



INSIGHTSIAS

SIMPLIFYING IAS EXAM PREPARATION

INSTA PT 2021 EXCLUSIVE

SCIENCE AND TECHNOLOGY

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Space Technology

1. PSLV-C50

The Indian Space Research Organisation (ISRO) has successfully placed into **geosynchronous transfer orbit (GTO)** India's **42nd communications satellite, CMS-01**, carried on board the **PSLV-C50**.

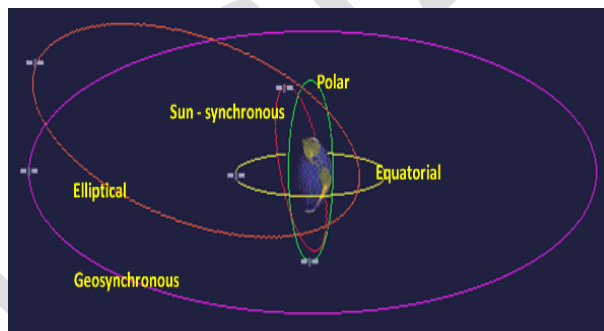
About CMS-01:

- It is a communications satellite envisaged for providing services in extended C Band of the frequency spectrum and its coverage will include the Indian mainland and the Andaman & Nicobar and Lakshadweep islands.
- The satellite is expected to have a life of over seven years.

Different orbits:

- A **Geosynchronous Orbit (GEO)** takes a satellite around the Earth at a rate of once per day, keeping it roughly in the same area over the ground.
- A **Geostationary Orbit (GSO)** is a geosynchronous orbit with an inclination of zero, meaning, it lies on the equator.

All geostationary satellites are **geosynchronous**. Not all geosynchronous satellites are geostationary.



What, then, is a transfer orbit?

- Rockets sending payloads to geosynchronous and geostationary orbits drop off their payload in transfer orbits, halfway points en route to the satellite's final position.
- From transfer orbit, a satellite conducts engine burns to circularize its orbit and change its inclination.

2. PSLV-C51

PSLV-C51 was successfully launched by ISRO.

- This was **the 53rd flight of ISRO's launch vehicle and the first dedicated mission of its commercial arm, NewSpace India Ltd.**
- The mission was undertaken under a commercial arrangement with Spaceflight Inc., U.S.

Satellites onboard:

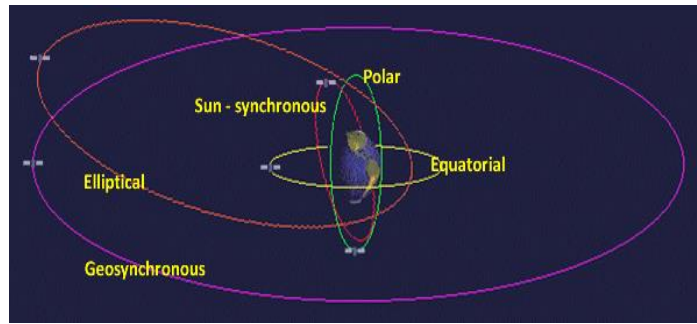
It carried 19 satellites (Including Brazil's optical earth observation satellite, **Amazonia-1**, and 18 co-passenger satellites — five from India and 13 from the U.S.).

- Amazonia-1 is **the first fully Brazilian-made satellite, which would help to monitor the Amazon forests.**
- The Amazonia-1 was injected into its precise orbit of 758 km in a **sun-synchronous polar orbit.**

The **Bhagavad Gita** was also sent on board an SD card to give the scripture, which teaches oneness as the highest form of humanity, the highest honour.

What is PSLV?

- Polar Satellite Launch Vehicle is an indigenously-developed expendable launch system of the ISRO.
- It comes in the category of medium-lift launchers with a reach up to various orbits, including the Geo Synchronous Transfer Orbit, Lower Earth Orbit, and Polar Sun Synchronous Orbit.
- All the operations of PSLV are controlled from the Satish Dhawan Space Center, Sriharikota.



Difference between PSLV and GSLV:

- India has two operational launchers- Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).
- PSLV was developed to launch low-Earth Orbit satellites into polar and sun synchronous orbits. It has since proved its versatility by launching geosynchronous, lunar and interplanetary spacecraft successfully.
- On the other hand, GSLV was developed to launch the heavier INSAT class of geosynchronous satellites into orbit. In its third and final stage, GSLV uses the indigenously developed cryogenic upper stage.

3. EOS-01

EOS-01 launch. This was **ISRO's first mission since the launch of RISAT-2BR1**.

What is EOS-01?

It is an **earth observation satellite**.

EOS-01 is nothing but another **Radar Imaging Satellite (RISAT)** that will work together with RISAT-2B and RISAT-2BR1.

- Henceforth **all the earth observation satellites would be called EOS-series**.

What are earth-observation satellites used for?

Land and forest mapping and monitoring, mapping of resources like water or minerals or fishes, weather and climate observations, soil assessment, geospatial contour mapping are all done through earth-observation satellites.

Advantages of radar imaging over optical instruments:

Radar imaging is unaffected by weather, cloud or fog, or the lack of sunlight. It can produce high-quality images in all conditions and at all times.

4. Bhuvan

The Department of Space (DoS), under which ISRO comes, has signed an MoU with geospatial technology company CE Info Systems Pvt Ltd.

- The collaboration will enable them to jointly identify and build a holistic geospatial portal utilising earth observation datasets, '**NavIC**', **Web Services and APIs (application programming interface) available in MapmyIndia**.
- The geospatial portals will be called '**Bhuvan**', '**VEDAS**' and '**MOSDAC**'.

Key facts:

Bhuvan is the national geo-portal developed and hosted by ISRO comprising geospatial data, services, and tools for analysis.

VEDAS (Visualisation of Earth observation Data and Archival System) is an online geoprocessing platform that uses optical, microwave, thermal, and hyperspectral EO data covering applications particularly meant for academia, research and problem solving.

MOSDAC (Meteorological and Oceanographic Satellite Data Archival Centre) is a data repository for all the meteorological missions of ISRO and deals with weather-related information, oceanography, and tropical water cycles.

What is NAVIC?

Navigation with Indian Constellation (NavIC) is an independent regional navigation satellite system designed to provide position information in the Indian region and 1500 km around the Indian mainland.

NavIC will provide two types of services:

1. Standard Positioning Service (SPS) which is provided to all the users.
2. Restricted Service (RS), which is an encrypted service provided only to the authorised users.

Its applications include:

1. Terrestrial, Aerial and Marine Navigation.
2. Disaster Management.
3. Vehicle tracking and fleet management.
4. Integration with mobile phones.
5. Precise Timing.
6. Mapping and Geodetic data capture.
7. Terrestrial navigation aid for hikers and travellers.
8. Visual and voice navigation for drivers.

How many satellites does NAVIC consist of?

It is powered by eight IRNSS satellites, of which one provides messaging services.

Three of these will be geostationary over the Indian Ocean, i.e., they will appear to be stationary in the sky over the region, and four will be geosynchronous – appearing at the same point in the sky at the same time every day.

- This configuration ensures each satellite is being tracked by at least one of fourteen ground stations at any given point of time, with a high chance of most of them being visible from any point in India.

5. Gaganyaan mission

- **Gaganyaan** is an **Indian crewed orbital spacecraft** intended to be the formative spacecraft of the **Indian Human Spaceflight Programme**.
- The crewed vehicle is planned to be launched on ISRO's **GSLV Mk III**.
- **Defence Research and Development Organisation (DRDO)** will provide support for critical human-centric systems and technologies like space grade food, crew healthcare, radiation measurement and protection, parachutes for the safe recovery of the crew module and fire suppression system.
- ISRO's Human Space Flight Centre and **Glavcosmos**, which is a subsidiary of the Russian state corporation Roscosmos, signed an agreement on July 1, 2019 for **cooperation in the selection, support, medical examination and space training of Indian astronauts**.
- Isro will receive assistance from the **French space agency CNES**, in terms of expertise various fields including space medicine, astronaut health monitoring, radiation protection and life support.
- On January 22, 2020 ISRO announced **Vyommitra**, a Female Robot who will accompany other astronauts in the mission.

Objectives of the Mission:

1. Enhancement of science and technology levels in the country
2. A national project involving several institutes, academia and industry
3. Improvement of industrial growth
4. Inspiring youth
5. Development of technology for social benefits
6. Improving international collaboration

6. Shukrayaan

The **Indian Space Research Organisation (ISRO)** has short-listed 20 space-based experiment proposals for its proposed Venus orbiter mission '**Shukrayaan**'.

About Shukrayaan:

It is a mission to study Venus for more than four years.

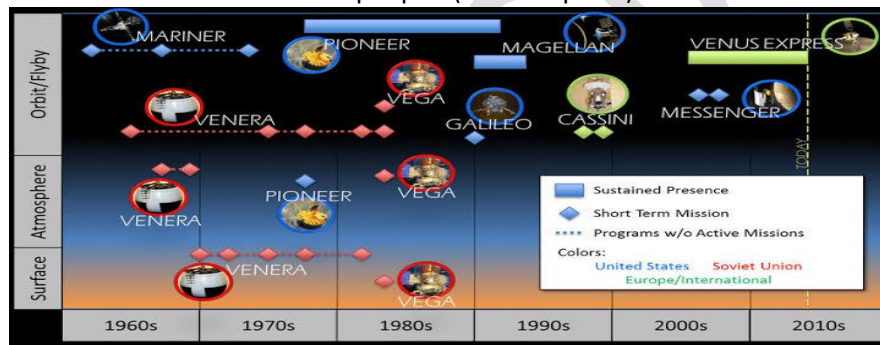
Scientific objectives: Investigation of the surface processes and shallow subsurface stratigraphy; and solar wind interaction with Venusian Ionosphere, and studying the structure, composition and dynamics of the atmosphere.

The satellite is planned to be launched onboard **GSLV Mk II rocket**.

The proposed orbit is expected to be around 500 x 60,000 km around Venus. This orbit is likely to be reduced gradually, over several months to a lower apoapsis (farthest point).

Why study Venus?

- Venus is often described as the **"twin sister"** of the **Earth** because of the similarities in size, mass, density, bulk composition and gravity.
- It is believed that both planets share a common origin, forming at the same time out of a condensing nebulosity around 4.5 billion years ago.
- Venus is around **30 per cent closer to the Sun** as compared to **Earth** resulting in much higher **solar flux**.



7. AstroSat

AstroSat's Ultraviolet Imaging Telescope spots rare ultraviolet-bright stars in a massive intriguing cosmic dinosaur in the Milky Way.

Significance of the discovery:

Such UV-bright stars are speculated to be the reason for the ultraviolet radiation coming from old stellar systems such as elliptical galaxies which are devoid of young blue stars. Hence, it is all the more important to observe more such stars to understand their properties.



About AstroSat:

- AstroSat is **India's first multi-wavelength space telescope**, which has five telescopes seeing through different wavelengths simultaneously — visible, near UV, far UV, soft X-ray and hard X-ray.
- Onboard the AstroSat is a 38-cm wide **UltraViolet Imaging Telescope (UVIT)**, which is capable of imaging in far and near-ultraviolet bands over a wide field of view.
- AstroSat was launched on 28 September 2015 by ISRO into a near-Earth equatorial orbit.
- It is a **multi-institute collaborative project**, involving IUCAA, ISRO, Tata Institute of Fundamental Research (Mumbai), Indian Institute of Astrophysics (Bengaluru), and Physical Research Laboratory (Ahmedabad), among others.

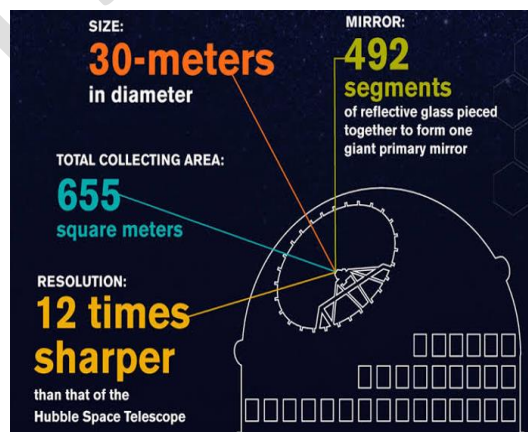
**8. Thirty Meter Telescope (TMT)**

Indian astronomers collaborated with Nobel laureate on Thirty Meter Telescope Project.

- **2020 Physics Nobel Laureate Prof. Andrea Ghez** had worked closely with Indian astronomers on the design of back-end instruments.

About TMT:

- It is an astronomical observatory with an extremely large telescope (ELT).
- It is an international project being **funded by scientific organisations of Canada, China, India, Japan and USA.**
- **Planned location:** Mauna Kea on the island of Hawaii in the US state of Hawaii.
- **Purpose:** The TMT is designed for near-ultraviolet to mid-infrared observations, featuring adaptive optics to assist in correcting image blur.

**Significance:**

- TMT will enable scientists to study fainter objects far away from us in the Universe, which gives information about early stages of evolution of the Universe.
- It will give us finer details of not-so-far-away objects like undiscovered planets and other objects in the Solar System and planets around other stars.

9. NISAR

NASA and ISRO are collaborating on developing a satellite called NISAR.

About NISAR:

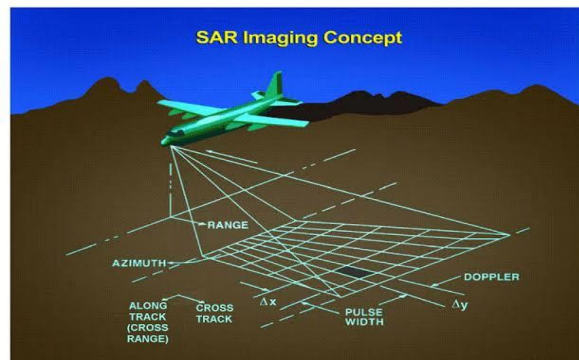
- The satellite will be launched in 2022 from the Satish Dhawan Space Center in Sriharikota, India, into a near-polar orbit.

- It will scan the globe every 12 days over the course of its three-year mission of imaging the Earth's land, ice sheets and sea ice to give an "unprecedented" view of the planet.
- It will **detect movements of the planet's surface** as small as 0.4 inches over areas about half the size of a tennis court.
- NASA will provide one of the radars for the satellite, a high-rate communication subsystem for science data, GPS receivers and a payload data subsystem.
- ISRO will provide the spacecraft bus, the second type of radar (called the S-band radar), the launch vehicle and associated launch services.
- NISAR will be equipped with the largest reflector antenna ever launched by NASA and its primary goals include tracking subtle changes in the Earth's surface, spotting warning signs of imminent volcanic eruptions, helping to monitor groundwater supplies and tracking the rate at which ice sheets are melting.

Synthetic aperture radar:

The name **NISAR** is short for **NASA-ISRO-SAR**. SAR here refers to **the synthetic aperture radar** that NASA will use to measure changes in the surface of the Earth.

- Essentially, SAR refers to a technique for producing high-resolution images. Because of the precision, **the radar can penetrate clouds and darkness, which means that it can collect data day and night in any weather.**



10. Parker Solar Probe

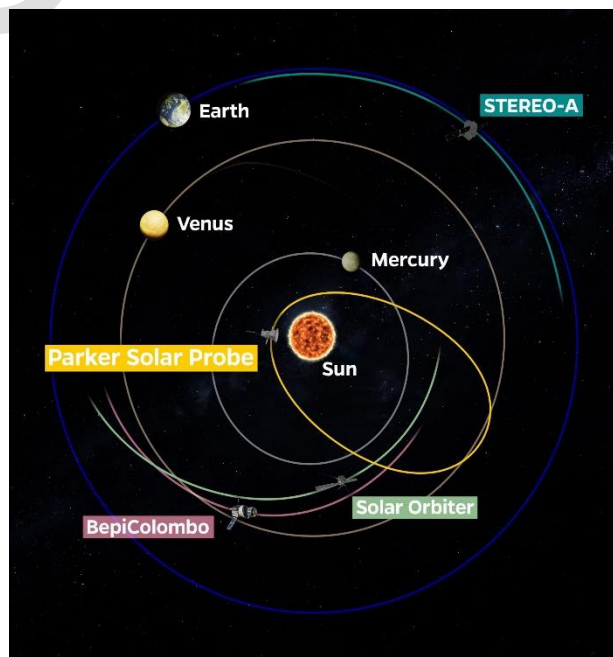
Parker Solar Probe Marks Seventh Successful Swing around the Sun.

About the mission:

- NASA's Parker Solar Probe mission will revolutionize our understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth and other worlds.
- Parker Solar Probe will travel through the sun's atmosphere, closer to the surface than any spacecraft before it, facing brutal heat and radiation conditions — and ultimately providing humanity with the closest-ever observations of a star.

Journey:

- In order to unlock the mysteries of the sun's atmosphere, **Parker Solar Probe will use Venus' gravity** during seven flybys over nearly seven years to gradually bring its orbit closer to the sun.
- The spacecraft will fly through the sun's atmosphere as close as 3.9 million miles to our star's surface, well within the orbit of Mercury and more than seven times closer than any spacecraft has come before.



Goals:

The primary science goals for the mission are to trace how energy and heat move through the solar corona and to explore what accelerates the solar wind as well as solar energetic particles.

Parker Solar Probe has three detailed science objectives:

1. Trace the flow of energy that heats and accelerates the solar corona and solar wind.
2. Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
3. Explore mechanisms that accelerate and transport energetic particles.

Why study corona?

- The corona is hotter than the surface of the sun.
- The corona gives rise to the solar wind, a continuous flow of charged particles that permeates the solar system.
- Unpredictable solar winds cause disturbances in our planet's magnetic field and can play havoc with communications technology on Earth.
- Nasa hopes the findings will enable scientists to forecast changes in Earth's space environment.

11. Aditya- L1 mission

Indian Space Research Organisation (ISRO) is preparing to send its first scientific **expedition to study the Sun**. Named **Aditya-L1**, will observe the Sun from a close distance, and try to obtain information about its **atmosphere and magnetic field**.

About Aditya- L1 mission:

What is it? It is **India's first solar mission**.

It will be launched using **the Polar Satellite Launch Vehicle (PSLV) in XL configuration**.

The space-based observatory will have **seven payloads (instruments)** on board to study the Sun's corona, solar emissions, solar winds and flares, and Coronal Mass Ejections (CMEs), and will carry out round-the-clock imaging of the Sun.

Objectives:

- Study the sun's outer most layers, the corona and the chromospheres.
- Collect data about coronal mass ejection, which will also yield information for space weather prediction.

Significance of the mission:

The data from Aditya mission will be immensely helpful in discriminating between different **models for the origin of solar storms and also for constraining how the storms evolve** and what path they take through the interplanetary space from the Sun to the Earth.

Position of the satellite:

In order to get the best science from the sun, continuous viewing of the sun is preferred without any occultation/ eclipses and hence, Aditya- L1 satellite will be placed in **the halo orbit around the Lagrangian point 1 (L1) of the sun-earth system**.

What are Lagrangian points and halo orbit?

Lagrangian points are the locations in space where the combined gravitational pull of two large masses roughly balance each other. Any small mass placed at that location will remain at constant distances relative to the large masses.

There are five such points in Sun-Earth system and they are denoted as L1, L2, L3, L4 and L5.

A halo orbit is a periodic three-dimensional orbit near the L1, L2 or L3.

Why do we study the sun and the solar wind?

The sun is **the only star we can study up close**. By studying this star we live with, we learn more about stars throughout the universe.

The sun is **a source of light and heat for life on Earth**. The more we know about it, the more we can understand how life on Earth developed.

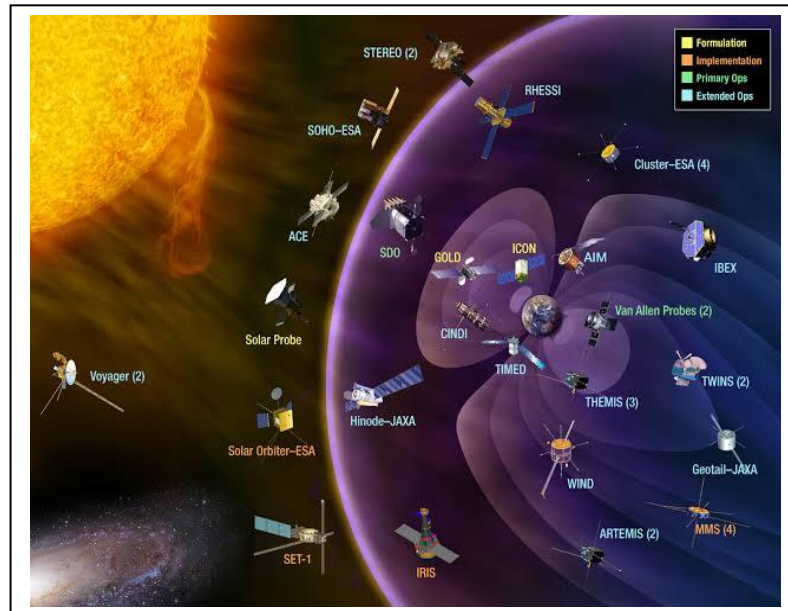
It is **the source of the solar wind**; a flow of ionized gases from the sun that streams past Earth at speeds of more than 500 km per second (a million miles per hour).

Disturbances in the solar wind shake Earth's magnetic field and pump energy into the radiation belts, part of a set of changes in near-Earth space known as space weather.

Effects On satellites: Space weather can change the orbits of satellites, shorten their lifetimes, or interfere with onboard electronics. The more we learn about what causes space weather – and how to predict it – the more we can protect the satellites we depend on.

Safety and preparedness:

The solar wind dominates the space environment. As we send spacecraft and astronauts further and further from home, we must understand this space environment just as early seafarers needed to understand the ocean.



12.Solar Orbiter

The European Space Agency has released the closest pictures ever taken of the Sun captured by the **Solar Orbiter**.

What are Solar Flares?

- It is **a large explosion of magnetic energy in the Sun's atmosphere** which causes an intense burst of increased brightness.
- Flares occur in active regions around **sunspots**.
- **During solar flares**, the Sun releases bursts of **energetic particles that enhance the solar wind** that constantly emanates from the star into the surrounding space.
- When these particles interact with Earth's magnetosphere, they can cause **magnetic storms** that can disrupt telecommunication networks and power grids on the ground.

What is Corona?

The solar corona is **the outermost layer of the Sun's atmosphere** that extends millions of kilometres into outer space.

Its **temperature is more than a million degrees Celsius**, which is orders of magnitude **hotter than the surface of the Sun**, a 'cool' 5500 °C.

- After many decades of studies, **the physical mechanisms that heat the corona are still not fully understood**, but identifying them is considered the 'holy grail' of solar physics.

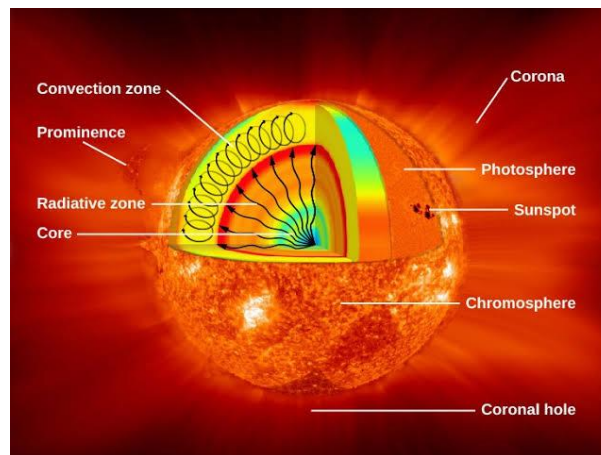
About Solar Orbiter Mission:

Solar Orbiter is a space mission of **international collaboration between ESA (European Space Agency) and NASA.**

The spacecraft was launched from **Cape Canaveral on a United Launch Alliance Atlas V rocket** in February 2020.

It was selected as **the first medium-class mission of ESA's Cosmic Vision 2015-2025 Programme.**

- This is **the first mission that will provide images of the sun's north and south poles** using a suite of six instruments on board that will capture the spacecraft's view.
- It is a **seven-year mission** and will come within 26 million miles of the sun.
- It will be able to brave the heat of the sun because it has a custom **titanium heat shield coated in calcium phosphate** so that it can endure temperatures up to 970 degrees Fahrenheit.

**13.OSIRIS-REx and asteroid Bennu**

Recently NASA's OSIRIS-REx spacecraft briefly touched **asteroid Bennu**, from where it is meant to collect samples of dust and pebbles and deliver them back to Earth in 2023.

What is the OSIRIS-REx mission?

OSIRIS-Rex stands for Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer.

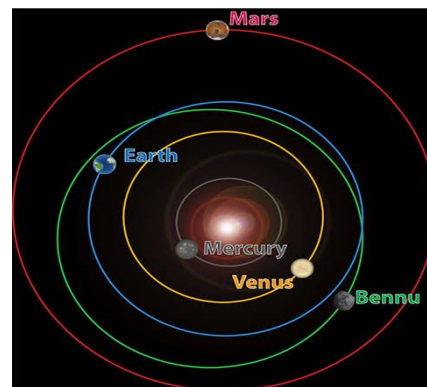
- This is **NASA's first mission meant to return a sample from the ancient asteroid.**
- Launched in 2016, it reached its target in 2018.

Asteroid Bennu:

The asteroid was discovered by a team from the NASA-funded **Lincoln Near-Earth Asteroid Research team in 1999.**

Scientists believe that it was **formed in the first 10 million years of the solar system's formation**, implying that it is **roughly 4.5 billion years old.**

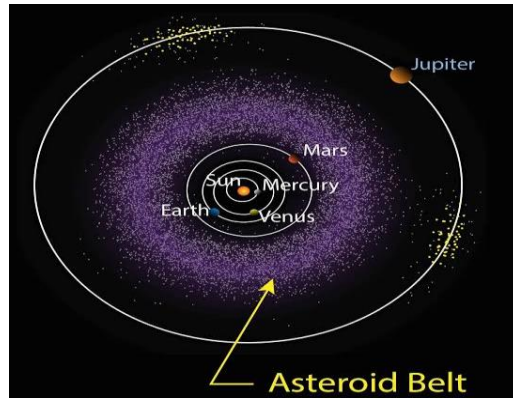
- Because of Bennu's age, **it is likely to contain material that contains molecules that were present when life first formed on Earth**, where life forms are based on carbon atom chains.
- Because of its **high carbon content**, the asteroid **reflects about four per cent of the light that hits it**, which is very low when compared with a planet like Venus, which reflects about 65 per cent of the light that hits it. **Earth reflects about 30 per cent.**
- It classified as a **Near Earth Object (NEO)**, might strike the Earth in the next century, between the years 2175 and 2199.

**Site for sample collection:**

NASA has selected a site located in a crater high in Bennu's northern hemisphere designated "Nightingale".

What is an asteroid?

Asteroids are rocky objects that orbit the Sun, much smaller than planets. They are also called **minor planets**. As per NASA, 994,383 is the count for known asteroids, the remnants from the formation of the solar system over 4.6 billion years ago.

**Why most asteroids are found in only one region?**

- Most such objects can be found in **the asteroid belt between Mars and Jupiter**, which is estimated to contain somewhere between 1.1-1.9 million asteroids.
- The explanation for the concentration of asteroids in this belt comes from **the formation of Jupiter**, whose gravity brought an end to the formation of any planetary bodies in this region, as a result of which the smaller bodies kept colliding with each other, fragmenting into asteroids.

Other types of asteroids:

1. **Trojans**, which are **asteroids that share an orbit with a larger planet**.
2. **Near-Earth Asteroids (NEA)**, which have orbits that pass close by the Earth. Those that cross the Earth's orbit are called **Earth-crossers**.

Why are scientists studying asteroids?

- To look for information about the formation and history of planets and the sun since asteroids were formed at the same time as other objects in the solar system.
- To look for asteroids that might be potentially hazardous.

What are Near-Earth Objects (NEOs)?

NASA defines NEOs as comets and asteroids nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighbourhood.

- These objects are **composed mostly of water ice with embedded dust particles**.

What are Potentially hazardous asteroids (PHAs)?

In **the asteroid belt between Mars and Jupiter** Over 1,400 asteroids are classified as **potentially hazardous asteroids (PHAs)**.

- According to NASA, "Potentially Hazardous Asteroids (PHAs) are currently **defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth**".
- Specifically, all **asteroids with a minimum orbit intersection distance (MOID) of 0.05 au or less are considered PHAs**.

14. Stardust 1.0

Stardust 1.0 was launched recently from Loring Commerce Centre in Maine, US.

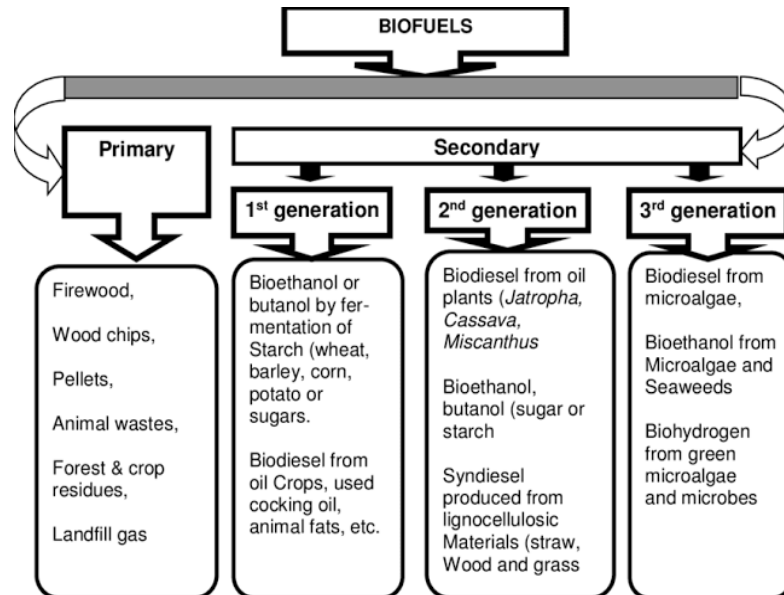
- It has become **the first commercial space launch powered by biofuel**, which is non-toxic for the environment as opposed to traditionally used rocket fuels.
- Stardust 1.0 is a launch vehicle suited for student and budget payloads.

What are Biofuels?

Any hydrocarbon fuel that is produced from an organic matter (living or once living material) in a short period of time (days, weeks, or even months) is considered a biofuel.

Biofuels may be solid, liquid or gaseous in nature.

- Solid: Wood, dried plant material, and manure.
- Liquid: Bioethanol and Biodiesel.
- Gaseous: Biogas.



15. Perseverance rover

NASA successfully flew its tiny helicopter **Ingenuity** on Mars, **the first powered flight on another planet**.

- Ingenuity's goal is to demonstrate its technology works, and it won't **contribute to Perseverance's science goals**.

About Perseverance:

- Launched on July of 2020.
- A key objective for Perseverance's mission on Mars is astrobiology, including the search for signs of ancient microbial life.
- The rover will characterize the planet's geology and past climate, pave the way for human exploration of the Red Planet, and be the first mission to collect and cache Martian rock and regolith (broken rock and dust).
- Perseverance is fueled by electrical power by using heat of plutonium's radioactive decay.
- Perseverance will carry a unique instrument, **MOXIE or Mars Oxygen ISRU Experiment**: which for the first time will manufacture molecular oxygen on Mars using carbon dioxide from the carbon-dioxide-rich atmosphere (ISRU means In Situ Resource Utilization: or the use of local resources to meet human needs or requirements of the spacecraft).

Previous Mars Missions by NASA:

- NASA has been sending rovers on Mars since 1997 when the Mars Pathfinder Mission was initiated.
- Second time, the space organization sent twin rovers, Spirit and Opportunity to Mars in 2003.
- The third attempt was by sending Curiosity in 2012.

16. NASA's sonification project

The sonification project is led by **the Chandra X-ray Center in collaboration with NASA's Universe of Learning Program (UoL)**.

The objective of the project is to transform data from astronomical images into audio.

- This project allows audiences — including visually-impaired communities — to experience space through data.

What is data sonification?

It refers to the use of sound values to represent real data. Simply put, it is the auditory version of data visualisation.

How did NASA translate astronomical images into sound?

- NASA's distant telescopes in space collect inherently digital data, in the form of ones and zeroes, before converting them into images.
- The images are essentially visual representations of light and radiation of different wavelengths in space, that can't be seen by the human eye.
- The Chandra project has created a celestial concert of sorts by translating the same data into sound. **Pitch and volume** are used to denote the brightness and position of a celestial object or phenomenon.

17.SpaceX

- SpaceX recently broke a world space record by launching 143 satellites in quick succession, beating **India's record of deploying 104 satellites in February 2017**.
- The launch vehicle for the SpaceX record-breaking flight was the Falcon 9 and the mission was designated as **Transporter-1**.
- The launch marks **the first dedicated mission for SpaceX's SmallSat Rideshare Program**, which enables small-satellite customers to book a ride to orbit with SpaceX directly.

18.SpaceX's Crew Dragon capsule

NASA has certified **SpaceX's Crew Dragon capsule and the Falcon 9 rocket**, making it **the first spacecraft certification provided by the space agency**.

This means **SpaceX can now operate regular flights to the space station**.

What is the Crew-1 mission?

The mission is part of NASA's Commercial Crew Program, whose objective is to make access to space easier in terms of its cost, so that cargo and crew can be easily transported to and from the ISS, enabling greater scientific research.

- Significantly, Crew-1 will be **the first operational flight of the SpaceX Crew Dragon spacecraft on a Falcon 9 rocket to the ISS** and is **the first of the three scheduled flights scheduled over the course of 2020-2021**.

About the SpaceX's Crew Dragon capsule:

It will carry up to four astronauts on NASA missions, maintaining a space station crew of seven to maximize time dedicated to scientific research on the orbiting laboratory.

What will members of Crew-1 do at the ISS?

- The Crew-1 team will conduct microgravity studies.
- Some of the research that the crew is carrying with themselves includes materials to investigate food physiology, which will study the effects of dietary improvements on immune function and the gut microbiome and how those improvements can help crews adapt to spaceflight.
- Once in orbit, astronauts will collect samples to provide data to scientists back on Earth so that they can continue to study how dietary changes affect his body.
- Another experiment aboard is a student-designed experiment titled, **"Genes in Space-7"** that aims to understand how spaceflight affects brain function.

19.Sentinel-6 satellite

The **Copernicus Sentinel-6 Michael Freilich satellite** is designed to monitor oceans.

- It was recently launched aboard a **SpaceX Falcon 9 rocket**.
- This is a **part of the next mission dedicated to measuring changes in the global sea level**.

What is the mission?

- The mission is called the **Jason Continuity of Service (Jason-CS) mission**.
- It is designed to **measure the height of the ocean**, which is a key component in understanding how the Earth's climate is changing.
- It has been **developed jointly by** the European Space Agency (ESA), NASA, European Organisation for the Exploitation of Meteorological Satellites (Eumetsat), the USA's National Oceanic and Atmospheric Administration (NOAA) and the EU, with contributions from France's National Centre for Space Studies (CNES).

What will the satellite do?

- Provide measurements of global sea-level rise.
- Send pulses to the Earth's surface and measure how long they take to return to it, which will help scientists measure the sea surface height.
- Measure water vapour along this path and find its position using GPS and ground-based lasers.

Significance of the Mission:

This data will allow improvements in both short-term forecasting for weather predictions in the two-to-four-week range (hurricane intensity predictions), and long-term forecasting, for instance for seasonal conditions like **El Niño and La Niña**.

Why is it important to measure the height of the ocean?

1. With this, it is possible to observe the height of the oceans on a global scale and **monitor critical changes in ocean currents and heat storage** only from space.
2. It helps scientists **foresee the effects of the changing oceans on the climate**.

Other satellites that have been launched since 1992 to track changes in the oceans on a global scale include:

- The TOPEX/Poseidon, Jason-1 and OSTN/Jason-2, among others.

20.Pan-STARRS1 telescope

Recently the NASA-funded **Pan-STARRS1 telescope** detected an unknown object which followed a curved path in the sky, indicating its proximity to the Earth.

Initially, **the object was thought to be an asteroid orbiting the Earth** and was hence given a name by the Minor Planet Center.

- However, scientists have now concluded that the Near-Earth Object called **2020 SO** is **the rocket booster that helped lift the space agency's Surveyor spacecraft** toward the Moon in 1966.

What was Surveyor-2?

The **Surveyor-2 spacecraft** was supposed to make a soft landing on the Moon's surface in September 1966, during which time one of the three thrusters failed to ignite as a result of which the spacecraft started spinning and crashed on the surface.

- **The aim of the mission** was to reconnoiter the lunar surface ahead of the Apollo missions that led to the first lunar landing in 1969.

About Pan-STARRS1 telescope:

The **Panoramic Survey Telescope and Rapid Response System, Pan-STARRS** for short, is a system for wide-field astronomical imaging, developed and operated by the Institute of Astronomy at the University of Hawaii.

- Pan-STARRS1 (PS1) is the first part of Pan-STARRS to be completed.

21. New Shepard

- It is a rocket system meant to take tourists to space successfully.
- It has completed its seventh test launch recently.
- The system is built by Amazon founder Jeff Bezos's space company called Blue Origin.
- It offers flights to space over 100 km above the Earth and accommodation for payloads.
- Essentially, it is a rocket system that has been designed to take astronauts and research payloads past **the Karman line** – the internationally recognised boundary of space.



22. Chang'e-5 probe

- Chang'e-5 mission is the first lunar sample-return mission since the 1970s.
- China is **the third country to have retrieved lunar samples after the United States and the Soviet Union.**

About the Chang'e-5 probe:

- The probe is named after **the mythical Chinese moon goddess.**
- **The rocket is comprised of four parts:** an orbiter, a returner, an ascender and a lander.
- The objective of the mission is **to bring back lunar rocks, the first attempt by any nation to retrieve samples from the moon in four decades.**
- This will **help scientists learn about the moon's origins, formation and volcanic activity on its surface.**

Identified location for the collection of samples:

The Chinese probe collected surface material from a previously unexplored area known as **Oceanus Procellarum — or "Ocean of Storms"** — which consist of a vast lava plain.

23. HL-2M Tokamak

China successfully powered up its "artificial sun" nuclear fusion reactor (HL-2M Tokamak reactor) for the first time marking a great advance in the country's nuclear power research capabilities.

Key Points:

- The HL-2M Tokamak reactor is China's largest and most advanced nuclear fusion experimental research device.
- The mission is named Experimental Advanced Superconducting Tokamak (EAST).
- The reactor is often called an "artificial sun" on account of the enormous heat and power it produces.
- It uses a powerful magnetic field to fuse hot plasma and can reach temperatures of over 150 million degrees Celsius- approximately ten times hotter than the core of the sun.



24. BeiDou

China has completed its **BeiDou Navigation Satellite System constellation.**

What is the BeiDou navigation system?

It is **Chinese Satellite Navigation System**.

The system uses a **network of satellites and can provide positional accuracies of under ten metres** (GPS provides positioning accuracies of under 2.2 metres).

- China **initiated BeiDou in 1994** with aims to integrate its application in different sectors, including fishery, agriculture, special care, mass-market applications, forestry and public security.
- **BeiDou offers services including** accurate positioning, navigation and timing as well as short message communication.

Which other countries are working on building their navigation systems?

1. The GPS is owned by the US government and operated by the US Air Force.
2. Russia has its navigation system called GLONASS.
3. The European Union (EU) has Galileo.
4. India's navigation system is called Navigation with Indian Constellation (NavIC).

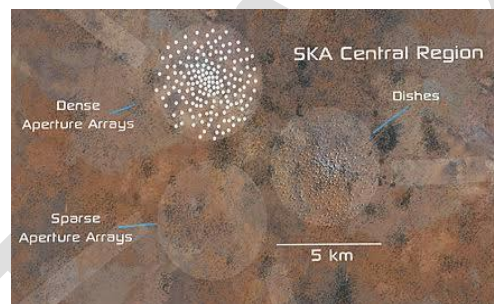
25. Square Kilometre Array

The Square Kilometre Array Observatory (SKAO)

Council held its maiden meeting and approved the establishment of **the world's largest radio telescope**.

About SKAO:

- SKAO is a new intergovernmental organisation dedicated to radio astronomy and is headquartered in the UK.
- At the moment, organisations from ten countries are a part of the SKAO.
- These include Australia, Canada, China, India, Italy, New Zealand, South Africa, Sweden, the Netherlands and the UK.



What are radio telescopes?

- Unlike optical telescopes, radio telescopes can detect invisible gas and, therefore, they can reveal areas of space that may be obscured by cosmic dust.

About SKA Telescope:

- The telescope is proposed to be the largest radio telescope in the world.
- It will be located in Africa and Australia whose operation, maintenance and construction will be overseen by SKAO.

26. Tianwen-1

- China's first Mars probe is called Tianwen-1 (formerly Huoxing 1).
- The spacecraft consists of an orbiter, a lander and a rover.
- Launched last year on a Long March 5 rocket from Xichang, China.
- **Landing site:** Somewhere in Utopia Planitia, a vast plain in Mars' northern latitudes and the same place NASA's Viking 2 mission landed in the 1970s.
- If the mission is successful, China will become the third country to achieve a Mars landing after the USSR and the United States.

There are five core science objectives:

1. Create a geological map of Mars.
2. Explore the characteristics of the Martian soil and potentially locate water-ice deposits.
3. Analyze the surface material composition.
4. Investigate the Martian atmosphere and climate at the surface.
5. Understand the electromagnetic and gravitational fields of the planet.

27. Hayabusa2 project

Japan's Hayabusa2 spacecraft left the asteroid Ryugu and reached Earth containing the precious samples.

- The soil samples and data from the asteroid could provide clues to the origins of the solar system.

Hayabusa2 project:

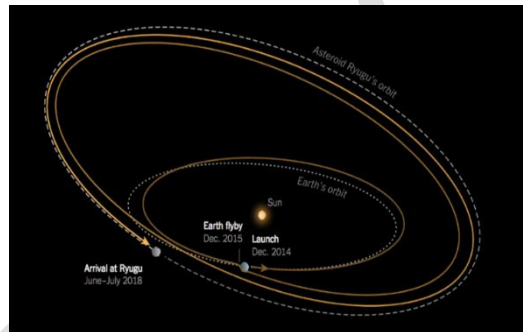
It is an **asteroid sample-return mission operated by the Japanese space agency, JAXA.**

It was **launched on 3 December 2014** and rendezvoused with Ryugu on 27 June 2018.

- It carried **multiple science payloads** for remote sensing, sampling, and four small rovers that will investigate the asteroid surface to inform the environmental and geological context of the samples collected.

The scientific objectives of Hayabusa2 mission are twofold:

1. To characterize the asteroid from remote sensing observations (with multispectral cameras, near-infrared spectrometer, thermal infrared imager, laser altimeter) on a macroscopic scale
2. To analyse the samples returned from the asteroid on a microscopic scale.



What is the significance of the mission?

Ryugu is a **C-type asteroid** – a relic from the early days of the Solar System. Scientists think that C-type asteroids contain both organic matter, and trapped water, and might have been responsible for bringing both to Earth, thereby providing the planet with the materials necessary for life to originate.

28. HOPE Mission

The Hope mission is a **Mars orbiter spacecraft**, which will study the thin atmosphere of Mars.

The mission is officially named **the Emirates Mars Mission (EMM)** and the orbiter has been named **Hope** or '**Al Amal**'.

- It is **the first interplanetary mission for the Arab World.**

The Hope orbiter:

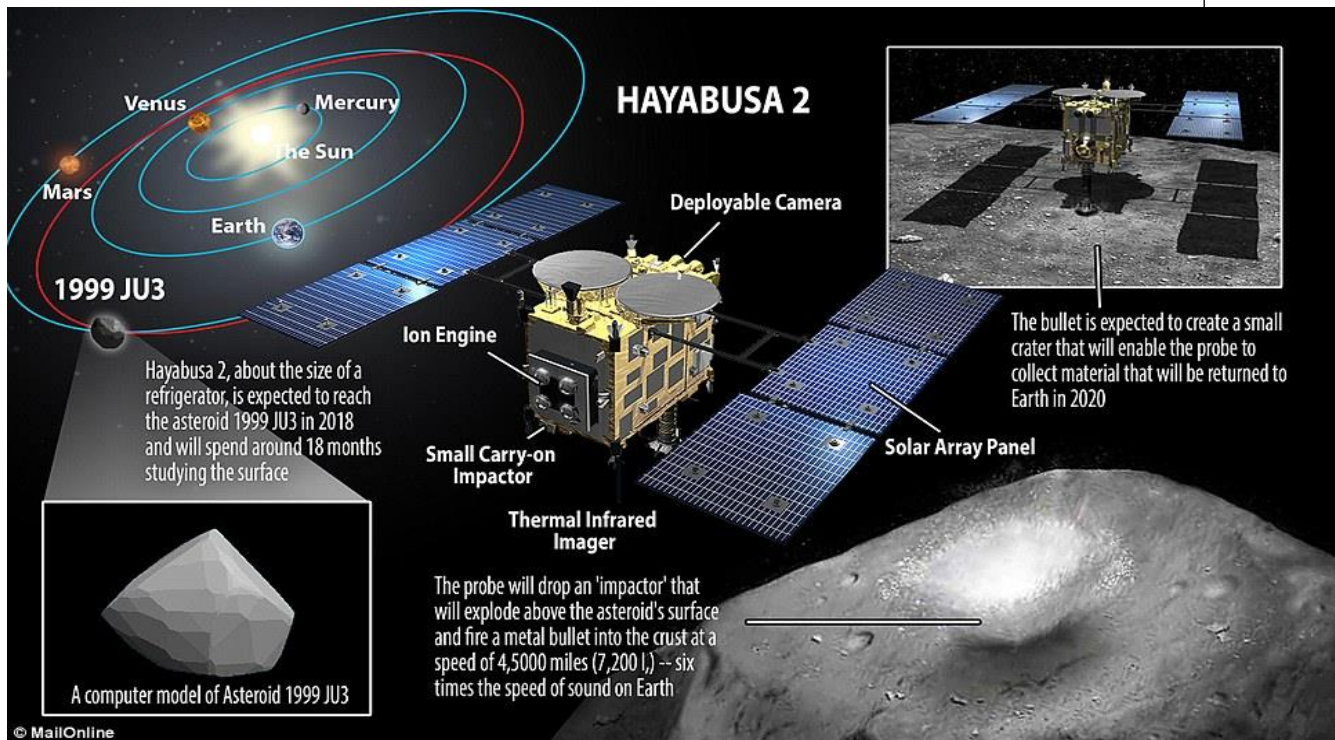
The Hope probe has a mission life of one Martian year, which is almost two Earth years.

The three main objectives of the Hope probe are:

1. to understand the climate dynamics and global weather map of Mars by studying the lower atmosphere of Mars.
2. to explain how the weather of Mars affects the escape of hydrogen and oxygen, by correlating conditions in the lower and upper atmosphere.
3. to understand the presence and variability of hydrogen and oxygen in the upper atmosphere, and why Mars is losing these gases to space.

Significance of the mission:

1. It is a known fact that the Red Planet was once habitable, from signatures of flowing water and organic material that point to a past that could have supported living things.
2. An understanding of Mars' past could help scientists understand the future of Earth.



29. Ariel Space Mission

The **European Space Agency (ESA)** has formally adopted **Ariel**.

What is Ariel?

Ariel (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) will be launched in 2029.

- It will perform a **large-scale survey of over a thousand exoplanets over a period of four years.**
- The explorer that will **study the nature, formation and evolution of exoplanets.**

Significance:

Ariel is the **first mission of its kind dedicated to measuring the chemical composition and thermal structures of hundreds of exoplanets.**

It will also help to answer one of the key questions of ESA's **Cosmic Vision Plan**, which is, **"What are the conditions for planet formation and the emergence of life?"**.

How exoplanets are found?

As per NASA, only a handful of exoplanets have been found using telescopes and the rest have been detected using indirect methods. These include:

- **Tracking the dimming of a star that happens when a planet passes in front of it. NASA's Kepler Space telescope** uses this method to spot thousands of planets.
- **Gravitational lensing and the "wobbling method"**, which is based on the idea that an orbiting planet will cause its parent star to orbit slightly off-centre.

Why study exoplanets?

The search for exoplanets is driven by the possibility that **life may exist beyond Earth and even if there is no evidence for this**, scientists believe that their hunt for an answer will reveal details about where humans came from and where we're headed.

Key Points:

- As of now the existence of **more than 4,000 exoplanets is considered confirmed**, while there are thousands of other candidate exoplanets that need further observations to say for certain if they are exoplanets.
- **Proxima Centauri b** is the closest exoplanet to Earth and is four light-years away and inhabits the **"habitable zone" of its star**, which means that it could possibly have liquid water on its surface.

30.Christmas Star

After nearly 400 years, Saturn and Jupiter the two largest planets in our solar system was closest in the night sky by an astronomical event called the **"great conjunction" and popularly referred to as the "Christmas Star"**.

So, what is the "Great Conjunction"?

- A conjunction is not unique to Saturn and Jupiter however, it is the name given to any event where planets or asteroids appear to be very close together in the sky when viewed from the Earth.
- Astronomers use the word "great" for the conjunction of Jupiter and Saturn because of the planets' sizes.

The "Great Conjunction" happens once in about 20 years because of the time each of the planets take to orbit around the Sun.

31.Fast radio bursts

Intense pulses of radio waves known as **fast radio bursts (FRB)** have been found in **the Milky Way for the first time**.

- So far, such waves have been frequently detected in other galaxies.

Significance of this discovery:

The FRB was **not only the closest such signal ever recorded near the Earth**. It was also **3,000 times brighter than any other magnetar radio signal detected till now**.

How are FRBs generated?

The new study has confirmed that FRBs are generated by a rare type of neutron star known as a **'magnetar'**.

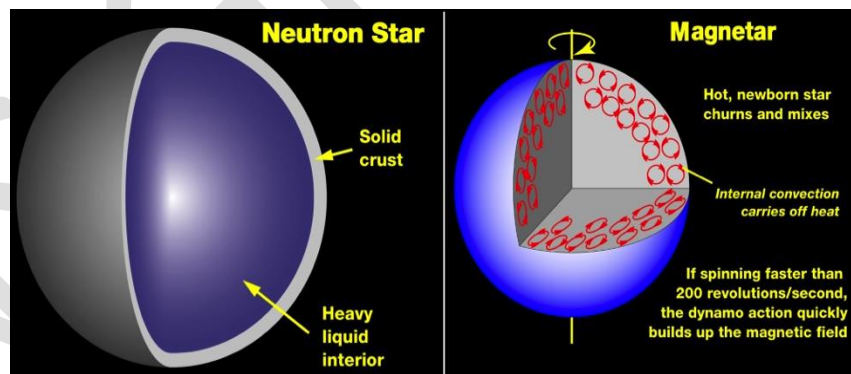
What are Magnetars?

A magnetar is a **type of neutron star**.

- Magnetars are the **most powerful magnets in the cosmos**. Their magnetic fields are 5,000 trillion times more powerful than that of the Earth.

The source of latest FRBs:

- They came from a magnetar known as **SGR 1935+2154**, located about 30,000 light-years from the earth.
- It lies in **the centre of the Milky Way, in the constellation Vulpecula**.



32.16 Psyche

- It is an asteroid which **orbits between Mars and Jupiter**.
- Located around 370 million kilometres away from Earth in the **asteroid belt**.
- First discovered in **1853** and was named after the ancient **Greek goddess of the soul, Psyche**.

Why in News?

A recent study has found that this asteroid could be made entirely of metal and is worth an estimated \$10,000 quadrillion — more than the entire economy of Earth.

- Images from **NASA's Hubble Space Telescope** has shown that the surface may mostly **comprise iron and nickel**, similar to the Earth's core.



33. Water on the Moon

Water molecules, discovered in **Clavius Crater in the Moon's southern hemisphere**.

- And **it is the first time water has been detected on the sunlit side**, showing it is not restricted to the shadowy regions.
- This was confirmed by NASA's **Stratospheric Observatory for Infrared Astronomy (SOFIA)**.

Significance of the discovery:

Apart from being a **marker of potential life**, water is a precious resource in deep space.

- For astronauts landing on the Moon, water is necessary not only to sustain life but also for purposes such as generating rocket fuel.
- If space explorers can use the Moon's resources, it means they need to carry less water from Earth.

How could the water have formed?

- **Space rocks** carrying small amounts of water could have bombarded the Moon.
- Alternatively, **the Sun's solar wind could have carried hydrogen**, which then **reacted with minerals in the lunar soil** to create hydroxyl, which later transformed into water.

About SOFIA:

SOFIA is a **modified Boeing 747SP jetliner** that flies at altitudes up to 45,000 feet.

It is a **joint project of NASA and the German Aerospace Center**.

- It has an infrared camera that picks up the wavelength unique to water molecules.
- SOFIA's mission is **to look at dark and distant objects**. The Moon, on the other hand, is so close and bright that it fills the SOFIA guide camera's entire field of view.

Chandrayaan-1 and water discovery:

ISRO's Chandrayaan-1 mission has already provided evidence for the existence of water.

- In 2009, the **Moon Mineralogy Mapper (M3) instrument aboard Chandrayaan-1** found water molecules in the polar regions.

We know **rusting exists on Earth and Mars**, but now scientists have found that there is on the moon as well. The images sent by ISRO's **Chandrayaan 1 orbiter**, show that **the moon may be rusting along the poles**.

What next?

SOFIA will look for water in additional sunlit locations to learn more about how the water is produced, stored, and moved across the Moon.

Meanwhile, **NASA's Volatiles Investigating Polar Exploration Rover (VIPER)** will carry out a mission to create the first water resource maps of the Moon.

34. Lunar Reconnaissance Orbiter (LRO) spacecraft

NASA's **Lunar Reconnaissance Orbiter (LRO) spacecraft** has found evidence that **the Moon's subsurface might have greater quantities of metals** such as iron and titanium than thought before.

- The metallic distribution was observed by **the Miniature Radio Frequency (Mini-RF) instrument** aboard the LRO.

Implications of latest findings:

It is known that **Earth's crust has lesser amounts of iron oxide than the Moon**— a finding that scientists have been trying to explain.

- Now, the new discovery of even greater quantities of metal on the Moon makes their job even more difficult. It really raises the question of what this means for our previous formation hypotheses.

A possible reason could be that the Moon was created from a material much deeper beneath Earth's surface than was believed before, or that the newly found metal presence could be the result of molten lunar surface cooling down gradually.

About Lunar Reconnaissance Orbiter (LRO):

It is a NASA mission to the moon within **the Lunar Precursor and Robotic Program (LPRP)** in preparation for future manned missions to the moon and beyond (Mars).

LRO is the first mission of **NASA's 'New Vision for Space Exploration'**.

35. Black holes

2020 Nobel Prize in physics has been awarded to Roger Penrose, Reinhard Genzel and Andrea Ghez for furthering the **understanding of black holes**.

Basics:

What are black holes?

A black hole is formed when stars collapse and can be defined as **a space in the universe with an escape velocity so strong that even light cannot escape it**.

- Escape velocity is the speed at which an object must travel to override a planet or an object's gravitational force.


Main features of blackholes:

- Since light cannot get out, black holes are invisible and can only be tracked with the help of a space telescope or other special tools.

- Light cannot escape from blackholes because the gravity inside a black hole is very strong as a result of a lot of matter being squeezed into a small space.

2020 NOBEL PRIZE IN PHYSICS

Awarded to **Roger Penrose** for showing that the general theory of relativity leads to black hole formation, and to **Reinhard Genzel & Andrea Ghez** for discovering a supermassive black hole at the centre of our galaxy.



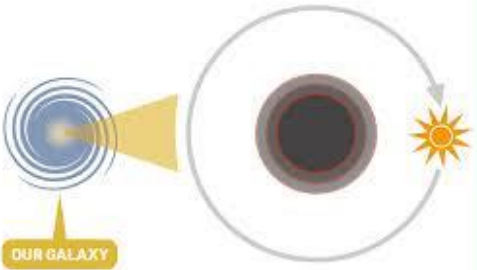
EVENT HORIZON
The point at which gravity is strong enough that even light can't escape.

THE SINGULARITY
Density and gravity become infinite and time stops.

Originally, black holes were considered to be theoretical. Einstein, famed for his general theory of relativity, expressed doubts about their existence. However, in 1965, **Roger Penrose** used new mathematical models to prove that black holes could form as a consequence of Einstein's general theory of relativity. He described them in detail and showed that at their centre is a singularity, at which the laws of physics cease to operate.

Reinhard Genzel and Andrea Ghez led research groups which mapped the orbits of some of the brightest stars close to the centre of our galaxy. To do this they had to develop new techniques to compensate for distortions to their observations caused by the Earth's atmosphere.

The results from both groups showed that the stars near our galaxy's centre move rapidly. They showed that this is due to the centre of our galaxy containing a concentrated mass equivalent to 4 million times the mass of our sun: a supermassive black hole.



OUR GALAXY

WHY DOES THIS RESEARCH MATTER?

The work of this year's winners has provided evidence for the existence of black holes. It also raises further unanswered questions about black hole structure and how they match theoretical predictions.

Nobel Prize in Physics Press release: <https://www.nobelprize.org/uploads/2020/10/press-physicsprize2020.pdf>

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What do the award winners' work tell us about black holes?

- Penrose:** Discovered "that black hole formation is a robust prediction of the general theory of relativity."
- Genzel and Ghez:** Discovered a "supermassive compact object at the centre of our galaxy." This is now known to be **the Sagittarius A* supermassive black hole**, which has a mass four million times that of the Sun and is confined to an area roughly the size of our Solar System.

Key points for Prelims:

- Sagittarius A*** is one of two black holes whose photographs have been captured by **the Event Horizon Telescope project**.
- Black holes do not emit or radiate anything, even light. So, there is no way their image can be captured. But the area just outside its boundary, called **the event horizon**, which has vast amounts of gas, clouds and plasma swirling violently, does emit all kinds of radiations, even visible light.
- Anything that crosses the event horizon is destined to fall to the very centre of the black hole and be squished into a single point with infinite density, called **the singularity**.

36. Merger of two black holes

Gravitational waves from a **collision between two black holes** were detected in **2019** at the gravitational wave observatory **LIGO (United States)** and the detector **Virgo (Italy)**.

- It was calculated to have come from roughly **17 billion light years away**, and from a time **when the universe was about half its age**.

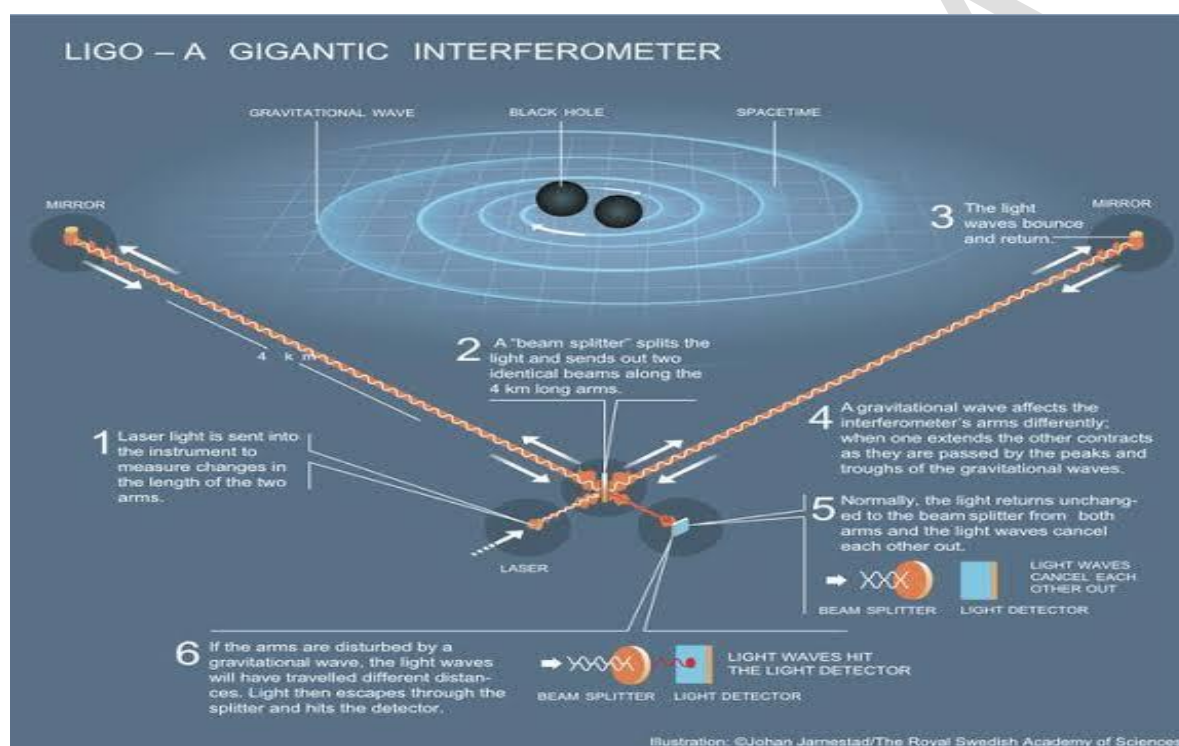
What's unique about this merger?

One of the two parent black holes was of an **unusual "intermediate mass"**, which challenges traditional scientific knowledge. It is **the first "intermediate mass" black hole ever observed**.

What are Gravitational Waves?

They are **invisible ripples that form when a star explodes in a supernova; when two big stars orbit each other; and when two black holes merge**.

- Travelling at the speed of light**, gravitational waves squeeze and stretch anything in their path.
- Proposed by **Albert Einstein in his General Theory of Relativity** over a century ago.
- It was only in 2015, however, that **the first gravitational wave was actually detected — by LIGO**.



What is LIGO?

It is a massive observatory for detecting cosmic gravitational waves and for carrying out experiments.

- The objective is to use gravitational-wave observations in astronomical studies.
- The project **operates three gravitational-wave (GW) detectors**. Two are at **Hanford**, Washington, north-western US, and one is at **Livingston** in Louisiana, south-eastern US.
- The proposed **LIGO India project** aims to move one advanced LIGO detector from Hanford to India.

37.Solar Cycle 25

Scientists from **NASA and the National Oceanic and Atmospheric Administration (NOAA)** have announced their predictions about the new solar cycle, called **Solar Cycle 25**, which they believe has begun.

Key findings:

- The solar minimum for Solar Cycle 25 occurred in December 2019.

- Scientists predict a solar maximum (middle of the solar cycle) will be reached by July 2025.
- This solar cycle will be as strong as the last solar cycle, which was a “below-average cycle” but not without risks.

What is a solar cycle?

The Sun is a huge ball of **electrically-charged hot gas**. This charged gas moves, generating a powerful **magnetic field**. This magnetic field goes through a cycle, called **the solar cycle**.

Every **11 years or so**, the **Sun's magnetic field completely flips**. This means that the Sun's north and south poles switch places. Then it takes about another 11 years for the Sun's north and south poles to flip back again.

So far, astronomers have documented **24 such cycles**, the last one ended in 2019.

How do scientists track solar activity?

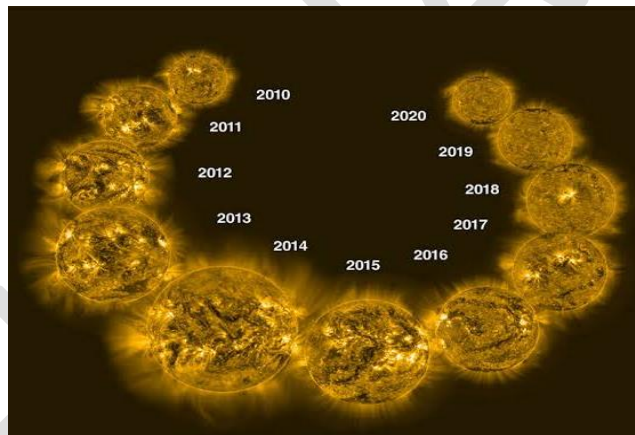
Scientists track a solar cycle by using **sunspots**.

The **beginning of a solar cycle** is typically characterised by only **a few sunspots** and is therefore referred to as **a solar minimum**.

What is solar minimum and maximum?

One way to track the solar cycle is by counting the number of sunspots.

- The beginning of a solar cycle is a solar minimum, or when the Sun has the least sunspots. Over time, solar activity—and the number of sunspots—increases.
- The middle of the solar cycle is the solar maximum, or when the Sun has the most sunspots. As the cycle ends, it fades back to the solar minimum and then a new cycle begins.



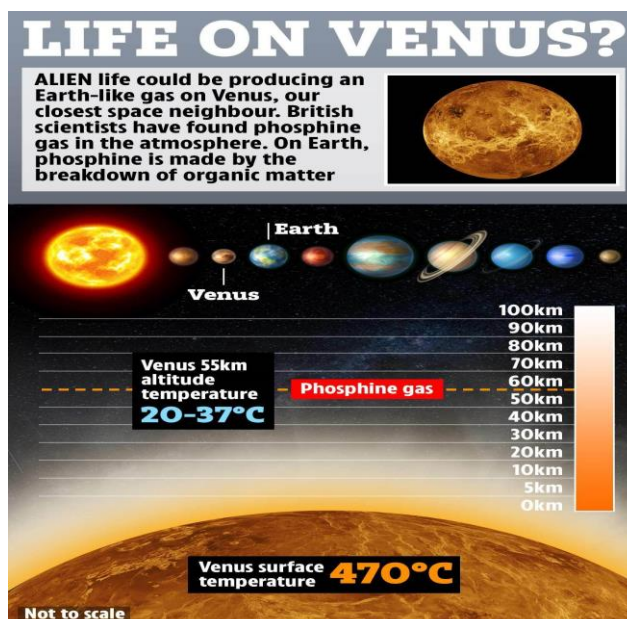
Impacts of Solar Cycle on Earth:

- Solar eruptions can cause lights in the sky, called aurora, or impact radio communications. Extreme eruptions can even affect electricity grids on Earth.
- Solar activity can affect satellite electronics and limit their lifetime.
- Radiation can be dangerous for astronauts who do work on the outside of the International Space Station.

38. Phosphine

Presence of this gas was observed on Venus. This indicates possible sign of life on Venus.

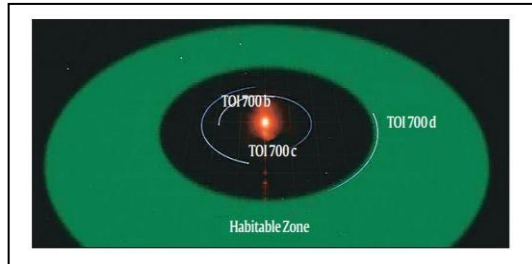
- It is a flammable gas that on Earth occurs from the breakdown of organic matter.
- On Earth, this gas is associated with living organisms.
- It can only be made by life—whether human or microbe.
- Used as a chemical weapon during World War I, phosphine is still manufactured as an agricultural



fumigant, is used in the semiconductor industry, and is a nasty byproduct of meth labs.

39. Habitable Zone

- The habitable zone (or “Goldilocks zone”) is the range of orbital distances from a star at which liquid water can exist on the surface of a planet.
- It is the area around a star where it is not too hot and not too cold for liquid water to exist on the surface of surrounding planets.
- This range of distances changes depending on the size and temperature of the star.
- Earth is in the habitable zone of the sun – one of the reasons our planet has liquid water like oceans and lakes.



Why in News?

NASA reported the discovery of an Earth-size planet, named TOI 700 d, orbiting its star in the “habitable zone”.



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Come what may!

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Defence Technology

1. Solid Fuel Ducted Ramjet (SFDR) Technology

Tested by Defence Research and Development Organisation (DRDO) recently.









- The successful demonstration of the technology has provided the DRDO with a technological advantage that will enable the agency to develop long-range air-to-air missiles.

Benefits:

- Ramjet powered missiles provide greater range and a higher average speed compared to missiles powered by solid propellants.
- ramjet missiles use atmospheric oxygen rather than including an oxidizer as part of the solid motor.
- Ramjet missiles can also carry a bigger warhead as they do not have to carry an oxidizer.

2. Arjun Main Battle Tank MK-1A

- The Arjun Main Battle Tank project was initiated by DRDO in 1972 with the Combat Vehicles Research and Development Establishment (CVRDE) as its lead laboratory.

| ARJUN MK-1A SPECIFICATIONS | | | | |
|--|--|--|---|--|
|  Max. speed on road 58 kmph |  Max. speed on cross country 40 kmph |  Combat weight 68 tonnes (fully loaded) | Gun 120 mm rifled | Rate of fire 6-8 rounds per minute |
|  Ammunition: 39 rounds (FSAPDS/HESH/TB/PCB) |  Anti-aircraft machine gun: 12.7 mm |  Fire control system: Day & night stabilised sight |  Night vision: Thermal imager and driver's night sight |  Crew: 4 (commander, gunner, loader and driver) |

A key feature of most of the upgrades carried out in Arjun Mk-1A is they are compatible, which means that when Arjun Mk-1 vehicles come for overhauling the new features of Mk-1A can be retrofitted depending on the army's need — CVRDE director V Balamurugan

- The Arjun tanks stand out for their 'Fin Stabilised Armour Piercing Discarding Sabot (FSAPDS)' ammunition and 120-mm calibre rifled gun.
- It also has a computer-controlled integrated fire control system with stabilised sighting that works in all lighting conditions.

3. Tejas

- Tejas is a single-seat, single-jet engine, multirole light fighter.
- It is the smallest and lightest multi-role supersonic fighter aircraft in the Indian Air Force.
- It has been designed and developed by Hindustan Aeronautics Limited (HAL).
- It is designed to carry a range of air-to-air, air-to-surface, precision-guided, and standoff weaponry.

4. Kalvari class of submarines

Indian Navy's **fifth Kalvari-class Diesel Electric attack submarine INS Vagir** was launched recently at Mazgaon Dock in Mumbai.

- The other vessels in the class are INS Kalvari, INS Khanderi, INS Karanj, INS Vela and INS Vagsheer.

About Kalvari Class of submarines:

This class of submarines have **Diesel Electric transmission systems** and these are primarily attack submarines or 'hunter-killer' type which means they are designed to target and sink adversary naval vessels.

- They can be used** in anti-warship and anti-submarine operations, intelligence gathering and surveillance and naval mine laying.
- These submarines are built under **Project 75** and their design is based on **the Scorpene class of the submarines**.
- Being constructed by the public sector shipbuilder **Mazagon Dock Ltd (MDL)** in Mumbai.

- Design is **based on Scorpene class of submarines** designed and developed by French defence major Naval Group formerly DCNS and Spanish state owned entity Navantia.

Origins of the names of ships mentioned above:

1. **Kalvari** – means Tiger Shark.
2. **Vagir** has been named after a Sand Fish, a predatory marine species.
3. **Khanderi** has been named after an Island Fort built by Chhatrapati Shivaji, which played a key role in his Navy.
4. **Karanj** has also been named after an Island located South of Mumbai.

5. INS Viraat

- Originally commissioned by the British Navy as HMS Hermes on November 18, 1959, the aircraft carrier had taken part in the Falkland Islands war in 1982.
- India bought the British carrier in 1986 and rechristened it as INS Viraat.
- INS Viraat is the Guinness record holder for being the longest-serving warship of the world.

6. INS Kavaratti

- It is an anti-submarine warfare (ASW) ship.
- It has up to 90% indigenous content.
- It is the last of four indigenously-built ASW under '**Project 28**' or **Kamorta-class corvettes of the Navy**.
- '**Project 28**' was approved in 2003. The other three warships under this project are INS Kamorta (commissioned in 2014), INS Kadmat (2016) and INS Kiltan (2017).

7. Quick Reaction Surface to Air Missile (QRSAM)

- QRSAM is a **canister-based system**, which means that it is stored and operated from specially designed compartments.
- It is a **short-range surface-to-air missile (SAM) system**, primarily **designed and developed by DRDO** to provide a protective shield to moving armoured columns of the Army from enemy aerial attacks.
- The entire weapon system has been **configured on a mobile and manoeuvrable platform** and is capable of providing air defence on the move.
- It has been designed for induction into the Army and has **a range of 25 to 30 km**.

8. BrahMos Missile

- It is a surface-to-surface supersonic cruise missile featuring indigenous Booster and Airframe Section.
- It flies almost three times the speed of sound at Mach 2.8.
- The new BrahMos missile can strike targets over 400-km away with pin-point accuracy.
- The missile was jointly developed by India and Russia and was first tested in 2001.

9. SMART Missile

India has successfully flight-tested its indigenously developed Supersonic Missile Assisted Release of Torpedo (SMART) from a test range off Odisha coast.

- SMART is a missile assisted release of lightweight anti-submarine torpedo system for anti-submarine warfare (ASW) operations far beyond torpedo range.

10. Rudram Anti-Radiation Missile

- The missile has been developed by the **Defence Research and Development Organisation (DRDO)**.
- It has **a strike range of around 100 to 150 km**.

- It is the **first indigenous air-to-ground missile** developed by the DRDO, after the supersonic BrahMos, which has been developed jointly with Russia.
- The missile has been designed for **suppression of enemy air defenses (SEAD)**.
- The missile can be launched from a varying range of altitudes for destroying enemy surveillance radars, tracking and communication systems.

11. Anti-tank guided missile (ATGM), Nag

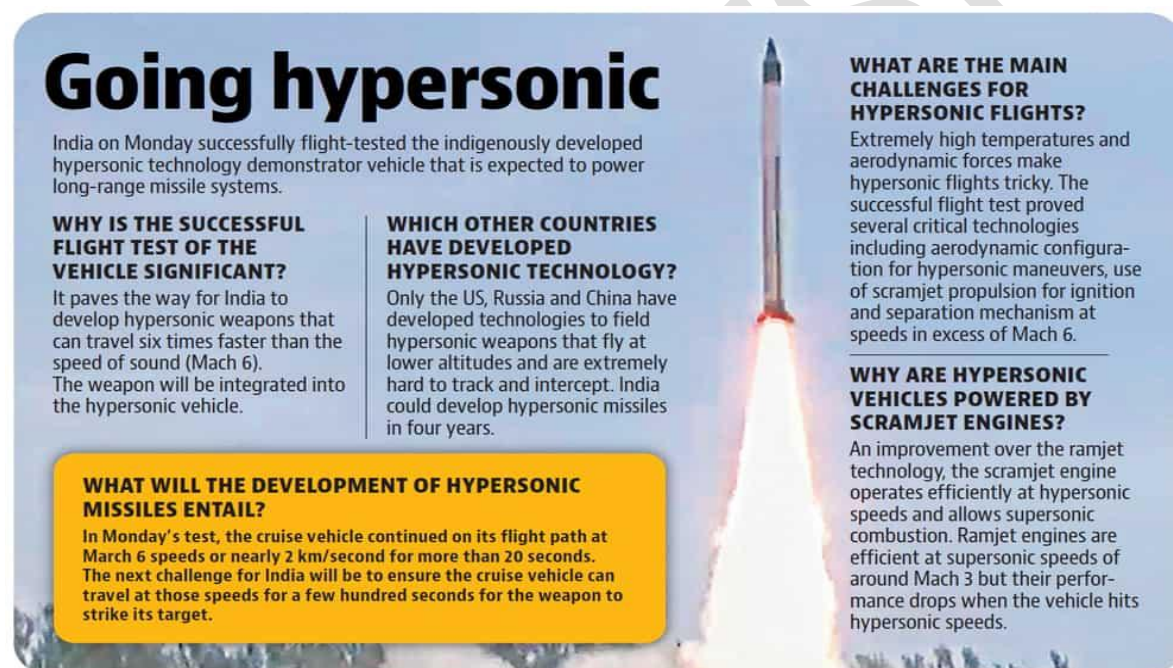
DRDO recently carried out the final user trial of the third generation anti-tank guided missile (ATGM), Nag, at the Pokhran firing range.

- Developed indigenously by the Defence Research and Development Organisation (DRDO), the Nag ATGM can be launched from both- land as well as air-based platforms.
- With a range of 4-7 km, the missile is fitted with home-developed infrared seeker and avionics, the capabilities possessed by only a few nations in the world.

12. Hypersonic Missile Technology

India has become **the fourth country after the United States, Russia and China to develop and successfully test hypersonic technology**.

India recently tested **the Hypersonic Test Demonstrator Vehicle (HSTDV)**. Developed by Defence Research and Development Organisation (DRDO).



Going hypersonic

India on Monday successfully flight-tested the indigenously developed hypersonic technology demonstrator vehicle that is expected to power long-range missile systems.

WHY IS THE SUCCESSFUL FLIGHT TEST OF THE VEHICLE SIGNIFICANT?
It paves the way for India to develop hypersonic weapons that can travel six times faster than the speed of sound (Mach 6). The weapon will be integrated into the hypersonic vehicle.

WHICH OTHER COUNTRIES HAVE DEVELOPED HYPERSONIC TECHNOLOGY?
Only the US, Russia and China have developed technologies to field hypersonic weapons that fly at lower altitudes and are extremely hard to track and intercept. India could develop hypersonic missiles in four years.

WHAT ARE THE MAIN CHALLENGES FOR HYPERSONIC FLIGHTS?
Extremely high temperatures and aerodynamic forces make hypersonic flights tricky. The successful flight test proved several critical technologies including aerodynamic configuration for hypersonic maneuvers, use of scramjet propulsion for ignition and separation mechanism at speeds in excess of Mach 6.

WHY ARE HYPERSONIC VEHICLES POWERED BY SCRAMJET ENGINES?
An improvement over the ramjet technology, the scramjet engine operates efficiently at hypersonic speeds and allows supersonic combustion. Ramjet engines are efficient at supersonic speeds of around Mach 3 but their performance drops when the vehicle hits hypersonic speeds.

WHAT WILL THE DEVELOPMENT OF HYPERSONIC MISSILES ENTAIL?
In Monday's test, the cruise vehicle continued on its flight path at Mach 6 speeds or nearly 2 km/second for more than 20 seconds. The next challenge for India will be to ensure the cruise vehicle can travel at those speeds for a few hundred seconds for the weapon to strike its target.

Significance and implications of this test flight:

This indigenous technology will pave the way towards **development of missiles travelling at six times the speed of sound (Mach 6)**.

What is Hypersonic Test Demonstrator Vehicle (HSTDV)?

The HSTDV is an **unmanned scramjet demonstration aircraft** for hypersonic speed flight.

How it works?

The HSTDV cruise vehicle is mounted on a solid rocket motor, which will take it to a required altitude, and once it attains certain mach numbers for speed, the cruise vehicle will be ejected out of the launch vehicle. Subsequently, the scramjet engine will be ignited automatically.

Where can it be used?

- It has utility for long-range cruise missiles of the future.
- It can be used for launching satellites at low cost too.

What are cruise missiles? How are they different from ballistic missiles?

A **cruise missile** either locates its target or has a preset target. It navigates using a guidance system — such as inertial or beyond visual range satellite GPS guidance — and comprises a payload and aircraft propulsion system.

- **Cruise missiles** can be launched from land, sea or air for land attacks and anti-shipping purposes, and can travel at subsonic, supersonic and hypersonic speeds.
- Since **they stay relatively close to the surface of the earth**, they cannot be detected easily by anti-missile systems, and are designed to carry large payloads with high precision.

Ballistic missiles, meanwhile, are **launched directly into the upper layers of the earth's atmosphere**.

- They **travel outside the atmosphere**, where the warhead detaches from the missile and falls towards a predetermined target.
- They are **rocket-propelled self-guided weapons systems** which can carry conventional or nuclear munitions. They can be launched from aircraft, ships and submarines, and land.

What are ICBMs?

Intercontinental ballistic missiles or ICBMs are **guided missiles which can deliver nuclear and other payloads**.

ICBMs have a **minimum range of 5,500 km**, with maximum ranges varying from 7,000 to 16,000 km.

- Only a handful of countries, including **Russia, United States, China, France, India and North Korea**, have ICBM capabilities.

13. Anti-Satellite Missile (A-SAT)

Defence Research and Development Organisation (DRDO) successfully conducted an **Anti-Satellite (A-SAT) missile test 'Mission Shakti'** from Dr APJ Abdul Kalam Island in Odisha.

- A DRDO developed A-SAT Missile successfully engaged an Indian orbiting target satellite in **Low Earth Orbit (LEO)** in a 'Hit to Kill' mode.
- The interceptor missile was a three-stage missile with two solid rocket boosters.

Significance:

India is only **the 4th country to acquire such a specialised and modern capability**, and Entire effort is indigenous.

- Till now, only the US, Russia and China had the capability to hit a live target in space.

Does the test create space debris?

The test was done in the lower atmosphere to ensure that there is no



space debris. Whatever debris that is generated will decay and fall back onto the earth within weeks.

What is the international law on weapons in outer space?

The principal international Treaty on space is the **1967 Outer Space Treaty**. The Outer Space Treaty prohibits only weapons of mass destruction in outer space, not ordinary weapons.

- India is a signatory to this treaty, and ratified it in 1982.

14.ABHYAS

DRDO recently conducted the successful flight test of **ABHYAS--High-speed Expendable Aerial Target (HEAT)**.

- Abhyas is designed and developed by Aeronautical Development Establishment (ADE), DRDO.
- The vehicle is programmed for fully **autonomous flight**.



Usage: Abhyas's radar cross-section (RCS) and its visual and infrared signatures can be used to simulate a variety of aircraft for air-defense weapon practices. It can also function as a jammer platform and decoy.

15.Pinaka rocket system

- Pinaka is a free flight artillery rocket system having a range of 37.5 km.
- Pinaka rockets are launched from a multi-barrel rocket launcher which has a capability to launch 12 rockets in 44 seconds.
- The weapon system is designed and developed by Pune-based DRDO lab, Armament Research and Development Establishment (ARDE).



“A little struggle is a must. Storms are needed, thunder, lightning is needed. They shake up the soul to evolve in a positive way”

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Technologies / New Discoveries

1. Spectrum Auctions

- Devices such as cellphones and wireline telephones require signals to connect from one end to another. These signals are carried on airwaves, which must be sent at designated frequencies to avoid any kind of interference.
- The Union government owns all the publicly available assets within the geographical boundaries of the country, which also include airwaves.**
- To sell these assets to companies willing to set up the required infrastructure to transport these waves from one end to another, the central government through the Department of Telecommunications (DoT) auctions these airwaves from time to time.

These airwaves are called spectrum, which is subdivided into bands which have varying frequencies. All these airwaves are sold for a certain period of time, after which their validity lapses, which is generally set at 20 years.

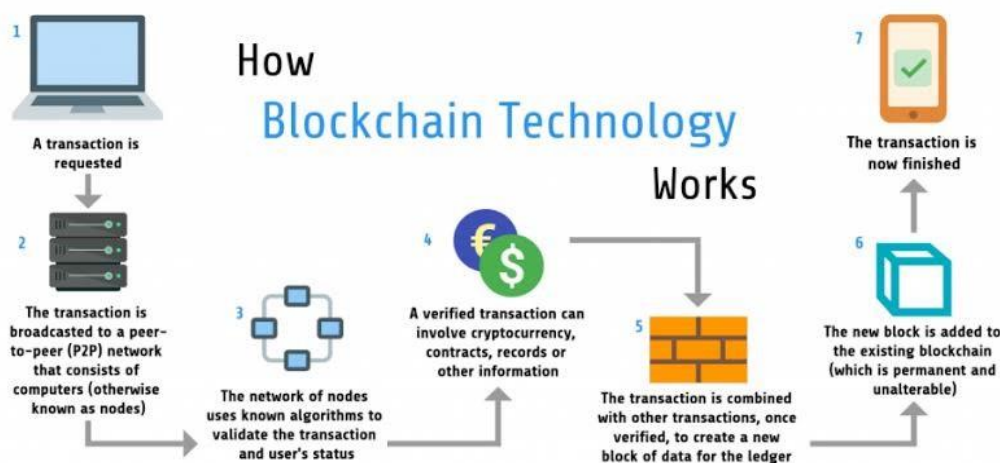


2. Cryptocurrency

The corporate affairs ministry has announced **companies will have to disclose any holding or dealings in cryptocurrencies or virtual currencies in their financial statements filed with the Registrar of Companies.**

What are Cryptocurrencies?

- A cryptocurrency is a **digital or virtual currency** that is secured by cryptography, which makes it nearly impossible to counterfeit or double-spend.
- Many cryptocurrencies are **decentralized networks based on blockchain technology**—a distributed ledger enforced by a disparate network of computers.
- A defining feature of cryptocurrencies is that they are **generally not issued by any central authority**, rendering them theoretically immune to government interference or manipulation.
- Bitcoin, first released as open-source software in 2009, is the first decentralized cryptocurrency.



3. FASTags

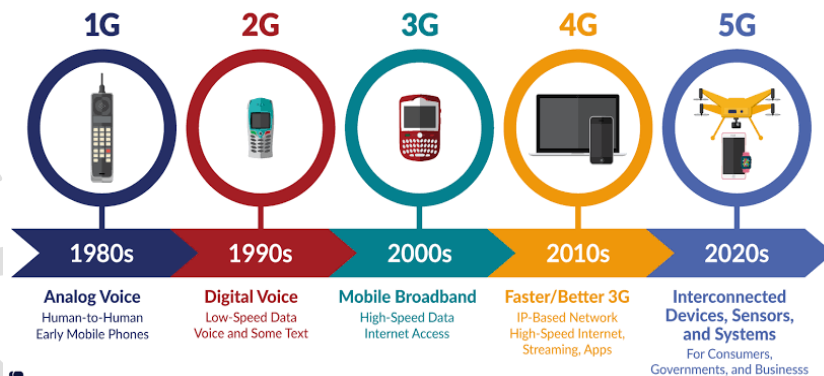


How does FASTag work?

- The device employs **Radio Frequency Identification (RFID) technology** for payments directly from the prepaid or savings account linked to it.
- It is affixed on the windscreen, so the vehicle can drive through plazas without stopping.
- The payment method is a part of the **National Electronic Toll Collection (NETC) programme**. The National Payments Corporation of India (NPCI) collects the payments.

4. 5G Technology

- 5G is the next generation of mobile broadband that will eventually replace, or at least augment 4G LTE connection.
- 5G offers exponentially faster download and upload speeds.
- 5G will deliver multi-Gbps peak rates (eventually up to 10 gigabits per second (Gbit/s)), ultra-low latency, massive capacity, and a more uniform user experience.
- Like its predecessors, 5G networks are cellular networks, in which the service area is divided into small geographical areas called cells. All 5G wireless devices in a cell are connected to the Internet and telephone network by radio waves through a local antenna in the cell.



5. Quantum Supremacy

China Claims Quantum Supremacy With Computer 10 Billion Times Faster Than Google's Prototype.

What is Quantum Supremacy?

It describes the point where quantum computers can do things that classical computers cannot.

- **Superposition and entanglement** are what give quantum computers the ability to process so much more information so much faster.

Differences between a standard computer and a quantum computer:

1. A **classical computer** performs calculations using bits that is 0 representing off and 1 representing on. It uses transistors to process information in the form of sequences of zeros and ones called computer binary language. More transistors more processing ability.
2. A **quantum computer** uses the laws of quantum mechanics. Here, different states can be achieved in particles due to their **internal angular momentum called spin**. The two states 0 and 1 can be represented in the spin of the particle.

Thus, in a classical computer information is expressed through single number either 0 or 1.

A quantum computer uses **qubits which is described as a 0 and 1 at the same time giving us more processing power**.

Quantum technology is manifested through applications in **secure communication, disaster management** through better prediction, computing, simulation, chemistry, **healthcare**, cryptography, imaging among others.

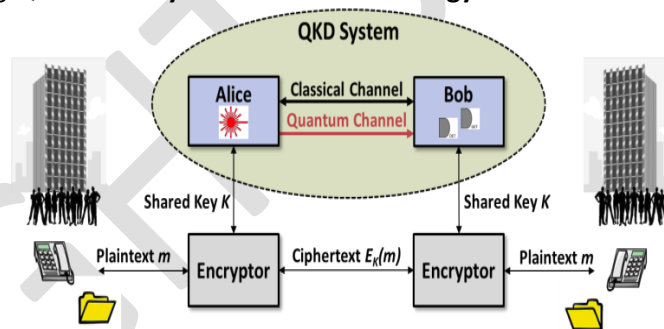
Scientists have expanded quantum theory to **understand biological phenomena such as smell, consciousness, enzyme catalysis, photosynthesis**, avian navigation like that of the Robin, origin of life and effects on coronavirus.

6. Quantum key distribution (QKD)

The **Defence Research and Development Organisation (DRDO)** successfully demonstrated communication between its two labs using **Quantum Key Distribution technology**.

What you need to know about this technology?

- **Quantum computing** refers to a new era of faster and more powerful computers, and the theory goes that they would be able to break current levels of encryption.
- QKD works by **using photons** — the particles which transmit light — to transfer data.
- QKD allows two distant users, who do not share a long secret key initially, to produce a common, random string of secret bits, called a **secret key**.
- Using the one-time pad encryption this key is proven to be secure to encrypt and decrypt a message, which can then be transmitted over a standard communication channel.

**Significance of this technology:**

- The encryption is **"unbreakable"** and that's mainly because of the way data is carried via the photon. **A photon cannot be perfectly copied and any attempt to measure it will disturb it.** This means that a person trying to intercept the data will leave a trace.
- The **implications could be huge for cybersecurity**, making businesses safer, but also making it more difficult for governments to hack into communication.

7. Quantum dots (QDs)

- Quantum dots (QDs) are semiconductor particles a few nanometres in size, having optical and electronic properties that differ from larger particles due to quantum mechanics.
- When the quantum dots are illuminated by UV light, an electron in the quantum dot can be excited to a state of higher energy.

- Potential applications of quantum dots include single-electron transistors, solar cells, LEDs, lasers, single-photon sources, second-harmonic generation, quantum computing, cell biology research, and medical imaging.
- Their small size allows for some QDs to be suspended in solution, which may lead to use in inkjet printing and spin-coating. They have been used in Langmuir-Blodgett thin-films. These processing techniques result in less expensive and less time-consuming methods of semiconductor fabrication.

8. Microwave energy

Microwaves are defined as **electromagnetic radiations** with a frequency ranging between 300 MHz to 300 GHz while the wavelength ranges from 1 mm to around 30 cm.

- They fall between the **infrared radiation and radio waves in the electromagnetic spectrum.**

Properties of microwaves:

- Metal surfaces reflect microwaves.
- Microwaves of certain frequencies are absorbed by water.
- Microwave transmission is affected by wave effects such as refraction, reflection, interference, and diffraction.
- Microwaves can pass through glass and plastic.

What are “microwave weapons”?

“Microwave weapons” are supposed to be a type of direct energy weapons, which aim highly focused energy in the form of sonic, laser, or microwaves, at a target.

9. Light Detection and Ranging Survey (LiDAR) technique

National High Speed Rail Corporation Limited adopts **Light Detection and Ranging Survey (LiDAR) technique** using Laser enabled equipment **mounted on a Helicopter** for conducting ground survey for the preparation of Detailed Project Report for the proposed Delhi-Varanasi HSR corridor.

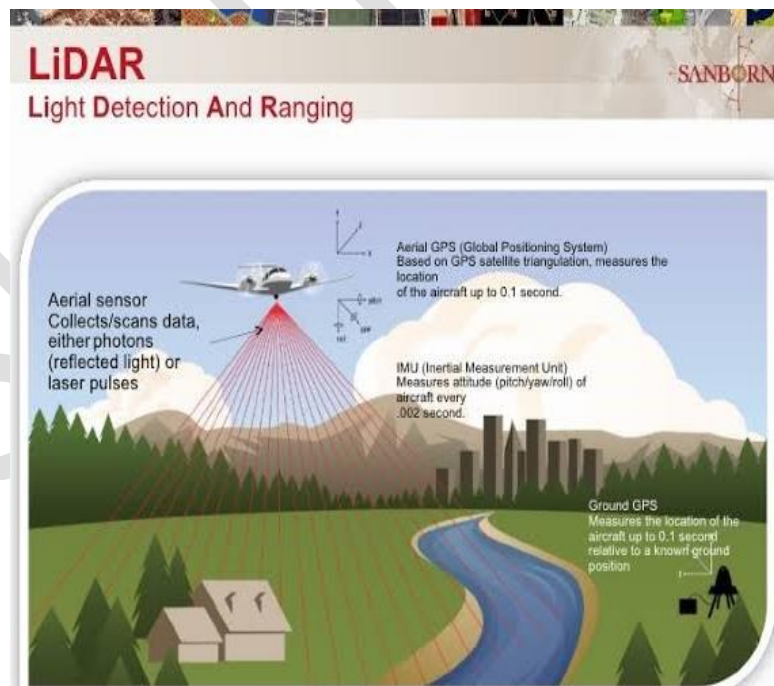
What is LiDAR?

It is a remote sensing method that **uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth.**

- These light pulses—combined with other data recorded by the airborne system— generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.

How it works?

LiDAR follows a simple principle — **throw laser light at an object on the earth surface and calculate the time it takes to return to the LiDAR source.** Given the speed at which the light



travels (approximately 186,000 miles per second), the process of measuring the exact distance through LiDAR appears to be incredibly fast.

- A lidar instrument principally consists of a laser, a scanner, and a specialized GPS receiver.
- Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas.

InstaFact:

- The aerial LiDAR survey technique, for the first time for any railway project in India, was adopted for the Mumbai- Ahmedabad High Speed Rail Corridor primarily because of its high accuracy.

10. Facial recognition technology

While **the facial recognition tracking (FRT) system** has seen rapid deployment by multiple government departments in recent times, there are **no specific laws or guidelines to regulate the use of this potentially invasive technology**.

Background:

- There are currently 16 different FRT systems in active utilisation by various Central and State governments across India for surveillance, security or authentication of identity.
- Another 17 are in the process of being installed by different government departments.

What are the Concerns?

1. It poses a huge **threat to the fundamental rights to privacy and freedom of speech and expression** because it does not satisfy the threshold the Supreme Court had set in its landmark privacy judgment in **the 'Justice K.S. Puttaswamy Vs Union of India' case**.
2. Many institutions have not conducted **"privacy impact assessment"** prior to deployment of the facial recognition system (FRS).
3. **Function creep**: A function creep happens when someone uses information for a purpose that is not the original specified purpose.

What is facial recognition?

Facial recognition is a biometric technology that uses distinctive features on the face to identify and distinguish an individual.

- AFRS works by maintaining a large database with photos and videos of peoples' faces. Then, a new image of an unidentified person — often taken from CCTV footage — is compared to the existing database to find a match and identify the person.
- The artificial intelligence technology used for pattern-finding and matching is called "neural networks".

Benefits of facial recognition:

1. Improves outcomes in the area of Criminal identification and verification.
2. Easy identification amongst crowds.
3. Boosts the police department's crime investigation capabilities.
4. Helps civilian verification when needed. No one will be able to get away with a fake ID.

11. Nuclear Magnetic Resonance (NMR) test

NMR spectroscopy is an analytical chemistry technique used in quality control and reserach for determining the content and purity of a sample as well as its molecular structure.

10 out of 13 honey brands from India had failed in this 'purity test'.

- The NMR test is not required by Indian law for honey that is being marketed locally but is needed for export.

12.mRNA vaccines

How do vaccines work?

Vaccines work by **training the body to recognise and respond to the proteins produced by disease-causing organisms, such as a virus or bacteria.**

Traditional vaccines are made up of **small or inactivated doses of the whole disease-causing organism, or the proteins that it produces**, which are introduced into the body to provoke the immune system into mounting a response.

What are mRNA vaccines?

mRNA vaccines **trick the body into producing some of the viral proteins itself.**

- They work by using **mRNA, or messenger RNA**, which is **the molecule that essentially puts DNA instructions into action.**
- Inside a cell, mRNA is used as a template to build a protein.

How it works?

1. To produce an mRNA vaccine, scientists produce a synthetic version of the mRNA that a virus uses to build its infectious proteins.
2. This mRNA is delivered into the human body, whose cells read it as instructions to build that viral protein, and therefore create some of the virus's molecules themselves.
3. These proteins are solitary, so they do not assemble to form a virus.
4. The immune system then detects these viral proteins and starts to produce a defensive response to them.

Significance of mRNA vaccines:

There are two parts to our immune system: **innate** (the defences we're born with) and **acquired** (which we develop as we come into contact with pathogens).

- **Classical vaccine molecules** usually only work with the acquired immune system and the innate immune system is activated by another ingredient, called an **adjuvant**.
- Interestingly, **mRNA in vaccines could also trigger the innate immune system**, providing an extra layer of defence without the need to add adjuvants.

13.Holographic imaging

Scientists have developed a method using holographic imaging to detect both viruses and antibodies.

How it is done?

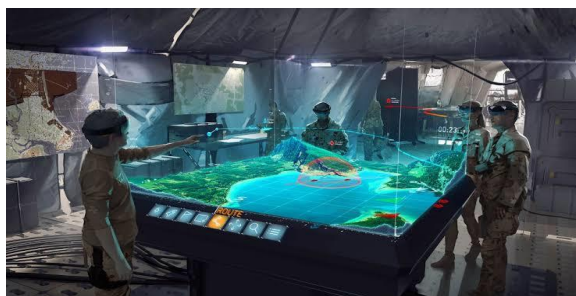
1. The method uses laser beams to record holograms of their test beads.
2. The surfaces of the beads are activated with biochemical binding sites that attract either antibodies or virus particles, depending on the intended test.
3. Binding antibodies or viruses causes the beads to grow by a few billionth parts of a metre.
4. Scientists then can detect this growth through changes in the beads' holograms.

Benefits of this method:

- The test could be done in under 30 minutes.
- It is highly accurate.
- It can be performed by minimally trained personnel.

What is holography?

It is a process that **creates three-dimensional images called holograms.**



- This is done using **laser beams**, the properties of **interference and diffraction**, **light intensity recording**, and **illumination of the recording**.

Uniqueness of holographic images:

The images created so change according to the relative position of the individual viewer as if the objects displayed are actually present.

14. Hydrogen-enriched compressed natural gas (HCNG)

Ministry of Road Transport and Highways has allowed use of H-CNG (18% mix of hydrogen) in CNG engines.

- A notification for amendments to **the Central Motor Vehicles Rules 1989**, for inclusion of H-CNG as an automotive fuel has been published.

Background:

The Bureau of Indian Standards (BIS) has also developed specifications (IS 17314:2019) of Hydrogen enriched Compressed Natural Gas (H-CNG) for automotive purposes, as a fuel.

What is HCNG?

The **blending of hydrogen with CNG** provides a blended gas termed as HCNG.

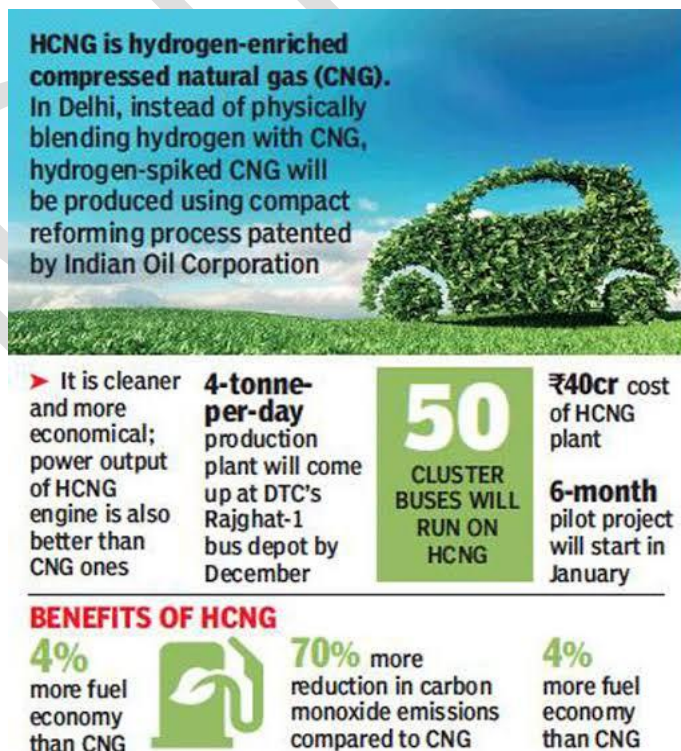
- It can be used in place of gasoline, diesel fuel and propane (C₃H₈) / LPG and its combustion produces fewer undesirable gases.

Advantages of HCNG:

- HCNG reduces emissions of CO up to 70%.
- Enables up to 5 % savings in fuel.
- First step towards future Hydrogen economy.
- Engines can be calibrated to release lower amounts of NO.
- Engines need minimum modification to run on HCNG.
- Ideal fuel for high load applications and heavy-duty vehicles.
- Better performance due to higher Octane rating of H₂.

Disadvantages of using HCNG:

- Determining the most optimized H₂/ NG (Natural Gas) ratio.
- It requires new infrastructures for preparing HCNG.
- Many steps need to be taken for commercializing it at a large scale.
- Current cost of H₂ is more than the cost of Natural Gas. So, HCNG's cost is more than CNG.



15. Kakrapar Atomic Plant achieves Criticality

Third unit at **Kakrapar Atomic Power Plant in Gujarat** achieves criticality.

- Currently, **nuclear power capacity constitutes less than 2% of the total installed capacity of 3,68,690 MW (end-January 2020).**

What is criticality or when a reactor is said to be critical?

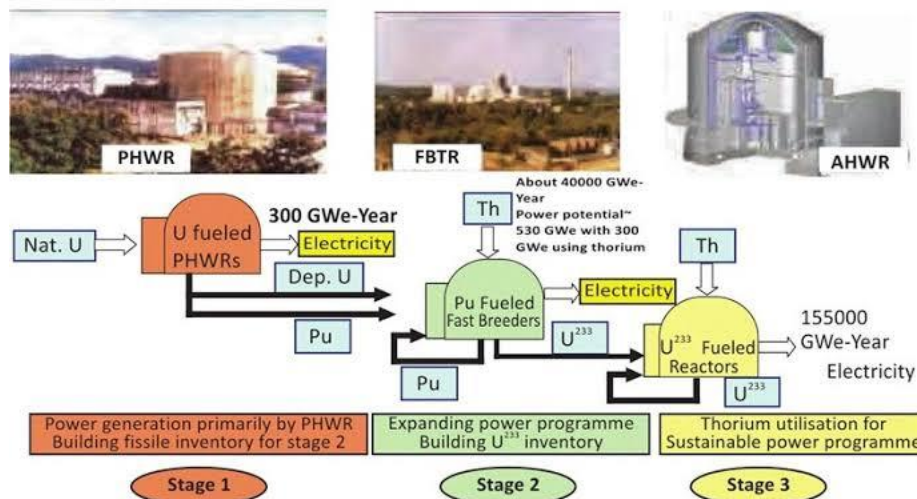
A reactor is said to be critical when the nuclear fuel inside a reactor sustains a fission chain reaction, where each fission event releases a sufficient number of neutrons to sustain a series of reactions. Criticality is first step towards power production.

- In simple terms, **the power plant reached the normal operating condition of a reactor.** It indicates that the plant is now set to generate power.

Why is this achievement significant?

This is a landmark event in India's domestic civilian nuclear programme given that **KAPP-3 is the country's first 700 MWe (megawatt electric) unit, and the biggest indigenously developed variant of the Pressurised Heavy Water Reactor (PHWR).**

Three Stage Indian Nuclear Power Programme incorporates closed fuel cycle and thorium utilisation as a main-stay for sustained growth.



Pressurized Heavy Water Reactor:

A PHWR is a nuclear power reactor, commonly using **unenriched natural uranium** as its fuel, that uses **heavy water (deuterium oxide D₂O)** as its coolant and moderator.

- The heavy water coolant is kept under pressure, allowing it to be heated to higher temperatures without boiling, much as in a typical pressurized water reactor.
- While heavy water is significantly more expensive than ordinary light water, it yields greatly enhanced neutron economy, allowing the reactor to operate without fuel enrichment facilities (mitigating the additional capital cost of the heavy water) and generally enhancing the ability of the reactor to efficiently make use of alternate fuel cycles.

16.Applications of Nano Technology

Nanotechnology Applications in:

- Medicine:** Researchers are developing customized nanoparticles the size of molecules that can deliver drugs directly to diseased cells in your body.
- Electronics:** increase the capabilities of electronics devices while we reduce their weight and power consumption.
- Food:** Nanotechnology is having an impact on several aspects of food science, from how food is grown to how it is packaged. Companies are developing nanomaterials that will make a difference not only in the taste of food, but also in food safety, and the health benefits
- Fuel cells:** Nanotechnology is being used to reduce the cost of catalysts used in fuel cells
- Better Air Quality:** Nanotechnology can improve the performance of catalysts used to transform vapours escaping from cars or industrial plants into harmless gasses.
- Better Water Quality:** Nanotechnology is being used to develop solutions to different problems in water quality.



| Agriculture | Food Processing | Food Packaging | Supplements |
|--|---|--|---|
| <ul style="list-style-type: none"> Single molecule detection to determine enzyme/substrate interactions Nanocapsules for delivery of pesticides, fertilizers and other agrichemicals more efficiently Delivery of growth hormones in a controlled fashion Nanosensors for monitoring soil conditions and crop growth Nanochips for identity preservation and tracking Nanosensors for detection of animal and plant pathogens Nanocapsules to deliver vaccines Nanoparticles to deliver DNA to plants (targeted genetic engineering) | <ul style="list-style-type: none"> Nanocapsules to improve bioavailability of nutraceuticals in standard ingredients such as cooking oils Nanoencapsulated flavor enhancers Nanotubes and nanoparticles as gelation and viscosifying agents Nanocapsule infusion of plant based steroids to replace a meat's cholesterol Nanoparticles to selectively bind and remove chemicals or pathogens from food Nanoemulsions and -particles for better availability and dispersion of nutrients | <ul style="list-style-type: none"> Antibodies attached to fluorescent nanoparticles to detect chemicals or foodborne pathogens Biodegradable nanosensors for temperature, moisture and time monitoring Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption Electrochemical nanosensors to detect ethylene Antimicrobial and antifungal surface coatings with nanoparticles (silver, magnesium, zinc) Lighter, stronger and more heat-resistant films with silicate nanoparticles Modified permeation behavior of foils | <ul style="list-style-type: none"> Nanosize powders to increase absorption of nutrients Cellulose nanocrystal composites as drug carrier Nanoencapsulation of nutraceuticals for better absorption, better stability or targeted delivery Nanocochleates (coiled nanoparticles) to deliver nutrients more efficiently to cells without affecting color or taste of food Vitamin sprays dispersing active molecules into nanodroplets for better absorption |

17. Gold Nanoparticles

- The National Centre for Polar and Ocean Research (NCPOR) and the Goa University (GU) have successfully synthesized gold nanoparticles (GNPs) using psychrotolerant Antarctic bacteria through a non-toxic, low-cost, and eco-friendly way.
- These GNPs can be used as a composite therapeutic agent clinical trials, especially in anti-cancer, anti-viral, anti-diabetic, and cholesterol-lowering drugs.
- Nanoparticles (NPs) have wide variety of potential applications in the fields of biomedical, optical and electronics research. Metallic NPs have been efficiently exploited for biomedical applications and among them GNPs are found to be effective in biomedical research.
- GNPs also have unique physicochemical properties. Their biocompatibility, high surface area, stability, and nontoxicity make them suitable for various applications in **therapeutic use including detection and diagnosis of diseases, bio-labeling, and targeted drug delivery**.
- As nano-carriers, GNPs are capable of transferring various drugs made out of peptides, proteins, plasmid DNAs, small interfering RNAs, and chemotherapeutic agents to target diseased cells of the human body.
- GNPs are also found to be useful in the **electronics industry**. Scientists have constructed a transistor known as NOMFET (Nanoparticle Organic Memory Field-Effect Transistor) by embedding GNPs in a porous manganese oxide as a room temperature catalyst to break down volatile organic compound in air and combining GNPs with organic molecules.

18. Nanobots

- Scientists are exploring the use of **nanobots for a number of healthcare uses**, not only for fighting cancer, but also to **unblock blood vessels** in hard to reach areas, taking biopsies or measuring the level of certain chemicals in otherwise inaccessible areas of the body.
- A nanobot is a device typically ranging from 0.1-10 micrometres (a micrometre is one millionth of a metre), roughly the size of a red blood cell or smaller. This is too small to add a traditional robotic element like a motor, computer chip or camera.

19. Artificial photosynthesis (AP)

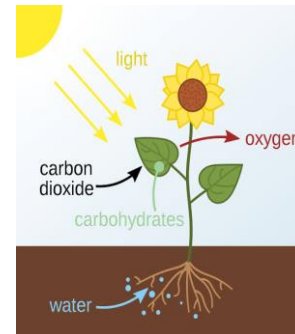
Researchers from **the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)** have developed an integrated system that can capture carbon dioxide (CO₂) and convert it into solar fuel.

- They have named this process as **artificial photosynthesis (AP)** — which they feel can aid mitigate effects of emissions made by use of fossil fuels.

How it works?

This artificial photosynthesis (AP) harnesses solar energy and converts the captured carbon dioxide to carbon monoxide (CO) (using a photosensitizer), which can be used as a fuel for internal combustion engines.

- Here, scientists are essentially conducting the same fundamental process in natural photosynthesis but with simpler nanostructures.
- This process of converting CO₂ into solar fuel also generates oxygen from water.



20. High Electron Mobility Transistors (HEMTs)

Indian scientists have developed a highly reliable **HEMT from gallium nitride (GaN)**.

Significance:

- This is the first-ever indigenous HEMT device and is useful in electric cars, locomotives, power transmission and other areas requiring high voltage and high-frequency switching.
- This would reduce the cost of importing such stable and efficient transistors required in power electronics.
- It will also make India self-reliant in power transistor technology.

What are HEMTs?

High Electron Mobility Transistor (HEMT) is a normally OFF device and can switch currents up to 4A and operates at 600 V.

HEMTs are **used in integrated circuits as digital on-off switches**.

- HEMT transistors are **able to operate at higher frequencies than ordinary transistors**, up to millimeter wave frequencies, and are used in high-frequency products such as cell phones, satellite television receivers, voltage converters, and radar equipment.
- They are widely **used in satellite receivers, in low power amplifiers and in the defense industry**.

21. Aluminium-air batteries

State-owned Indian Oil Corporation Ltd. has entered into a joint venture with Israel-based battery technology startup Phinergy to develop **aluminium-air technology** based battery systems for electric vehicles and stationary storage, as well as hydrogen storage solutions.

What is an aluminium-air battery?

Aluminium-air batteries utilise oxygen in the air which reacts with an aluminium hydroxide solution to oxidise the aluminium and produce electricity.

Benefits:

- Lower cost and more energy-dense alternative to lithium-ion batteries which are currently in widespread use for electric vehicles in India.
- Offer much greater range of 400 km or more per battery compared to lithium-ion batteries which currently offer a range of 150-200 kilometres per full charge.

- The aluminium plate in an aluminium-air battery is converted into aluminium trihydroxide over time and that aluminium can be reclaimed from aluminium trihydroxide or even traded directly for industrial uses.

Challenges:

Aluminium-air batteries cannot be recharged like lithium-ion batteries. Therefore, large scale use of aluminium-air battery-based vehicles would require the wide availability of battery swapping stations.

22. Einsteinium

Researchers have been able to characterise some of the properties of **Einsteinium**.

What is Einsteinium?

Named after Einstein, it was discovered in 1952 in the debris of the first hydrogen bomb (the detonation of a thermonuclear device called "Ivy Mike" in the Pacific Ocean).

Properties:

- It is difficult to create and is highly radioactive.
- The most common isotope of the element, einsteinium 253 has a half-life of 20 days.
- Einsteinium-254 is one of the more stable isotopes of the element that has a half-life of 276 days.
- The element is also not visible to the naked eye and after it was discovered, it took over nine years to manufacture enough of it so that it could be seen with the naked eye.
- Because of its high radioactivity and short half-life of all einsteinium isotopes, even if the element was present on Earth during its formation, it has most certainly decayed.

23. Intranasal vaccine

Bharat Biotech's BBV154 is the first publicised attempt at getting an intranasal Covid-19 vaccine.

What is an intranasal vaccine?

- Vaccines are most commonly administered as injectable shots into the muscles (intramuscular) or the tissue just between the skin and the muscles (subcutaneous).
- However, with intranasal vaccines, the solution is squirted or sprayed into the nostrils and inhaled instead of injecting it.

What are the benefits to an intranasal vaccine during a pandemic?

- Such vaccines not only aim to overcome barriers to delivery and administration that come with producing and distributing injectable vaccines, they also may be able to tap an additional set of immune cells found in the tissues lining the nose, mouth and lungs.
- Intranasal vaccines cut down on the need for syringes, needles and other components like alcohol swabs, as they are not injected.
- Eliminates needle-associated injuries and infections and is easy to administer, as it also does not require trained healthcare workers.

What are the potential setbacks?

- Past attempts to develop intranasal vaccines, including for measles flu, have not been very successful.
- These vaccines have mostly been made using live, weakened viruses, but have never cleared clinical trials.
- Only a live attenuated influenza flu vaccine has been licenced through this route of delivery.

24. Mock eggs

The innovation of **plant-based mock egg** by Prof Kavya Dashora, IIT Delhi has secured first prize at **Innovate4SDG contest** by 'UNDP (United Nation Development Program) Accelerator Lab India'.

Significance:

- The development of the mock egg meets the protein needs of the diet-specific, health conscious, vegan and vegetarian people, claims IIT-Delhi.
- This innovation addresses **SDG 2 and 3 (zero hunger and good health and well-being)**.

What is the Mock Egg?

The mock egg has been developed from very simple farm-based crop proteins, which not only looks and tastes like egg but also very close in nutritional profile to a poultry egg.



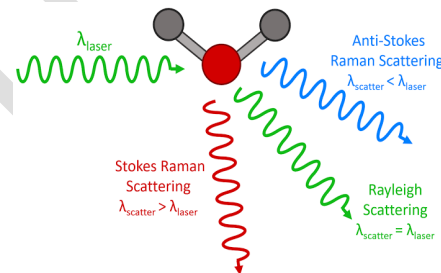
25. Raman Spectroscopy

Raman Spectroscopy is a **non-destructive chemical analysis technique** which provides detailed information about chemical structure, phase and polymorphy, crystallinity and molecular interactions. It is based upon the interaction of light with the chemical bonds within a material.

Raman Scatter:

It is a light scattering technique, whereby a **molecule scatters incident light from a high intensity laser light source**.

- Most of the scattered light is at the same wavelength (or color) as the laser source and does not provide useful information – this is called **Rayleigh Scatter**.
- However a small amount of light (typically 0.0000001%) is scattered at different wavelengths (or colors), which depend on the chemical structure of the analyte – this is called **Raman Scatter**.



Why in News?

Researchers have turned to **Raman Spectroscopy** to detect RNA viruses present in saliva samples.

- It has been reported that novel coronavirus is found in sufficient numbers in human saliva.

Government Initiatives /Departments

1. Technical Education Quality Improvement Programme (TEQIP)

- In the year 2002, the ministry of Human Resource and Development (now **Ministry of Education**) launched the TEQIP scheme.
- The project commenced with the World Bank assistance.
- The programme aims to overhaul the quality of technical education in the Low Income States and Special Category States (SCS) in India.

The measures include:

- **Institution based:** accreditation of the courses through National Board of Accreditation (NBA), governance reforms, improving the processes, digital initiatives, securing autonomy for the colleges.
- **Student based:** improving the quality of teaching, teacher training, equipping the class rooms, revision of syllabus, industry interaction, compulsory internships for students, training the students in industry-relevant skills, preparing them for the GATE exam etc.

2. National Technical Textiles Mission

The Cabinet Committee on Economic Affairs (CCEA) had, in 2020, approved the setting up of a National Technical Textiles Mission.

Aim:

To position the country as a global leader in technical textiles and increase the use of technical textiles in the domestic market.

The Mission will be implemented for four years from 2020-2021 and will have four components:

1. The first component will focus on **research and development and innovation**. The research will be at both, fibre level and application-based in geo, agro, medical, sports and mobile textiles and development of bio-degradable technical textiles.
2. The second component will be for **promotion and development of market** for technical textiles. The Mission will aim at taking domestic market size to \$40 billion to \$50 billion by 2024.
3. The third component will focus on **export promotion so that technical textile exports** from the country reach from the ₹14,000 crore now to ₹20,000 crore by 2021-2022 and ensure 10% average growth every year till the Mission ends.
4. The last component will be on **education, training and skill development**.

What are technical textiles?

- Technical textiles are defined as textile materials and products manufactured primarily for their technical performance and functional properties rather than aesthetic and decorative characteristics.
- Depending upon their application areas, **Technical Textiles products are divided into 12 broad categories:** Agrotech, Buildtech, Clothtech, Geotech, Homotech, Indutech, Mobiltech, Meditech, Protech, Sportstech, Oekotech, Packtech.



3. National Hydrogen Mission (NHM)

- Finance Minister in the Union budget for 2020-21 formally announced the NHM which aims for generation of hydrogen from green power resources.

Challenges for India:

1. Economic sustainability of extracting green or blue hydrogen.
2. Hydrogen fuel cell technology is at nascent stage and is expensive which in turn increases the cost of production of hydrogen.
3. The maintenance costs for fuel cells post-completion of a plant can be costly, like in South Korea.
4. The commercial usage of hydrogen as a fuel and in industries requires mammoth investment in R&D of such technology and infrastructure for production, storage, transportation and demand creation for hydrogen.

What is Hydrogen fuel?

- Hydrogen is **the lightest and first element on the periodic table**. Since **the weight of hydrogen is less than air**, it rises in the atmosphere and is therefore **rarely found in its pure form, H₂**.
- At standard temperature and pressure, hydrogen is a nontoxic, nonmetallic, odorless, tasteless, colorless, and **highly combustible diatomic gas**.
- Hydrogen fuel is a **zero-emission fuel** burned with oxygen. It **can be used in fuel cells or internal combustion engines**. It is also **used as a fuel for spacecraft propulsion**.

Occurrence of Hydrogen:

- It is the most abundant element in the universe. The sun and other stars are composed largely of hydrogen.
- Astronomers estimate that 90% of the atoms in the universe are hydrogen atoms. Hydrogen is a component of more compounds than any other element.
- Water is the most abundant compound of hydrogen found on earth.
- Molecular hydrogen is not available on Earth in convenient natural reservoirs**. Most hydrogen on Earth is bonded to oxygen in water and to carbon in live or dead and/or fossilized biomass. It can be created by splitting water into hydrogen and oxygen.

Storage:

Hydrogen **can be stored physically as either a gas or a liquid**.

- Storage of hydrogen as a gas typically requires high-pressure tanks.
- Storage of hydrogen as a liquid requires cryogenic temperatures because the boiling point of hydrogen at one atmosphere pressure is -252.8°C .
- Hydrogen can also be stored on the surfaces of solids (by adsorption) or within solids (by absorption).

Potential of clean hydrogen industry in reducing greenhouse gas emissions:

1. The only by-product or emission that results from the usage of hydrogen fuel is water — making the fuel 100 per cent clean.
2. Hydrogen is considered an alternative fuel. It is due to its ability to power fuel cells in zero-emission electric vehicles, its potential for domestic production, and the fuel cell's potential for high efficiency.
3. In fact, a fuel cell coupled with an electric motor is two to three times more efficient than an internal combustion engine running on gasoline.
4. Hydrogen can also serve as fuel for internal combustion engines.
5. The energy in 2.2 pounds (1 kilogram) of hydrogen gas contains about the same as the energy in 1 gallon (6.2 pounds, 2.8 kilograms) of gasoline.

WHY HYDROGEN?

- India's electricity is heavily coal-dependent. Hydrogen will replace fossil fuels, address pollution and oil-price rise
- It's the most abundant element in the universe, is lighter, energy dense, and two-three times more efficient than burning petrol
- It will benefit transportation (contributes 1/3rd of India's greenhouse-gas emissions), iron and steel and chemicals sectors

GREY HYDROGEN:

Constitutes India's bulk production. Extracted from hydrocarbons (fossil fuels, natural gas). By-product: CO₂

BLUE HYDROGEN:

Sourced from fossil fuels. Emissions/by-products (CO, CO₂) are captured and stored, so, better than grey hydrogen



GREEN HYDROGEN:

Generated from renewable energy (like solar, wind). Electricity splits water into hydrogen and oxygen. By-products: water, water vapour

TYPES OF EVs

HYDROGEN-POWERED VEHICLES SCORE OVER TRADITIONAL ELECTRIC VEHICLES (EVs):

HEVs (HYBRID ELECTRIC VEHICLES): High fuel economy (less fuel use than petrol cars), low tailpipe emission

BEVs (BATTERY-POWERED ELECTRIC VEHICLES): Fully electric, rechargeable batteries, no petrol

PHEVs (PLUG-IN HYBRID VEHICLES): Batteries + petrol

FCEVs (FUEL-CELL ELECTRIC VEHICLES): Hydrogen + oxygen (fully electric, but refuel, not recharge like BEVs)

THE GOOD

- Near zero carbon footprint (electricity to extract hydrogen comes from fossil fuels)
- Provides range like a Tesla Model S, about 400 miles or 550 km per charge
- Stored in tanks (like CNG) and integrated into cars' bellies (unlike CNG)
- Lighter than heavy lithium-ion batteries. Better for long-haul trucks, commercial vehicles
- Refuels in 5 minutes

THE BAD

SCALE:

Only 3 manufacturers — Honda, Toyota (Japan) and Hyundai (South Korea). Under 25,000 hydrogen FCEVs on road in 2020, compared to 8 million EVs

LACK OF INFRA: Less than 500 hydrogen stations globally

SAFETY: Explosion risk and highly combustible. Stored at very high (up to 700 bar) pressure, but tank is outside passenger bay

4. Draft 'Arctic' policy

India has unveiled a new draft 'Arctic' policy.

India's Arctic Policy Roadmap For Sustainable Engagement draft rides on five pillars:

1. Science and research activities.
2. Economic and human development cooperation.
3. Transportation and connectivity.
4. Governance and international cooperation.
5. National capacity building.

Highlights of the Policy:

1. The policy commits to expanding scientific research, "sustainable tourism" and mineral oil and gas exploration in the Arctic region.
2. The draft spells out goals in India's Arctic Mission such as to better understand the scientific and climate-related linkages between the Arctic and the Indian monsoons.

3. It also seeks to harmonise polar research with the third pole (the Himalayas) and to advance the study and understanding of the Arctic within India.
4. The policy calls for exploration opportunities for responsible exploration of natural resources and minerals from the Arctic and identifying opportunities for investment in Arctic infrastructure in areas such as “offshore exploration/mining, ports, railways and airports.

Arctic region:

- The Arctic region comprises the Arctic Ocean and parts of countries such as Canada, Denmark (Greenland), Norway, Russia, USA (Alaska), Finland, Sweden and Iceland.
- These countries together form the core of the Arctic Council, an intergovernmental forum. The region is home to almost four million inhabitants, of which, about one-tenth are indigenous people.

India's engagement in the Arctic:

- India already has a research station in the Arctic, **Himadri**, for the research work.
- India received the **‘Observer’ country status in the Arctic Council** in 2013 and is one among the 13 countries across the world, including China, to have that position. The status was renewed in 2018.

Significance of arctic study for India:

- Though none of India's territory directly falls in the Arctic region, it is a crucial area as **the Arctic influences atmospheric, oceanographic and biogeochemical cycles of the earth's ecosystem.**
- Due to climate change, **the region faces the loss of sea ice, ice caps, and warming of the ocean which in turn impacts the global climate.**
- The frigid Arctic, which keeps losing ice due to global warming, is one of the batteries feeding the variations in Indian monsoons.

5. TiHAN-IIT Hyderabad

- Inaugurated recently.
- It is India's first Test bed for Autonomous Navigation Systems (Terrestrial and Aerial).
- Special Features of this Facility include Test Tracks, Emulation of Real-World Scenarios, State of the Art Simulation Technologies, Road Infrastructure, V2X Communication, Drone Runways and Landing Area and many more.

Background:

The Department of Science and Technology (DST), Government of India, has sanctioned Rs. 135 crores to IIT Hyderabad under **the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** to set up a Technology Innovation Hub on Autonomous Navigation and Data Acquisition Systems (UAVs, RoVs, etc.).

What are Cyber Physical Systems (CPS)?

They are a new class of engineered systems that integrate computation and physical processes in a dynamic environment. CPS encompasses technology areas of Cybernetics, Mechatronics, Design and Embedded systems, Internet of Things (IoT), Big Data, Artificial Intelligence (AI) among others.

About National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS):

- To harness the potential of this new wave of technology and make India a leading player in CPS, the Union Cabinet approved NM-ICPS in 2018.

The mission implementation would develop and bring:

1. Cyber Physical Systems (CPS) and associated technologies within reach in the country,
2. adoption of CPS technologies to address India specific National / Regional issues,

3. produce Next Generation skilled manpower in CPS,
4. catalyze Translational Research,
5. accelerate entrepreneurship and start-up ecosystem development in CPS,
6. give impetus to advanced research in CPS, Technology development and higher education in Science, Technology and Engineering disciplines, and
7. place India at par with other advanced countries and derive several direct and indirect benefits.

Implementation:

- The Mission aims at establishment of 15 numbers of Technology Innovation Hubs (TIH), six numbers of Application Innovation Hubs (AIH) and four numbers of Technology Translation Research Parks (TTRP).
- These Hubs & TTRPs will connect to Academics, Industry, Central Ministries and State Government in developing solutions at reputed academic, R&D and other organizations across the country in a hub and spoke model.

6. Submarine Communications cable

The Union Cabinet has approved laying of **undersea optical fibre cable to connect 11 islands of Lakshadweep with Kochi by May 2023**, to help improve broadband connectivity in the Union Territory.

- The project will be funded by the **Universal Service Obligation Fund**.

What is Submarine Communications cable?

- It is a cable laid on the sea bed between land-based stations to carry telecommunication signals across stretches of ocean and sea.
- The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed.

Importance of submarine cables:

- Currently 99 per cent of the data traffic that is crossing oceans is carried by undersea cables.
- The reliability of submarine cables is high, especially when multiple paths are available in the event of a cable break.
- The total carrying capacity of submarine cables is in the terabits per second, while satellites typically offer only 1,000 megabits per second and display higher latency.



7. PM- WANI

Public Wi-Fi plan 'PM Wani' gets cabinet approval.

- The move is aimed at helping accelerate the uptake of broadband Internet services.
- It was first recommended by the **Telecom Regulatory Authority of India (TRAI) in 2017**.

Key features of the project:

1. This will allow setting up of public WiFi hotspots across the country via public data offices (PDOs).
2. It will not require the PDOs to get a license or pay a fee.
3. This will involve multiple players, including PDOs, Public Data Office Aggregators (PDOA), app providers, and a central registry.

Significance of the project:

Public Wi-Fi networks will **'democratize' content distribution and broadband access to millions at affordable rates**. This will be the **UPI (unified payments interface) of connectivity services**.

8. Bulk drug park

Himachal Pradesh is vying for the allotment of a **bulk drug park** under a central government scheme.

The Central Government is planning to **setup three such parks across the country**.

What are bulk drugs or APIs?

A **bulk drug** is also called an **active pharmaceutical ingredient (API)**.

It is **the key ingredient of a drug or medicine, which lends it the desired therapeutic effect or produces the intended pharmacological activity**.

- Take **for example- Paracetamol**- It is a bulk drug, which acts against pain. It is **mixed with binding agents or solvents** to prepare the finished pharmaceutical product, ie a paracetamol tablet, capsule or syrup, which is consumed by the patient.

How are APIs prepared?

They are prepared from multiple reactions involving chemicals and solvents.

- The **primary chemical or the basic raw material** which undergoes reactions to form an API is called **the key starting material, or KSM**.
- Chemical compounds formed during the intermediate stages during these reactions are called **drug intermediates or DIs**.

Why is India promoting bulk drug parks?

India has **one of the largest pharmaceutical industries in the world (third largest by volume)**.

But this industry **largely depends on other countries, particularly China, for importing APIs, DIs and KSMs**.

So, any disruptions in those countries would definitely affect the pharmaceutical industries here in India.

So, what India is doing?

The department of pharmaceuticals announced **a scheme for the promotion of three bulk drug parks in the country**.

- These parks are expected to bring down manufacturing costs of bulk drugs in the country and increase competitiveness in the domestic bulk drug industry.

Key features of the scheme for promotion of Bulk Drug parks:

- The scheme will support three selected parks in the country by providing **a one-time grant-in-aid** for the creation of common infrastructure facilities.
- The **grant-in-aid will be 70 per cent of the cost of the common facilities** but in the case of Himachal Pradesh and other hill states, it will be 90 per cent.
- The Centre will provide **a maximum of Rs 1,000 crore per park**.

9. Deep Ocean Mission

India will soon launch an ambitious '**Deep Ocean Mission**'.

About the Mission:

The mission proposes to explore the deep ocean similar to the space exploration started by ISRO about 35 years ago.

The focus of the mission will be on deep-sea mining, ocean climate change advisory services, underwater vehicles and underwater robotics related technologies.

- Two key projects** planned in the 'Deep Ocean Mission' report include **a desalination plant** powered by tidal energy and **a submersible vehicle** that can explore depths of at least 6,000 metres.

Significance:

- The mission will give a boost to efforts to explore India's vast Exclusive Economic Zone and Continental Shelf.
- The plan will enable India to develop capabilities to exploit resources in **the Central Indian Ocean Basin (CIOB)**.

Potential:

India has been allotted **75,000 square kilometres** in the **Central Indian Ocean Basin (CIOB)** by UN International Sea Bed Authority for exploration of poly-metallic nodules.

- **CIOB reserves contain** deposits of metals like iron, manganese, nickel and cobalt.
- It is envisaged that **10% of recovery of that large reserve can meet the energy requirement of India for the next 100 years.**

What are PMN?

Polymetallic nodules (also known as **manganese nodules**) are potato-shaped, largely porous nodules found in abundance carpeting the sea floor of world oceans in deep sea.

Composition: Besides manganese and iron, they contain nickel, copper, cobalt, lead, molybdenum, cadmium, vanadium, titanium, of which nickel, cobalt and copper are considered to be of economic and strategic importance.

10.Desalination plants

Maharashtra announced the setting up of a desalination plant in Mumbai, becoming the fourth state in the country to experiment with the idea.

What are desalination plants?

A desalination plant turns salt water into water that is fit to drink.

- The most commonly used technology used for the process is **reverse osmosis** where an external pressure is applied to push solvents from an area of high-solute concentration to an area of low-solute concentration through a membrane.
- **The microscopic pores** in the membranes allow water molecules through but leave salt and most other impurities behind, releasing clean water from the other side.
- These plants are **mostly set up in areas that have access to sea water.**

How widely is this technology used in India?

This technology has been limited to affluent countries in the Middle East and has recently started making inroads in parts of the United States and Australia.

- In India, Tamil Nadu has been the pioneer in using this technology, setting up two desalination plants near Chennai in 2010 and then 2013.
- Gujarat and Andhra Pradesh are also exploring the ideas.

Challenges:

- High cost of setting up and running a desalination plant.
- The disposal of the byproduct — highly concentrated brine — of the desalination process.

11.Scheme on Fortification of Rice

15 States have been identified for implementing **Centrally Sponsored Pilot Scheme on Fortification of Rice & its distribution through Public Distribution System.**

- The Pilot Scheme has been approved for a period of three years beginning 2019-2020.

What is Rice Fortification?

Fortification is the practice of **deliberately increasing the content of essential micronutrient**, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.

Need for Rice Fortification?

Rice is the world's most important staple food. An estimated 2 billion people eat rice every day, forming the mainstay of diets across large of Asia and Africa.

Regular milled rice is low in micronutrients and serves primarily as a source of carbohydrate only. The fortification of rice is a major opportunity to improve nutrition.

- **Fortified rice contains** Vitamin A, Vitamin B1, Vitamin B12, Folic Acid, Iron and Zinc.

12. Gyan Circle Ventures

Union Education Minister virtually inaugurates **Gyan Circle Ventures**.

What are Gyan Circle Ventures?

They are **Technology Business Incubators (TBI)**.

Funded by **the Ministry of Information Technology (MeitY)**.

- Led by the Indian Institute of Information Technology, Sri City (Chittoor), Andhra Pradesh.

Key features:

- Gyan Circle Ventures would function as a Technology Incubation and Development of Entrepreneurs (TIDE 2.0) incubation center.
- They will serve as a hub for innovation and startups by providing support, in various phases, via investments, infrastructure and mentoring.

13. National Supercomputing Mission (NSM)

It is being implemented and steered jointly by **the Department of Science and Technology (DST) and Department of Electronics and Information Technology (DeitY)**.

- Implemented by **the Centre for Development of Advanced Computing (C-DAC), Pune and the Indian Institute of Science (IISc), Bengaluru**.

Focus of the mission:

- The Mission envisages empowering national academic and R&D institutions spread over the country by installing a vast supercomputing grid comprising of more than 70 high-performance computing facilities.
- These supercomputers will also be networked on the National Supercomputing grid over the National Knowledge Network (NKN). The NKN is another programme of the government which connects academic institutions and R&D labs over a high speed network.
- The Mission includes development of highly professional High Performance Computing (HPC) aware human resource for meeting challenges of development of these applications.

Achievements:

- The first supercomputer assembled indigenously, called **Param Shivay**, was installed in IIT (Banaras Hindu University).
- Similar systems **Param Shakti and Param Brahma** were installed at IIT-Kharagpur and IISER, Pune. They are equipped with applications from domains like Weather and Climate, Computational Fluid Dynamics, Bioinformatics, and Material science.

India has developed an indigenous server (**Rudra**), which can meet the **High-Performance Computing (HPC)** requirements of all governments and PSUs. This is the first time that a server system was made in India, along with the full software stack developed by C-DAC.

14. IndiGen Program

Results from the extensive computation analysis of the 1029 sequenced genomes from India were published recently.

- This analysis was carried out under **IndiGen Program**.

Key findings:

- Comparisons with the global genome datasets revealed that 18,016,257 **(32.23%) variants were unique and found only in the samples sequenced from India**. This emphasizes the need for an **India centric population genomic initiative**.

Why this genome data is significant? What can it be used for?

- It helps to **classify variants involved in mendelian disorders and improve precision medicine outcomes**.
- The resource can also **enable the identification of markers for carrier screening, variations causing genetic diseases, prevention of adverse events and provide better diagnosis and optimal therapy through mining data of clinically actionable pharmacogenetic variants**.
- The data will allow researchers **to build Indian-specific reference genome dataset and efficiently impute haplotype information**. This resource can provide useful insights for clinicians and researchers in **comprehending genetics not only at the population level but at the individual level**.

About the Genomics for Public Health in India (IndiGen) programme:

CSIR initiated the Program in April 2019.

It aims to **undertake whole genome sequencing** of thousands of individuals representing diverse ethnic groups from India.

- The objective is to enable genetic epidemiology and develop public health technologies applications using population genome data.

What is Gene Sequencing?

A **genome is the DNA or sequence of genes in a cell**.

- Most of the DNA is in the nucleus and intricately coiled into a structure called **the chromosome**.
- Every human cell contains a pair of chromosomes, each of which has three billion base pairs or one of four molecules that pair in precise ways
- The order of base pairs and varying lengths of these sequences constitute **the “genes”**.

Sequencing a genome means **deciphering the exact order of base pairs in an individual**.

15.Entrepreneurs in Residence (EIR) programme

It is under **the National Initiative for Developing and Harnessing innovations (NIDHI)** of Department of Science and Technology.

- It supports aspiring or budding entrepreneur of considerable potential for pursuing a promising technology business idea over a period up to 18 months with a subsistence grant up to Rs 30000 per month with a maximum cap for total support of Rs 3.6 lakh to each EIR over a maximum of 18 months.

What is NIDHI program?

- **Department of Science & Technology** has launched a **NIDHI program (National Initiative for Developing and Harnessing Innovations)** under which programmes for setting up of incubators, seed fund, accelerators and ‘Proof of concept’ grant for innovators and entrepreneurs have been launched.
- Under NIDHI, **PRAYAS (Promoting and Accelerating Young and Aspiring innovators & Startups) programme** has been initiated in which established Technology Business Incubators (TBI) are supported with PRAYAS grant to support innovators and entrepreneurs with grants for ‘Proof of Concept’ and developing prototypes.

16. National Biopharma Mission (NBM)

It is an industry-academia **collaborative mission for accelerating biopharmaceutical development in the country.**

It was **launched in 2017** at a total cost of Rs 1500 crore and is **50% co-funded by World Bank loan.**

It is being **implemented by the Biotechnology Industry Research Assistance Council (BIRAC).**

- Under this Mission, the Government has launched **Innovate in India (i3) programme** to create an enabling ecosystem to promote entrepreneurship and indigenous manufacturing in the biopharma sector.



What is Biotechnology Industry Research Assistance Council (BIRAC)?

It is a **not-for-profit Public Sector Enterprise, set up by Department of Biotechnology (DBT)** as an Interface Agency to strengthen and empower the emerging Biotech enterprise to undertake strategic research and innovation, addressing nationally relevant product development needs.

17. SATAT Initiative

The initiative is aimed at providing a **Sustainable Alternative Towards Affordable Transportation (SATAT)** as a developmental effort that would benefit both vehicle-users as well as farmers and entrepreneurs.

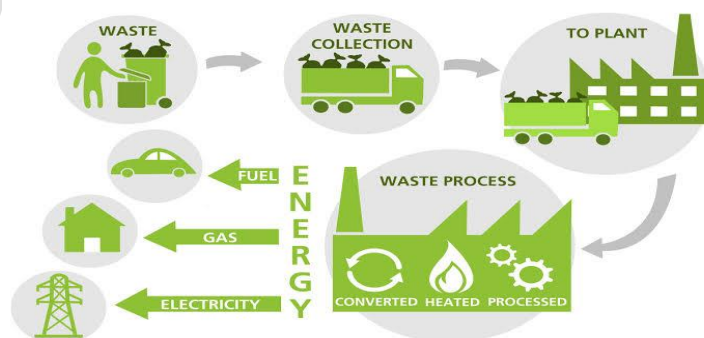
Compressed Bio-Gas plants are proposed to be set up mainly through independent entrepreneurs.

What is Bio- Gas?

Bio-gas is produced naturally through a process of **anaerobic decomposition** from waste / bio-mass sources like agriculture residue, cattle dung, sugarcane press mud, municipal solid waste, sewage treatment plant waste, etc. After purification, it is compressed and called CBG, which has **pure methane content of over 95%.**

What is CBG?

Compressed Bio-Gas is exactly similar to the commercially available natural gas in its composition and energy potential. With calorific value (~52,000 KJ/kg) and other properties similar to CNG, Compressed Bio-Gas can be used as an alternative, renewable automotive fuel.



18. Centre for Augmenting WAR with COVID-19 Health Crisis (CAWACH)

The Centre for Augmenting WAR with COVID-19 Health Crisis (CAWACH) is an initiative by the National Science & Technology Entrepreneurship Development Board (NSTEDB), Department of Science and Technology (DST).

- CAWACH supports innovations in the areas of diagnostics, devices, informatics including bio-informatics & information management systems, any intervention for the control of COVID-19

and/or startup ideas to address/mitigate various challenges faced by country/society due to the severe impact of COVID-19.

- It offers funding to the tune of Rs. 50 lakhs to Rs. 200 lakhs to selected startups.

CAWACH

Centre for Augmenting War with COVID-19 Health Crisis

COME JOIN CAWACH TO LEAD A WAR AGAINST CORONA



CALLING STARTUPS, INNOVATORS & INDIAN COMPANIES TO BRING YOUR INNOVATIONS TO JOIN THE WAR AGAINST COVID19. CAWACH WILL HELP IN ACCELERATING YOUR PRODUCT ENTRY TO MARKET

FUNDING

₹ 50 Lacs - ₹ 2.0 CR

(~₹ 1 Cr) per startup

HIGH IMPACT PRODUCTS BASED ON SCALABLE INNOVATIONS THAT ADDRESS COVID-19 CHALLENGES

DIAGNOSTICS

Rapid diagnostic kits, Antibody rapid kits, Genomics based mapping solutions, reagents, safe sample collections, Patient monitoring system

VENTILATORS & PPE

Portable ventilators, respirator, resuscitator, pulse oximeters, oxygen concentrators and other peripheral medical equipment such as contactless thermometers & Stethoscopes, accessories

Personal Protective Equipment (Masks, Shields, Suits, Goggles, Linen and disposable gowns, gloves, lab shoes), relevant medical accessories,

STERILIZERS & DISINFECTANTS

Sanitizers, disinfectants and allied systems such as booths/ community disinfectant stations / chambers, bio-hazardous waste management solutions, large scale sanitization and sterilization, surface sterilization units (preferably automated & IoT enabled)

INFORMATICS

Health care information systems, Movement tracking & tracing, Crowd management, Geofencing, Logistics, any containment solutions involving software/mobile applications, Patient tracking/ monitoring systems

High impact, scalable solutions that addresses/mitigates various challenges faced by country/society due to severe impact of COVID-19

APPLICATIONS

Apply
www.isba.in/cawach

Application submitted by
15 APR 2020
will be taken up for support on priority in first batch

WHO CAN APPLY?

- ⊕ A startup as per definition under Startup India, preferably registered on Startup India Portal
- ⊕ Less than 7 years in existence
- ⊕ Should have qualified team in place
- ⊕ Preferably at revenue stage or has raised fund earlier
- ⊕ Preferably to have already deployed or ready to deploy product within a few of weeks



National Science & Technology Entrepreneurship Development Board (NSTEDB)
Department of Science and Technology
Ministry of Science & Technology
Government of India



19. National Innovation Foundation (NIF) – India

Science & Technology minister dedicates an Innovation Portal developed by National Innovation Foundation (NIF) – India to the nation.

Highlights:

Innovation Portal is **developed by National Innovation Foundation (NIF) – India**, an autonomous body of the Department of Science and Technology (DST).

- The National Innovation Portal (NIP) is **currently home to about 1.15 lakh innovations scouted from common people of the country**, covering Engineering, Agriculture, Veterinary and Human Health.
- In terms of **domain areas**, presently the innovations cover Energy, mechanical, automobile, electrical, electronics, household, nutraceuticals etc.

About National Innovation Foundation (NIF) – India:

It is an autonomous body of the Department of Science and Technology (DST), Government of India.

- Set up in February 2000 at Ahmedabad, Gujarat to provide institutional support for scouting, spawning, sustaining and scaling up the grassroots innovations across the country.
- It is India's national initiative to strengthen the grassroots technological innovations and outstanding traditional knowledge.
- Its mission is to help India become a creative and knowledge-based society by expanding policy and institutional space for grassroots technological innovators.

20. National Internet Exchange of India (NIXI)

The National Internet Exchange of India (NIXI) announced that it will offer a free **IDN (Internationalized Domain Name)** in any of their preferred 22 official Indian language.

- It will be available **along with every IN domain booked by the registrant.**
- This offer has been created **to stimulate the adoption of भारत (IDN) domain name** and proliferation of local language content.

About NIXI

National Internet Exchange of India (NIXI) is a **not for profit organization working since 2003** for spreading the internet technology to the citizens of India.

21. Software Technology Parks of India (STPI)

It is an **autonomous society** under the **Ministry of Electronics and Information Technology (MeitY)**.

- Established in **1991**.
- Objective of **encouraging, promoting and boosting the export of software from India.**
- The **STPI's Governing Council's Chairperson** is the Union Minister for Electronics & Information Technology.

Other key objectives:

- To provide statutory and other promotional services to the exporters by **implementing Software Technology Parks (STP)/ Electronics and Hardware Technology Parks (EHTP) Schemes, SEZ scheme** and other such schemes which may be formulated and entrusted by the Government from time to time.
- To **promote micro, small and medium entrepreneurs** by creating conducive environment for entrepreneurship in the field of IT/ITES.
- To **establish and manage infrastructure resources such** as Datacom facilities, Project Management and Consultancy and IT support facilities.

Biotechnology

1. FSSAI guidelines on GMO Crops

FSSAI issued an order setting the permissible limit for **genetically modified organisms (GMO)** in imported food crops at 1%.

GMO regulation in India:

The task of regulating GMO levels in imported consumables was initially with **the Genetic Engineering Appraisal Committee (GEAC)** under the Union environment ministry.

- Its role in this was diluted with the enactment of **the Food Safety and Standards Act, 2006** and FSSAI was asked to take over approvals of imported goods.

What are Genetically Modified Organism (Transgenic Organism)?

In GMO, **genetic material (DNA)** is altered or artificially introduced using genetic engineering techniques.

Genetic modification involves the **mutation, insertion, or deletion of genes**.

- Inserted genes usually come from a different organism (e.g. In Bt cotton, Bt genes from bacterium *Bacillus thuringiensis* are induced).

Genetic modification is done to induce a desirable new trait which does not occur naturally in the species.

GM techniques are used in:

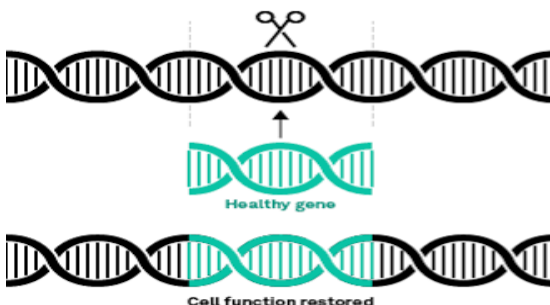
1. Biological and medical research,
2. Production of pharmaceutical drugs,
3. Experimental medicine (e.g. gene therapy),
4. Agriculture (e.g. golden rice, Bt cotton etc.),
5. Genetically modified bacteria to produce the protein insulin,
6. To produce biofuels from some GM bacteria, etc.

2. Zolgensma gene therapy

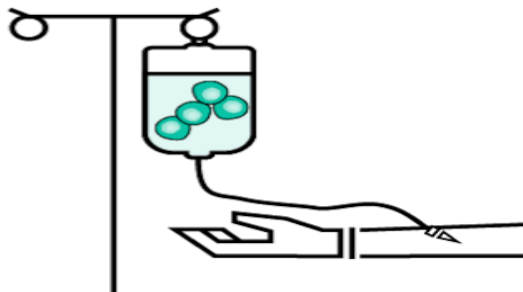
Zolgensma gene therapy is a one-time injection that replaces the defective gene with normal gene and rectifies the disorder. In 2019, US FDA approved this therapy for children aged less than two years.

Gene therapy vs. cell therapy

Gene therapy involves the introduction, removal or change in a person's genetic material to treat or cure a disease. The genetic content is usually transferred via carrier or vector to the appropriate cells of the body.



Cell therapy involves the transfer of intact, live cells into a patient to treat or cure a disease. The cells may be the patient's own (autologous cells) or that of a donor (allogeneic cells). The type of cell administered depends on the condition and relevant cell function.



Some protocols use **both** gene therapy and cell therapy, during which stem cells are genetically modified in tissue culture to express a new gene, expanded to sufficient numbers and then returned to the patient.

Credit: Cat Weeks
Source: American Society of Gene and Cell Therapy

3. Angiogenesis

Researchers are working to develop transgenic zebrafish model by the use of the CRISPR/Cas9 gene-editing tool to further study the compensatory angiogenesis mechanism in the tumour microenvironment.

- Angiogenesis is the physiological process through which new blood vessels form from pre-existing vessels, formed in the earlier stage of vasculogenesis.
- It is a normal and vital process in growth and development, as well as in wound healing and in the formation of granulation tissue.
- However, it is also a fundamental step in the transition of tumours from a benign state to a malignant one. Deregulation of angiogenesis is the main reason for tumour growth and progression.

4. Nobel Prize in Chemistry

2020 Nobel Prize in Chemistry Awarded for **CRISPR/Cas9 'Genetic Scissors'**.

- Emmanuelle Charpentier and American Jennifer Doudna share the prize for developing the **CRISPR/Cas9 tool** to edit the DNA of animals, plants and microorganisms with precision.

What is CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)?

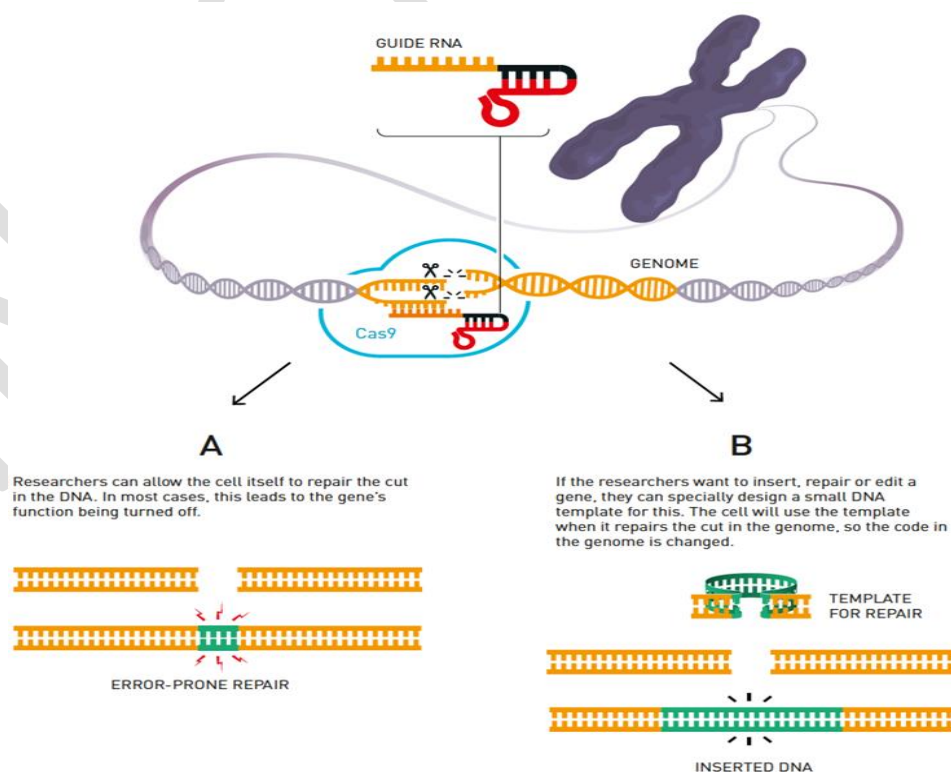
How it works?

It locates the specific area in the genetic sequence which has been diagnosed to be the cause of the problem, cuts it out, and replaces it with a new and correct sequence that no longer causes the problem.

Details (For better understanding- need not mug up):

1. An RNA molecule is programmed to locate the particular problematic sequence on the DNA strand, and a special protein called **Cas9** (genetic scissor) is used to break and remove the problematic sequence.

2. A DNA strand, when broken, has a natural tendency to repair itself. But the auto-repair mechanism can lead to the re-growth of a problematic sequence. Scientists intervene during this auto-repair process by supplying the desired sequence of genetic codes, which replaces the original sequence.



3. It is like cutting a portion of a long zipper somewhere in between, and replacing that portion with a fresh segment.

What is the significance of this technology?

1. **It's simple:** Its simplicity has often been compared to the 'Cut-Copy-Paste' mechanism in any word processor (or probably, the equally common 'Find-Replace' mechanism).
2. **Potential applications:** Its uses can potentially transform human beings, and all other life forms. It can potentially eliminate genetic, and other, diseases, multiply agricultural production, correct deformities, and even open up the more contentious possibilities of producing 'designer babies', and bringing cosmetic perfection.
3. **Efficient:** Because the entire process is programmable, it has a remarkable efficiency, and has already brought almost miraculous results. Genetic sequences of disease-causing organisms can be altered to make them ineffective.
4. **For Agriculture:** Genes of plants can be edited to make them withstand pests, or improve their tolerance to drought or temperature.

The concerns are over **the ethics of producing babies with particular genetic traits.**

'Feluda' test for Covid-19

Feluda is the acronym for **FNCAS9 Editor Linked Uniform Detection Assay.**

- It is low-cost **paper-based test strip** to detect Covid-19 and can deliver a result in 45 minutes.
- **How it works?**
 - It uses indigenously developed **CRISPR gene-editing technology** to identify and target the genetic material of SARS-CoV2, the virus that causes Covid-19.
 - It has a quicker turnaround time and requires less expensive equipment.
 - 'Feluda' is also the world's first diagnostic test to deploy a specially adapted Cas9 protein to successfully detect the virus.

5. Intentional genomic alteration (IGA) and GalSafe pigs

The US Food and Drug Administration (FDA) approved a first-of-its-kind **intentional genomic alteration (IGA)** in a line of domestic pigs referred to as **GalSafe pigs**.

- These pigs may be used for food and human therapeutics.
- This will be **the first time that the regulator has approved an animal biotechnology product for both food and biomedical purposes.**

What is intentional genomic alteration?

- Intentional genomic alteration in animal's means making specific changes to the genome of the organism using modern molecular technologies that are popularly referred to as "genome editing" or "genetic engineering".
- Such changes in the DNA sequence of an animal may be carried out for research purposes, to produce healthier meat for human consumption and to study disease resistance in animals among other reasons.

6. Cord blood banking

Cord blood (short for **umbilical cord blood**) is the blood that remains in the umbilical cord and placenta post-delivery.

- It contains special cells called **hematopoietic stem cells** that can be used to treat some types of diseases.

What is Cord blood banking?

Cord blood banking is **the process of collecting the cord blood and extracting and cryogenically freezing its stem cells and other cells of the immune system for potential future medical use.**

- Globally, cord blood banking is recommended as a **source of hematopoietic stem cell transplantation for haematological cancers and disorders where its use is recommended.**
- For all other conditions, the use of cord blood as a source of stem cells is not yet established.

What Can It Be Used For?

The **umbilical cord fluid is loaded with stem cells.**

- They can treat cancer, blood diseases like anemia, and some immune system disorders, which disrupt your body's ability to defend itself.
- The fluid is easy to collect and has 10 times more stem cells than those collected from bone marrow.
- Stem cells from cord blood rarely carry any infectious diseases and are half as likely to be rejected as adult stem cells.

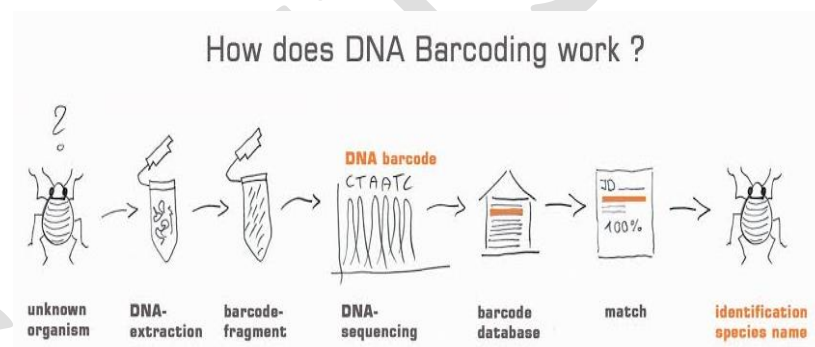
Concerns associated with stem cell banking:

- Over the past decade, stem cell banking has been aggressively marketed even as its use is still in experimental stages. But **these companies charge enormous fees from parents to preserve cells.**
- The concern here is that **it is merely by emotional marketing that companies convince parents to bank the cells for several years promising future therapeutic use.**

7. International Barcode of Life (iBOL)

The mission of the International Barcode of Life (iBOL) is to unite **DNA barcoding** research as a global science.

- Through a research alliance spanning 26 nations with varying levels of investment and responsibilities, iBOL is successfully extending the geographic and taxonomic coverage of **the Barcode of Life Data Systems (BOLD).**



DNA Barcoding:

- **DNA barcoding** is a method of species identification using a short section of DNA from a specific gene or genes.
- The premise of DNA barcoding is that, by comparison with a reference library of such DNA sections (also called "sequences"), an individual sequence can be used to uniquely identify an organism to species.
- These "barcodes" are sometimes used in an effort to identify unknown species, parts of an organism, or simply to catalog as many taxa as possible, or to compare with traditional taxonomy in an effort to determine species boundaries.

8. DNA profiling

- DNA profiling (also called DNA fingerprinting) is the process of determining an individual's DNA characteristics.
- DNA profiling is a forensic technique in **criminal investigations**, comparing criminal suspects' profiles to DNA evidence so as to assess the likelihood of their involvement in the crime.
- It is also used in **parentage testing**, to establish immigration eligibility, and in genealogical and medical research.

- DNA profiling has also been used in the **study of animal and plant populations** in the fields of zoology, botany, and agriculture.

9. Genetically Modified Crops

- Conventional plant breeding involves crossing species of the same genus to provide the offspring with the desired traits of both parents.
- Genetic engineering aims to transcend the genus barrier by introducing an alien gene in the seeds to get the desired effects. **The alien gene could be from a plant, an animal or even a soil bacterium.**
- Bt cotton, the only GM crop that is allowed in India, has two alien genes from the soil bacterium *Bacillus thuringiensis* (Bt) that allows the crop to develop a protein toxic to the common pest pink bollworm.
- **In India, the Genetic Engineering Appraisal Committee (GEAC) is the apex body that allows for commercial release of GM crops.**
- In 2002, the GEAC had allowed the commercial release of Bt cotton. **More than 95 per cent of the country's cotton area has since then come under Bt cotton.**
- Use of the unapproved GM variant can attract a jail term of 5 years and fine of Rs 1 lakh under the Environmental Protection Act, 1986.



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Events / Celebrations

1. National Science Day

28th February is celebrated as National Science Day (NSD) in India.

NSD is celebrated to commemorate discovery of **the 'Raman Effect'**, which led to **Sir C.V. Raman winning the Noble Prize**.

- The first National Science Day was celebrated on February 28, 1987.

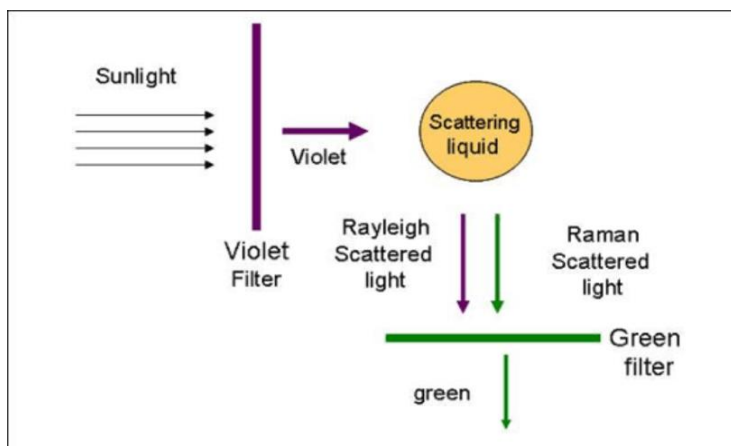
Theme: "Future of STI: Impacts on Education, Skills, and Work".

What is Raman Effect?

A phenomenon in spectroscopy discovered by the eminent physicist Sir Chandrasekhara Venkata Raman in 1928.

Raman Effect is **a change in the wavelength of light that occurs when a light beam is deflected by molecules**.

1. When a beam of light traverses a dust-free, transparent sample of a chemical compound, a small fraction of the light emerges in directions other than that of the incident (incoming) beam.
2. Most of this scattered light is of unchanged wavelength. A small part, however, has wavelengths different from that of the incident light; its presence is a result of the Raman Effect.



2. National Mathematics Day

Celebrated every year on December 22.

- It is **observed to honor the birth anniversary of the famous mathematician Srinivasa Ramanujan** who greatly contributed towards mathematical analysis, number theory, infinite series and continued fractions.

Highlights of Srinivasa Ramanujan's life:

- In 1911, Ramanujan published the first of his papers in the Journal of the Indian Mathematical Society.
- Ramanujan traveled to England in 1914, where Hardy tutored him and collaborated with him in some research.
- He worked out the Riemann series, the elliptic integrals, hypergeometric series, the functional equations of the zeta function, and his own theory of divergent series.
- The number 1729 is known as the Hardy-Ramanujan number after a famous visit by Hardy to see Ramanujan at a hospital.
- Hardy observed Ramanujan's work primarily involved fields less known even amongst other pure mathematicians.
- Ramanujan's home state of Tamil Nadu celebrates 22 December as 'State IT Day', memorialising both the man and his achievements, as a native of Tamil Nadu.

The Dev Patel-starrer **'The Man Who Knew Infinity' (2015)** was a biopic on the mathematician.

Miscellaneous

1. Country's biggest floating solar power plant

The country's biggest floating solar power plant till date, by generation capacity, is being developed by the NTPC in the reservoir of its thermal plant at Ramagundam in Peddapalli district, **Telangana**.

Generation Capacity: 100 megawatts.



2. Ethanol as an alternate fuel

Government has been promoting use of ethanol as a blend stock with main automotive fuel like petrol in line with **the National Policy on Biofuels (NBP) -2018 under the Ethanol Blended Petrol (EBP) Programme**.

- This policy envisages an indicative target of **blending 20% ethanol in petrol by 2030**.

Efforts by the Government in this regard:

1. Government has allowed **production of ethanol from sugarcane and food grain based raw-materials**.
2. The Government has fixed the ex-mill price of ethanol from sugarcane based raw-materials.
3. Remunerative prices of ethanol produced from different feedstock has been fixed.
4. The government has notified interest subvention schemes for setting up of molasses and grain based new distilleries or expansion of existing distilleries.

Ethanol:

- Ethanol can be produced from sugarcane, maize, wheat, etc which are having high starch content.
- In India, ethanol is mainly produced from sugarcane molasses by fermentation process.
- Ethanol can be mixed with gasoline to form different blends.
- As the ethanol molecule contains oxygen, it allows the engine to more completely combust the fuel, resulting in fewer emissions and thereby reducing the occurrence of environmental pollution.
- Since ethanol is produced from plants that harness the power of the sun, ethanol is also considered as renewable fuel.

3. Over-the-top (OTT) Platform

Internet and Mobile Association of India (IAMAI) has announced the adoption of a comprehensive **implementation toolkit**, which is in line with '**Universal Self-Regulation Code**' for online curate content providers (OCCP).

The government has brought "**Over the Top**" (OTT) platforms or video streaming service providers under **the ambit of Ministry of Information and Broadcasting**.

What is OTT?

An "over-the-top" media service is any online content provider that offers streaming media as a standalone product.

- The term is commonly applied to video-on-demand platforms, but also refers to audio streaming, messaging services, or internet-based voice calling solutions.
- OTT services circumvent traditional media distribution channels such as telecommunications networks or cable television providers.
- As long as you have access to an internet connection — either locally or through a mobile network — you can access the complete service at your leisure.

4. Net Neutrality

It means that **governments and internet service providers treat all data on the internet equally** and does not differentially charge consumers for higher-quality delivery or giving preferential treatment to certain websites.

- Network neutrality requires **all Internet service providers (ISPs) to provide the same level of data access and speed to all traffic**, and that traffic to one service or website cannot be blocked or degraded.

How net neutrality is treated/regulated in India?

- The net neutrality principles, approved by the telecom department in 2018, prohibit service providers from discriminating against internet content and services by blocking, throttling or according preferential higher speeds.

5. Manufactured sand

The Rajasthan government has brought a policy on **manufactured sand (M-sand)**, giving **industry status** to the units producing it for construction work and reducing the dependence on bajri (riverbed sand).

Background:

The Supreme Court had banned illegal mining on riverbeds in 2017.

What is M-Sand?

- M-sand is a substitute of river sand for concrete construction.
- Manufactured sand is produced from hard granite stone by crushing.
- The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material.
- The size of manufactured sand (M-Sand) is less than 4.75mm.

Its significance:

- It can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.
- It is well graded in the required proportion.
- It does not contain organic and soluble compounds that affect the setting time and properties of cement, thus the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust and silt coatings.

6. SAHAYAK-NG

- SAHAYAK-NG is India's first indigenously designed and developed Air Droppable Container.
- It is a GPS aided air dropped container with the capacity to carry a payload of up to 50 kg and can be dropped from a heavy aircraft.
- The successful maiden test was conducted by the DRDO along with the Indian Navy.

7. Magnetotelluric-MT survey

The National Centre for Seismology (NCS) conducted a unique geophysical (magnetotelluric-MT) survey in Delhi- NCR region to accurately assess potential seismic hazards.

- Its findings will help different user agencies for designing quake-resistant buildings, industrial units and structures such as hospitals and schools.

What is MT method?

Magnetotelluric (MT) is a geophysical method which uses natural time variation of the earth's magnetic and electric fields to understand geological (underground) structure and processes.

8. Vanadium

Promising concentrations of vanadium found in the palaeo-proterozoic carbonaceous phyllite rocks in the Depo and Tamang areas of Papum Pare district in Arunachal Pradesh. This was the first report of a primary deposit of vanadium in India.

Key Points:

1. Vanadium is a high value metal used in strengthening steel and titanium.
2. India consumed 4% of about 84,000 tonnes of vanadium produced across the globe in 2017. China, which produces 57% of the world's vanadium, consumed 44% of the metal.
3. The largest deposits are in China, followed by Russia and South Africa.

9. Spintronics

- Spintronic, also known as spin electronics, is the study of the intrinsic spin of the electron and its associated magnetic moment, in addition to its fundamental electronic charge, in solid-state devices.
- A phenomenon called **the 'Rashba effect'**, which consists of splitting of spin-bands in an electronic system, might play a key role in spintronic devices.

The **Rashba effect, or Rashba-Dresselhaus effect**, is a momentum-dependent splitting of spin bands in two-dimensional condensed matter systems.

10. Lab-grown meat

How is lab-grown or cultured meat different from plant-based meat?

The latter is **made from plant sources** such as soy or pea protein, while **cultured meat is grown directly from cells in a laboratory**.

- Both have **the same objective**: to offer alternatives to traditional meat products that could feed a lot more people, reduce the threat of zoonotic diseases, and mitigate the environmental impact of meat consumption.

In terms of cellular structure, cultured or cultivated meat is the same as conventional meat except that **cultured meat does not come directly from animals**.

Benefits of cultivated meat:

1. Since cultivated meat is created in clean facilities, the risk of contamination by pathogens such as salmonella and E coli, which may be present in traditional slaughterhouses and meat-packing factories, is significantly reduced.
2. It does not require antibiotics either, unlike animals raised for meat, thereby reducing the threat posed to public health by growing antibiotic resistance.

11. Food fortification

According to the World Health Organisation (WHO), food fortification is defined as the practice of **deliberately increasing the content of essential micronutrients** so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health.

How is it regulated in India?

- In October 2016, **Food Safety and Standards Authority Of India (FSSAI)** operationalized the **Food Safety and Standards (Fortification of Foods) Regulations, 2016** for fortifying staples namely Wheat Flour and Rice (with Iron, Vitamin B12 and Folic Acid), Milk and Edible Oil (with Vitamins A and D) and Double Fortified Salt (with Iodine and Iron) to reduce the high burden of micronutrient malnutrition in India.
- India's **National Nutritional strategy, 2017**, had listed food fortification as one of the interventions to address anaemia, vitamin A and iodine deficiencies apart from supplementation and dietary diversification.

What do activists say?

- Vitamin C and calcium are available in abundance in natural food.
- **Vitamin C is water soluble.** If the rice is laced with Vitamin C, it will get washed away while the rice is cleaned before cooking.
- It is a futile exercise to add Vitamin C to uncooked rice. And the move would lead to wasteful expenditure of taxpayers' money.

12. Biofortification

It is the process of increasing nutritional value of food crops by increasing the density of vitamins and minerals in a crop **through either conventional plant breeding; agronomic practices or biotechnology.**

- Examples of these vitamins and minerals that can be increased through biofortification include provitamin A Carotenoids, zinc and iron.

How are crops fortified?

1. Conventional crop breeding techniques are used to identify varieties with particularly high concentration of desired nutrients.
2. These are cross-bred with varieties with other desirable traits from the target areas (such as virus resistance, drought tolerance, high yielding, taste) to develop biofortified varieties that have high levels of micronutrients (for example, vitamin A, iron or zinc), in addition to other traits desired by farmers and consumers.

What is Agronomic biofortification?

It entails application of minerals such as zinc or iron as foliar or soil applications, drawing on plant management, soil factors, and plant characteristics to get enhanced content of key micronutrients into the edible portion of the plant.

How does Biofortification differ from food fortification?

- **Biofortification** has the increased nutritional micronutrient content embedded in the crop being grown.
- **Food fortification** increases the nutritional value of foods by adding trace amounts of micronutrients to foods during processing.

13. Vaccine hesitancy

- Vaccine hesitancy is defined by WHO as a **"delay in acceptance or refusal of vaccines despite availability of vaccination services"**.
- It was **one of 10 threats to global health this year.**

An **adjuvant** is a **pharmacological or immunological agent that improves the immune response of a vaccine.** Adjuvants may be added to a vaccine to boost the immune response to produce more antibodies and longer-lasting immunity, thus minimizing the dose of antigen needed.

14. Ammonia**What is Ammonia?**

- A tri-hydride of nitrogen (NH_3), ammonia is a building block for ammonium nitrate (NH_4NO_3) that is used in agriculture as a high-nitrogen fertiliser.
- It interacts immediately upon contact with moisture present in the skin, eyes, oral cavity, and respiratory tract to form ammonium hydroxide, which is very caustic and disrupts the cell membrane lipids, ultimately leading to cellular destruction.

What are main uses of ammonia?

- Ammonia is critical in the manufacturing of fertilizers, and is one of the largest-volume synthetic chemicals produced in the world.

- More than 80 per cent of ammonia made is consumed in the manufacturing of fertilizer, and most of the remainder goes into the production of formaldehyde.

15. Bioweapons

Also called **germ weapons**, they are any of a number of disease-producing agents—such as bacteria, viruses, rickettsiae, fungi, toxins, or other biological agents—that may be utilized as weapons against humans, animals, or plants.

- Biological weapons, like chemical weapons, radiological weapons, and nuclear weapons, are commonly referred to as **weapons of mass destruction**.

The Biological Weapons Convention (BWC):

It is the **first multilateral disarmament treaty** banning the development, production and stockpiling of an entire category of weapons of mass destruction, was **opened for signature on 10 April 1972**. The BWC **entered into force on 26 March 1975**.

The BWC bans:

1. The development, stockpiling, acquisition, retention, and production of:
2. Biological agents and toxins “of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;”
3. Weapons, equipment, and delivery vehicles “designed to use such agents or toxins for hostile purposes or in armed conflict.”
4. The transfer of or assistance with acquiring the agents, toxins, weapons, equipment, and delivery vehicles described above.

16. GI tag

A GI is primarily an **agricultural, natural or a manufactured product** (handicrafts and industrial goods) originating from a definite geographical territory.

- Typically, such a name conveys an assurance of quality and distinctiveness, which is essentially attributable to the place of its origin.

What are the benefits?

Once the GI protection is granted, no other producer can misuse the name to market similar products. It also provides comfort to customers about the authenticity of that product.

Who is a registered proprietor of a geographical indication?

- Any association of persons, producers, organisation or authority established by or under the law can be a registered proprietor.
- Their name should be entered in the Register of Geographical Indication as registered proprietor for the Geographical Indication applied for.

How long the registration of Geographical Indication is valid?

- The registration of a geographical indication is valid for a period of 10 years.
- It can be renewed from time to time for further period of 10 years each.

Who accords and regulates Geographical Indications?

- **At the International level:** Geographical Indications are covered as a component of intellectual property rights (IPRs) under the **Paris Convention for the Protection of Industrial Property**. GI is also governed by the **World Trade Organisation's (WTO's) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)**.
- **In India,** Geographical Indications registration is administered by the **Geographical Indications of Goods (Registration and Protection) Act, 1999** which came into force with effect from September 2003. The first product in India to be accorded with GI tag was Darjeeling tea in the year 2004-05.

17. Trademark

In layman's language, it is a **visual symbol which may be a word signature, name, device, label, numerals or combination of colours** used by one undertaking **on goods or services or other articles of commerce** to distinguish it from other similar goods or services originating from a different undertaking.

The legal requirements to register a trademark are:

1. The selected mark should be capable of being represented graphically (that is in the paper form).
2. It should be capable of distinguishing the goods or services of one undertaking from those of others.
3. It should be used or proposed to be used mark in relation to goods or services for the purpose of indicating or so as to indicate a connection in the course of trade between the goods or services and some person have the right to use the mark with or without identity of that person.

Different types of trademarks that may be registered in India:

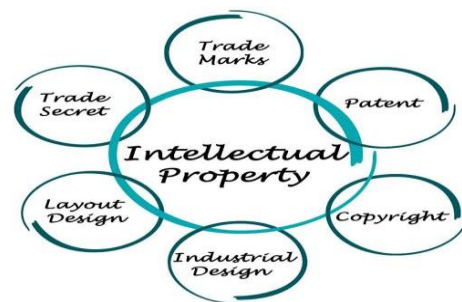
1. Any name (including personal or surname of the applicant or predecessor in business or the signature of the person), which is not unusual for trade to adopt as a mark.
2. An invented word or any arbitrary dictionary word or words, not being directly descriptive of the character or quality of the goods/service.
3. Letters or numerals or any combination thereof.
4. The right to proprietorship of a trademark may be acquired by either registration under the Act or by use in relation to particular goods or service.
5. Devices, including fancy devices or symbols
6. Monograms
7. Combination of colors or even a single color in combination with a word or device
8. Shape of goods or their packaging
9. Marks constituting a 3- dimensional sign.
10. Sound marks when represented in conventional notation or described in words by being graphically represented.

Registrar:

The **Controller General of Patents, Designs and Trade Marks** heads the TRADE MARKS Registry offices and functions as the **Registrar of TRADE MARKS**.

What is Intellectual Property Appellate Board (IPAB)?

- It was **constituted on September 15, 2003** by the Indian Government to hear and resolve the appeals against the decisions of the registrar under the **Indian Trademarks Act, 1999 and the Geographical Indications of Goods (Registration and Protection) Act, 1999**.
- Since April 2, 2007, IPAB has been authorized to hear and adjudicate upon the appeals from most of the decisions, orders or directions made by the **Patent Controller under the Patents Act**. **Therefore, all pending appeals of Indian High Courts under the Patents Act were transferred to IPAB.**



18. Vikram Sarabhai

ISRO pays tribute to Dr Vikram Sarabhai by announcing that **Chandrayaan 2 Orbiter has captured the Moon images of "Sarabhai" Crater**.

About Vikram Sarabhai and his contributions:

Vikram Sarabhai was **born on August 12, 1919.**

Sarabhai was **instrumental in forming India's future in astronomy and setting up the country's space research facilities.**

Key contributions:

1. Based on his persuasion, the Indian government agreed to set up the **Indian National Committee for Space Research (INCOSPAR)** in 1962. He was **the first chairman of the committee.**
2. The INCOSPAR was restructured and renamed as **Indian Space Research Organisation (ISRO)** in 1969.
3. Sarabhai **founded the Physical Research Laboratory in Ahmedabad in the year 1947.** The laboratory started its operation from RETREAT, Sarabhai's residence in Ahmedabad. Its **first topic of research was cosmic rays.**
4. He also set up **India's first rocket launch site in Thumba**, a small village near the Thiruvananthapuram airport in Kerala.
5. Vikram Sarabhai was also **responsible for bringing cable television to India.** His constant contact with NASA paved a way for the establishment of **Satellite Instructional Television Experiment (SITE) in 1975.**
6. Sarabhai was **the mastermind behind building India's first satellite, Aryabhata.**
7. He was **one of the founding members of the Indian Institute of Management, Ahmedabad (IIMA).**
8. Vikram Sarabhai received **the Padma Bhushan in 1966** for his contribution to India's progress. He was also awarded **the Padma Vibhushan in 1972, posthumously.**

19. Flavonoids

Flavonoids are a group of **phytonutrients** present in almost all vegetables and fruits.

They, along with carotenoids, are **responsible for the varied colours of fruits and vegetables.**

- They are associated with health benefits being good **antioxidants**, having **anti-inflammatory properties** and also offer **benefits for the immune system.**

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