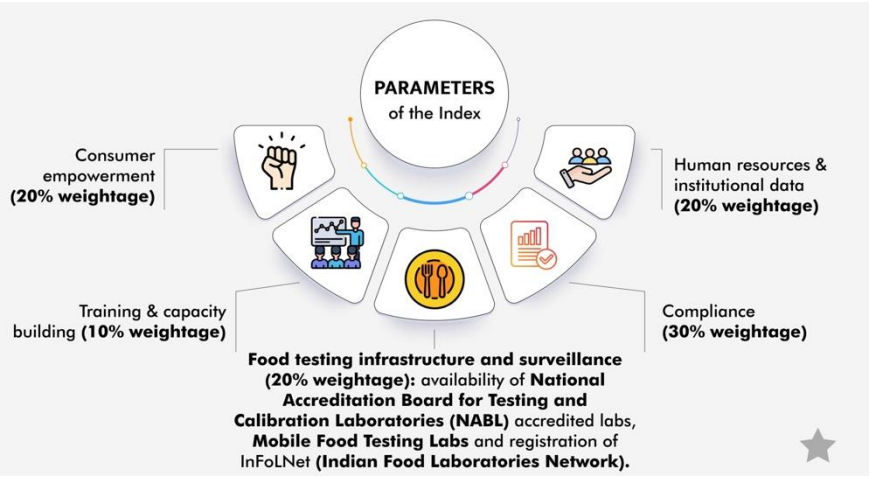
4.7. FOOD SAFETY

Why in news?

Food Safety and Standards Authority of India (FSSAI) released the **State Food Safety Index (SFSI) 2021-22.**

About State Food Safety Index (SFSI)

- **Released annually** since its inception in 2018-19.

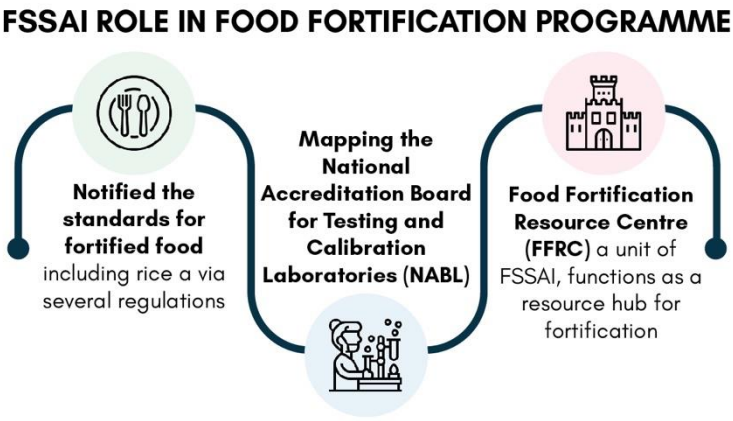


- **Aim:** Encouraging states and UTs to establish a proper food safety ecosystem in their jurisdiction.
- **Findings of State Food Safety Index 2021-2022**
  - **Top-Ranking Large States:** Tamil Nadu followed by Gujarat and Maharashtra.
  - **Top-Ranking Small states:** Goa followed by Manipur and Sikkim.
  - **Top-Ranking UTs:** Jammu & Kashmir followed by Delhi and Chandigarh.

4.8. RICE FORTIFICATION

Why in news?

Recently, the **Department of Food and Public Distribution has issued Standard Operating Procedure (SOP)** to maintain desired quality standards for implementation of 'Rice Fortification'.



About Standard Operating Procedure (SOP)

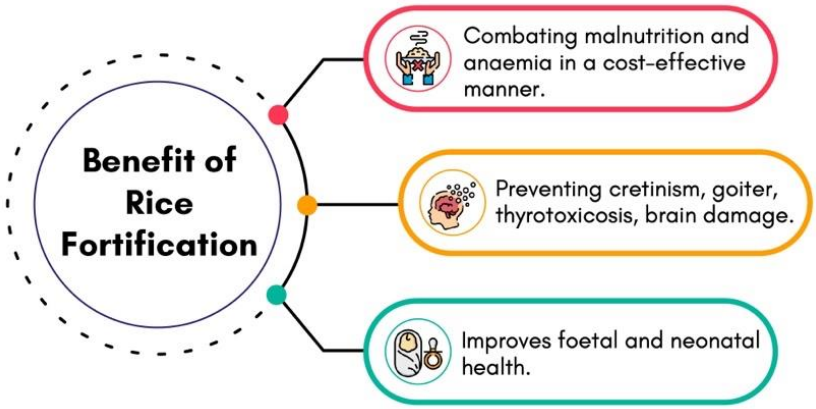
- **Aim:** To address malnutrition, anaemia and micronutrient deficiencies.
- **SOP in brief**
  - **Rice Specification:** Milled rice in which Fortified Rice Kernels (FRK) will be blended should **comply with rice specification as per Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011.**
  - **Packaging of fortified food:** Takes into consideration the nature of the fortificant added and its effect on the shelf life of such food.
    - ✓ Fortified food package shall contain, **"Fortified with (name of the fortificant)" and the +F logo on its label.** It may also carry a tagline **"Sampoorna Poshan Swasth Jeevan"** under the logo.
    - ✓ **Food fortified with Iron** shall carry a warning **statement for People with Thalassemia.**

About food fortification

- **Deliberately increasing the content of essential micronutrients** in a food to improve the nutritional quality of food and to provide public health benefit with minimal risk to health.
- **Regulation**: Under Food Safety Standards (Fortification of Foods) Regulation, 2018.
- **Fortified food means a food, as specified under** the **FSSAI Regulation, 2011** that has undergone the process of fortification as per the provisions of these regulations.
- In India, **wheat flour and rice are fortified with Iron, Vitamin B12 and Folic Acid, Milk and Edible Oil with Vitamins A and D** and **Double Fortified Salt with Iodine and Iron.**

About Rice Fortification

- It is a process of **adding micronutrients to rice.**
  - Rice, when fortified, shall **contain mandatory micronutrients** (Iron, Folic Acid, and Vitamin B12), or **optional** (Zinc, Vitamin A, Thiamine, Riboflavin, Niacin, and Pyridoxine) as per levels given by **Food Safety and Standards (Fortification of Foods) Regulations, 2018**.
- According to the FSSAI norms, **fortified rice shall contain iron**, **folic acid** and **Vitamin B-12**.
  - In addition, rice may also be fortified with **micronutrients such as zinc, Vitamin A, Vitamin B1, Vitamin B2, Vitamin B3** and **Vitamin B6**.
- **Technologies to add micronutrients** to regular rice**:**
  - **Dusting:** Adds micronutrients onto the surface of the rice grains using electrostatic force.
    - ✓ This technology provides **limited nutrient protection** when rice is washed, soaked or cooked in excess water, which is then discarded.



  - **Coating and extrusion:** It is **two-step process**. First, coating or extrusion technology is used to **produce fortified kernels** and second the **fortified kernels are blended with non-fortified rice** at a ratio of 0.5% to 2%.
- In India, **rice is fortified using extrusion technology** in which **milled rice is pulverized and mixed with a premix** containing vitamins and minerals.
  - FRK is **added to traditional rice in ratio ranging from 1:50 to 1: 200**.

4.9. ORAL REHYDRATION SOLUTION

Why in News?

Dr Dilip Mahalanabis who pioneered the proper practical, emergency use of oral rehydration solution, commonly known by its abbreviation "ORS," for diarrhoeal diseases passed away recently.

More on News

- Dr Dilip Mahalanabis was **working in refugee camps during the 1971 Bangladesh Liberation war** when he **came up with ORS.**
- In 2002, **Dr Dilip Mahalanabis along with Dr Nathaniel F Pierce was awarded the Pollin Prize** by Columbia University (considered the equivalent of Nobel in peadiatrics).

About Oral rehydration salts (ORS)

- ORS are a **mixture of electrolytes (salts) and carbohydrates (in the form of sugar) dissolved in water.**
  - They are **used to replace salts and water that the body loses** during dehydration caused by gastroenteritis, diarrhoea or vomiting.
  - The electrolytes are **potassium and sodium**.
- These components **maximize fluid absorption in the gastrointestinal tract**.
  - The gastrointestinal tract relies on **sodium-glucose cotransporters (SGLTs)**, which are carrier proteins in the intestinal cells.
    - ✓ Cotransporters help **move substances across membranes**.
  - Specifically, **SGLTs pair together sodium and glucose transport in the small intestine**. This allows glucose to increase the absorption of fluids.
  - Additionally, **sodium needs glucose to be properly absorbed**. Therefore, ORS contains both glucose and sodium.
- Since 1975, the **WHO and UNICEF have used ORS to treat dehydration** due to diarrhea.
  - It's commonly **used in countries with limited access to clean water** or other hydration options.

4.10. DISEASES IN NEWS

4.10.1. VIRAL DISEASES

Monkeypox	• Monkeypox **satisfied the requirement of a public health emergency of international concern (PHEIC)** under the WHO's International Health Regulations (IHR),2005.
	  ○ **WHO recently recommended new name "mpox" for monkeypox disease** as the current name was perceived to be racist and stigmatising.
	• **Monkeypox** is **zoonotic disease caused by the virus** belonging to the Orthopoxvirus genus.
	  ○ The Orthopoxvirus genus also includes **variola virus (which causes smallpox), vaccinia virus (used in the smallpox vaccine), and cowpox virus.**
	• It was first discovered in 1958, **largely occurring close to tropical rainforests of Central and West Africa**.
	• **Animal-to-human transmission** can occur **from direct contact with the blood, bodily fluids, or cutaneous or mucosal lesions of infected animals.**

Human Papilloma Virus (HPV)	• Cervavac', the **country's first quadrivalent human papillomavirus vaccine (qHPV) approved for market authorization.** ○ **Manufactured by:** Serum Institute of India. • **HPV is a sexually transmitted virus** that may cause **cervical cancer.** • Cervical cancer is the **second most common cancer of women** in India **despite being largely preventable.** • Cervical cancer **can be eliminated if all prepubertal girls are given HPV vaccination globally**.
Epstein Barr Virus (EBV)	• **As per a recent study, Cancer-causing** EBV can infect the neuronal cells **leading to diseases of the central nervous system** and **brain cancer.** ○ Conducted by: IIT Indore under the **'Fund for Improvement of S&T Infrastructure (FIST) scheme'** • EBV viruses are **widely present in the human population.** • They are **usually harmless,** but the virus gets **reactivated inside the body in some unusual conditions** like immunological stress or immunocompetent.

Zombie Virus	• Zombie virus is **virus emerged due to thawing of permafrost as global temperature is rising**.
	  ○ Researchers **examined ancient viruses** samples collected from permafrost in the Siberia region of Russia.
	• The oldest virus is 48,500 years old, called **Pandoravirus yedoma**.
	  ○ Pandoravirus was discovered **below the bottom of a lake in Yukechi Alas in Yakutia, Russia.**
	• It has the **potential to be infectious** and hence **pose a "health danger"** after researching live cultures.

Marburg virus disease (MVD)	• **Ghana has reported** first-ever suspected cases of MVD. • It's a **highly infectious viral hemorrhagic fever** with a **fatality ratio of up to 88 percent.** ○ It was **first identified in 1967 in Germany's Marburg and Frankfurt**. • It **belongs to same family as Ebola**. • **Fruit bats of Pteropodidae Family are key carriers** of the disease. • It is **transmitted to people from fruit bats and spreads among humans** through human-to-human transmission. • Currently there are **no vaccines or antiviral treatments** approved for MVD.

African Swine Fever (ASF)	• **Recently, ASF cases have been reported from Bihar**.
	• ASF is a **highly contagious and deadly viral disease** affecting pigs and wild boar with up to 100% case fatality rate.
	  ○ ASF is **not a threat to human health** and **cannot be transmitted from pigs to humans.**
	  ○ Currently, there is **no effective vaccine** against ASF.
	  ○ It was **first reported in India in 2019.**

- According to IHR, **an outbreak qualifies as a PHEIC if** it's unusual or unexpected, has potential for international spread, and requires an immediate international response.
  - Once **it spreads internationally, it is declared as a Pandemic**.
- **IHR, 2005 is a binding international legal agreement** involving 196 countries across the globe, including all the Member States of WHO.

Tomato Flu (Tomato Fever)	• Tomato flu has been **reported from Kerala, Tamil Nadu, Haryana, and Odisha**.
	• It is **characterised by fever, joint pain, and red, tomato-like rashes** usually seen in **children below age of five years and adults with weaker immunity.**
	  ○ It is **caused by a virus** and shows symptoms similar to those of COVID-19 but is **not related to SARS COV-2.**
	  ○ There is **no specific treatment or vaccine available** for disease.

Lumpy Skin Disease (LSD)	• Recently, **Lumpi-ProVacInd** vaccine has been developed by **Indian Council of Agricultural Research (ICAR).**
	  ○ It is a **homologous, live attenuated vaccine** specifically targeted to protect cattle against LSD virus.
	• LSD is a **vector-borne pox disease** that is **caused by Capripoxvirus** and is an emerging threat to livestock worldwide.
	  ○ It is **genetically related to the goat pox and sheep pox virus** family.
	• LSD **infects cattle and water buffalo mainly through vectors** such as blood-feeding insects.
	• The disease **has been endemic in most African countries,** and since 2012 it has **spread rapidly** through the Middle East, Southeast Europe and West and Central Asia.
	  ○ LSD was **reported for the first time in India in 2019** from Odisha.
	• **The disease is not zoonotic,** meaning it does not spread from animals to humans.

White spot syndrome virus (WSSV)	• Scientists from **Agharkar Research Institute (ARI)** have **developed and patented a diagnostic tool** that detects **WSSV.**
	  ○ ASI is an autonomous institute of the Department of Science and Technology.
	• **About WSSV**
	  ○ It as **DNA based highly contagious viral infection of crustaceans** that can cause **high levels of mortality** in cultured **shrimp.**
	  ○ The virus infects **only crustaceans (prawns, lobsters and crabs etc.)** and appears **not to be related** to any other known viruses.
	  ○ At present there **is no treatment available to interfere with the unrestrained occurrence** and spread of the disease.

Porcine Virus	• **Porcine virus is identified as the possible reason** for death of the first patient to have **xenotransplantation** (animal to human transplants). • Porcine Virus is a **herpes virus** found in the tissues throughout the body **including the nose of newborn piglets where it causes inflammation** (rhinitis). • It is **common among pigs across the world while similar infections** with related viruses occur in many other species. • **Eight Herpes Viruses** routinely **infect only humans** such as **Herpes Simplex Virus types 1 and 2**

Canine Distemper	• The **Gujarat Biotechnology Research Centre** completed the first trials of the **Canine Distemper Virus (CDV) vaccine for the Asiatic lion.**
	• Canine distemper is **caused by the paramyxovirus virus** and it spreads through body fluids like infected urine, blood and saliva.
	  ○ The virus attacks the **respiratory, gastrointestinal and nervous systems of puppies and dogs and can be transmitted to lions, tigers, leopards** and other wild cats as well as seals.
	  ○ There is **no known cure for CDV.**

Acute Encephalitis Syndrome (AES)	• AES is characterized **as acute-onset of fever and a change in mental status and/or new-onset of seizures in a person of any age** at any time of the year. • It most commonly **affects children and young adults** and can lead to considerable morbidity and mortality. • **Viruses are the main causative agents in AES cases**, although other sources such as bacteria, fungus, parasites, spirochetes, chemicals, toxins and non-infectious agents have also been reported.

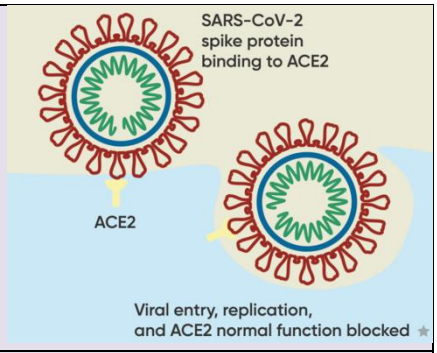
Avian Influenza or Bird flu	• Centre has deployed a high-level team to **Kerala to investigate Avian Influenza Outbreak.**
	• **About Avian Influenza**
	  ○ It is **a viral disease which is contagious** and can spread from one bird to other birds and animals.
	  ○ It is **caused by Influenza Type A viruses which generally affect poultry birds** such as chickens and turkeys.
	  ○ Depending on the origin host, **influenza A viruses can be classified as avian influenza** (H_5N_1, H_9N_2 etc.), **swine influenza** (H_1N_1 and H_3N_2), etc.
	• It also **effects humans through direct contact with infected animals** or contaminated environments.

4.10.2. OTHER DISEASES

Africa's 1st Malaria Vaccine	• **Gavi**, the global vaccine alliance, **announced support** for the **rollout of the first malaria vaccine in Africa** (starting with Ghana, Kenya and Malawi) from 2022-2025. • Malaria is **caused by parasites** that are **transmitted to people** through infected **female Anopheles mosquitoes.** o **5 parasite species cause malaria in humans,** and **2 of this:** ✓ **P. falciparum** (most prevalent on African continent) and **P. vivax** (prevalent outside of sub-Saharan Africa)– **pose greatest threat.**
Kala Azar	• Also known as **Black fever, or Visceral Leishmaniasis** it is a **protozoan parasitic disease, spread by sandfly bites**. o **Flies are infected with** the parasite **called 'leishmania donovani'.** • Disease is linked to **malnutrition, poor housing, a weak immune system etc.** o It is a **treatable and curable disease.** o It is the **second deadliest parasitic disease** in the world after malaria • In India, the disease is **endemic in Bihar, Jharkhand, Uttar Pradesh and West Bengal.** o **National Kala-Azar Elimination Programme** was launched to control this disease**.** o **India missed the 2015 deadline** to eliminate kala azar.
Trachoma	• **Malawi** became the **first country in southern Africa to eliminate trachoma.** o In 2017, **India eliminated trachoma.** o **According to the WHO**, active trachoma is considered eliminated if the **prevalence of active infection among children below 10 years is less than 5%.** • **Trachoma is an infection of the eye** caused by **bacterium Chlamydia trachomatis.** • It is **contagious and** is responsible for the **blindness or visual impairment of about 1.9 million people.**
Diabetes	• After U.S. and Canada, **first case of infection from diabetes medication in India reported.** • Diabetes is a chronic disease that **occurs when pancreas does not produce enough insulin,** hormone that regulates blood sugar. o **Type 1 diabetes** (insulin-dependent, juvenile or childhood-onset) is characterized by **deficient insulin production** and requires daily administration of insulin. o **Type 2 diabetes** (**non-insulin-dependent**, or adult-onset) results from the **body's ineffective use of insulin.** ✓ **More than 95%** of people with diabetes **have type 2 diabetes**.
Shigella bacteria	• **Kerala seeks to contain** Shigella spread. • Shigella is a **genus of bacteria** that causes an **infection called shigellosis.** o Shigellosis is a **gastrointestinal infection** caused by one of four species of Shigella bacteria, including S. sonnei. o It is **second leading cause of bacterial diarrhea worldwid**e and **third leading cause of death in children less than 5 years old**. o Transmitted through **contaminated food or water,** or through **person-to-person contact.** o Endemic in most **low- or middle-income countries (LMICs).** • **No vaccines available** for shigellosis.
Sickle cell anaemia	• Researchers at **Indian Institute of Science**, Bengaluru have **designed a low-cost method to detect** sickle cell anemia. • **About Sickle cell anemia:** o Occurs due to a **genetic mutation** that **causes hemoglobin in red blood cells** (RBCs) to **clump together**. o Affects the **shape of RBCs**. RBCs are **usually round and flexible**, so they **move easily** through blood vessels. o In sickle cell anemia, some RBCs are **shaped like sickles or crescent moons** (Refer image). o They **become rigid and sticky**, which can slow or **block blood flow.**

4.11. OTHER IMPORTANT NEWS

PEN Plus strategy	• **Africa has adopted the PEN Plus strategy** to tackle **severe non-communicable diseases (NCD)** such as type 1 diabetes (T1D), rheumatic heart disease (RHD) and sickle cell disease. • Package of Essential NCD Interventions (PEN) was **adopted by the WHO in 2010** to support the **decentralization of services to the primary care level.** • "PEN-Plus" refers to the approach to **address severe NCDs** through an **integrated outpatient service at first-level hospitals**

Angiotensin converting enzyme 2 (ACE2)	• According to a recent study **the membrane-bound form of ACE2 is essential for enabling infection** with SARS-CoV-2. Soluble ACE2 lacks the ability to anchor to the cell membrane. • ACE2 is a **"receptor," protein** that provides the **entry point for the coronavirus** into **human cells.** • **It is of two types:** o **A full-length form** that can bind to the cell membrane of healthy host cells o **A shorter, soluble form** that circulates in the blood in small amounts. 
iNCOVACC	• Bharat Biotech's iNCOVACC, the **world's first intranasal vaccine for COVID-19** received approval for emergency use in India. • It is a **recombinant replication deficient adenovirus vectored vaccine** with a pre- fusion stabilized spike protein. • **Benefits** o It **produces antibodies as well as reduce risk of transmission, while** other vaccines only produce antibodies. o **Additional immune response**- addition to immunity in blood, it activates immunity of cells found in tissues lining nose, mouth and lungs. o **Easy delivery** – cut down syringe, needles etc o **High compliance** (Ideally suits for children's and adults).
International Coordinating Group (ICG) on Vaccine provisions	• Amid shortage of cholera vaccines **ICG decided to temporary suspend standard two-dose vaccination regimen**, using instead a single-dose approach. o Cholera is an **acute diarrhoeal infection** in the small intestine **causing sometimes fatal dehydration.** • ICG was **established in 1997** to **manage and coordinate provision of emergency vaccine supplies and antibiotics** to countries during major outbreaks. • ICG **monitors its vaccine security global stock levels for** several vaccines including **cholera, meningitis and yellow fever** to ensure availability of sufficient supply. • ICG is made up of **members from WHO, UNICEF, Médecins Sans Frontières, and International Federation of Red Cross and Red Crescent Societies**.

5. DEFENCE

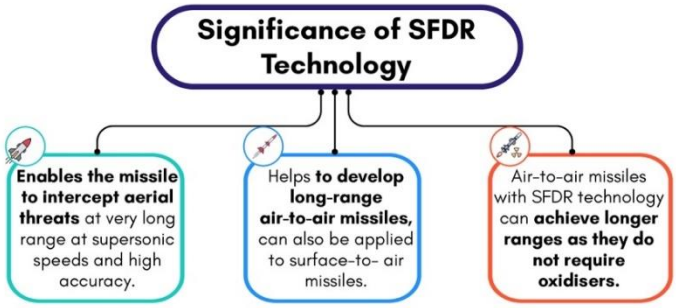
5.1. SOLID FUEL DUCTED RAMJET (SFDR) TECHNOLOGY

Why in news?

Recently, Defence Research and Development Organisation (DRDO) successfully **flight tested SFDR booster**.

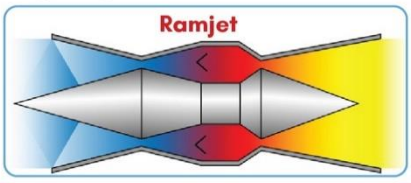
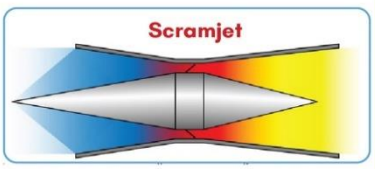
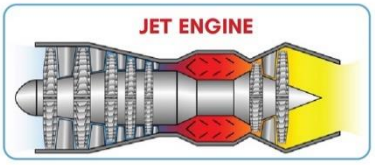
About SFDR

- It is a **missile propulsion system** that includes a **thrust modulated ducted rocket** with a reduced smoke nozzle-less missile booster.
  - **First flight of SFDR**, developed under a joint Indo-Russian R&D project, **was tested in 2018**. It had **achieved the speed of Mach 3**.
- The system **utilises a solid fuelled air-breathing Ramjet Engine**.
  - Unlike solid-propellant rockets, the **Ramjet takes up oxygen from the atmosphere** during flight. Thus, it is **light in weight** and can **carry more fuel.**
- **Range:** Air targets in the **ranges from 70 - 340 km.**



Difference between Ramjet, Scramjet and Dual Mode Ramjet (DMRJ)

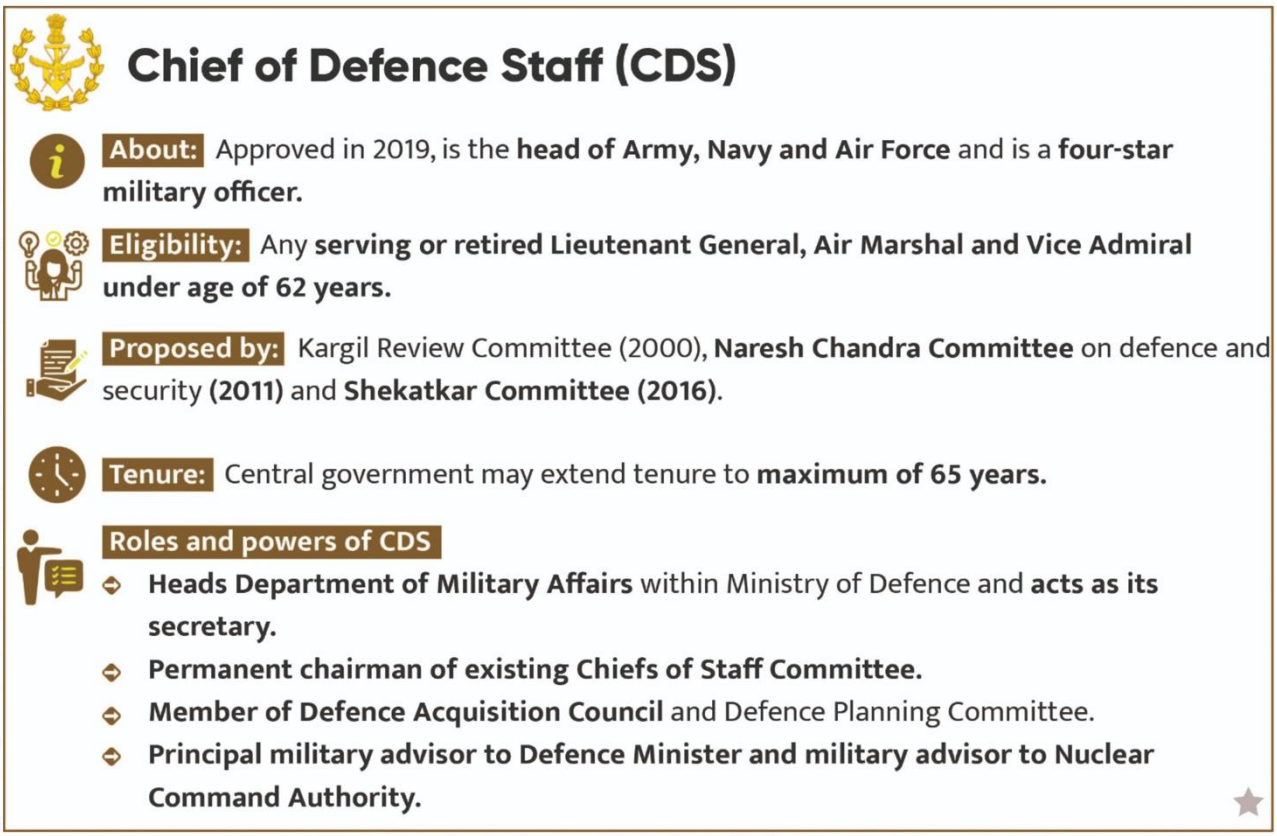
- Ramjet, Scramjet and DMRJ are the **three concepts of air-breathing engines** which are being developed by various space agencies.

Ramjet	Scramjet (Supersonic combustion ramjet)	Dual Mode Ramjet (DMRJ)
• Uses **vehicle's forward motion to compress incoming air for combustion** without a rotating compressor. • Work at **supersonic speeds around Mach 3** (three times the speed of sound) and can **operate up to speeds of Mach 6.** • **Efficiency starts to drop at hypersonic** speeds. • Does **not have any turbines** unlike the turbojet engines (jet engines). 	• **Efficiently operates at hypersonic speeds** and allows **supersonic combustion.** • Uses **Hydrogen as fuel** and the atmospheric **oxygen from the atmospheric air** as the oxidiser. • Both ramjets and scramjets have **no moving parts.** 	• When a ramjet transforms into scramjet **over Mach 4-8 range.** • Operate both in **subsonic and supersonic combustor modes.** 

5.2. CHIEF OF DEFENCE STAFF (CDS)

Why in News?

Lt General Anil Chauhan appointed next Chief of Defence Staff (CDS).



5.3. GSAT 7 SERIES SATELLITES

Why in News?

Indian Army reportedly tested the **operational readiness of its satellite-based systems** deployed across the country under operation 'Skylight'.

More on News

- **Unlike the Indian Air Force and the Navy**, the army **currently does not have a dedicated satellite**.
  - **Currently, the Army is using 30%** of the communication **capabilities of the GSAT 7A.**
  - **Defence Acquisition Council has cleared** an army proposal for **a GSAT-7B satellite**.

About GSAT 7 series satellites

- **GSAT 7 series satellites** are advanced satellites developed by ISRO to meet the **communication needs of the defence services.**
  - **GSAT 7 satellite** (launched in 2013) is mainly **used by the Indian Navy** for its communication needs.
    - ✓ It helps the Navy to have a **secure, real time communication link**.
  - **GSAT 7A (launched in 2018**) helps in **boosting the connectivity** between the **ground radar stations, airbases and the airborne early warning and control aircraft** (AEW&C) of the **IAF (**Indian Air Force)**.**
  - **GSAT 7B** will primarily fulfil the communication **needs of the Army**.
    - ✓ It will help the **Army enhance its surveillance in border areas**.

5.4. BRAHMOS

Why in News?

Recently, Philippines signed a deal for purchase of BrahMos supersonic cruise missiles.

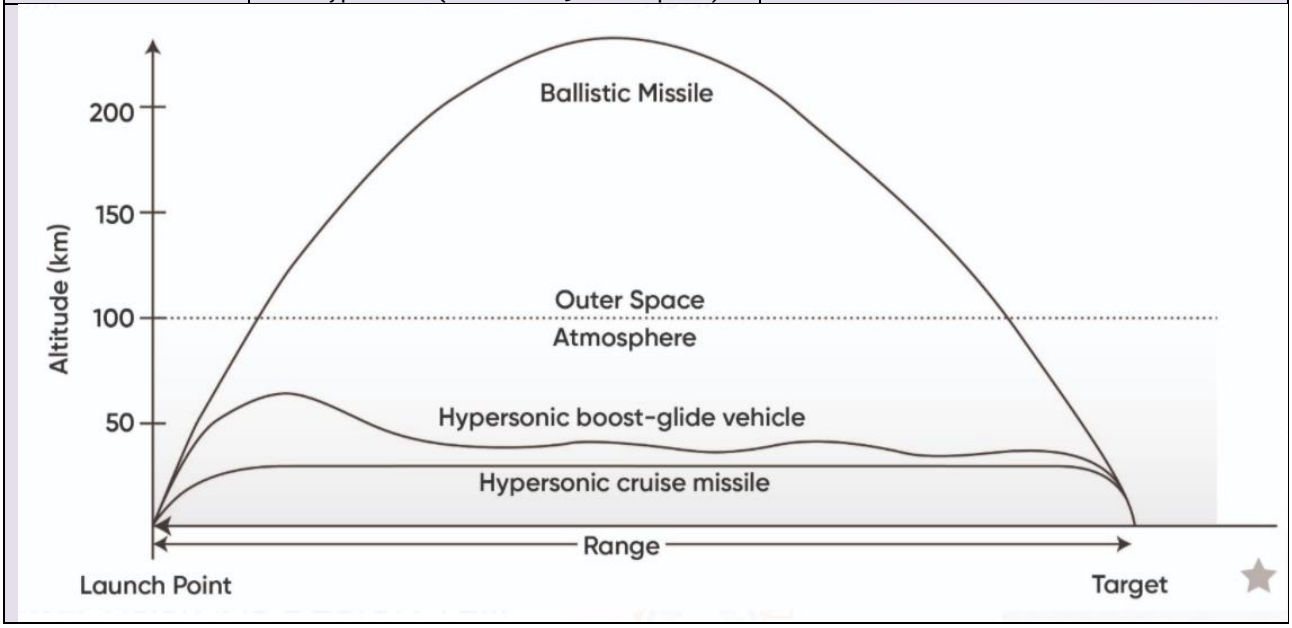
About BrahMos

- **BrahMos is a universal long range supersonic cruise missile** system that can be launched from land, sea and air against surface and sea-based targets.
  - BrahMos is a collaboration between India (Defence Research and Development Organisation (DRDO)) and Russia (NPO Mashinostoyenia).
  - Name **represents Brahmaputra and Moskva rivers.**
- **It is a two-stage missile** with a solid propellant booster engine as first stage and liquid ramjet as second stage.
  - It operates at **fire and forget principle**
- The range of the missile **was originally capped at 290 km** as per obligations of the Missile Technology Control Regime (MTCR)
  - **Following India's entry in MTCR in 2016,** it was decided to extend the range to 450 km and to 600 km at a later stage.

Other similar missile systems

- **Chinese HD-1 supersonic missile** is a comprehensive weapon system consisting of missile, launch, command and control, target indication and comprehensive support systems.
- **Tomahawk (used by U.S and its allies)** is a long-range, all-weather, subsonic cruise missile that launches from ships and submarines and can strike targets precisely from 1,000 miles away.
- **Israel's Sea Breaker**, the 5th generation long range, autonomous, precision-guided missile system, is meant to hit high-value maritime and land target.
- **P-800 Oniks/Yakhont** is a Russian supersonic anti-ship cruise missiles that has an effective guidance system and is a fire-and-forget missile.

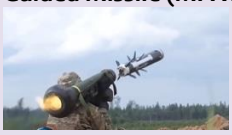
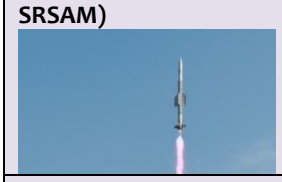
	Cruise Missile	Ballistic Missile
About	• An unmanned **self-propelled** (till the time of impact) **guided vehicle** that sustains **flight through aerodynamic lift** for most of its flight path. • They **fly within the earth's atmosphere** and use jet engine technology. • **Example:** BrahMos, Harpoon (USA), Exocet (France)	• **Has a ballistic trajectory** over most of its flight path, regardless of whether it is a weapon-delivery vehicle. • **Powered by rockets initially** but then they **follow an unpowered, free-falling trajectory** toward their targets • **Example:** Prithvi I, Prithvi II, Agni I, Agni II and Dhanush ballistic missiles
Classification	• Subsonic (around 0.8 Mach speed), Supersonic (around 2-3 Mach speed), Hypersonic (More than 5 Mach speed)	• Based on launch mode, range, propulsion system.

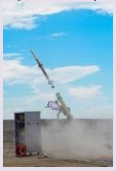


5.4.1. OTHER MISSILES IN NEWS

Agni missile
 
	• A successful training launch of **Agni-3 Intermediate Range Ballistic Missile** was carried out.
	• Agni-3 has a **range of over 3000 kilometers** and can carry **a payload of over 1.5 tonnes.**
	  ○ Agni series of missiles constitute the **backbone of India's nuclear weapons delivery**.
	  ○ It was conceived under **Integrated Guided Missile Development Program.**

S-400
 
	• India **on track for sanctions waiver from US** for buying Russian S-400 missile system.
	• S-400 is a **mobile long-range surface-to-air missile (LR-SAM) system.**
	  ○ **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.**

Anti-Tank Guided Missiles (ATGM) 	• DRDO successfully test fires **indigenously developed laser-guided ATGMs from Main Battle Tank (MBT) Arjun.** • ATGM employs a **tandem high explosive anti-tank (HEAT) warhead to defeat explosive reactive armour (ERA) protected armoured vehicles.** ○ Also, it has **multi-platform launch capability.**
Man Portable Anti-Tank Guided Missile (MPATGM) 	• **DRDO successfully flight tested** the final deliverable configuration of MPATGM. • The **indigenously developed** anti-tank missile is **a low weight, fire & forget missile and is launched from a man portable launcher,** integrated with thermal sight. • Missile has **miniaturized infrared imaging seeker and advanced avionics** for on-board control and guidance.
Vertical Launch Short Range Surface-to-Air Missile (VL-SRSAM) 	• DRDO **successfully flight tested indigenously designed and developed VL-SRSAM.** • VL-SRSAM, **a ship-borne weapon system,** is to **strike aerial threats at close ranges** (40 to 50 km at an altitude of around 15 km), including sea-skimming targets. ○ Its **design is based on Astra missile,** which is a Beyond Visual Range Air to Air missile.
Quick Reaction Surface-to-Air Missile (QRSAM) 	• **DRDO** successfully **completed six flight-tests of QRSAM system.** • QRSAM **is a short-range surface-to-air missile** system, **indigenously designed and developed by the DRDO.** • It provides a **protective shield to moving armoured columns of the Army** from enemy aerial attacks. • It has a range of 25 to 30 km.

Very Short Range Air Defence System (VSHORADS) missile
 
	• DRDO **conducted a successful test flight of VSHORADS missile.**
	• **VSHORADS is a Man Portable Air Defence System (MANPAD)** designed and developed indigenously by the DRDO.
	  ○ It can **neutralise low altitude aerial threats** at short ranges.
	  ○ It is **propelled by a dual thrust** solid motor and incorporates miniaturized Reaction Control System and integrated avionics.

HELINA
 
	• **Indigenously** developed (by DRDO) **helicopter launched Anti-Tank Guided Missile (ATGM) 'HELINA'** was successfully flight tested.
	• **About HELINA (Helicopter based NAG):**
	  ○ **It is third generation** fire and forget class ATGM system mounted on the Advanced Light Helicopter.
	  ○ The system has **all weather day and night** capability.

Astra Mk-I beyond visual range (BVR) air-to-air missiles	• Ministry of Defence signed a **contract with Bharat Dynamics Ltd (BDL)** for Astra Mk-I missiles.

	○ **DRDO has transferred technology** to BDL to produce these missiles and associated systems. • **BVR** missiles can engage **beyond the visual range of 37 kilometers**. • **Air-to-Air missiles** are fired from an airborne asset **to destroy an airborne target.** • Missile has been **designed for deployment on fighter jets** like Sukhoi-30 MKI and Tejas of the IAF and the Mig-29K of Navy.
Pralay Missile 	• **Maiden flight test of Pralay missile** was successfully conducted by DRDO. • **About Pralay** ○ **Indigenously** developed **surface-to-surface missile.** ○ Has a **range of 150-500 kilometres** with an accuracy of less than 10 metres. ○ Has a guidance system that includes **state-of-the-art navigation mechanisms** and integrated avionics.

5.5. SUBMARINES

Why in News?

Fifth Scorpène-class submarine Vagir was delivered to Navy.

More on News

- **Built under:** Six Scorpene submarines are **being built indigenously under Project-75** by Mazagon Dock Shipbuilders Limited (MDL) **under technology transfer from Naval Group of France.**
  - **Other 5 are:** Kalvari, Khanderi, Karanj, Vela, Vagsheer.
- **Operating Range:** anti-warship and anti-submarine operations, intelligence gathering and surveillance and naval mines laying.

Various classification of submarines

Submersible Ship Ballistic Nuclear (SSBNs)	Nuclear-Power attack Submarines (SSNs)	Diesel-electric attack submarines (SSKs)
• Serve as an **undetectable launch platform for intercontinental missiles.** • **Designed specifically for stealth** and **precise delivery** of nuclear warheads. • **INS Arihant** is India's SSBN.	• Nuclear-powered attack submarine **armed with non-nuclear weapons.** • Designed to **engage in mine warfare, seek out and destroy enemy ships,** and support **battle group operations.** • **Countries** currently have nuclear-powered submarines- **UK, US, China, Russia, India and France**	• They have **diesel engines.** • Battery capacity **constrain amount of time a diesel sub can stay underwater,** leading to frequent resurfacing. • **India's SSKs** include **Shishumar Class** (from Germany); **Kilo Class or Sindhughosh Class** (from Russia); **Kalvari Class Scorpene.**

5.6. OTHER IMPORTANT NEWS

5.6.1. SUBMARINES, SHIPS AND AIRCRAFT CARRIERS

INS Vikrant 	• **PM commissioned** India's first Indigenous Aircraft Carrier **INS (Indian Naval Ship) Vikrant.** • INS Vikrant has been **designed by Indian Navy's Directorate of Naval Design,** and **built at Cochin Shipyard Limited,** a public sector shipyard under Ministry of Shipping. • **India has had aircraft carriers earlier too** — but those were built either by British (INS Vikrant and Viraat) or Russians (INS Vikramaditya). • **Details about INS Vikrant** ○ **Over 76% of material** and equipment **on board is indigenous.** ○ Uses **Short Take Off But Assisted Recovery (STOBAR) aircraft-operation mode** that uses a ski-jump for launching aircrafts.
Project 15 B 	• **Mormugao and Surat ship** of Project 15B **launched recently.** • **Project 15B** ○ This project is **a continuation of Kolkata class destroyers,** which were part of Project 15A commissioned in the previous decade. ○ Being built at Mazagon Dock Shipbuilders Limited.

	○ **Four ships** under Project 15 B are viz. **Visakhapatnam, Mormugao, Imphal and Surat.** ○ These are **stealth guided missile destroyers.**
Project 17A 	• **Taragiri and Udaygiri** ship of Project 17A Frigates were launched. ○ These ships are **advanced version of P17 Frigates (Shivalik Class).** • P17A ships have been **designed in-house by Indian Navy's Warship Design Bureau.** ○ **75% of the orders** for equipment & system of Project 17A ships **are being placed on indigenous firms** including MSMEs.
Project 75(I) 	• **Ministry of Defence extended the proposal deadline** for six advanced submarines **under Project75(I).** • Project 75(I) **envisages indigenous construction of six modern conventional submarines** with contemporary equipment, advanced torpedoes etc. • It has been **cleared under the strategic partnership model** under overall arch of 'Make in India'.
Indian Naval Ship (INS) Vagsheer 	• Vagsheer, **sixth and last submarine of Project 75,** has been launched. ○ Vagsheer is a **diesel attack submarine,** designed to perform sea denial as well as access denial warfare. • **P 75 is** one of two lines of submarines, other being P75I, as **part of a plan for indigenous submarine construction** with technology taken from overseas firms**.** ○ Under P75, **Kalvari, Khanderi, Karanj and Vela have been commissioned.** Sea trials are on for Vagir. ○ **Constructed by:** Mazagon Dock Ltd

5.6.2. AIRCRAFTS, DRONES AND HELICOPTERS

Dornier (Do-228) Aircraft flight 	• **Ministry of Civil Aviation** has announced the launch of **first commercial flight of the made-in-India Dornier-228.** ○ Do-228 has been made by **Hindustan Aeronautics Limited (HAL) and delivered to Alliance Air.** ✓ **Alliance Air** will be India's first commercial airline to fly an India- made aircraft for civil operations. ○ Aircraft will link **five remote towns of Arunachal Pradesh to Assam's Dibrugarh.** • It is part of government's **UdeDeshkaAamNaagrik (UDAN) regional connectivity scheme.**
Light Combat Helicopter (LCH) 	• Indian Air Force inducted the **indigenously developed** (by Hindustan Aeronautics Ltd.) **multi-role LCH-Prachand.** ○ India has become the **seventh country to make attack helicopters.** • **Key features** ○ **Range:** 550 km; **Endurance:** Over 3 hrs; **Service ceiling** (the maximum density altitude to which it can fly): 6.5 kilometres. ○ **Only combat helicopter in the world** which can land and takeoff at an **altitude of 5,000 meter.** • Equipped with a **countermeasure dispensing system** that protects it from enemy radars or infrared seekers of the enemy missiles.
Indigenous stealth drone 	• Indigenous stealth drone, **also referred to as an Unmanned Combat Airborne Vehicle (UCAV),** makes maiden flight. ○ The **UCAV is a precursor to the Ghatak armed stealth drone programme called** AURA (Autonomous Unmanned Research Aircraft). ✓ AURA is described as a **self-defending, high-speed, reconnaissance UAV** with a weapon firing capability. • It has been **designed and developed by the Aeronautical Development Establishment.**
Chinook helicopters 	• US Army **has grounded its fleet of CH-47 Chinook helicopters** after finding the helicopter to be at risk of engine fires. • **About Chinook Helicopter** ○ Chinook is a **multi-role, vertical-lift platform, which is used for transporting troops, artillery, equipment, and fuel even over difficult terrains.** ○ It is also **used for humanitarian and disaster relief operations.** • It was **inducted into the Indian Air Force in 2019.**

Tejas Mark-2
 
	• **Cabinet Committee on Security has cleared Tejas Mark-2 project** — a more capable version of indigenous Tejas light combat aircraft (LCA).
	  ○ **Tejas is a single engined, light weight, highly agile, multi-role supersonic fighter** jet.
	  ○ **Designed by** Aeronautical Development Agency under DRDO and Hindustan Aeronautics Limited.
	• **Tejas Mark-2** has been described as **a 4.5-generation machine** that will **have 70 per cent indigenisation**.
	• It will be **fitted with more powerful GE-414 engines,** giving it a **longer combat range and greater capacity to carry weapons than** existing **Tejas Mark-1.**

Kamikaze Drones 	• Army to induct **kamikaze drones in eastern Ladakh**. • **Kamikaze Drones** are **small, unmanned aircraft that are packed with explosives** that can be flown directly at a tank or a group of troops that are **destroyed when it hits the target and explodes.** ○ Also called Switchblade drones as their **bladelike wings spring out on launch.**
Hermes Starliner unmanned system 	• **Israel becomes first country to allow drones (Hermes Starliner) in civilian airspace.** • It will allow Hermes Starliner drone to **fly in civilian airspace rather than being restricted to unsegregated airspace.**

5.6.3. MISCELLANEOUS

Dirty bomb 	• Russia claimed **that Ukraine is planning to use a dirty bomb**. • **Dirty Bomb is a bomb that contains radioactive material,** such as uranium, which is scattered through the air when its conventional explosive detonates. • It **doesn't need to contain highly refined radioactive material**, as is used in a nuclear bomb. • Instead, it uses **radioactive materials from hospitals, nuclear power stations or research laboratories.** • This makes them **much cheaper and quicker to make** than nuclear weapons.

Indigenous defence equipment (IDE) handed to Indian Army	• **Minister of Defence handed over several IDE** to Indian Army:
	  ○ **Future Infantry Soldier as a System (F-INSAS):** A programme for infantry modernisation to equip soldiers with modern assault rifle, helmet and a bullet proof jacket, communication and surveillance system.
	  ○ **Anti-Personnel mine 'Nipun':** Also known as soft target blast munition, it replaces the vintage NMM 14 mines.
	  ○ **Landing Craft Assault:** To serve as a replacement for the boats currently in use in the Pangong Tso lake.

Carl-Gustaf M4
 
	• **Sweden has announced plans to manufacture** its Carl-Gustaf M4 weapon system **in India.**
	  ○ The **Army has been using the Carl-Gustaf since 1976** and currently operates the Mk2 and Mk3 versions.
	• The Carl-Gustaf recoilless rifle is **a man-portable, multi-role weapon system**.
	  ○ M4 weapon system is **capable of firing a variety of ammunition,** including anti-armour and illumination rounds, **with the maximum range being 1,500 metre.**

Pinaka Multi-Barrel Rocket Launcher (MBRL) System 	• **Armenia has placed the first export order for India's Pinaka MBRL**. • Pinaka MBRL Sysytem is an **indigenous rocket system** designed and developed by Armament Research and Development Establishment (ARDE) of **DRDO.** • It is a **mobile rocket launching system** (mounted on a Tatra truck) with **maximum range** varying from around **40 km (Pinaka Mk-1) to 75 km (Pinaka-ER or Extended Range).**
Submersible Platform for Acoustic Characterization & Evaluation (SPACE)	• It is a **state-of-the-art testing and evaluation facility** (launched by DRDO) **for sonar systems** developed for use by Indian navy. ○ Sonar (Sound Navigation and Ranging) is **helpful for exploring and mapping ocean** because **sound waves travel farther in water than do radar and light waves.**

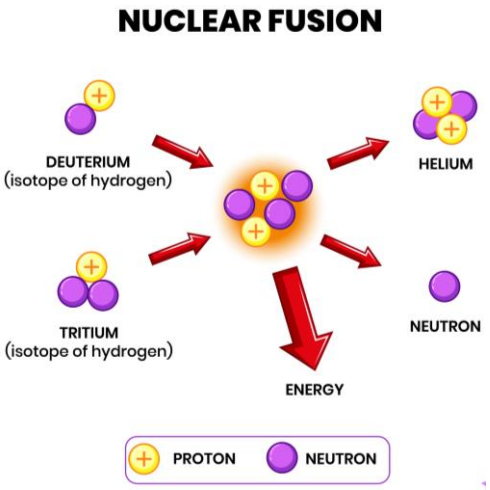
	• SPACE is one-of-a-kind facility in the world with **specially designed submersible platform,** which **can be lowered up to depths of 100 meters**. • SPACE will be **mainly utilized for evaluating Sonar systems,** allowing for quick deployment and easy recovery of scientific packages such as sensors and transducers.
ABHYAS 	• ABHYAS - High speed Expendable Aerial Target (HEAT) was **successfully flight-tested from the Integrated Test Range (ITR),** Chandipur off the coast of Odisha. • It **consists of twin under-slung boosters which provide the initial acceleration** to the vehicle. • ABHYAS is an **indigenous unmanned aerial target system** to meet the requirement of Indian Armed Forces to eliminate air-borne threats. • **Designed by:** Aeronautical Development Establishment of DRDO.

High-Energy Laser System (HELS)
 
	• **SFO Technologies partners with** DRDO's **Center for High Energy Systems and Sciences (CHESS) lab** to develop HELS.
	• HELS weapons emit enough **thermal energy to directly render a target ineffective** without using a conventional munition.
	• They could **affect targets across air, ground, sea, and space.**
	• **HELS** is a **laser weapon belonging** to **Directed Energy Weapon** (**DEW**) Category.
	  ○ DEW covers technologies that produce a beam of **concentrated electromagnetic energy or atomic or subatomic particles.**
	  ○ **India's Project:** Directionally Unrestricted Ray-Gun Array (DURGA II), Kilo Ampere Linear Injector (KALI), Project Aditya etc.
	  ○ **Countries like China, Russia, UK, Israel etc.** have programs to develop DEW.

Butterfly Mines
 
	• Russia is accused of using **PFM-1, known as butterfly mines,** which **look like toys** and are **therefore dangerous for children.**
	  ○ **PFM-1 and PFM-1S** are two kinds of anti-personnel landmines that are commonly referred to as **'Butterfly mines' or 'Green Parrots.**
	  ○ These mines can be **deployed by being dropped from helicopters** or **through ballistic dispersion.**
	• Anti- personal mines are **banned by international convention on land mines,** but **Russia and Ukraine are not signatories to it.**

6. ALTERNATIVE ENERGY

6.1. NUCLEAR FUSION

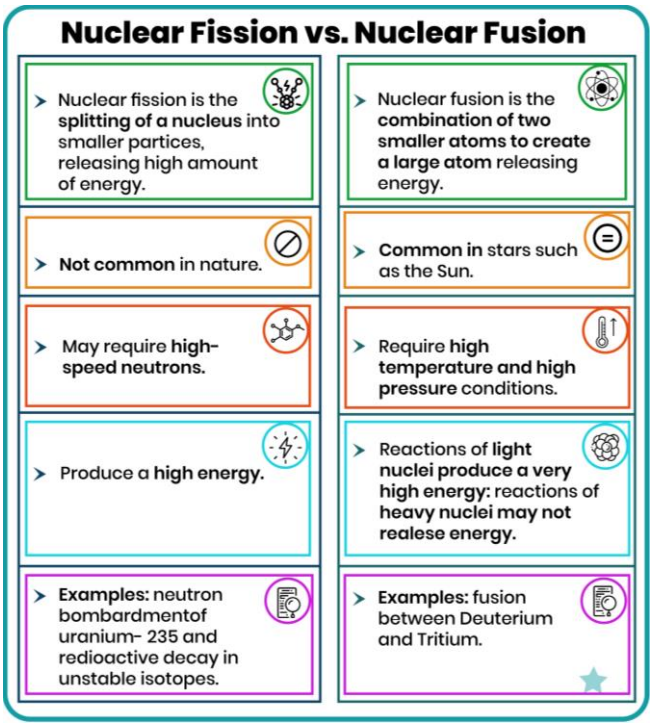


Why in news?

In a fusion experiment using lasers, the scientists at Lawrence Livermore National Laboratory in California achieved a net energy gain for the first time.

More about news

- **Achieving Ignition:** Scientists for the first time ever, were able to achieve ignition in **nuclear fusion i.e., creating a nuclear reaction that generates more energy than it consumes.**
- **Execution:** Used powerful lasers to heat and compress hydrogen nuclei. **When the nuclei fuse, they release heat.** When this heat is equal to or greater than the heat delivered to the container, the event is called ignition.



About Nuclear Fusion

- Process by **which two light atomic nuclei (for example tritium and deuterium)** combine to form a single heavier (**Helium)** one while releasing massive amounts of energy.
- Fusion reactions take place in a state **of matter called plasma** a hot, charged gas made of positive ions and free-moving electrons with unique properties distinct from solids, liquids, or gases.
- **Challenge to fusion:** Strong repulsive electrostatic forces between the positively charged nuclei prevent them from getting close enough together to collide and for fusion to occur.
- **When does it happen:** If the attractive nuclear force (which binds protons and neutrons together in atomic nuclei) between the nuclei outweighs the repulsive (electrostatic) force, then a fusion reaction can occur.
    - Such conditions can occur when **the temperature increases,** causing the ions to move faster and eventually reach speeds high enough to bring the ions close enough together.
- **Conditions required to achieve fusion**
    - **Temperature** of **more than 100 million degrees Celsius.**
    - **Maintaining a high enough density for a long enough time** so that the rate of fusion reactions will be large enough to generate the desired power.

Types of Nuclear Fusion: Inertial and Magnetic

- **In an inertial fusion (used in the present experiment),** laser or ion beams are focused very precisely onto the surface of a target. This results in very high temperatures.
- **In Magnetic fusion,** hundreds of cubic meters of plasma at a density of less than a milligram per cubic meter are confined by a magnetic field at high pressure and heated to fusion temperature.
- It is relatively **easier to attain break-even energy levels through inertial fusion** compared to magnetic fusion.

- **Advantages of fusion:** abundant energy, fuels are widely available, don't emit harmful gases like CO_2, much less radioactive waste compared to fission etc.
- **Challenges in fusion process**
    - At such high temperatures, **matter exists only in plasma state, which is extremely difficult to work with.**

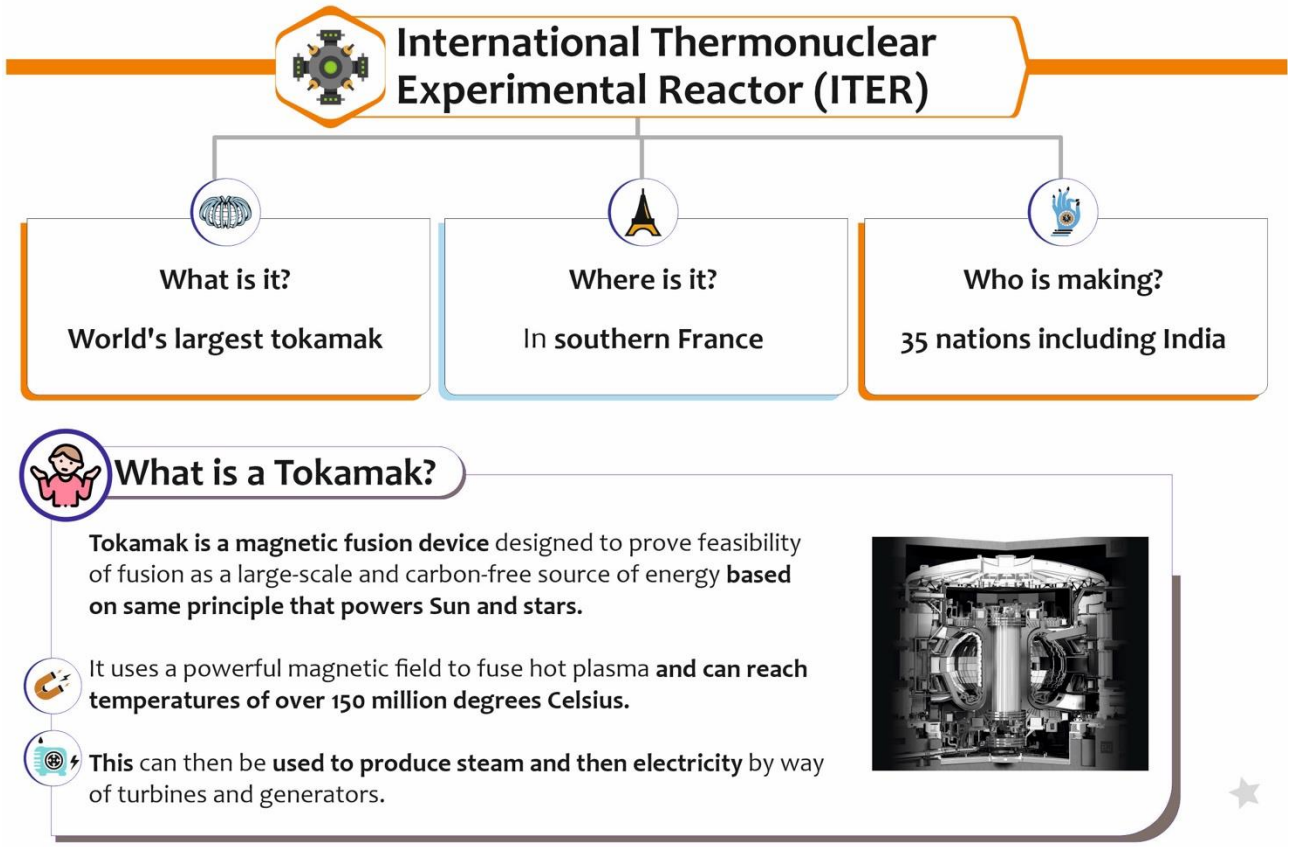
- Fusion reactions are **not easily controlled due to high temperatures.**

Similar initiatives across the world

- **International Thermonuclear Experimental Reactor (ITER) Assembly**.
- **China's Artificial Sun:** The Experimental Advanced Superconducting Tokamak (EAST) device replicates the nuclear fusion.
- **SST-2 tokamak:** India's **experimental fusion reactor** at the Institute of Plasma Research in Gujarat.
- **The Joint European Torus (JET):** project for opening the way to future nuclear fusion grid energy.

Related News

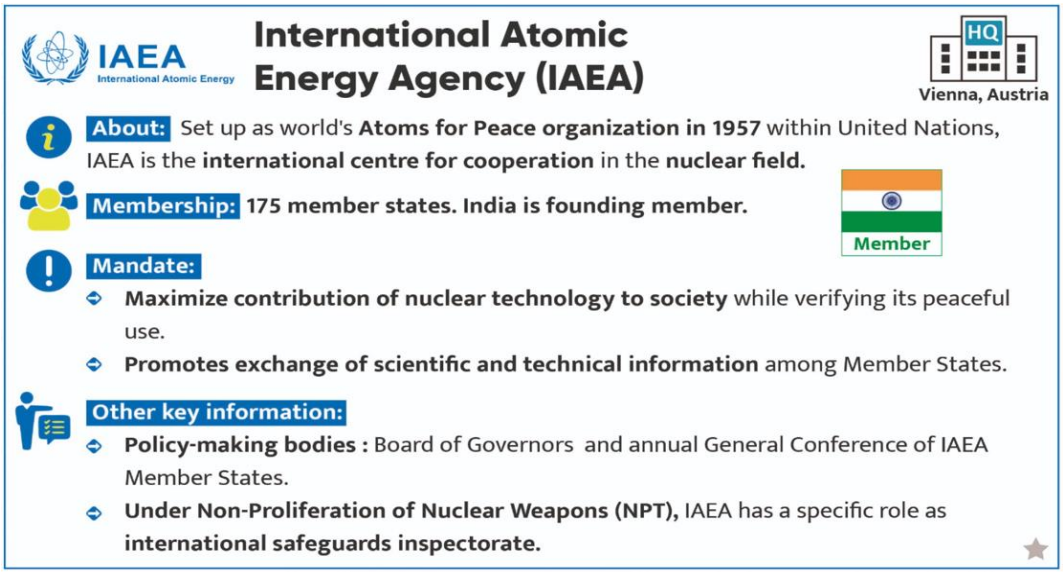
- **India has supplied Cryolines** for ITER project in France.
- **Institute for Plasma Research (IPR),** an aided institute of Department of Atomic Energy, **is India's collaborating agency.**
  - Other than supplying cryolines, IPR has also supplied ITER about six km of return lines for warm gases, manufactured in India.



6.2. SMALL MODULAR REACTORS (SMRS)

Why in news?

Recently, Niti Aayog member suggested for **focusing on setting up small modular reactors** as it would help meet the country's energy needs and also in replacing aging thermal power plants.



About Small modular reactors (SMRs)

- SMRs are **advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit.**
  - According to the International Atomic Energy Agency (IAEA), **more than 70 SMR concepts are currently under development in 18 countries.**
- **Advantages of SMRs**
  - **Smaller footprint:** SMRs can be sited on **locations not suitable for larger nuclear power plants.**
  - **Affordable:** Prefabricated units of SMRs can be manufactured and then **shipped and installed on site.**
  - **Savings:** SMRs offer **savings in cost and construction time.**
- **IAEA has established the Platform on SMRs and their Applications,** a one-stop shop for countries to coordinate support related to all aspects of SMR development.

	Microreactors	Small Modular Reactors	Conventional Nuclear Reactors
			
Power Capacity	Fewer than 10 MW (e) (Megawatt electric)	Up to 300 MW (e)	700+ MW (e)
Refueling	Years without refueling	Every 3 to 7 years	1 and 2 years

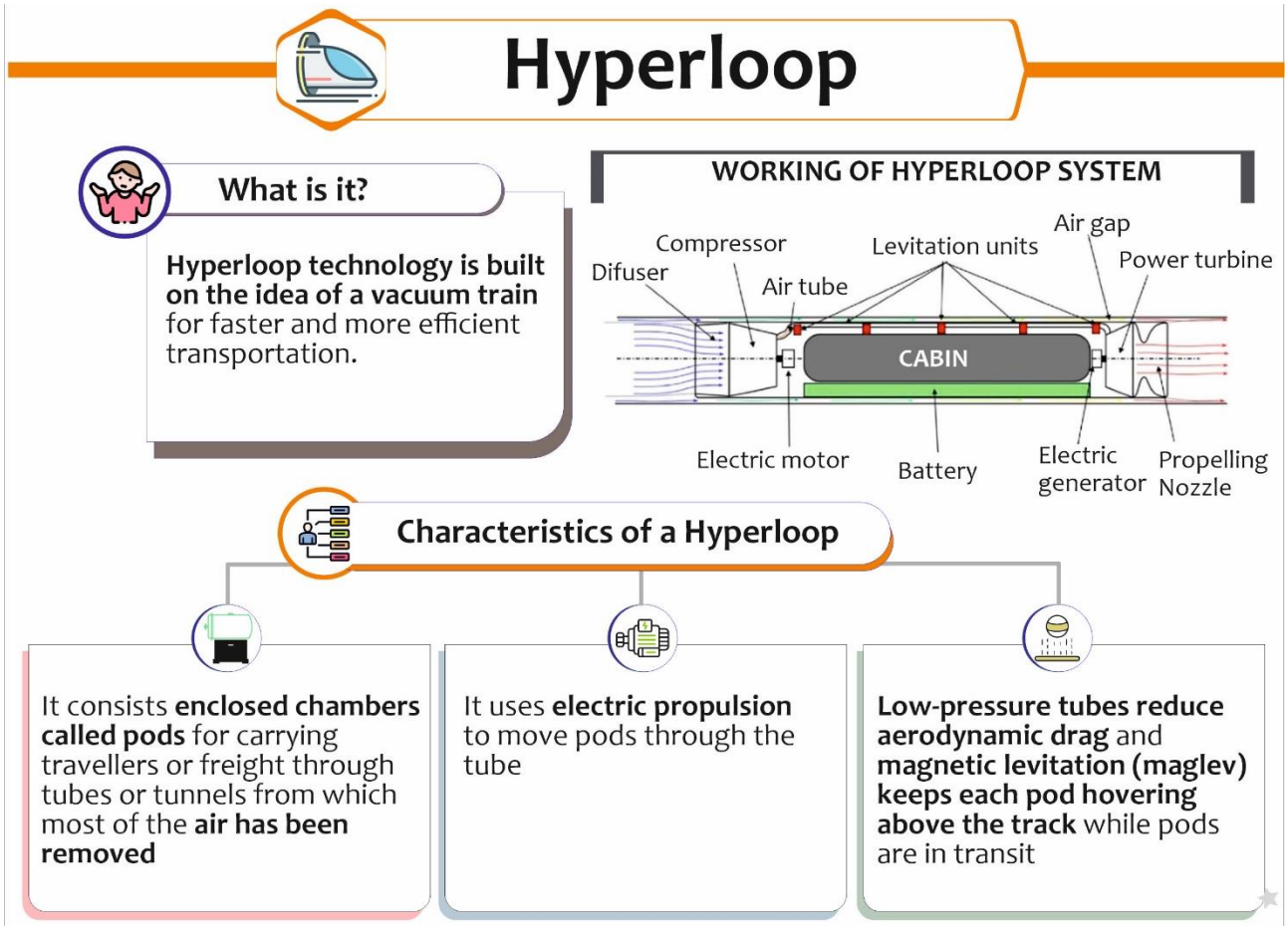
6.3. HYPERLOOP SYSTEM

Why in news?

Indian railways is collaborating with IIT Madras for the development of 'indigenous' Hyperloop system.

More about news

- Team named **'Avishkar Hyperloop'**, formed by IIT Madras has been working on the development of Hyperloop-based system for transportation.
- IIT Madras has also proposed to set up a **'Centre of Excellence for Hyperloop Technologies'**.



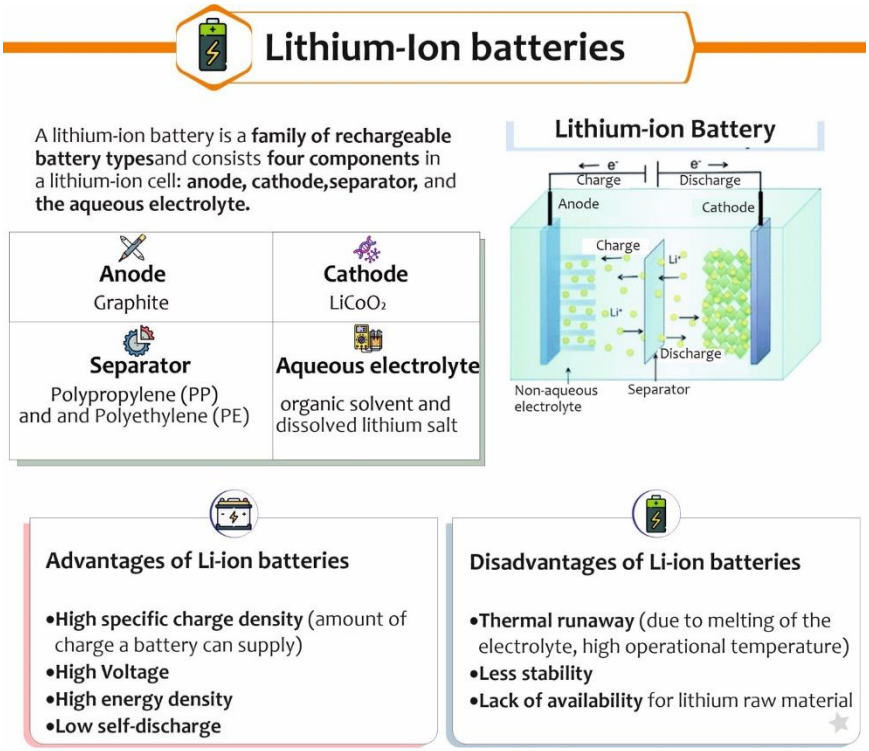
6.4. LITHIUM-ION BATTERY

Why in news?

Recently Union Government constituted an expert panel to probe the recent series of battery explosions in electric vehicles (EVs).

Steps taken for Lithium-ion batteries in India

- **National Mission on Transformative Mobility:** To encourage **domestic Lithium-Ion Cell manufacturing** and EV components.
- **ISRO and BHEL agreement:** to develop low-cost lithium-ion batteries.
- **India's first lithium cell plant manufacturing facility** will be launched in **Tirupati, Andhra Pradesh.**
- **Lithium triangle nations:** India is focusing on **'Lithium Triangle' nations Argentina, Bolivia and Chile** for **joint**

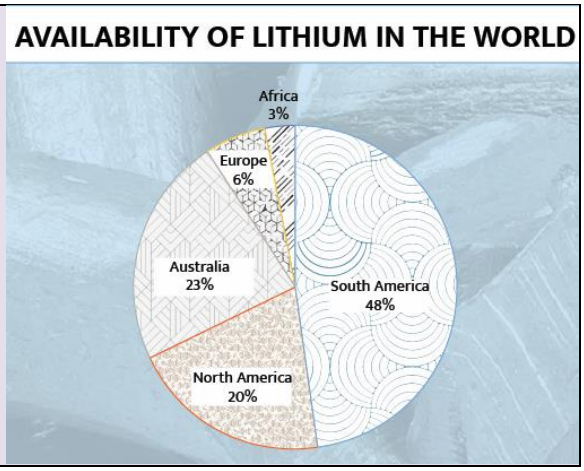


About Lithium

- Lithium is **lightest solid metal.** It is currently **produced from hard rock or brine mines.**
- **Australia is the world's biggest supplier**, with production of Lithium from hard rock mines, while **Argentina, Chile and China** are producing it from salt lakes.

Lithium in India

- In India first traces of Lithium ever to be discovered in the ancient **igneous rock of Karnataka's Mandya district.**
  - Recently **Lithium reserves were also discovered in J&K.**
- Currently **India imports all its lithium needs**, with **China and Hong Kong biggest suppliers.**



Comparison of various battery types

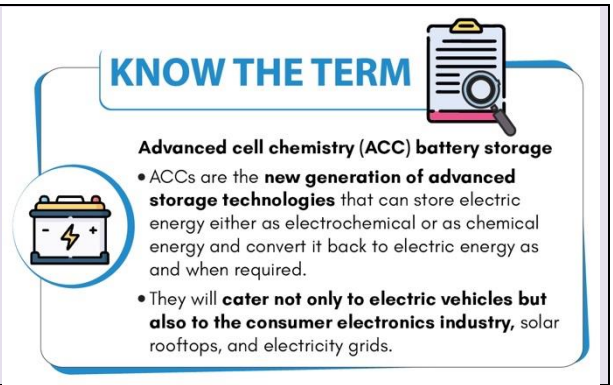
Type	Advantage	Disadvantage
Lead Acid batteries	**Mature technology, low cost** and ruggedness compared with other battery technologies.	**Heavy and bulky,** do not cycle well.
Nickel-cadmium batteries	**Availability in all sizes,** can be moved around easily, can be **stored, or used for up to 5 years, offer more than 1,000 charge and discharge cycles.**	**Environmental concerns** related to cadmium. **Prone to memory effect** that can cause a battery to lose electrical storage area. **Higher self-discharge rate** than Lithium-ion.
Nickel metal hydride batteries	Widely used in **consumer electronics,** addresses the issues arising from the environmental effects of cadmium.	**Not considered for large stationary applications because of high cost** of Nickel, also have a high self-discharge rate and generally take a long time to charge.
All solid-state batteries	**High energy densities** and charge/discharge current limits, a higher life even in harsh conditions, lower charging time.	Challenges in both **manufacturing and fundamental technology understanding.**

Metal air	**High energy density** than lithium-ion batteries, only anode replacement needed, comparatively longer shelf life than lithium-ion.	**Not electrically rechargeable**, lower charge/discharge rates compared with Lithium-ion batteries
Sodium ion batteries	Wider operational temperature range and are safer. Cheaper than Lithium-ion.	Lower energy density than lithium-ion batteries.

Related Concept

Battery Energy Storage

- Energy storage is the **capture of energy produced for later use to reduce imbalances** between energy demand and energy production.
- Based on the application, **battery energy storage can be classified into three categories:**
  - **Consumer electronics applications** (for mobile phones, tablets, laptops, cameras, etc.)
  - **Stationary applications** (such as for commercial and industrial applications).
  - **Transportation applications**.



Related News

Bureau of Indian Standard (BIS) formulates performance standards for Electric Vehicle (EV) Batteries

- BIS has published standards for **Test Specifications for Lithium-ion (Li-ion) Traction Battery Packs** and Systems (Performance Testing) for Electrically Propelled Road Vehicles.
  - **IS 17855:2022 standards are formulated considering real life scenarios** such as parked vehicles (no battery use for a longer period), battery running at high and low temperatures etc.

Ministry of Heavy Industries (MHI) mandated New Safety tests for electric vehicles (EVs) receiving subsidies

- **MHI announced a list of safety tests that will be mandatory** for EVs manufacturers **from April 2023 to receive subsidies under** following EV promotion schemes:
  - **Production Linked Incentive (PLI) Scheme for Automobiles and Auto Components.**
  - **PLI Scheme for Advance Chemistry Cell (ACC).**
  - **FAME (Faster Adoption and Manufacturing of Electric Vehicles) II.**
- These tests, **carried at 3 levels** (Battery Pack, Battery Management System (BMS) and Cell Level), **are accepted internationally for safeguarding Human Safety.**
  - Currently, **there are no centralised testing facilities for EVs in India** and manufacturers have their own benchmarks.

6.5. FLEX FUEL

Why in news?

Ministry of Road Transport & Highways has launched **first of its kind pilot project on Flexi-Fuel Strong Hybrid Electric Vehicles (FFV-SHEV) in India**.

About Flex Fuel vehicles (FFV)

- Like traditional vehicles, flex fuel vehicles **have an internal combustion engine, but instead of regular petrol, it can run on blended fuel — petrol with ethanol or methanol.**
  - The ethanol mix can **vary between 20% and 85%.**
- Unlike electric hybrid vehicles, **no bulky parts need to be added** to the basic gasoline vehicle architecture.
- **Upgrading existing vehicles** is possible **but expensive and not considered feasible.**
- **An FFV-SHEV** possesses a flex-fuel engine and an electric powertrain.
  - This setup **extends dual advantages of higher ethanol use and greater fuel efficiency**, as it can run on its EV mode for a good amount of time, while the engine stands shut off.
- **Significance of FFV:** Less polluting, check on diversion of sugar used in ethanol blending, burn with whatever proportion of mixture is in its combustion chamber, reduced import bill etc.
- **Challenges of FFV:** lack of adequate infrastructure, issue with ethanol supply since this largely comes from sugarcane in India, less mileage etc.

Alternate Fuels - A Comparison

Fuel Type	Significance	Challenges
Ethanol as fuel	▪ **Renewable, domestically produced** transportation fuel. ▪ Has a **higher octane number** than gasoline, which provides increased power and performance. ▪ Ethanol production creates jobs in rural areas	▪ **Sporadic availability of ethanol** ▪ 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.
Flex fuel	▪ With much lower cost of running, they also offer **better economy for consumers.**	▪ The **benefit for the environment is less as compared to battery EVs** or hydrogen fuel cell vehicles of the future
Hydrogen as a fuel	▪ Can be produced from **diverse domestic resources** ▪ **Potential for near-zero greenhouse gas emissions**	▪ **Storing hydrogen is difficult** as it has a lower volumetric energy density ▪ **High production cost**
Biodiesel	▪ **Lean-burning, renewable substitute** for petroleum diesel. ▪ **Improves fuel lubricity** and raises the cetane number of the fuel. ▪ It is **safer than petroleum diesel** because it is less combustible.	▪ **Higher viscosity, lower energy content, higher nitrogen oxide (NO x) emissions,** lower engine speed and power.
Electricity	▪ **Improve fuel economy,** lower fuel costs, and reduce emissions.	▪ **Public charging stations are not as ubiquitous as gas stations.** ▪ The advanced batteries in electric vehicles are **designed for extended life but will wear out eventually.**
Natural Gas	▪ **Domestic availability,** established distribution network, relatively low cost, and emissions benefits.	▪ **Driving range of Natural gas vehicles (NGVs)** is generally less than that of comparable gasoline and diesel vehicles

6.6. FUEL CELL

Why in News?

India's first indigenously developed hydrogen fuel cell bus, **jointly developed by Council of Scientific and Industrial Research** (CSIR) **and private firm KPIT Technologies Ltd,** was launched recently.

Council of Scientific and Industrial Research (CSIR)

HQ New Delhi, India

About: **Autonomous body, established in 1942, under Ministry of Science and Technology** and is known for its **cutting edge R&D knowledge base** in diverse S&T areas.

Areas covered: oceanography, geophysics, chemicals, drugs, genomics, aeronautics, biotechnology, nanotechnology, instrumentation, environmental engineering, Information technology.

President of CSIR: **Prime Minister.**

Mission:

- **Technology Innovation and Translational Research** to align with National Goals.
- Creation of **scalable and sustainable green technologies** in the energy sector.
- **Ensuring sustainable agriculture and nutritional security** through biotechnological research.

About Fuel Cell

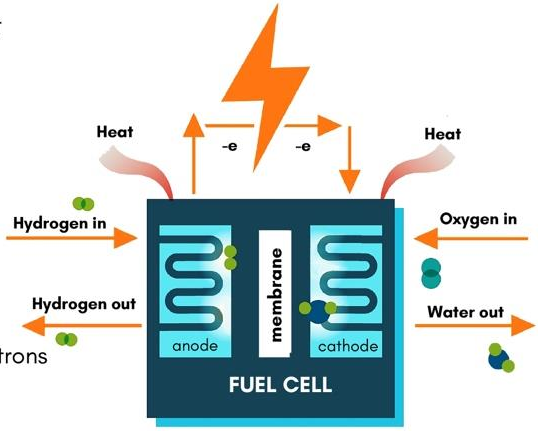
- **Electrochemical devices to convert chemical energy into electrical energy.**
- Fuel cells **do not need to be periodically recharged** like batteries, but instead continue to produce electricity **as long as it is supplied with a source of hydrogen** and a source of oxygen (usually air).
- **Source of hydrogen is generally referred to as the fuel and this gives the fuel cell its name.**
- **Applications:** Transport, Portable (military applications, Auxiliary Power Units, laptops etc.), Stationary (power to industrial/commercial/residential buildings etc.),
- **Benefits:** Lower operational costs due to higher efficiency and high energy density of hydrogen, Noise-free operation, operating times are much longer.
- **Challenges:** Transportation, flammability and storage of hydrogen gas, High cost, Technological challenges like system size, management of air, heat and water etc.

Steps taken by government

- India is aiming to achieve **E10 by 2022 and E20 by (20% ethanol blend) by 2025.**
- **Bharat Stage Norms:** India directly shifted from BS-IV to BS-VI norms.
- Government has included **automobile & auto components of flex-fuel engines into the Production Linked Incentive (PLI) scheme.**

How Fuel Cells Work

1. The hydrogen atoms enter at the **anode.**
2. The atoms are stripped of their electrons.
3. The positively charged protons pass through the membrane to the **cathode.**
4. The negatively charged electrons are forced through a circuit, generating electricity.
5. After passing through the circuit, the electrons combine with protons to generate the fuel cell's byproducts: **water** and **heat**.



Related News

In a first, Rolls-Royce successfully tests hydrogen-powered jet engine.

About Hydrogen-powered Engine

- **A hydrogen internal combustion** engine (ICE) **works on the same principles as a traditional ICE**, except that it **uses hydrogen in place of a petroleum-based fuel.**
  - Burning the hydrogen fuel produces the energy needed to drive the engine.
- A hydrogen ICE is **not the same as a hydrogen fuel cell,** which has been used in some electric vehicles.
  - **In hydrogen fuel cell, hydrogen powers the cells** leading to creation of electricity **that will drive the vehicle's engine.**

6.7. OTHER IMPORTANT NEWS

Roshini	• It is **India's first Saline Water Lantern** which uses **sea water as electrolyte** between specially designed electrodes to power the LED lamps.
	  ○ **Developed by:** National Institute of Ocean Technology (NIOT), Chennai.
	  ○ Technology can also be used in hinterlands, **as any saline/normal water mixed with common salt can be used to power the lantern.**

Mission Innovation	• **Mission Innovation launched Integrated Bio-refineries Mission** (IBM) to accelerate Clean Energy solutions through Public-Private Alliances.
	• Mission Innovation is a **global initiative to catalyze action** and investment in research, development and demonstration **to make clean energy affordable, attractive and accessible** to all this decade.
	  ○ It consists of 22 countries and EU. **India is a founding member.**
	  ○ **1st phase of the mission** was launched alongside the **Paris Agreement in 2015** and **2nd phase** of MI, was **launched in 2021.**
	• **About IBM**
	  ○ It is launched with the goal of **replacing 10% of fossil-based fuels, chemicals, and materials with bio-based alternatives by 2030.**
	  ○ This is the **6th Mission launched by Mission Innovation.**
	  ○ **Other 5 missions includes** Clean Hydrogen, Green Powered Future, Zero-Emission Shipping, Carbon Dioxide Removal, and Urban Transitions.

UK-NITI Aayog collaborative initiatives on electric mobility	• In the backdrop of COP 26 President visit to India, **NITI Aayog launched two initiatives namely,**
	  ○ **E-AMRIT (Accelerated e-Mobility Revolution for India's Transportation) mobile application** to raise awareness on electric mobility.
	  ○ **Report on Advanced Chemistry Cell (ACC) Battery Reuse** supported by UK's Green Growth Fund Technical Cooperation Facility.

7. AWARDS AND PRIZES

7.1. NOBEL PRIZE IN CHEMISTRY 2022

Prize awarded for: the development of click chemistry and bioorthogonal chemistry.

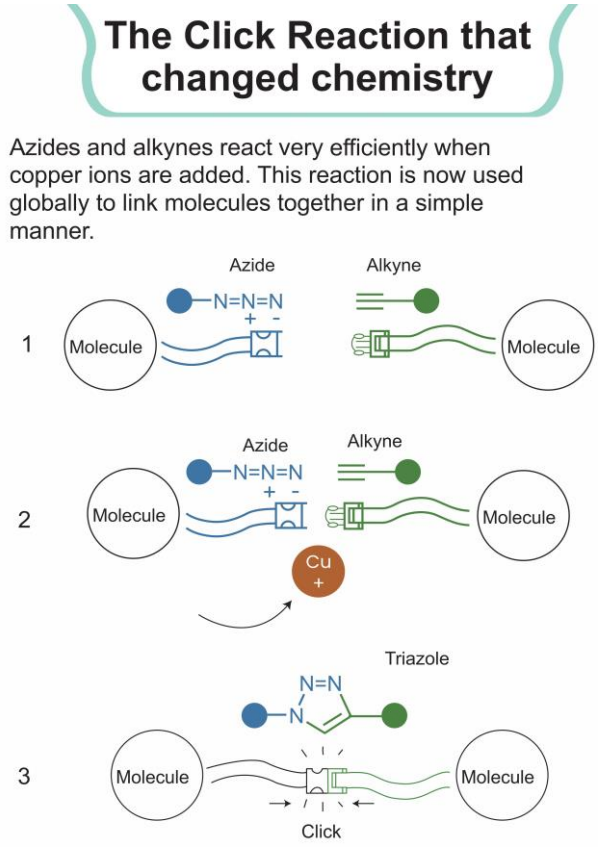
Awardees: The prize was given to **Carolyn R. Bertozzi (USA), Morten Meldal (Denmark)** and **K. Barry Sharpless (USA)**.

Related Facts

- **It was 2nd Nobel Prize in Chemistry** for **K Barry Sharpless,** who won his **first prize** in **2001** for his work on **chirally catalyzed oxidation reactions.**
- He is the **fifth person** to receive **Nobel Prize twice** after **Madam Curie, Linus Pauling, John Bardeen** and **Fredrick Sanger**.
  - The **International Committee of the Red Cross (ICRC)** has won it **three times** while **UNHCR**, the **UN Refugee Agency**, has won it **twice**.

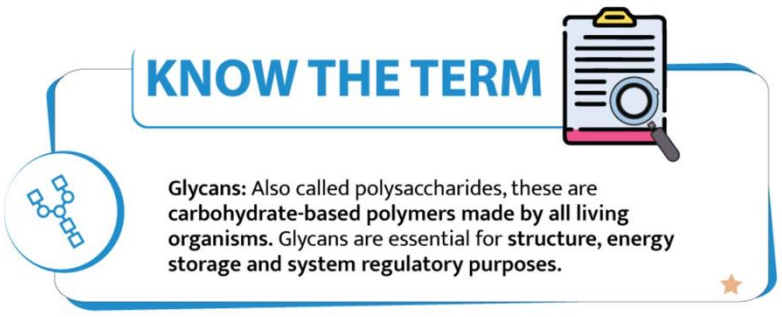
About Click Chemistry and Bioorthogonal Chemistry

- **K. Barry Sharpless** and **Morten Meldal** have laid the **foundation of click chemistry**- a branch of science in which molecular building blocks snap together quickly and efficiently.
  - Instead of trying to make carbon atoms react with each other, **click chemistry focuses on using smaller molecules that already have a complete carbon frame.**
  - One such reaction is **copper-catalysed azide-alkyne cycloaddition (CuAAC)** that is now widely used medicinal chemistry (refer **image**).
- **Carolyn Bertozzi developed click reactions that work inside living organisms** to map important but elusive biomolecules on the surface of cells called glycans.
  - Also known as **Bioorthogonal reactions,** these reactions take place without disrupting the normal chemistry of the cell.



Significance of the Work

- **Development of enzyme inhibitors and receptor ligands, pharmaceuticals** (anticancer agents, antimicrobials etc.), **herbicides, photostabilizers, etc.**
- **Mapping of complex biological processes** like DNA and **creating unique materials**.
- Bioorthogonal Reactions are used **to explore how cells function** and **track biological processes**.
  - This has helped in **improved targeting of cancer pharmaceuticals**.

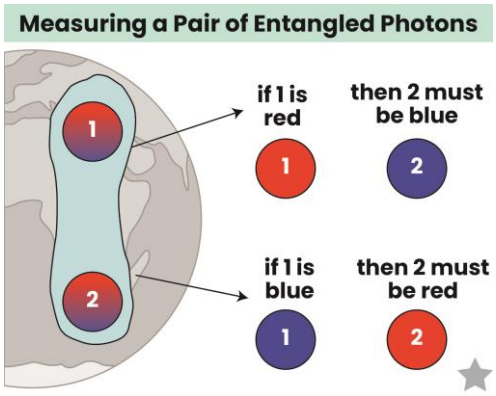


7.2. NOBEL PRIZE IN PHYSICS 2022

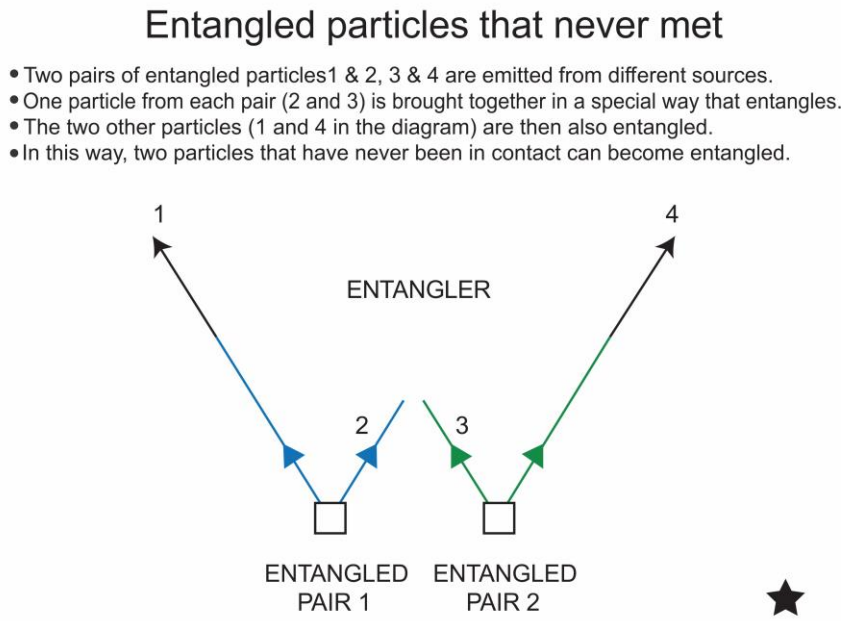
Prize awarded for: experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science.

Awardees: The prize was given to **Alain Aspect (France), John F. Clauser (USA)** and **Anton Zeilinger (Austria)**.

About Quantum experiments and Bell inequalities



- They demonstrated the **potential to investigate** and **control particles** that are in **entangled states**.
  - **Entanglement** is when multiple objects – such as a pair of electrons or photons – share a single quantum state.
  - By **measuring the property of one particle** we can immediately determine the **result of an equivalent measurement** on the other particle, without any check (see **image**).
- They **also demonstrated a phenomenon** called **Quantum Teleportation –** a way of transferring an unknown quantum state from one particle to another.
  - It **uses features of entanglement** which can be used to **transport information,** carried by the object, to another place where the object is then reconstituted.
  - **Anton Zeilinger** group also demonstrated **entanglement swapping,** i.e., two pairs of entangled particles that never met (see **image**).



- **Another important part** of their research was theoretical insight **on Bell inequalities**.
  - Bell inequalities make it possible to **differentiate between quantum mechanics' indeterminacy and an alternative description** using secret instructions, or hidden variables.

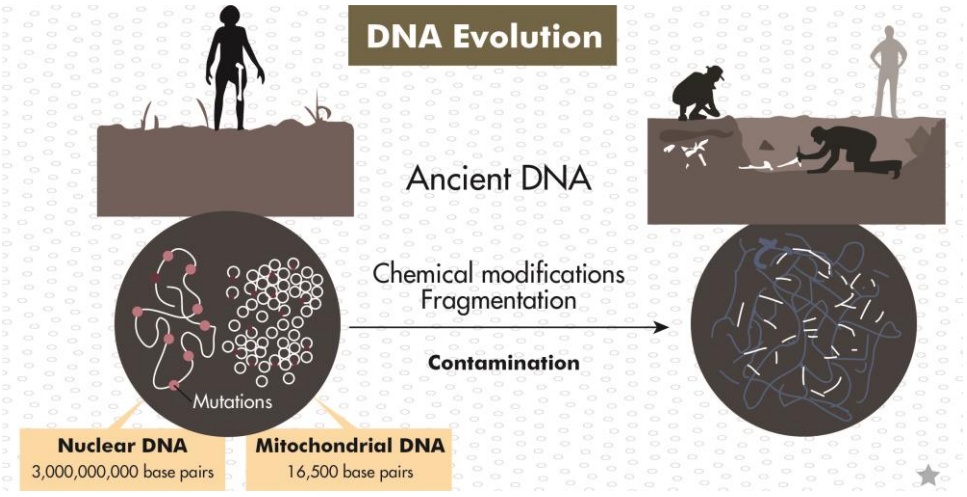
Significance of the Work

- Will have implications in **quantum computers, quantum networks,** and **secure quantum cryptography.**
- **Lay the foundation for** research in **Quantum Information Science (QIS).**
  - QIS is an **interdisciplinary field that seeks to understand information using quantum mechanics principles.**

7.3. NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE 2022

Prize awarded for: discoveries concerning the genomes of extinct hominins and human evolution.

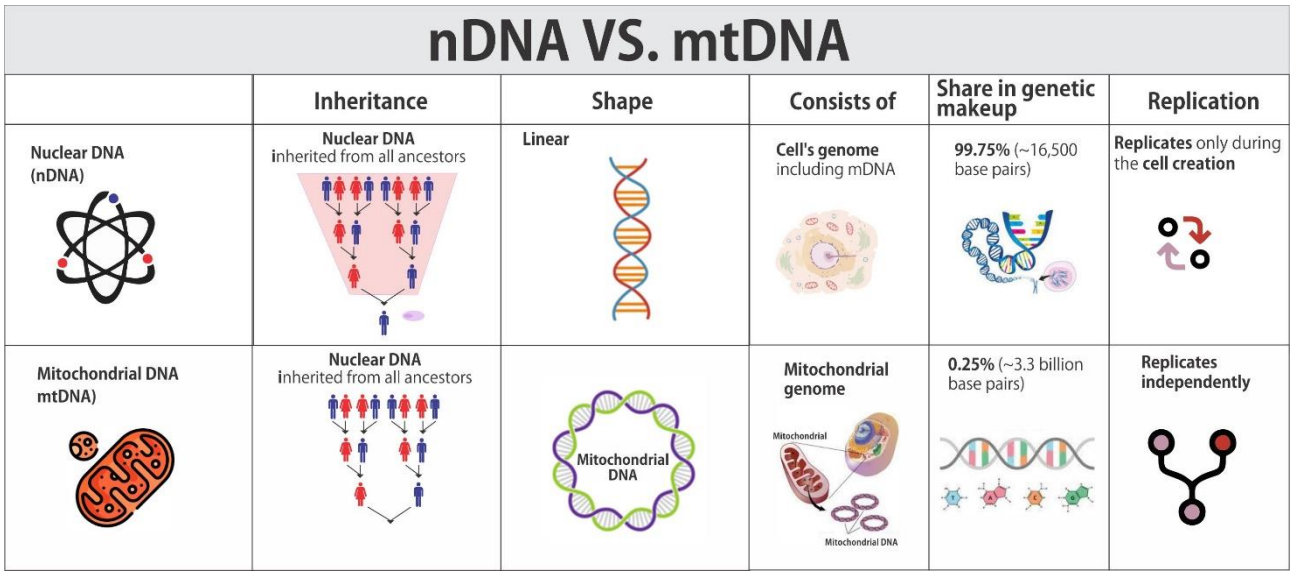
Awardee: Prize was given to Swedish geneticist **Svante Pääbo.**



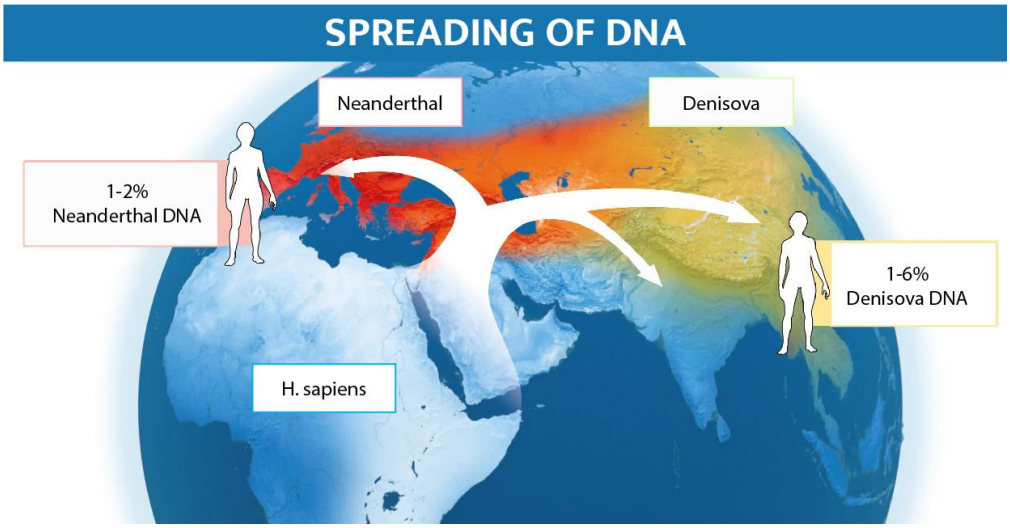
About his discoveries on human evolution

- He **sequenced the genome of the Neanderthal,** an extinct relative of present-day humans.

- Neanderthals developed **outside Africa** and populated **Europe** and **Western Asia** from around **400,000 years**. They went extinct around **30,000 years ago**.
- He analyzed and sequenced the **mitochondrial DNA** (mtDNA) of Neanderthals – demonstrating that Neanderthals were **genetically distinct**.
  - ✓ Though the **mtDNA** is small and contains only a fraction of genetic information, it is present in thousands of copies for sequencing.
  - ✓ In comparison, the **Nuclear DNA (nDNA)** tends to degrade and modify chemically over time, making it difficult to sequence them.



- **He made the discovery of** a previously unknown hominin **Denisova,** discovered in **2008** from southern part of **Siberia**.
- He also found that **gene transfer had occurred from these now extinct hominins** to Homo sapiens following the migration out of Africa around 70,000 years ago.
  - **Homo sapiens,** or anatomically modern human, first appeared in Africa approximately **300,000 years ago**.
  - About **70,000 years ago**, groups of Homo sapiens **migrated from Africa to the Middle East** and, from there they spread to the rest of the world (refer **image**).



Significance of his work

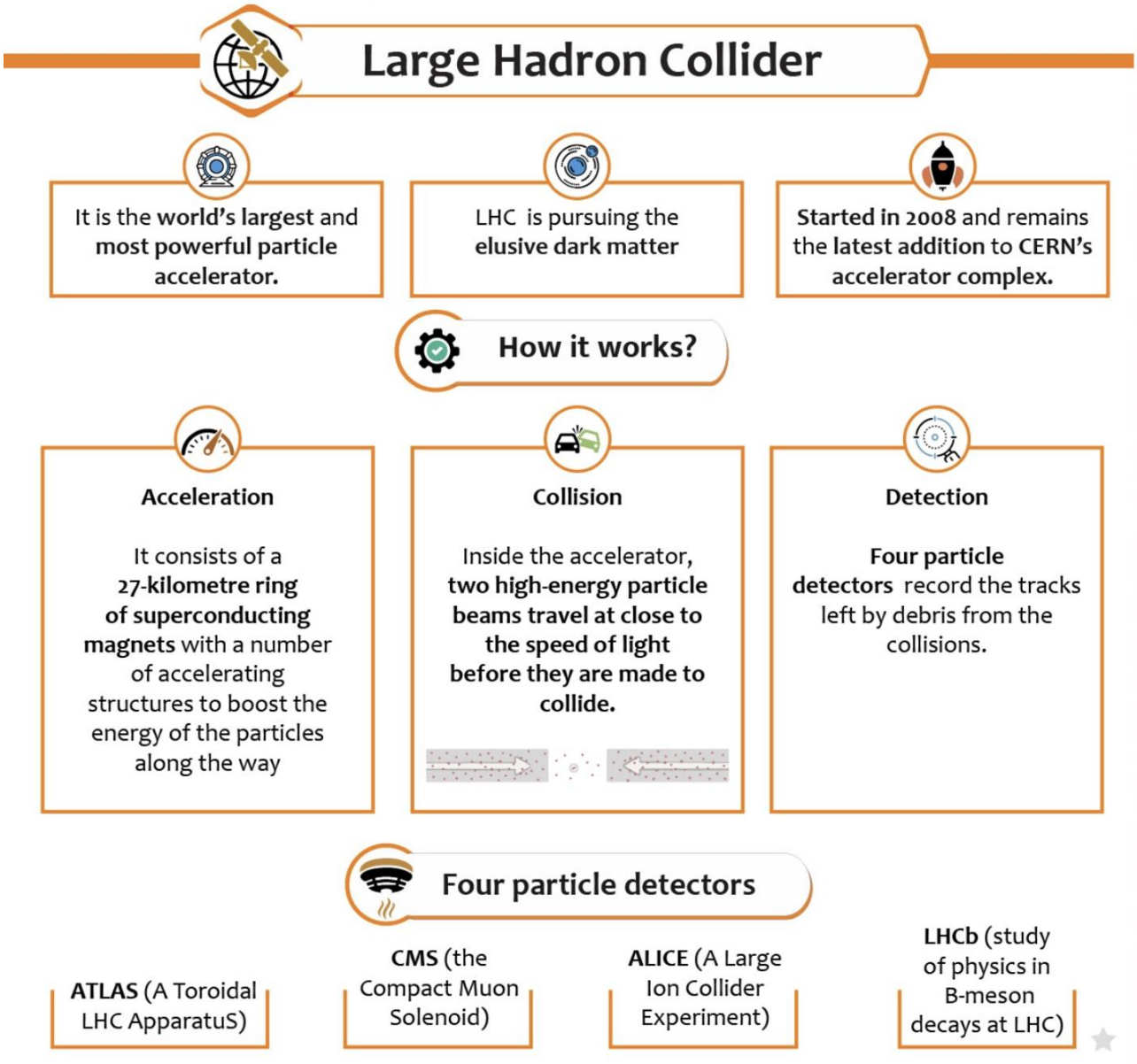
- Gave rise to **a new scientific discipline called paleogenomics**, i.e. the study and analysis of genes of ancient or extinct organisms.
- His **work on differences between living humans from extinct hominins** is useful for:
  - **Better understanding** of human evolution and migration.
  - **Understanding** how the ancient flow of genes influences humans today. E.g.
    - ✓ **Neanderthal genes** affect our **immune response** to different infections, and
    - ✓ Denisovan version of the gene EPAS1 confers an **advantage for survival at high altitude** (commonly found among **Tibetans**).

8. MISCELLANEOUS

8.1. EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

Why in news?

Large Hadron Collider (LHC) was restarted after a 3-year shutdown.



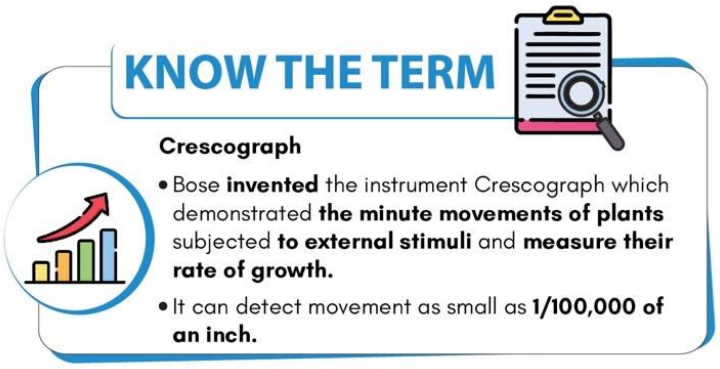
Related News
Pentaquarks and Tetraquarks

- **Large Hadron Collider beauty (LHCb) experiment has observed three new particles** at European Organisation for Nuclear Research (CERN).
  - **Pentaquark** and first-ever **pair of tetraquarks are** three members to list of new hadrons.
  - They will help physicists **better understand how quarks bind together** into composite particles.
- Quarks are **elementary particles that usually combine in groups of twos and threes** to form hadrons such as protons and neutrons that make up atomic nuclei.
  - They can also **combine into four-quark and five-quark particles,** called tetraquarks and pentaquarks.

8.2. ACHARYA JAGADISH CHANDRA BOSE (J.C. BOSE)

Why in News?

Ministry of Culture organized an international conference on the occasion of **164th birth anniversary** of **the Indian scientist Acharya Jagadish Chandra Bose (J.C. Bose**)

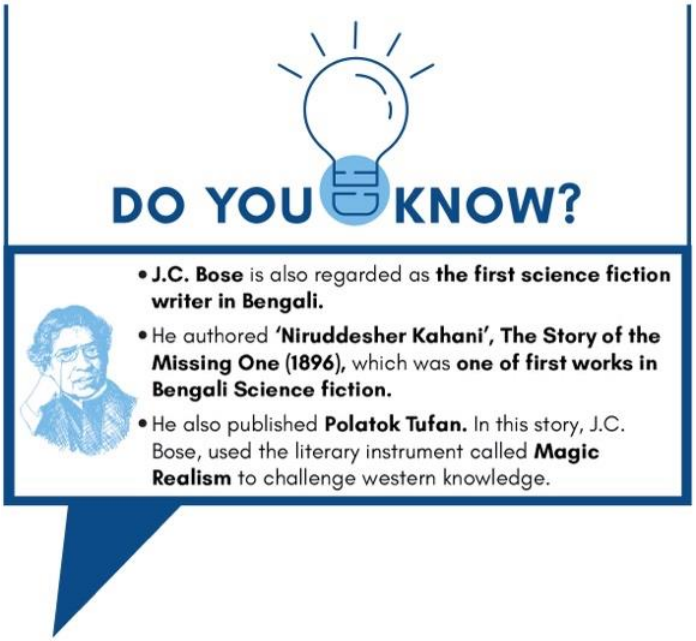


About J.C. Bose (1858-1937)

- **He was an Indian Physicist and plant physiologist.**
- He founded **the Bose Institute in 1917, Asia's first modern research centre** which focused on **interdisciplinary research.**
  - It became **an autonomous grant-in-aid institution** of the **Department of Science and Technology**
- He was **the first Asian** to be awarded **a US patent in in 1904** and **first Asian along with Srinivasa Ramanujan** to become **the fellows of the Royal Society (FRS) in 1920.**
- He was **the president of the 14th session** of the **Indian Science Congress in 1927.**

Contributions of Acharya J C Bose

- **Contributions in Physics:**
  - Researched **on millimeter waves** (spectrum band with wavelengths between 10 mm and 1 mm) and in the arena **of microwave devices.**
    - ✓ **Presently millimeter wave is used for a variety of services** on mobile and wireless networks, as it enables higher data rates.
  - Developed **World's first wireless communication link at 5-mm wavelength** using **a spark transmitter** (generates radio waves by means of electric spark) and **a spiral 'coherer'** (an instrument that detects radio waves) **as the receiver.**
    - ✓ **Bose's coherer** was used by **Guglielmo Marconi** to build an **operational two-way radio.**
  - Called **'Father of Radio Science'** as he first explained science behind radio technology.



- **Contribution in Biology:**
  - He researched the **seasonal effect on plants** and **the effect of chemical inhibitors** (substances which slow down chemical reactions) **and temperature on plants.**
    - ✓ **He invented Crescograph** to study plants.
  - **Proved that plants have life** and a sensitive nervous system.
  - **Biophysics and cybernetics:** His measurements of the effect of electromagnetic radiation on plant growth is becoming an important area of plant biophysics and cybernetics.

- He showed that **the living cells of the innermost layer of the cortex** (an outer layer of a stem or root in a vascular plant) were in a state of **pulsatory motion** (like rhythmic beating of the heart).
  - ✓ This pulsation caused **the pumping of water from cell to cell in an upward direction.**
- In this field, his two major works include **'Response in the Living and Non-Living'** and **'The Nervous Mechanism of Plants.'**

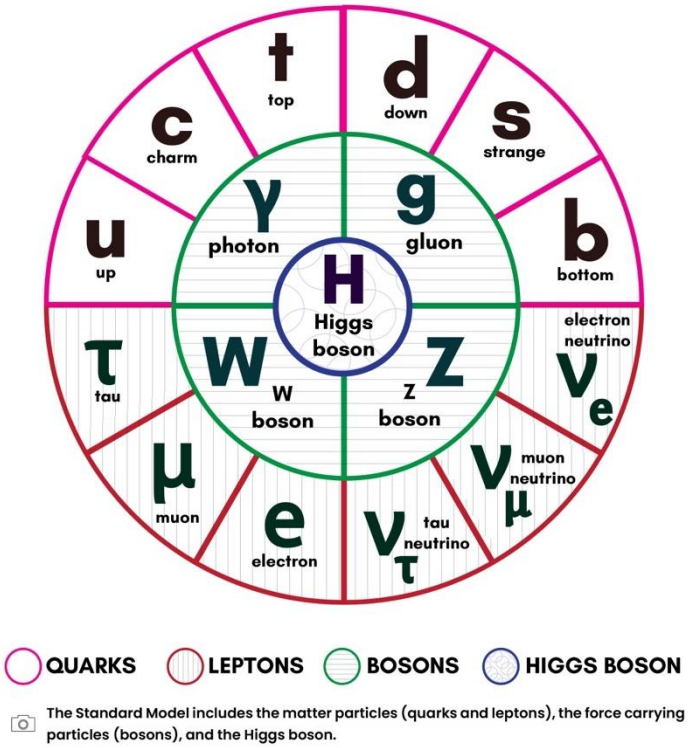
8.3. THE "MYSTERY" PARTICLE FINDING

Why in the news?

Recently scientists have found out that a fundamental particle **'W boson' (refer to the infographics)**

More about the news

- **It has a significantly greater mass** than theorized by the **Standard Model.**
- This recent discovery indicates there may be **a new fundamental ingredient to our universe.**
- **About the Standard Model**
  - It is a set of mathematical formulae and measurements **describing elementary or fundamental particles and their interactions.**
  - It contains **12 fundamental matter particles categorized** as **quarks and leptons** and **three forces that govern the behavior of matter: electromagnetism, the strong and weak nuclear forces.**
    - ✓ The force of gravity is currently not included in the standard model.



The Standard Model includes the matter particles (quarks and leptons), the force carrying particles (bosons), and the Higgs boson.

  - This model was developed in the early 1970s and is still considered to be the **most accurate theory covering the foundations of particle physics.**
  - It **predicted the existence** of yet-to-be discovered particles, such as **the Higgs boson.**
  - However, this model is yet incomplete and **falls short of in explaining:**
    - ✓ General relativity's description of gravity?
    - ✓ Why is the Universe expanding ever faster?
    - ✓ Why is there more matter than antimatter?

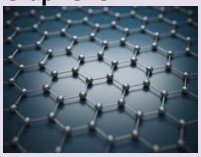
8.4. OTHER IMPORTANT NEWS

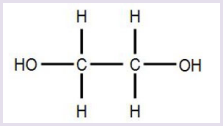
8.4.1. RESEARCH AND DEVELOPMENT

Manthan platform	• **Launched by:** Office of the Principal Scientific Adviser (PSA). • Objective is to **promote collaboration between industry and scientific research and development ecosystem** to help meet India's sustainability goals in alignment with UN SDG charter. • Platform aims **to enable and empower all spheres of science and technology within the country**.
State University Research Excellence (SERB-SURE)	• SERB-SURE is a **new innovative scheme for high-end research** at state and private universities and colleges. • **Launched by:** Science and Engineering Research Board, statutory body of Department of Science and Technology • It will provide **research support to active researchers** to **undertake research** in frontier areas of science, engineering, and quantitative social science.
Vritika Research Internship	• VRITIKA' is the call for **initiation and practice in science through Training and Skill Internship.** ○ **Sponsored by Science & Engineering Research Board (SERB),** Department of Science and Technology (DST).

	• It aims to provide **opportunities to promising PG students** from universities and colleges to get exposure and hands-on **research skill development experience.** • These internships will primarily be **facilitated by organizations / institutions / laboratories of national importance** such as IITs, IISc, IISERs, NITs, CSIR, ICAR, ICMR etc.
Studentship Program for Ayurveda Research Ken (SPARK) program	• SPARK **aims to support the research ideas of young undergraduate students**. o The Central Council for Research in Ayurvedic Sciences (CCRAS) **will offer research fellowships to young undergraduate students enrolled in Ayurveda colleges across the country**. • CCRAS is the **apex body, Under Ministry of AYUSH,** for research in Ayurveda on scientific lines.
Scientific Research Infrastructure Sharing Maintenance and Networks (SRIMAN) Guidelines, 2022	• The SRIMAN Guidelines are released by the **Department of Science and Technology** for **better access and sharing of publicly funded Scientific Research and Development Infrastructure**. o It includes **Networking and Cluster Approach**, creating **Cluster Central Instrumentation Facility (CCIF)** to reduce redundancy and acquire more variety of equipment. o CCIF will also tie up with industries, especially MSMEs and startups.AI-based iRASTE to make roads in India safer to drive. • **'Intelligent Solutions for Road Safety through Technology and Engineering' (iRASTE) project** is being **implemented in Nagpur to tackle problem of road accidents**. o It is **undertaken by IIIT Hyderabad** and **supported by the Department of Science and Technology (DST).** o It is under DST's **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** ✓ NM-ICPS aims to create a **strong foundation and a seamless ecosystem for CPS technologies by coordinating and integrating nationwide efforts** encompassing knowledge generation, human resource development, research, etc.
NIDHI Prayas	• **M/s TGP Bioplastics was provided assistance** to mitigate usage of Single Use Plastics (SUP). o This project has received seed funding under **NIDHI Prayas (DST), Niti Aayog and UNIDO** for the prototype development. • Department of Science & Technology has launched a **NIDHI program (National Initiative for Developing and Harnessing Innovations)** o Under NIDHI programs **for setting up of incubators, seed fund, accelerators** etc. **have been launched.** • Under NIDHI, **PRAYAS (Promoting and Accelerating Young and Aspiring innovators & Startups) programme** has been initiated in which established Technology Business Incubators are supported with PRAYAS grant.

8.4.2. MISCELLANEOUS

Scientific Social Responsibility (SSR)	• **Department of Science and Technology (DST)** released SSR Guidelines 2022. • **About SSR:** Ethical obligation of knowledge workers in all fields of science and technology to voluntarily contribute to the widest spectrum of stakeholders in society. • **Key highlights:** o Every knowledge institution would **prepare its implementation plan in consultation with Anchor Scientific Institution (ASI)** for achieving its SSR goals and prepare its SSR code of conduct. o There should be an **SSR assessment cell in each institution including ASI.** o SSR activities and projects of a knowledge institution **would not be outsourced or subcontracted.**
Graphene 	• A Centre for Nano and Soft Sciences (CeNS) team has developed **Graphene-stabilised tunable photonic crystal** that can make more **durable & better reflective display and lasers devices.** o **Photonic crystals** are optical nanostructures in which **refractive index changes periodically (such as in butterfly wings, peacock feathers).** • Graphene is a **single layer of carbon atoms, tightly bound in a hexagonal** honeycomb lattice. o It is an **allotrope of carbon**. • **Characteristics:** Thinnest compound at one atom thick, lightest material known, strongest compound discovered, good conductor of heat and electricity etc. • **Applications:** Energy, telecommunications, electronics, sensors and imaging, biomedical technologies etc.

Ethylene Glycol 	• Department of Chemicals and Petrochemicals issued a **gazette notification titled Ethylene Glycol (Quality Control) Order, 2022.** • Ethylene glycol is a **colorless and odorless alcoholic compound** that **can be fatal** if consumed. ○ It is a syrupy or **viscous liquid at room temperature.** • It is mostly **used as an automotive antifreeze** and **for manufacturing polyester fibres.** • Also **found in hydraulic brake fluids, stamp pad inks, ballpoint pens**, solvents, paints, cosmetics and plastics etc. • Diethylene glycol and ethylene glycol **are adulterants that are sometimes illegally used as solvents in liquid drugs** to cut costs.
Single-crystalline scandium nitride (ScN)	• Department of Science and Technology (DST) have discovered a novel material **called Single-crystalline ScN** that can convert infrared light to renewable energy. • **ScN** can emit, detect, and modulate infrared light with high efficiencies. • It belongs to **same family of materials as gallium nitride (GaN).** • ScN is **compatible with modern complementary-metal-oxide-semiconductor (CMOS)** or **Si-chip technology** and, therefore, could be easily integrated for on-chip optical communication devices.
Cordy gold nanoparticles (Cor-AuNPs) 	• It has been **developed to make drug delivery in the human body faster and surer.** • These nanoparticles have been derived from the **synthesis of the extracts of Cordyceps militaris (a high value parasitic fungus) and gold salts.** • It is the outcome of a **collaborative experiment by scientists from four Indian institutions.**

Nixtamalisation	• A study has thrown light on how Maya people **fortified their maize with chemical process known as 'nixtamalisation.**
	• Nixtamalisation is a **method by which the ancient peoples of Mesoamerica (a term used to describe Mexico and Central America) like the Maya** used to soak and cook their maize in an alkaline solution and make it more palatable, nutritious and non-toxic.
	  ○ Process ensures that maize **contains amino acids, calcium and Vitamin B2, which can be utilised by the human body.**
	  ○ It also **eliminates certain mycotoxins present in maize**.

8 IN TOP 10 SELECTIONS IN CSE 2021

from various programs of VisionIAS

2 AIR — ANKITA AGARWAL

3 AIR — GAMINI SINGLA

4 AIR — AISHWARYA VERMA

5 AIR — UTKARSH DWIVEDI

6 AIR — YAKSH CHAUDHARY

CIVIL SERVICES EXAMINATION 2020

1 AIR — SHUBHAM KUMAR

7 AIR — SAMYAK S JAIN

8 AIR — ISHITA RATHI

9 AIR — PREETAM KUMAR

YOU CAN BE NEXT

ABHYAAS 2023

ALL INDIA PRELIMS (GS+CSAT)

MOCK TEST SERIES

3 TEST

TEST-1	TEST-2	TEST-3
2 APRIL	23 APRIL	7 MAY

- All India Ranking
- Comprehensive Evaluation, Feedback & Corrective Measures
- Available In ENGLISH / हिन्दी

Register @ www.visionias.in/abhyaas

OFFLINE* IN 170+ CITIES

AGARTALA | AGRA | AHMADNAGAR | AHMEDABAD | AIZAWL | AJMER | ALIGARH | ALMORA | ALWAR | AMARAVATI (ANDHRA PRADESH) | AMBALA | AMBIKAPUR | AMRAVATI (MAHARASHTRA) | AMRITSAR | ANANTHAPURU | ASANSOL | AURANGABAD (MAHARASHTRA) | AYODHYA | BALLIA | BANDA | BAREILLY | BATHINDA | BEGUSARAI BENGALURU | BHAGALPUR | BHAVNAGAR | BHILAI | BHILWARA | BHOPAL | BHUBANESWAR | BIKANER | BILASPUR | BOKARO | BULANDSHAHR | CHANDIGARH | CHANDRAPUR CHENNAI | CHHATARPUR (MP) | CHITTOOR | COIMBATORE | CUTTACK | DAVANAGERE | DEHRADUN | DELHI-MUKHERJEE NAGAR | DELHI-RAJINDER NAGAR | DHANBAD DHARAMSHALA | DHARWAD | DHULE | DIBRUGARH | DIMAPUR | DURGAPUR | ETAWAH | FARIDABAD | FATEHPUR | GANGTOK | GAYA | GHAZIABAD | GORAKHPUR | GR NOIDA GUNTUR | GURDASPUR | GURUGRAM (GURGAON) | GUWAHATI | GWALIOR | HALDWANI | HARIDWAR | HAZARIBAGH | HISAR | HOWRAH | HYDERABAD | IMPHAL | INDORE ITANAGAR | JABALPUR | JAIPUR | JAISALMER | JALANDHAR | JAMMU | JAMNAGAR | JAMSHEDPUR | JAUNPUR | JHAJJAR | JHANSI | JODHPUR | JORHAT | KAKINADA KALBURGI (GULBARGA) | KANNUR | KANPUR | KARIMNAGAR | KARNAL | KASHIPUR | KOCHI | KOHIMA | KOLHAPUR | KOLKATA | KORBA | KOTA | KOTTAYAM | KOZHIKODE (CALICUT) | KURNOOL | KURUKSHETRA | LATUR | LEH | LUCKNOW | LUDHIANA | MADURAI (TAMIL NADU) | MANDI | MANGALURU | MATHURA | MEERUT | MIRZAPUR MORADABAD | MUMBAI | MUNGER | MUZAFFARPUR | MYSURU | NAGPUR | NALANDA | NASIK | NAVI MUMBAI | NELLORE | NIZAMABAD | NOIDA | ORAI | PALAKKAD | PANAJI (GOA) | PANIPAT | PATIALA | PATNA | PRAYAGRAJ (ALLAHABAD) | PUDUCHERRY | PUNE | PURNIA | RAIPUR | RAJKOT | RANCHI | RATLAM | REWA | ROHTAK | ROORKEE ROURKELA | RUDRAPUR | SAGAR | SAMBALPUR | SATARA | SAWAI | MADHOPUR | SECUNDERABAD | SHILLONG | SHIMLA | SILIGURI | SIWAN | SOLAPUR | SONIPAT SRINAGAR | SURAT | THANE | THANJAVUR | THIRUVANANTHAPURAM | THRISSUR | TIRUCHIRAPALLI | TIRUNELVELI | TIRUPATI | UDAIPUR | UJJAIN | VADODRA | VARANASI VELLORE | VIJAYAWADA | VISAKHAPATNAM | WARANGAL

HEAD OFFICE Apsara Arcade, 1/8-B, 1st Floor,
Near Gate 6, Karol Bagh Metro Station

8468022022 WWW.VISIONIAS.IN

JAIPUR | HYDERABAD | BHOPAL | GUWAHATI | RANCHI | LUCKNOW | PUNE | AHMEDABAD | CHANDIGARH | PRAYAGRAJ