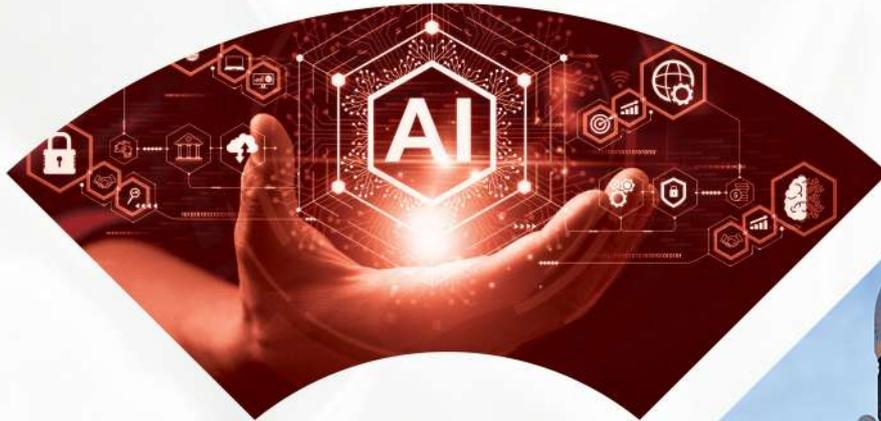
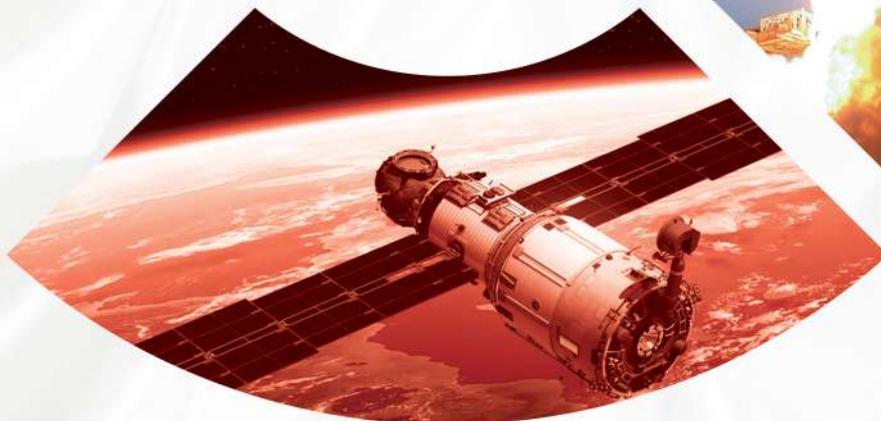


# FORTUNE Prelims Precise Compilation Volume I



## SCIENCE & TECHNOLOGY

January 2025 - December 2025



## Toppers in Top 100



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## ISROs Third Launch Pad

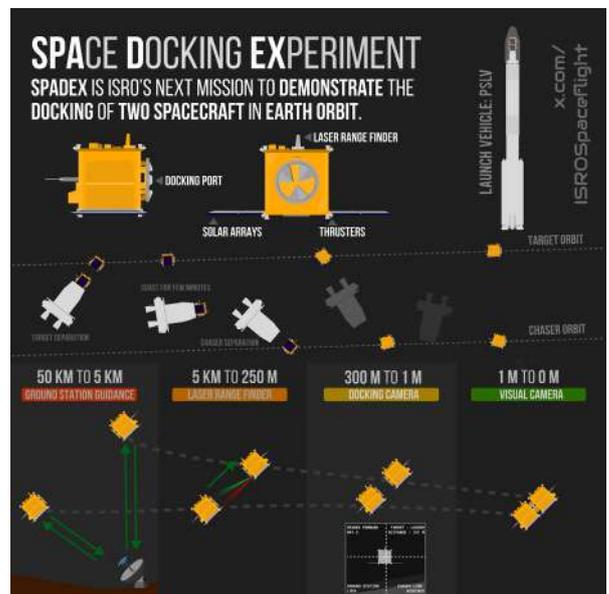


- The Union Cabinet approved a **third launchpad** at **Satish Dhawan Space Center (SDSC), Sriharikota**.
- The SDSC became operational on **October 9, 1971**, with the flight of 'Rohini-125', a small-sounding rocket, and was initially known as SHAR (Sriharikota Range).
- The **Sriharikota Range (SHAR)** was renamed the **Satish Dhawan Space Centre (SDSC)** on **September 5, 2002**, in honor of **Satish Dhawan**, former ISRO chairman.
- **The Second Launch Pad (SLP)** was **commissioned in 2005** and the first launch from this pad was **PSLV-C6** on **May 5, 2005**.
- Sriharikota is a sand dune formed as a **barrier island** in Andhra Pradesh.
- It was selected for India's **space program** due to its **proximity to the equator** (rockets gain an **extra velocity of ~450 m/s**) and **safe launch trajectories over the sea**

## Space Docking Experiment (SpaDeX)

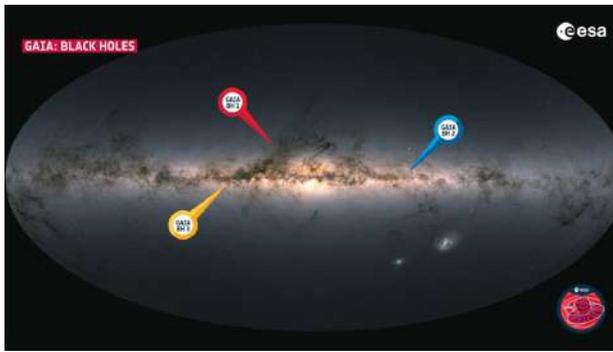
- ISRO successfully executed the **SpaDeX docking experiment** making India the **fourth country** after the USA, Russia and China this historic feat.
- The two satellites **SDX01 (Chaser)** and **SDX02 (Target)** which were launched by the PSLV C60.
- The mission uses **androgynous spacecraft**, which means that either of the two satellites can act as the active spacecraft during docking.
  - This is different from older systems where one spacecraft had a "male" part and the other a "female" part.

- The SpaDeX mission is designed to develop and demonstrate the technology needed for **spacecraft rendezvous, docking and undocking**.
- This is crucial for future missions like **lunar sample return, astronaut missions, and the Bharatiya Antariksh Station (BAS)**.
- The experiment also tested **power transfer between docked spacecraft**, enabling **in-space robotics, composite spacecraft control, and payload operations** after undocking.



## Gaia Mission

- Astronomers have discovered a massive black hole, **Gaia BH3**, located **about 2,000 light-years** away in the **constellation Aquila**.
- It is the third of its kind, following Gaia BH1 and BH2, all detected by the **European Space Agency's Gaia telescope**.
- Gaia, launched in 2013, aims to create the most precise **3D map of the Milky Way** by tracking the motion of billions of stars.
- Operating at the **second Lagrange point**, it observes each of its 1 billion target stars around 70 times over five years.
- Gaia BH3 appears to be a **passive black hole**, not actively pulling in material from its surroundings.



## Extremely Large Telescope

- The Extremely Large Telescope (ELT), nearing 60% completion in Chile's Atacama Desert, is set for its first observations by 2028.
- Built by the **European Southern Observatory (ESO)** at \$1.51 billion, it will be the world's largest visible and infrared telescope.
- Its **39.3-meter-wide primary mirror**, made of 798 segments, will search for life on **exoplanets** and study the universe's earliest stars and galaxies.
- The **Atacama**, with its dark, clear skies, minimal light pollution, and high altitude, hosts nearly 40% of global ground-based astronomy, set to rise to 60% within a decade.

The **European Southern Observatory (ESO)** is an intergovernmental organization for astronomical research, operating advanced ground-based telescopes in Chile, including the **Very Large Telescope (VLT)**, **Atacama Large Millimeter/submillimeter Array (ALMA)**, and the under-construction **Extremely Large Telescope (ELT)**.

Established in 1962, ESO is supported by **16 European countries and Australia**, focusing on exoplanets, black holes, and the early universe.



## Solar Ultraviolet Imaging Telescope (SUIT)

### Energy burst

Aditya-L1 has captured the first-ever image of a solar flare **'kernel'**



### KEY HIGHLIGHTS

- X6.3-class solar flare ranks among the most intense solar eruptions
- Observation confirms flare energy spreads across multiple solar layers
- It reveals new insights into the physics of massive solar explosions

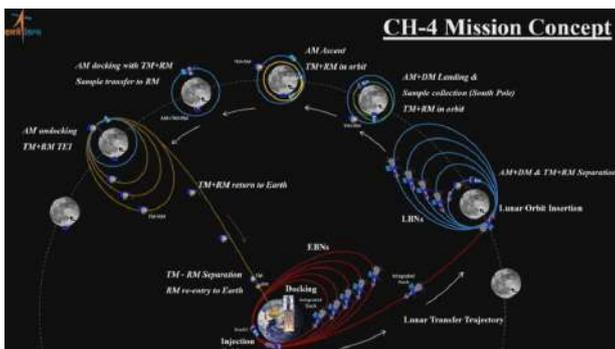
- The Solar Ultraviolet Imaging Telescope (SUIT) onboard the Aditya-L1, has captured an unprecedented view of **a powerful solar flare 'kernel'** in the lower solar atmosphere.
- SUIT is a unique space telescope developed by Pune's **Inter-University Center for Astronomy and Astrophysics (IUCAA)**.
- The SUIT telescope will address fundamental questions such as the **existence of a higher temperature atmosphere** above the cooler surface of the Sun and the origin and **variation of near-ultraviolet radiation** and high-energy solar flares.
- **Solar flare kernels** are compact features located in the **solar chromosphere** that are the sites of rapid heating and plasma upflow during the rise phase of flares.
- It is an energy release site in the corona that leads **to either a stream of non-thermal particles or a thermal conduction front** being directed down the coronal loop legs toward the photosphere.
- Heating then occurs in the chromosphere leading to flare ribbons and brightenings, and hot plasma rises toward the flare site, giving bright post-flare loops.

## Vikram & Kalpana

- The **Indian Space Research Organisation (ISRO)** recently announced the development of two advanced 32-bit microprocessors, Vikram 3201 and Kalpana 3201.
- Vikram 3201 is **India's first fully indigenous 32-bit microprocessor qualified for use in the harsh conditions** of launch vehicles.
- It is an advanced version of the **16-bit Vikram 1601 microprocessor**, which has been operational in Isro's launch vehicles since 2009.
- **Kalpana 3201** is also a 32-bit microprocessor designed to be compatible with **open-source software toolsets** and has been tested with **flight software**, making it versatile for various applications.

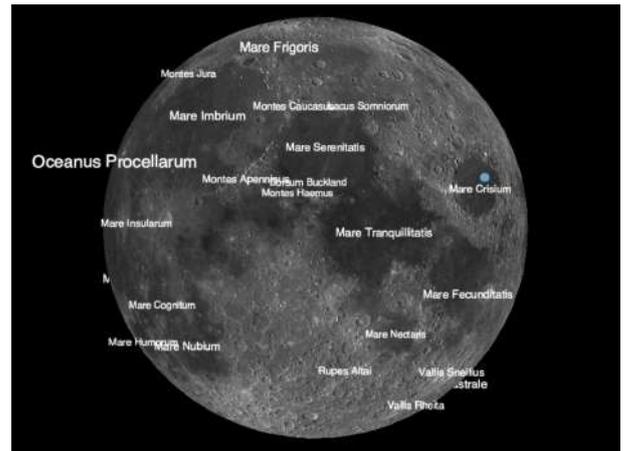
## De-docking Mission

- ISRO successfully completed the de-docking of the Space Docking Experiment (SpaDeX) satellites, **SDX-01 (Chaser)** and **SDX-02 (Target)**, launched on PSLV-C60 on December 30, 2024.
- This **precise separation in space**, achieved on March 13, 2025, followed their successful docking on January 16, 2025.
- **De-docking** is the process of carefully separating two spacecraft that have previously been connected (docked) in the microgravity environment of space.
- Key **steps** included extending SDX-2 and releasing capture levers, culminating in a flawless separation via de-capture commands.
- This achievement positions **India as the fourth nation globally to demonstrate space docking technology**.



## Blue Ghost Mission

- The US private agency **Firefly Aerospace's Blue Ghost lunar lander**, carrying NASA scientific instruments, successfully **landed on the Moon's Mare Crisium region**.
- This marks the first successful private lunar landing without crashing.
- **Mare Crisium** is located on the northeastern edge of the Moon's near side.
- This achievement **places Firefly alongside only five national space agencies** (Russia, US, China, India, and Japan) that have accomplished soft lunar landings.
- **Launched on a SpaceX Falcon 9** on January 15, 2025, the Blue Ghost carries 10 NASA payloads under the Commercial Lunar Payload Services (CLPS) program to study lunar heat flow and plume-surface interactions, aiming to improve our understanding of the Moon's interior and landing techniques.



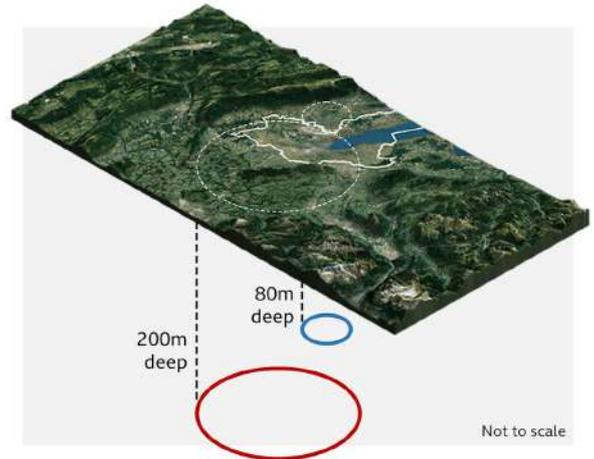
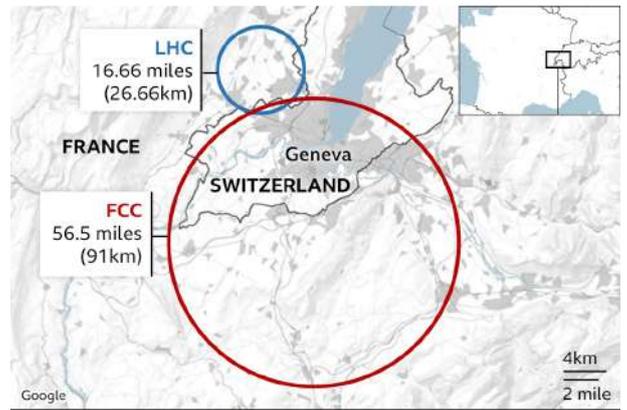
## Three Gorges Antarctic Eye Telescope

- China recently inaugurated the **Three Gorges Antarctic Eye** at the **Zhongshan Station, Antarctica**.
- The Telescope is a **3.2-metre aperture radio/millimetre-wave telescope**.
- It is designed to observe **neutral hydrogen (HI) and ammonia (NH<sub>3</sub>)**—two key markers in the vast nurseries where stars are born.
- By **mapping and analyzing these gases**, scientists aim to piece together a clearer picture of the **star formation process, galactic structure**, and the life cycles of cosmic matter.

- The telescope could survive temperatures that **plunge below  $-50^{\circ}\text{C}$**  and withstand wind speeds that could flatten a truck.
- At present, **70 permanent research stations are scattered across Antarctica**, representing 29 countries from every continent on Earth.
  - India has two active research stations – **Maitri and Bharti**.
  - The US has six stations and Australia has three.



### Proposed particle collider will be largest ever



Source: Cern

BBC

## The Future Circular Collider (FCC)

- CERN, the European Organization for Nuclear Research which runs the Large Hadron Collider (LHC), is pushing plans to build the three-times bigger (and faster) Future Circular Collider, which could cost as much as 20 billion euros.
- The FCC is planned as an underground circular tunnel with a **circumference of 90.7 km** and access shaft depths between 180 and 400 m, with eight surface sites and four experiments.
- The tunnel would initially house the **FCC-ee, an electron-positron collider** for precision measurements offering a 15-year research programme from the late 2040s.
- A second machine, the **FCC-hh**, would then be installed in the same tunnel, reusing the existing infrastructure, similar to when the LHC replaced the Large Electron-Positron collider (LEP).
- The **FCC-hh aims to reach collision energies of 100 TeV (tera-electronvolt)**, colliding protons and also heavy ions, and running until the end of the 21st century.

## ESA Biomass Mission

- The European Space Agency (ESA) successfully completed the launch of its **Biomass satellite** from the European Spaceport in Kourou, French Guiana.
- The mission will **map the world's forests to provide the very first comprehensive measurements of forest biomass** at a global scale.
- The data on forest biomass — **the mass of organic matter in forests** — are severely lacking on a global scale.
- To fulfil its objectives, the mission will **use a synthetic aperture radar (SAR) to map the Earth's surface**.
- This SAR sensor will operate in the long-wave P-band frequency range, **with a wavelength of 70 cm**.
- The **Biomass antenna reflector transmits the radar's footprint** onto Earth's surface and receives the returned signal, which carries information about the carbon content of forests.

## Lucy Spacecraft Flyby

- **NASA's Lucy spacecraft** successfully flew past **asteroid (52246) Donaldjohanson** at 48,000 km/h, passing within 960 km.
- The 4-km-wide, **carbon-rich asteroid** in the inner regions of the asteroid belt, likely broke off a larger body 150 million years ago and rotates every 251 hours, suggesting an elongated shape.
- The flyby is part of **Lucy's 12-year mission to explore 11 asteroids**, including 8 Jupiter Trojans, with its next major encounter set for 2027 with asteroid Eurybates and its moon Queta.
- Lucy is named after the finding of a **fossilised hominid skeleton found in Ethiopia in 1974**.
  - The asteroid Donaldjohanson was named in honour of Dr Donald Johanson, the **paleoanthropologist who found the Lucy fossil**.



## Tianwen-2 Asteroid Mission

- China recently launched its first mission, **Tianwen-2**, to survey and sample a near-Earth asteroid.
- The probe will investigate an asteroid called **469219 Kamo'oalewa**, which orbits the Sun at a distance relatively close to Earth. It measures just 40 to 100 metres in diameter.
- If successful, China will join the US and Japan in returning asteroid samples.
- Kamo'oalewa was discovered in 2016 by the **Pan-STARRS 1 asteroid survey telescope** on Haleakalā in Hawaii.
- It is one of just seven asteroids that fall into a little-understood class known as **quasi-satellites of Earth**.

➤ These are satellites that orbit the Sun, but because of their close distance to Earth, they are gravitationally influenced by the planet.

- To collect the samples, the Tianwen-2 mission will use a **“touch-and-go”** technique where the spacecraft **hovers close to the surface** of the asteroid while a robotic arm **fires an object or burst of gas to knock fragments** into a collection chamber.
- Depending on the surface conditions, the Tianwen-2 probe might also use a second **“anchor and attach”** technique.
  - In this, four robotic arms extend and drill into the surface to retrieve material.

## Shiv Shakti point

- In a new finding, scientists of the Physical Research Laboratory (PRL), Ahmedabad have revealed that the **landing site (Shiv Shakti point) of the Chandrayaan-3 mission** is a promising site to access primitive mantle samples.
- The Shiv Shakti point is located at the **southern high-latitude highlands of the nearside of the Moon**.
- The scientists have analysed the **concentrations of volatile elements** measured at Shiv Shakti station near the **South Polar Region**, using the Alpha Particle X-ray Spectrometer (APXS) onboard the **Pragyan rover of the mission**.
- They compared metal remnants and elemental concentrations of **sulfur, potassium, sodium among others**.
  - Sulfur, potassium and sodium can give insights into the mantle composition and chemistry.



## Axiom Mission 4 (Ax-4)

- **Group Captain Shubhanshu Shukla** created history, becoming the first Indian astronaut to reach the **International Space Station (ISS)** as the Axiom-4 (Ax-4) mission successfully docked with the orbiting laboratory, 41 years after **Rakesh Sharma's 1984 mission**.
- The Ax-4 crew, launched aboard a **SpaceX Dragon spacecraft** from Nasa's Kennedy Space Centre, completed a 28-hour journey before executing a flawless docking manoeuvre at the **ISS's Harmony module**.
- Axiom Mission 4 is the **fourth all-private astronaut mission** to the orbiting laboratory.

**SPACE ODYSSEY: SHUX IN PILOT'S SEAT**

**IFT-OFF:** Wednesday 12.01pm IST from Kennedy Space Center, Florida.  
**DOCKING:** Capsule to dock with International Space Station at 4.30pm IST, Thursday



**Tibor Kapu, 33** (Hungary) – Mission specialist  
**Shubhanshu Shukla, 39** (India) – Pilot  
**Peggy Whitson, 65** (US) – Commander  
**Sławosz Uzmański, 41** (Poland) – Mission specialist

▶ Shukla is second-in-command, after mission commander Peggy Whitson  
 ▶ He monitors and intervenes if automation fails  
 ▶ He assists in spacecraft operations, navigation and control during launch, docking, re-entry, and landing  
 ▶ Once docked with ISS, he will join experiments, tech demos, and outreach events

**MISSION DURATION 14 DAYS**

“The tricolour on my shoulder tells me that I am not alone, I am with all of you – **Shubhanshu Shukla**”  
 “Shukla carries with him the wishes, hopes and aspirations of 1.4 billion Indians – **PM Narendra Modi**”

- The **NISAR** (NASA-ISRO Synthetic Aperture Radar) satellite, jointly developed by ISRO and NASA, was launched on the **GSLV-F16** from **Sriharikota** — the first GSLV mission to place a satellite in a sun-synchronous polar orbit.
- A **sun-synchronous orbit (SSO)** is a type of polar orbit where a satellite passes over any given point on Earth at the same local solar time.
- This means that every time the satellite is overhead, the **sun is at the same angle** in the sky, providing consistent lighting conditions.
- With a five-year mission life, NISAR uses dual-frequency SAR (**NASA's L-band and ISRO's S-band**) and a 12-metre mesh reflector to provide all-weather, day-and-night Earth observations every 12 days.
- It will aid in **monitoring infrastructure** (subsidence and urban development), **natural disasters** (earthquakes, floods, landslides), **crop mapping, ground deformation, ice movement**, soil moisture, surface and ground water, and more, supporting disaster response and resource management.

Synthetic Aperture Radar (SAR) is a method of remote sensing that uses radar to create high-resolution images of landscapes and objects from a moving platform like a satellite or aircraft. Unlike optical cameras, SAR can produce clear images day or night and through clouds, rain, or smoke.

## NISAR Satellite Launched

**Watching from above**

NISAR, which has a mission life of five years, will observe Earth with a swathe of **242 km** and high spatial resolution



**Key applications include:** Shoreline monitoring, storm characterisation, mapping of surface water resources, and disaster response

**1** It is the first major earth-observing **satellite with radars of two frequencies**

**2** The radars will allow **NISAR to monitor both surface and subsurface changes** through clouds, smoke, vegetation

- Its scan-on-receive method will give a spatial resolution of **3-10 metres** and centimetre-scale vertical mapping

**Giant leap:** ISRO's GSLV-F16 carrying the NISAR satellite lifts off from Sriharikota on Wednesday. AP

## India's Atlantic Deep Ocean Dive

- India reached a new milestone in ocean exploration recently where two Indian aquanauts descended to depths of 4,025 and 5,002 metres in the Atlantic Ocean which places **India among fewer than six nations to explore such extreme ocean depths**.
- The **expedition was conducted with IFREMER**, the French marine research institute and the Indian aquanauts boarded the **Nautilie submersible** from the research ship L'Atalante near Portugal.
- This sets the stage for India's upcoming **Samudrayan Mission**, which aims to reach 6,000 metres using the indigenous submersible MATSYA-6000 by 2027.
- **Samudrayaan aims to send three aquanauts to a depth of 6,000 meters** in the indigenously developed submersible MATSYA-6000 by 2027.
- MATSYA-6000 is first-of-its-kind, **fourth-generation scientific submersible designed for an operational endurance of 12 hours and an emergency endurance of up to 96 hours**.

## Lunar Module Launch Vehicle (LMLV)

- The **Indian Space Research Organisation (ISRO)** is developing its **heaviest rocket**, named the Lunar Module Launch Vehicle (LMLV), aimed **to be ready by 2035 for lunar missions, including the planned first human mission to the Moon by 2040.**
- It is an **improved version of the NGLV (Next Generation Launch Vehicle)** and designed to be as tall as a 40-storey building, surpassing the current most powerful rocket, the LMV-3.
- It is being designed as a **three-stage heavy-lift rocket** with advanced propulsion technologies where the first two stages rely on liquid propellants, while the third stage will employ cryogenic propulsion.
- It is capable of carrying a payload limit of approximately **27 tonnes to the Moon** and **80 tonnes to low Earth orbit (LEO).**
- It **enables crewed lunar missions by 2040, carry larger payloads to the Moon, support deep space exploration and also helps to enhance India's self-reliance in human spaceflight technology.**

## Integrated Air Drop Test (IADT-1)

- Recently, **Indian Space Research Organisation (ISRO)** successfully conducted its first Integrated Air Drop Test (IADT-1) for the **Gaganyaan mission.**
- It aimed to validate the **performance of the parachute-based deceleration system** for the **Crew Module (CM)** of the Gaganyaan mission in a real-world scenario.
- It was a **critical exercise** to validate the parachute system that will bring back astronauts safely under the Gaganyaan mission.
- The test involved collaborations between **ISRO, Defence Research and Development Organisation (DRDO), the Indian Air Force, Indian Navy, and Indian Coast Guard.**

### Gaganyaan mission:

- It is **India's first human spaceflight program**, aiming to **send a crew of 3 astronauts to Low Earth Orbit (LEO) at 400 km** for 3 days and return them safely to Earth.

- It is launched in **Human-Rated Launch Vehicle (HLVM3)** which is a modified version of ISRO's LVM3 rocket, **including solid, liquid, and cryogenic stages**, re-configured to meet human rating requirements.
- It will place **India among the elite group of nations (US, Russia, China)** with human spaceflight capability.



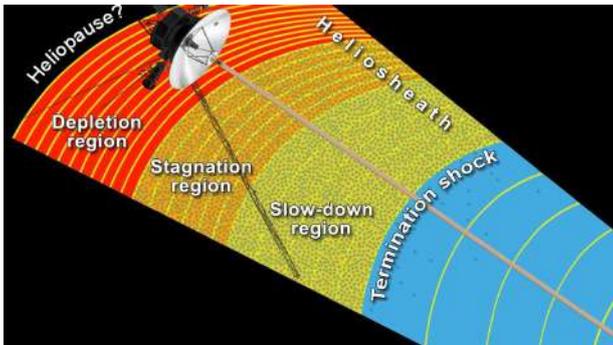
## Orbiting Carbon Observatory (OCO)

- Recently, the Trump administration asked to shut down NASA's Orbiting Carbon Observatories (OCO) program.
- OCOs are a series of dedicated **Earth remote sensing satellites** that were designed **specifically to observe atmospheric CO2 from space** in order to better understand the characteristics of climate change.
- The first mission of the series failed soon after launch in February 2009.
- A replacement satellite, **OCO-2**, was launched in July 2014, was built **based on the original OCO mission** to minimise cost, schedule, and performance impacts.
- In 2019, a third mission, **OCO-3**, was **sent to the International Space Station (ISS)** to further enhance the observation of atmospheric CO2.
- NASA and other agencies have used the data from this **to create high-resolution maps of plant growth around the world** that's useful to farmers, useful to rangeland and grazing and **drought monitoring and forest mapping** and all kinds of things, in addition to the CO2 measurements.



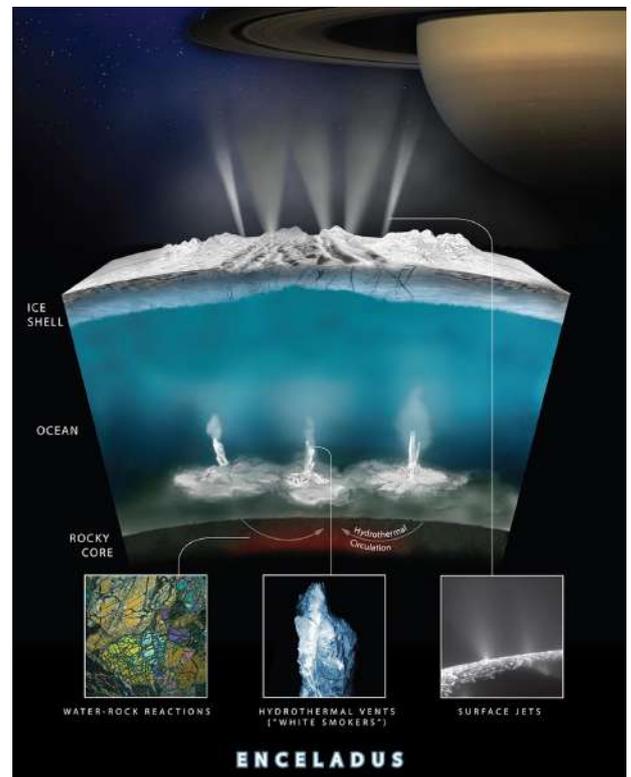
## NASA's IMAP Mission

- The NASA **Interstellar Mapping and Acceleration Probe (IMAP)** was recently launched to study the **heliosphere**, the solar wind-forming a protective bubble around our solar system.
- Equipped with **10 instruments**, IMAP **detects** charged particles, neutral atoms, magnetic fields, interstellar dust, and solar-wind structures.
- It will orbit the **Sun–Earth Lagrange Point 1 (L1)**, 1.6 million km from Earth, providing continuous observations and near real-time space weather data.
- IMAP will map the heliosphere's boundary, track particle acceleration, and study interstellar hydrogen and deuterium at the heliopause, offering the most **detailed insights into solar–interstellar interactions**.



## Organic Molecules on Saturn's Moon

- Scientists analyzing **NASA's Cassini data** have found new evidence that Saturn's icy moon **Enceladus** may harbour conditions suitable for life.
- Despite **frigid temperatures** (~-330°F), Enceladus has a **subsurface saltwater ocean**, with **water plumes from its South Pole** indicating active hydrothermal processes.
- **Ice particles collected by Cassini** revealed diverse organic compounds, including esters and ethers, which on Earth are key for life, suggesting potential habitability.
- **Cassini Mission** was a joint NASA-ESA-ASI mission which studied Saturn, its rings, and moons for 13 years (2004–2017).
- Cassini flew by Enceladus multiple times and collected data from its plumes
- Its **Huygens probe** landed on **Titan** in 2005, returning images and data.



## ISRO's Vyommitra

- **ISRO** will send the **first humanoid robot 'Vyommitra' to space** to aid in space-exploration and test environments before manned missions of Gaganyaan planned for 2027.
- **Vyommitra**, meaning "Space Friend," is ISRO's **indigenously developed female half-humanoid robot (head and torso only)**.
- It was designed by the **ISRO Inertial Systems Unit (IISU), Thiruvananthapuram**, and first unveiled on 22 January 2020 in Bengaluru.
- It is set to fly aboard the **Gaganyaan G1 uncrewed mission in December 2025** on the **LVM-3 rocket**, acting as a human proxy to test the Crew Module, life-support systems, and Environmental Control and Life Support System (ECLSS).
- Equipped with **AI and an aluminium alloy frame**, Vyommitra can speak **Hindi and English**, **operate six control panels**, monitor CO<sub>2</sub>, O<sub>2</sub>, temperature, and pressure, issue real-time warnings (e.g., air leaks, fire), conduct microgravity experiments, and communicate live with ISRO's ground station.
- By replacing animal testing and gathering critical radiation and microgravity data on a human-like form, **Vyommitra ensures crew safety** — making it a 100% Made-in-India milestone in human spaceflight.



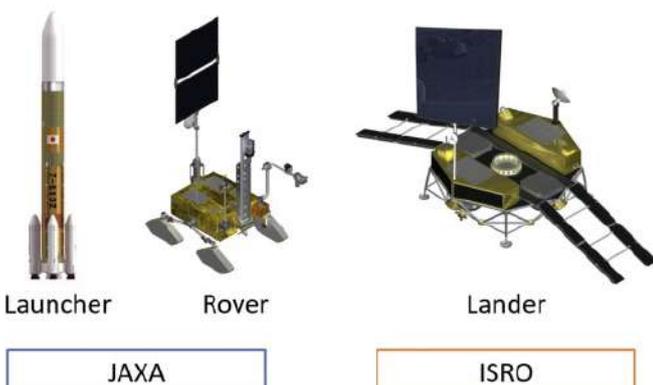
## MAVEN Mars Orbiter



- NASA's **Mars Atmosphere and Volatile Evolution (MAVEN)** spacecraft, launched in 2013 and operational around Mars since 2014, is the **first mission dedicated to studying the planet's upper atmosphere** and its escape into space.
- MAVEN measures the present rate at which atmospheric gases are lost to space to reconstruct how Mars' climate changed over time, showing that **nearly two-thirds of Mars' early atmosphere has escaped**.
- It orbits Mars every **3.5 hours**, dipping as close as **150 km** above the surface to directly sample the upper atmosphere.

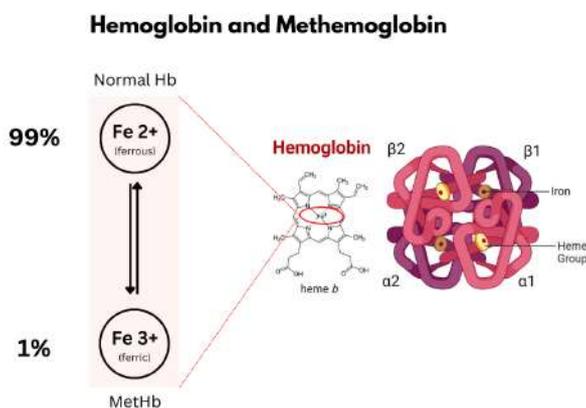
## LUPEX (LUNar Polar EXploration) Mission

- A **Japanese delegation** recently reviewed **ISRO's LUPEX (Chandrayaan-5) mission**, a joint project with **JAXA**.
- The **Lunar Polar Exploration Mission (LUPEX/ Chandrayaan-5)** is a planned **ISRO-JAXA joint mission** to send an **uncrewed lander and rover** to the Moon's **south pole no earlier than 2028**, exploring shadowed regions and assessing water.
- **JAXA** will provide the **H3 rocket and rover**, while **ISRO** will supply the **lander** and some instruments.
- LUPEX follows the planned **Chandrayaan-4 lunar sample-return mission**.
- The rover will carry instruments from **ISRO, JAXA, NASA, and ESA**.



## Methemoglobinemia

- The Central Ground Water Board (CGWB) annual assessment found excessive **nitrate (NO<sub>3</sub><sup>-</sup>)** in groundwater.
- Nitrate levels above 45 mg/L pose health risks, especially **methemoglobinemia (Blue Baby Syndrome)**.
- When **nitrate** is ingested, it is converted into **nitrite (NO<sub>2</sub><sup>-</sup>)** by bacteria in the body.
- This nitrite then **oxidizes the iron (Fe<sup>2+</sup>) in hemoglobin to Fe<sup>3+</sup>**, forming **methemoglobin**, which cannot bind and transport oxygen effectively.
- Infants have lower levels of **methemoglobin reductase** (responsible for converting methemoglobin back to hemoglobin) in their RBCs or erythrocytes and are consequently more vulnerable to these agents than adults.



## Esterase

- Indian researchers have successfully used an enzyme esterase from soil bacteria **to break down diethyl hexyl phthalate (DEHP) plasticizer**.
- The esterase enzyme is produced by soil bacteria **Sulfobacillus acidophilus**.
- Plasticizers are **chemicals added to plastics and personal care products** to enhance flexibility and shine.

- DEHP** plasticizer is found in baby toys, shampoos, and food containers, plasticizers pose health risks due to skin absorption.
- The enzyme degrades DEHP into **mono-(2-ethylhexyl) phthalate (MEHP)** and **2-ethyl hexanol**.
- It can also bind to **polypropylene**, aiding in plastic removal from water.
- The enzyme remains active for **about a month and catalyzes the degradation of DEHP plasticizer** with significant efficiency.

## Trichophyton (T.) indotineae

- Dermatologists from India and 13 other countries, including Germany, have **objected to the region-specific nomenclature** given to a novel species of fungus — **Trichophyton (T.) indotineae**.
  - T. indotineae causes widespread and **hard-to-treat skin infections** and is resistant to most anti-fungal medicines.
  - The fungal species has turned up in over 40 countries and its **origin currently remains unknown**.
  - Strains now referred to as T. indotineae had been detected **not just in India but also in other countries** like Australia, Oman, and Iran.
- 👉 Hence dermatologists object naming the fungus after India as unjustified and incorrect

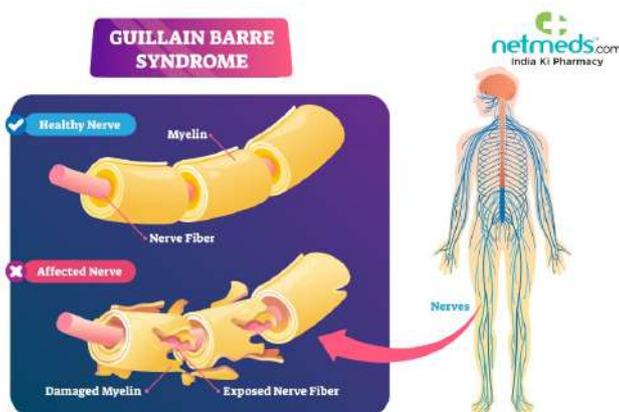
## Methylcobalamin

- The Food Safety and Standards Authority of India (FSSAI)** has provided clarity on use of methylcobalamin, **a form of Vitamin B12**, in health supplements, medical purposes and nutraceutical products.
- The permitted forms of Vitamin B12 currently include **cyanocobalamin and hydroxocobalamin**.

- Most of the Indian population is deficient in methylcobalamin due to a number of factors and most important among them is **the higher vegetarian population**.
- Best source for methylcobalamin is milk and milk products.
- Vitamin B12, a **crucial water-soluble vitamin**, is integral to DNA synthesis, red blood cell production, and neurological function.
- Deficiency in this vitamin can lead to **serious health consequences**, often requiring supplementation.

## Guillain Barre Syndrome

- Pune reported an outbreak of **Guillain-Barré Syndrome (GBS)** with 73 cases.
- GBS is a rare **autoimmune neurological disorder** where the immune system attacks the **peripheral nerves**, damaging the **myelin sheath**—an insulating layer that helps nerve signals travel efficiently.
- This leads to **muscle weakness and potential paralysis**.
- GBS can affect any age but is more common in **adults and males**, with an incidence of **1-2 per 100,000** people.
- According to the **WHO**, infection with **Campylobacter jejuni** (a cause of gastroenteritis) is a major risk factor, along with **viral infections and vaccinations**.

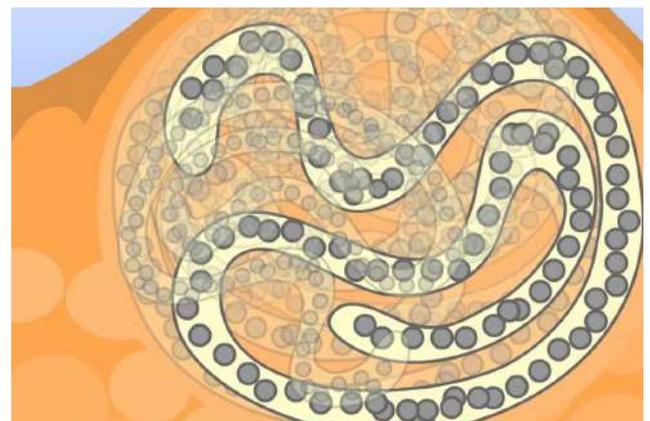


## Foetus in fetu (FIF)

- Doctors at Buldhana District Women's Hospital, Maharashtra, detected a rare "**foetus in fetu**" case, where an underdeveloped twin is enwrapped inside the body of the other in a monozygotic twin pregnancy.
- This rare congenital disorder, affecting about **1 in 500,000 births**, results from an uneven embryo split, leaving one twin trapped within the other.
- The **parasitic twin**, dependent on the host twin for nutrients, has some fetal features but cannot survive independently.
- In this case, it was detected during a routine scan, and doctors successfully removed it after a C-section delivery.

## Onchocerciasis

- The World Health Organization (WHO) recently congratulated Niger for having met the **criteria for onchocerciasis elimination**.
- Onchocerciasis, also known as river blindness, is a **neglected tropical disease (NTD)** caused by the **parasitic worm Onchocerca volvulus**.
- This makes it the **fifth country globally and the first country in Africa** to be acknowledged by WHO.
- It is transmitted through the **bite of infected blackflies (Simulium species)**, which breed near fast-flowing rivers and streams.
- The disease primarily affects **sub-Saharan Africa**, with some cases in **Latin America and Yemen**.
- **Symptoms** include severe itching, skin rashes, nodules under the skin, and progressive vision impairment that can lead to blindness



## Brucellosis Disease

- An **eight-year-old girl** from Kerala, **died from brucellosis** after two months of treatment.
- **Brucellosis** is a bacterial disease caused by **Brucella species**, mainly affecting cattle, goats, sheep, and dogs.
- **Humans** get infected through **direct contact, consuming contaminated animal products, or inhaling airborne agents**, with unpasteurized milk and cheese being the most common sources.
- **Symptoms** include **fever, weakness, weight loss, and discomfort**, with an incubation period of **one week to two months**.
- **Treatment** involves **doxycycline (45 days) and streptomycin (15 days)**.
- **Prevention** includes **vaccinating animals and pasteurizing** milk and dairy products.
- Brucella is known as the “**Great Imposter**” as the clinical signs in both humans and animals can be mistaken for other illnesses.
- There are **12 known species** of Brucella, with the most common ones causing human brucellosis being **Brucella melitensis** (from goats and sheep), **Brucella abortus** (from cattle), **Brucella suis** (from pigs), and **Brucella canis** (from dogs).
- Other species primarily affect marine animals and wildlife.

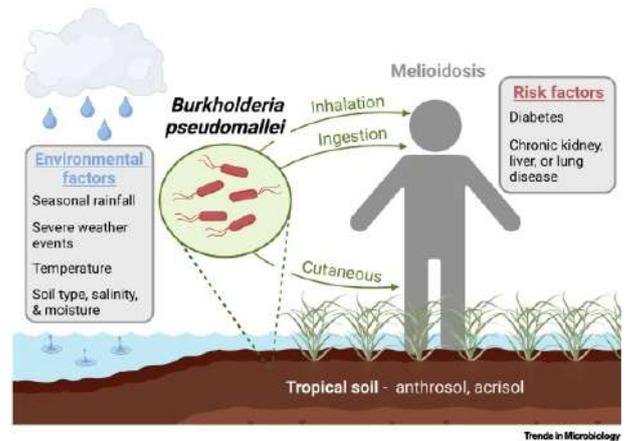
## Selenium

- Sudden hair loss cases in Maharashtra's Buldhana district were linked to high **selenium levels in wheat** from Punjab and Haryana supplied through ration shops.
- Selenium, essential in **small amounts for metabolism**, has a recommended daily intake of 20–70 mcg, with a tolerable upper limit of 400 mcg.
- Excess selenium can cause **selenosis**, leading to symptoms like hair loss, brittle nails, nausea, fatigue, skin rashes, garlic-like breath odor, and neurological issues.

☞ Severe cases may result in gastrointestinal problems, respiratory distress, and even organ damage.

- Selenium is an **essential trace element** that acts as an antioxidant, supports immunity, thyroid function, and metabolism.
- Found in **soil and foods** like nuts, seafood, and grains, it is crucial for **selenoprotein formation**.
- It also has **industrial uses** in glassmaking and electronics.

## Melioidosis in Odisha



- A study in Odisha has shown a clear **seasonality for melioidosis**, a tropical bacterial disease caused by **Burkholderia pseudomallei** found in soil and water.
- Infections **peak during and after the monsoon**, highlighting the influence of rainfall, temperature, and humidity.
- Globally, **South Asia, including India, accounts for a significant portion (44%)** of the estimated 1,65,000 annual melioidosis cases.
- The disease presents with **diverse symptoms**, from minor skin infections to severe pneumonia and potentially fatal sepsis (up to 50% mortality in septicaemic cases).
- **Humans and animals can contract it** through contact with contaminated soil or water, often through skin abrasions, inhalation, or ingestion.
- Treatment requires lengthy antibiotic courses and currently there is **no widely available vaccine for melioidosis**.

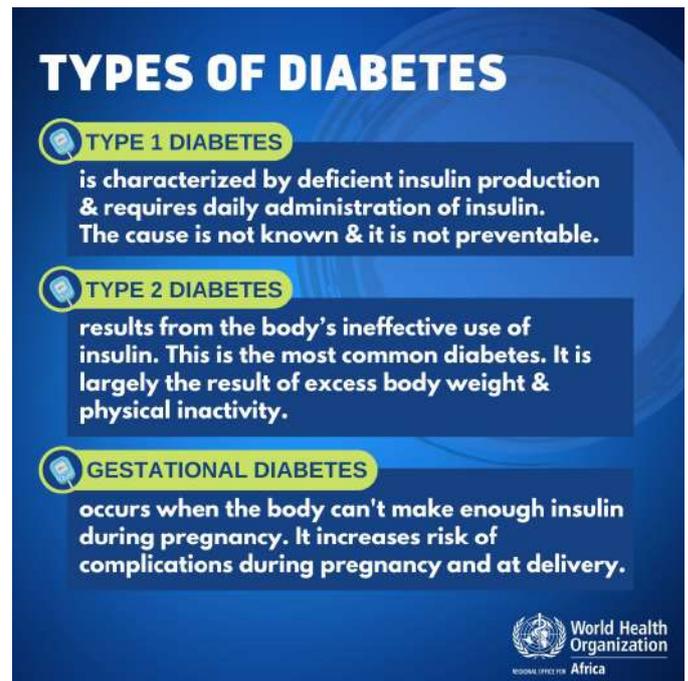
## Viral Meningitis

- Five students in Kalamassery, Ernakulam, Kerala, are receiving medical treatment for suspected viral meningitis.
- **Meningitis is the inflammation of the protective membranes** (meninges) covering the brain and spinal cord, caused by viral, bacterial, or fungal infections.
- **Viral meningitis, generally less severe than bacterial**, typically resolves without complications with symptoms like fever, headache, nausea, vomiting, and photophobia, requiring close observation, pain relief, fluids, and nutritional support.
- **Most cases clear up within one to two weeks**, often caused by enteroviruses that spread from the mouth or respiratory tract to the meninges.
- In contrast, **bacterial meningitis is a medical emergency** needing immediate diagnosis and antibiotic treatment to prevent severe complications or death.

## Type 5 diabetes

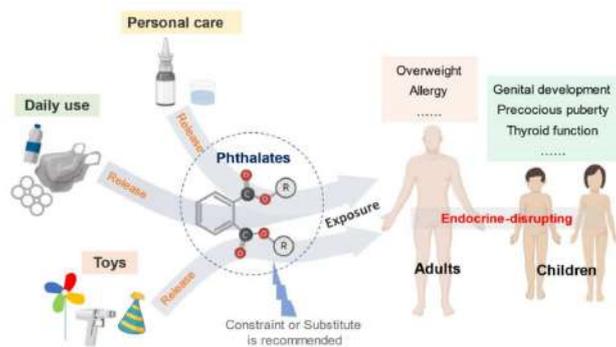
- The International Diabetes Federation (IDF) has officially recognised **malnutrition-related diabetes** as “**Type 5 diabetes**” at its World Diabetes Congress in Bangkok.
  - First described in Jamaica in 1955, this form of diabetes mostly affects **lean, malnourished teens and young adults** in low- and middle-income countries, with an estimated **25 million cases globally**.
  - Often misdiagnosed as Type 1 or 2, it has a **distinct metabolic profile** likely linked to impaired pancreatic development due to **chronic childhood undernutrition**.
  - Type 5 diabetes is marked by **low insulin secretion, low glucose production, and high glucose uptake**, making standard insulin therapy unsuitable and potentially dangerous.
  - Emerging evidence suggests that **low-dose insulin with oral agents** may offer a safe, cost-effective treatment.
  - Importantly type 3 and type 4 Diabetes has not been officially recognised yet.
- “**Type 3 diabetes**” is a **proposed** term for **Alzheimer’s disease**, suggesting it may be linked to brain insulin resistance.

- “**Type 4 diabetes**” refers to insulin resistance in **older adults** who are not overweight or obese, potentially underdiagnosed.



## Phthalates and Cardiovascular Deaths

- A new study has found that daily **exposure to phthalates** has been related to over 13% deaths in the world due to heart disease in 2018, among those aged 55-64.
- **Phthalates** are a group of chemical compounds primarily used to make plastics like **polyvinyl chloride (PVC)** more flexible, durable, and long-lasting.
- India had the highest count at 103,587 deaths, followed by China and Indonesia.
- The study focused on a kind of **phthalate called 'di-2-ethylhexyl phthalate (DEHP)**.
- DEHP is used for making plastics in items, such as **food containers, softer** and others.
- Data, including those from urine samples, was analysed to discern amounts of products formed due to a chemical breakdown of the phthalate.
- Exposure to this compound has been studied to **trigger inflammation in the heart's arteries**, which, over time, is associated with increased risk of heart attack or stroke



## Statins

- A study has found that **Statins, which are drugs that help lower ‘bad’ cholesterol**, could lower the death rate by nearly **40% for critically ill patients with sepsis**.
- **Sepsis**, in which the body’s immune system overreacts to an infection with an exaggerated inflammatory response, can cause organ damage and be life-threatening.
- Statins, mainly used for protecting against **cardiovascular disease**, are being studied for treating inflammatory disorders.
- They work by blocking an enzyme called **HMG-CoA reductase** that our body uses to make cholesterol.
  - This will lower the amount of cholesterol your body makes.

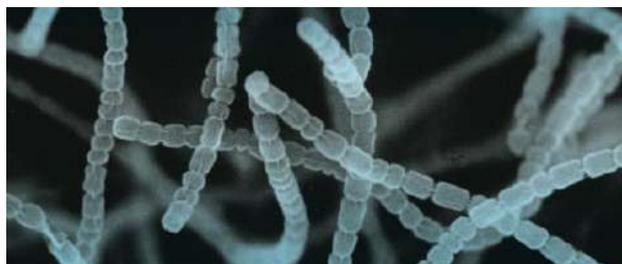
## Advanced Proton Therapy

- **Step-and-Shoot spot-scanning proton arc therapy (SPArc)** has been used for the first time to treat **adenoid cystic carcinoma**, a head and neck tumour.
- SPArc is an advanced form of **proton therapy**, a type of radiation treatment that uses **protons instead of X-rays** to treat cancer.
- It is especially useful for treating **hard-to-reach or sensitive areas**, such as head and neck tumors and **works by targeting tumours with protons** while sparing surrounding tissue.
- The SPArc methods reduced **radiation delivered** to the brainstem (by 10%), optic chiasm (56%), oral cavity (72%), and spinal canal (90%) over other techniques.

- The treatment used a computer program that mapped all spots and energy levels where proton beams could be delivered.
  - An **energy layer** refers to a specific depth in the body that receives proton beams of a particular energy—**higher energy reaches deeper tissue**, while lower energy treats shallower areas.
- The machine scans and delivers radiation to multiple spots within one energy layer, then switches to the next energy level to target deeper tissue, gradually **“painting” the entire tumour** with precise, controlled doses.

## Actinobacteria

- The **Rajgir hot spring in Bihar**, has been identified as a site where thermophilic **Actinobacteria**, a group known for producing antibiotics, are abundant.
- **Thermophiles** (meaning “heat lovers”) have been known to tolerate 45° to 70° C of heat.
- Such high temperatures offer a **mineral-rich neighbourhood** with relatively few competing life forms.
- To gain an edge, **some thermophilic bacteria produce potent antibiotics** as weapons to neutralise their competitors.
- **Actinobacteria** are well-known for producing antibiotics like streptomycin, tetracycline, and erythromycin.
- The discovery is crucial because it offers potential solutions to the **growing problem of AMR**, which is a major threat to global health.
- **Actinobacteria** often produce unique enzymes and compounds that are **stable at high temperatures**, making them valuable for industrial processes.
- Researchers used **metagenomics** that allows DNA/RNA analysis directly from environmental samples without culturing organisms to conduct the study.



## Legionnaires' Disease

### Legionnaires' disease

Five people who developed Legionnaires' disease in Lincoln, New Hampshire, may have been exposed to contaminated water droplets from a cooling tower behind a resort

Legionnaires' disease is a form of pneumonia caused by bacteria typically found in warm, moist places.

Named after outbreak of 182 cases at the American Legion convention in Pennsylvania in 1976

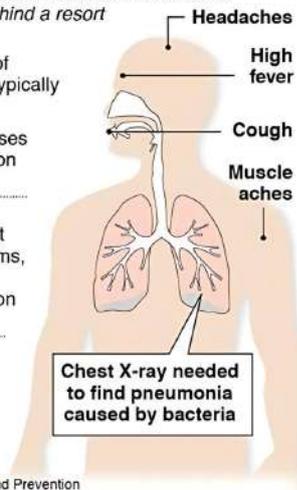
Caught by breathing mists from contaminated water source; most likely from air-conditioning systems, whirlpool spas, cooling towers; cannot be spread from one person to another

Time between exposure and symptoms 2 to 14 days

Treatment Antibiotics

Death rate Without treatment, 5 to 30 %

Source: U.S. Centers for Disease Control and Prevention  
Graphic: Staff, TNS



- New York City reported an increase in the ongoing **Legionnaires' disease outbreak**.
- **Legionnaires' disease** is a type of pneumonia caused by the bacteria legionella, which grows in warm water.
- It can be caused by plumbing systems where conditions are favorable for legionella growth, such as **cooling towers, whirlpool spas, hot tubs**, humidifiers, hot water tanks and evaporative condensers of large air-conditioning systems."
- The disease **cannot be transmitted person to person** but can be contracted from **breathing water vapor with the bacteria**.

## Tribal Genome Sequencing Project

- Gujarat has recently **become the first Indian State** to launch a genome sequencing initiative focused exclusively on tribal communities.
- The project, titled "Creation of Reference Genome Database for Tribal Population in Gujarat", is being implemented by the **Gujarat Biotechnology Research Centre (GBRC)**.
- The Project was announced with the aim of **identifying genetic health risks and enabling precision healthcare** for tribal populations.
- The initiative will sequence the genomes of 2,000 individuals from tribal communities across 17 districts in the State.

- The initiative will focus on **early detection and targeted treatment of genetic disorders** such as sickle cell anaemia, thalassaemia, and certain hereditary cancers

## Primary Amoebic Meningoencephalitis – PA

- Recently, three cases of primary amoebic meningoencephalitis (PAM) have been reported in Kerala, leading to the death of a 9-year-old and infecting a 3-month-old baby.
- It is a rare and often **fatal brain infection** caused by **Naegleria fowleri amoeba** or **brain-eating amoeba**, found in contaminated warm, freshwater sources like wells and ponds.
- Amoeba **enters the body through the nose** during swimming or bathing in contaminated freshwater, travels to the brain, causing tissue destruction and swelling and **it is not transmitted through drinking water or person-to-person**.
- Early symptoms include **headache, fever, nausea, vomiting, progressing to a stiff neck, confusion, seizures, hallucinations, and coma**.
- **Mortality is extremely high (>95%)**, with most patients dying within 1–18 days, often within 5 days of onset.
- There is **no effective treatment available**, currently combination of drugs including amphotericin B, azithromycin, fluconazole, and others are recommended to manage the infection.

## Rubella

- The **World Health Organization (WHO)** declared **Nepal free of rubella as a public health problem** in August 2025, making it the **first country in WHO's Southeast Asia Region to achieve** this milestone.
- Rubella (**German measles**), is a highly contagious **viral infection** caused by the **rubella virus**, an enveloped single-stranded RNA virus, which causes mild fever and rash.
- It **spreads through respiratory droplets** when an infected person coughs or sneezes.
- It is **mild in children and adults**, but poses **serious risks to pregnant women**, potentially leading to miscarriage, stillbirth, or **Congenital Rubella Syndrome (CRS) in infants**.

- The **Measles-Mumps-Rubella (MMR) vaccine** is the most effective preventive measure, **administered in 2 doses** to provide **long-term immunity** against rubella and its complications.

Vaccine-preventable diseases series #3

# RUBELLA



## RUBELLA (German measles)

is an acute, contagious viral infection. The virus spreads through airborne droplets via sneezing or coughing.

SYMPTOMS	DANGER
<ul style="list-style-type: none"> <li>Low fever</li> <li>Conjunctivitis</li> <li>Sore throat</li> <li>Inflammation of the mucous membrane in the nose</li> <li>Headache</li> <li>Feeling unwell</li> <li>Swollen lymph glands behind ears and neck</li> <li>Rashes</li> </ul>	<p>A pregnant mother who is infected may result in miscarriage, still-births or the baby has birth defect.</p> <p>Known as <b>congenital rubella syndrome</b> – the baby is born with deformities, which can cause problems to the eyes, ears, brain and heart.</p>
TREATMENT	PREVENTION
<ul style="list-style-type: none"> <li>No specific treatment</li> </ul>	<ul style="list-style-type: none"> <li>Measles-Mumps-Rubella (MMR) vaccination (in the National Immunisation)</li> </ul>


  
 Malaysia's Pioneer Expert-Driven Educational Programme [www.mypositiveparenting.org](http://www.mypositiveparenting.org)

## Hepatitis D

- The **World Health Organization (WHO)** has reclassified **Hepatitis D Virus (HDV)** as **carcinogenic**.
- Hepatitis** is a **liver inflammation** from viral infections, autoimmune disorders, alcohol/drug toxicity and has **five main viral types: A, B, C, D, and E**.
- Hepatitis D is a defective virus that depends on the **Hepatitis B Virus (HBV)** for infection and replication.
- It causes co-infection or superinfection with HBV, **increasing risk of liver cirrhosis and hepatocellular carcinoma** (a type of liver cancer) **by 2–6 times compared to HBV alone**.
- The mode of transmission of Hepatitis D is similar to hepatitis B and C, that is through **parenteral route or injections and transfusion, mother to child transmission and sexual contact**.
- Diagnosis of hepatitis D involves blood tests **detecting HDV RNA** or antibodies also **universal hepatitis B vaccination indirectly prevents hepatitis D**.



THE REPUBLIC OF SINGAPORE  
MINISTRY OF HEALTH

# Hepatitis D

**Cause**  
Hepatitis D Virus

**Transmission**  
Occurs in those who are already infected with HBV. Transmitted the same way as HBV

**Signs**  
In most cases there are no signs (asymptomatic), however some people may present with the following:

- Yellow discoloration of the eyes
- Dark urine
- Extreme body weakness
- Nausea
- Vomiting
- Abdominal pain

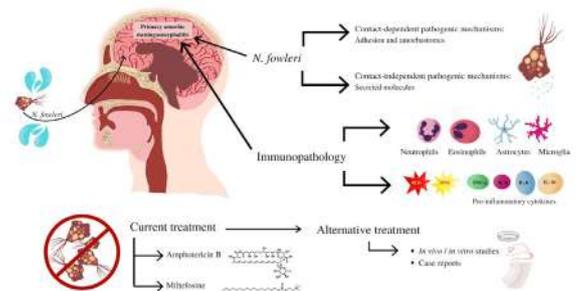
**Prevention**  
Once vaccinated for Hepatitis B, one is protected against Hepatitis D

**Treatment**

- Consult your doctor who will assess and decide on the treatment to be given
- Go for regular assessment tests as per doctor's guidance

#NoHepUG #WorldHepatitisDayUG

## Acanthamoeba



- Recently, it is revealed that **Acanthamoeba** is more widespread in Kerala's waterbodies than thought earlier.
- Acanthamoeba is a **free-living amoeba**, a kind of **one-celled organism that lives in water, soil, and dust** causes **serious infections like Acanthamoeba keratitis (eye) and Granulomatous Amoebic Encephalitis (GAE) (brain)**.
- It can also be found in swimming pools, hot tubs, drinking water systems, humidifiers, and in heating, ventilation, and air conditioning (HVAC) systems.
- It can **infect parts of the body through cuts or skin wounds or from being inhaled into the lungs or nostrils**.
- It can get into the eyes through **contact lens use**.
- Chlorination of wells, safe water practices, strict contact lens hygiene** are the preventive measures.

## Aflatoxin

- Indonesia has stopped importing Indian groundnuts due to **aflatoxin** contamination — a poisonous substance made by fungi **Aspergillus flavus** and **A. parasiticus**.
- They produce **aflatoxins** as a **defence mechanism** to survive stress — such as heat, drought, or attacks from other microbes or insects.
- These fungi **grow easily** in hot, humid climates and can infect crops like groundnuts, maize, rice, and spices before or after harvest.
- Aflatoxins are **heat-stable** and can survive in a wide **pH (1.7–9.3)** and temperature range (**12–48°C**).
- They are **carcinogenic**, damaging the liver and immune system, and cannot be detected by sight, smell, or taste.
- Because of their health risks, countries follow strict **Codex Alimentarius** (international food safety standards by the FAO and WHO) and **WTO-SPS (Sanitary and Phytosanitary Agreement)** standards to control contamination and ensure food safety in trade.

## Diethylene Glycol (DEG)

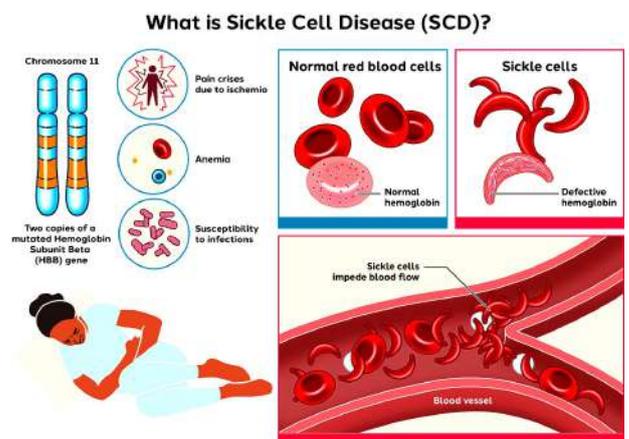
- Diethylene glycol (DEG) contamination was recently detected in **pharmaceutical syrups** from Tamil Nadu.
- **DEG and ethylene glycol (EG) are industrial solvents** not meant for medicines, but are sometimes found in cough syrups because they can be mistakenly or deliberately used as cheap **substitutes for glycerol or propylene glycol**, which are safe, viscous solvents used in medicines to dissolve ingredients and improve texture.
- Colourless and syrupy, DEG is **hard to detect without lab testing**.
- When ingested, it **breaks down into toxic compounds** causing kidney, liver, and nervous system damage, especially in children.
- **WHO** links DEG/EG-contaminated syrups to over 300 child deaths since 2022 and **recommends two-tier testing**: thin-layer chromatography for screening and gas chromatography for confirmation.

## Measles in Canada

- Canada has lost its **measles-free status** after a large outbreak infected thousands.
- Measles is a **highly contagious airborne viral disease** that begins in the respiratory tract and can cause severe illness and even death.
- It is caused by a **Morbivirus**, which is a genus of **single-stranded RNA** viruses within the **Paramyxovirus** family.
- Symptoms include **high fever**, runny nose, cough, red watery eyes, and a **red blotchy rash**.
- The **Measles, Mumps, and Rubella (MMR) vaccine (two doses)** offers the best protection.
- **India** still reports thousands of measles cases each year, and remains among the countries with high measles burden globally.

**Note:** **Mumps** is caused by a paramyxovirus of the genus **Rubulavirus**, while **rubella** is caused by a **Togavirus (Rubivirus)**. Rubella resembles measles with its red rash, which is why it's called "**German measles**," but it is a completely different disease.

## BIRSA 101 Gene Therapy

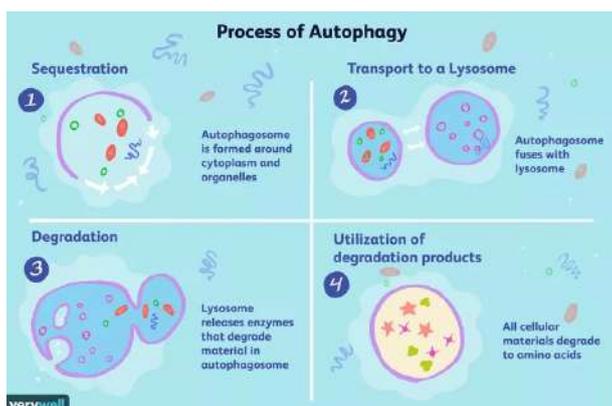


- **India's first indigenous CRISPR-based gene therapy** for **Sickle Cell Disease (SCD)**, was launched by the **Health Ministry**.
- It is named **BIRSA-101** after tribal leader Birsa Munda.
- Developed by **CSIR-IGIB**, it uses **CRISPR-Cas9 "molecular scissors"** to correct the genetic mutation causing SCD directly in patients' cells.
- Priced lower than global alternatives, it aims to be **accessible to poorer populations**.
- SCD is a genetic disorder causing **rigid, sickle-shaped red blood cells**.

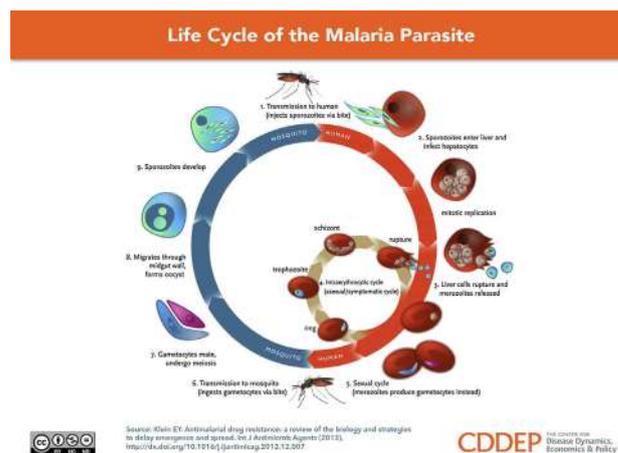
- This leads to **reduced oxygen transport, blood flow blockages, pain, organ damage, anemia, infections, and strokes.**
- Risk increases if **both parents are carriers** or one is affected.
- SCD is **common in tribals** due to genetic concentration, malaria-driven evolutionary selection, and social/geographical isolation.
- India has a **National Sickle Cell Anemia Elimination Mission (NSCAEM)**, launched in 2023, with the goal of eliminating the disease by **2047**

## Exocyst complex in Autophagy

- Scientists at the **Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru** have discovered that the **exocyst complex**, a group of eight proteins earlier known for **exocytosis** (transporting vesicles to the cell membrane), also plays a key role in **autophagy**, the cell's self-cleaning process.
- **Autophagy** is a basic cellular **housekeeping mechanism** that maintains homeostasis (internal cell stability) by degrading and recycling damaged or excess cell components and destroying pathogens.
- It is mediated by **Autophagy-Related Genes (ATGs)**, which encode proteins that form **autophagosomes** to carry cellular waste to **lysosomes** for digestion.
- **Lysosomes** are membrane-bound organelles found in cells that act as the cell's **digestive and recycling centres**
- Autophagy acts as a **double-edged sword**—it initially prevents cancer by maintaining cellular health, but some cancer cells later exploit it for survival.
- The discovery that the **exocyst complex links secretion with autophagy** improves understanding of cell maintenance and may help develop therapies for Alzheimer's, Parkinson's, and cancer.



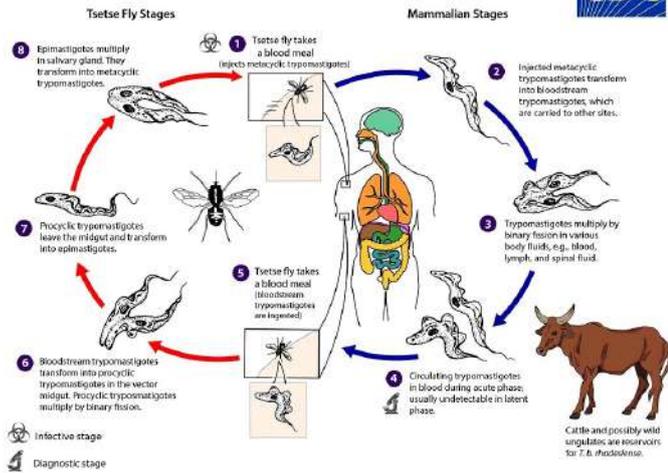
## Artemisinin



- A new study warns that heavy use of **artemisinin** may create **resistance hotspots** in parts of Africa.
- **Artemisinin** is an **antimalarial drug** derived from the leaves of the **sweet wormwood plant (Artemisia annua)**.
- It kills the **Plasmodium parasite** during the **blood stage of malaria**, stopping it from multiplying in red blood cells.
- Discovered in the 1970s by **Tu Youyou**, it is fast-acting but short-lived in the body, so it is usually combined with other drugs in **artemisinin-based combination therapies (ACTs)** for effective treatment of **Plasmodium falciparum malaria**.

## Sleeping Sickness

- **Kenya** has been certified by the **World Health Organization (WHO)** as **free from Human African Trypanosomiasis HAT (sleeping sickness)**, becoming the 10th African nation to eliminate the disease as a public health problem.
- It is a **vector-borne parasitic disease** caused by the **Trypanosoma parasite**.
- These parasites are passed to humans through the bite of **infected tsetse flies**, which get the infection from humans or animals carrying the parasites.
- It **takes 2 forms**, depending on the subspecies of the infecting parasite: **Trypanosoma brucei gambiense** (92% of reported cases) and **Trypanosoma brucei rhodesiense** (8%).
- Parasites enter the bloodstream and lymphatic system (first stage), without treatment they cross into the central nervous system, damaging the brain (second stage) and in later stages it disrupts sleeping pattern, hence named sleeping sickness



## Dieback Disease

- The **Forest College & Research Institute (FCRI), Mulugu, Telangana** is investigating widespread **dieback disease** affecting neem trees.
- Caused mainly by the fungus **Phomopsis azadirachtae**, the disease leads to **leaf browning, twig wilting, stem canker, crown thinning, fruit rot, and eventual tree death**, often mistaken for drought damage.
- Symptoms appear with the **rainy season** and worsen into early winter, potentially causing **100% loss in fruit production**, affecting commercial and medicinal use.
- Neem (Azadirachta indica)**, native to India, is valued for its **antibacterial, antifungal, and insecticidal properties**, as well as its wood and non-wood products.

## BIOTECHNOLOGY & GENETICS

### Selective Silencing

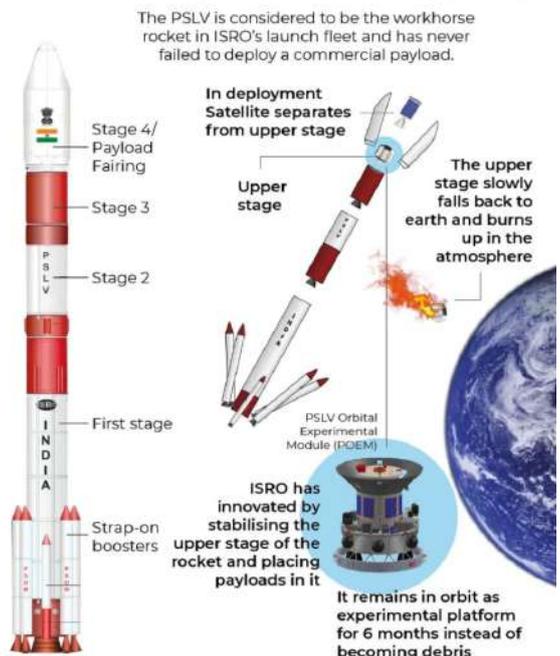
- Columbia University research reveals why some individuals with disease-causing genes remain symptom-free.
- Every cell in the body (except sperm and eggs) contains two copies of each gene, one inherited from each parent, and that both copies **contribute equally to cellular function**.
- However, this new study reveals that certain cells can exhibit a bias, **selectively inactivating one parent's copy of a gene**.
- By studying specific immune cells in typical individuals, the researchers found that these **cells inactivated either the maternal or paternal gene copy** in approximately 1 out of every 20 genes the cells use.
- This explains why people with the same genetic mutation can have **different symptom severities**.

### CROPS

- ISRO's **cowpea seedlings** have sprouted in space, marking its first **biological experiment** under the **CROPS (Compact Research Module for Orbital Plant Studies)** program.

- CROPS, developed by **Vikram Sarabhai Space Centre**, is an **automated platform** for growing plants in microgravity.
- It housed **eight cowpea seeds (Vigna unguiculata)** in a controlled, airtight environment onboard **POEM-4**.
- POEM-4 (PS4-Orbital Experiment Module)** repurposes the **PSLV's spent fourth stage** for in-orbit **microgravity experiments**, extending its use up to **three months** instead of becoming space debris.

### PSLV Orbital Experimental Module (POEM)



## IVF-ET Technology

- Puducherry has witnessed the birth of its first calf through **In-Vitro Fertilized Embryo Transfer (IVF-ET)** at Kanuvapet village, marking a milestone in cattle breeding.
- It was launched in 2024–25 under the **Rashtriya Gokul Mission**, a central government scheme launched by the **Ministry of Fisheries, Animal Husbandry and Dairyin**.
- The scheme aims to produce **high-yielding female calves** from elite milch cows and buffaloes, targeting up to 5,000 litres of milk per lactation.
- The procedure costs ₹21,000 per cow, with ₹5,000 subsidized under the Mission and the remaining ₹16,000 covered by the Puducherry government.
- **IVF-ET** involves fertilizing eggs outside the body and implanting selected embryos into recipient cows, enabling rapid genetic improvement and better herd productivity.

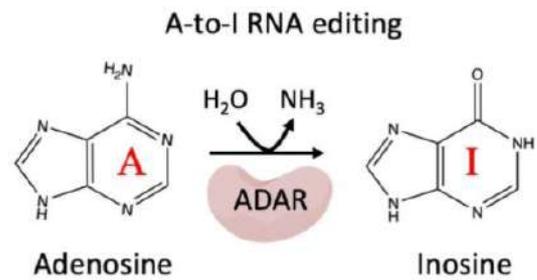
## A-to-I mRNA Editing

- Recent studies have reignited interest in **A-to-I mRNA editing**, involving the **conversion of adenosine (A) to inosine (I)** in mRNA.
- **A-to-I mRNA editing** is a process that changes the genetic message **after** it is copied from DNA to RNA (post-transcription), but **before** it's used to make proteins.

### Working mechanism

1. **mRNA** is the messenger molecule that carries instructions from DNA to the protein-making machinery in cells called **ribosomes**.
2. Normally, the **mRNA** has four building blocks: A (adenosine), U (uracil), C (cytosine), and G (guanine).
3. In **A-to-I editing**, special enzymes called **ADARs** (Adenosine Deaminases Acting on RNA) **change some adenosine (A) into inosine (I)**.
4. The ribosome (which reads the mRNA to make proteins) treats **inosine as if it were guanine (G)**.
5. This means the **protein made can be different** than what was originally coded by the DNA.

- This technology shows **potential applications** in cancer treatment, precision medicine, Anti-viral replication and even agriculture.



## Transposon-associated proteins (TnpB)

- The **Indian Council of Agricultural Research (ICAR)** has patented a **TnpB-based next generation genome editing technology**.
- **TnpB** is a small (~400-amino-acid) protein from the bacterium **Deinococcus radiodurans**, which can withstand extreme radiation and stress.
- **TnpB-based genome editing uses the TnpB protein as the nuclease** (the DNA-cutting enzyme), guided by a small RNA, to **cut or modify specific DNA sequences** — very similar to how CRISPR-based genome editing uses Cas proteins.
- **Tnpb is smaller than Cas9/Cas12** and is thus easier to deliver into plant cells.

### How it works:

1. A **guide RNA (gRNA)** is designed to match a specific DNA sequence.
  2. The enzyme (TnpB or Cas9) **binds to this RNA**.
  3. The RNA acts like a **GPS**, leading the enzyme to the matching DNA sequence.
  4. Once it finds the match, the enzyme **cuts or edits the DNA** at that spot.
- Genome editing is used to improve plant traits like **yield, disease resistance, and nutrition**.

**Note:** CRISPR stands for **Clustered Regularly Interspaced Short Palindromic Repeats**. CRISPR is a gene-editing tool that uses a guide RNA and a cutting protein (like Cas9) to make precise changes in DNA. **TnpB is considered an evolutionary ancestor of CRISPR systems**, and ICAR's technology works **similar to CRISPR but uses TnpB instead of Cas9/Cas12**.

## Animal-Based Biostimulants

- The **Union Agriculture Ministry** has withdrawn approval for 11 **animal-derived biostimulants** due to religious and dietary concerns.
- **Biostimulants** are substances or microorganisms (or combinations) applied to crops—usually as sprays or soil additives—to enhance nutrient uptake, improve growth, yield, quality, and stress tolerance.
- They **do not supply nutrients** directly like fertilisers, nor do they control pests like pesticides..
- The withdrawn products, **previously cleared by Indian Council of Agricultural Research (ICAR)**, included protein hydrolysates from sources like chicken feathers, pig tissue, bovine hide, and cod scales, used on crops such as paddy, tomato, potato, cucumber, and chilli.
- Biostimulants are **regulated under the Fertiliser (Inorganic, Organic or Mixed) (Control) Order, 1985 (FCO)** amended in 2021.

## Foetus in fetu (FIF)

- Doctors at Buldhana District Women's Hospital, Maharashtra, detected a rare "**foetus in fetu**" case, where an underdeveloped twin is enwrapped inside the body of the other in a monozygotic twin pregnancy.

- This rare congenital disorder, affecting about **1 in 500,000 births**, results from an uneven embryo split, leaving one twin trapped within the other.
- The **parasitic twin**, dependent on the host twin for nutrients, has some fetal features but cannot survive independently.
- In this case, it was detected during a routine scan, and doctors successfully removed it after a C-section delivery.

## Tribal Genome Sequencing Project

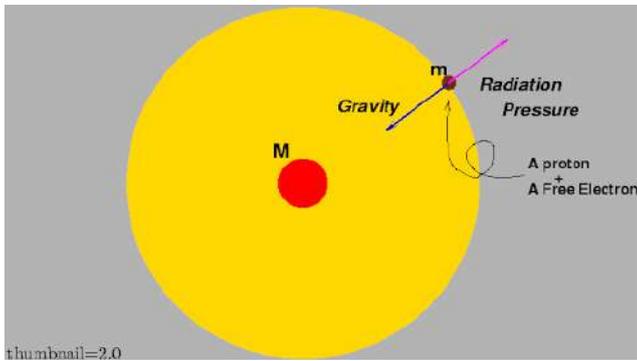
- Gujarat has recently **become the first Indian State** to launch a genome sequencing initiative focused exclusively on tribal communities.
- The project, titled "**Creation of Reference Genome Database for Tribal Population in Gujarat**", is being implemented by the **Gujarat Biotechnology Research Centre (GBRC)**..
- The Project was announced with the aim of **identifying genetic health risks and enabling precision healthcare** for tribal populations.
- The initiative will sequence the genomes of 2,000 individuals from tribal communities across 17 districts in the State.

## PHYSICS & ADVANCED SCIENTIFIC CONCEPTS

### Eddington limit

- An international team using NASA's James Webb Space Telescope (JWST) and Chandra X-ray Observatory discovered **LID-568**, a low-mass supermassive black hole that existed **1.5 billion years after the Big Bang**.
- Though **nothing escapes a black hole**, infalling matter heats up and emits radiation like **X-rays**, revealing the matter feeding (accretion) activity of black holes.
- At a point the **outward pressure from radiation** balances the **inward pull of gravity from black hole** and prevents further matter accretion.

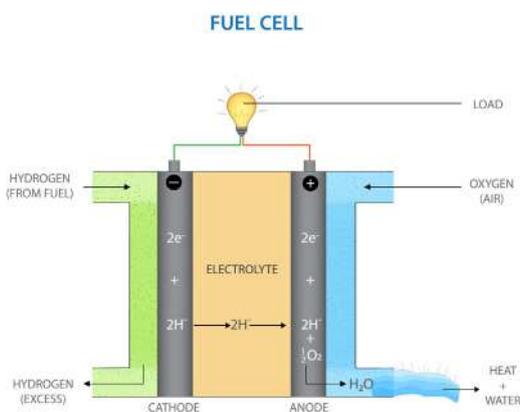
- This balancing point is called the **Eddington limit** (or **Eddington luminosity**) and is the maximum luminosity a celestial object, such as a **black hole or a star**, can achieve.
- At this limit, the radiation force **prevents additional matter from falling into the black hole**.
- If the luminosity exceeds this limit, the object undergoes **super-Eddington accretion**, where it continues feeding at an unusually high rate.
- LID-568 is feeding at **40 times the Eddington limit**, surpassing the expected upper threshold.



## Supersolid Light

- Researchers have achieved a scientific first by transforming light into a “supersolid,” a paradoxical state exhibiting both the **rigidity of a crystal and the frictionless flow of a superfluid**.
- Unlike typical supersolids made from **ultracold atoms**, this breakthrough utilized photons interacting with ridges on an **aluminum gallium arsenide semiconductor**
- They form quasiparticles called **polaritons** that self-organize into the supersolid state due to the physical constraints.
- This novel creation could **enhance our understanding of supersolids** and quantum phase transitions, potentially leading to future applications in quantum technologies like coolants and high-capacity batteries.

## Proton Exchange Membrane Fuel Cell

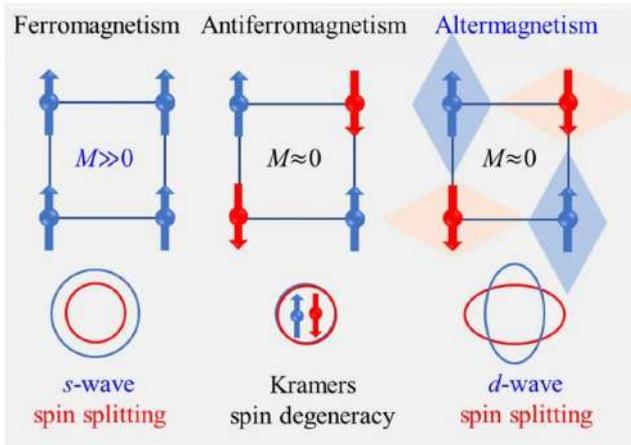


- The Centre for Fuel Cell Technology (CFCT) at ARCI, an autonomous institute under the Department of Science and Technology, has developed a **fuel cell-based uninterrupted power supply** for telecom towers.
- Utilizing **PEM (Proton Exchange Membrane) Fuel Cells**, this clean energy solution offers reliable backup power during grid outages, featuring quick start-up and low-temperature operation as a viable alternative to diesel generators.
- **PEMFCs generate electricity with only water vapor as a byproduct**, providing an environmentally friendly, high power density, and compact solution that **runs on storable hydrogen fuel** and requires less maintenance than traditional backups.
- Their **operation involves** an electrochemical reaction where hydrogen is oxidized at the anode, protons travel through a membrane, and react with oxygen at the cathode to produce electricity and water..

## Room-Temperature Altermagnets

- Researchers at the Chinese Academy of Sciences recently uncovered a new material that exhibits **Altermagnetism at room temperature**, namely **KV<sub>2</sub>Se<sub>2</sub>O**.
- Altermagnetism is a **new kind of magnetism** — a mix of two known types:
  - **Ferromagnetism:** Like in iron, nickel or cobalt — the tiny magnetic moments (or “spins”) of atoms align in the same direction, creating a strong **net magnetic field**.
  - **Antiferromagnetism:** Spins point in **opposite** directions and cancel each other out, so no magnetism is felt outside. For every spin pointing up, there is one pointing down next to it. Examples are oxides of manganese, iron or nickel.
- **Altermagnets** have spins arranged in a pattern where they alternate in a special way, creating **some magnetic effects** but **no overall magnetism outside**.
- They combine the best of both worlds: they behave like magnets but don’t create stray magnetic fields.
- This makes them great for future tech like **super-fast computers** and **tiny electronic devices** without disturbing nearby electronics.

- Unlike traditional magnets, altermagnets allow **ultra-fast spin dynamics**, meaning they can operate at **terahertz frequencies**—a million times faster than today’s computer memory.

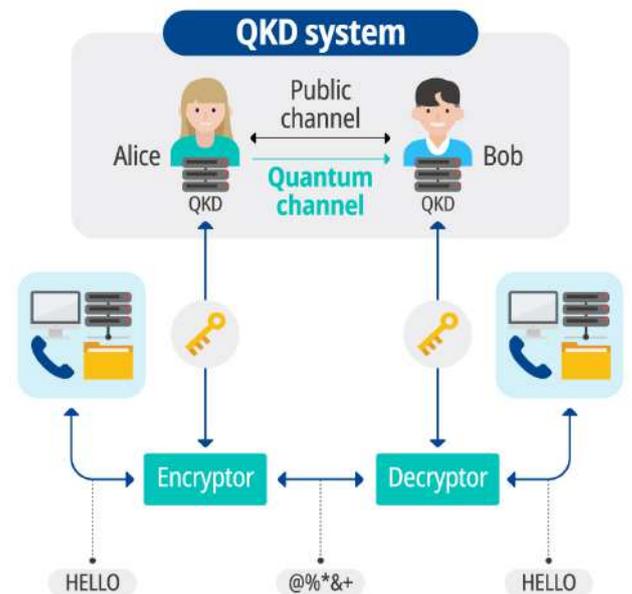


## Hoyle–Narlikar Theory of Gravity

- Eminent Indian astrophysicist, and Padma Vibhushan awardee Jayant Narlikar, known for propounding **Conformal gravity with Fred Hoyle**, passed away recently.
- **Conformal gravity**, also known as the Hoyle–Narlikar theory of gravity, sought to improve on Albert Einstein’s **General Theory of Relativity**, published in 1915.
- General Theory of Relativity describes **gravity not as a force, but as the curvature** of space-time caused by mass and energy.
  - The more massive an object (like the Sun), the more it bends space-time, influencing how objects move.
- At the heart of the Hoyle–Narlikar theory of gravity is **Mach’s principle**, which says that the **mass of every object** in the universe is **affected by its interaction with every other object**.
- Hoyle and Narlikar said that the inertia of an object, that is the tendency to resist change in its state of motion, arises from its interaction with all other matter in the universe.
- According to them, a universe with nothing in it is impossible and there must be at least two particles, each to give mass to the other.
- The masses, and therefore the gravity, of the **sun and the earth are partly due to each other**, partly to more distant objects such as the stars and galaxies

- The Hoyle–Narlikar theory also proposed a **“creation field” (C-field)**, a hypothetical negative-energy field responsible for the continuous creation of matter.
- This helped explain the **steady-state cosmology**, which said that the universe had no beginning and will endure forever.
  - ➔ The **steady-state concept** of the universe is essentially an alternative to **“Big-Bang” cosmology**, which proposed that the universe originated 13 billion years ago.
- The Hoyle–Narlikar theory of gravity was not widely accepted, especially after the discovery of the cosmic microwave background (CMB) radiation in 1965.

## Quantum Key Distribution (QKD)



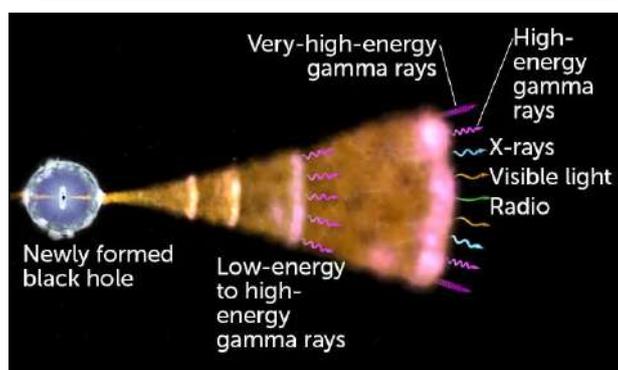
- In a major milestone, India’s **first Quantum Key Distribution (QKD) transmission** over a **4-core Multi-Core Fibre (MCF)** has been successfully tested by the Centre for Development of Telematics (C-DOT) and Sterlite Technologies Ltd (STL).
- **QKD is a secure way of sharing cryptographic keys** (string of bits used to encrypt and decrypt messages) between two parties using the laws of **quantum mechanics**.
  - ➔ It uses **quantum particles (usually photons)** to generate a random key.
- If anyone tries to intercept the key, the act of measuring the quantum particles disturbs them—**alerting the sender and receiver to eavesdropping**.

- **Traditional optical fibres** have one core (the part that carries light) but MCF enables multiple data streams through distinct cores in a single fibre, saving space and cost.
- It also **allows physical separation of quantum and classical signals**, enabling simultaneous QKD and high-capacity data transmission without signal interference.
- QKD ensures **ultra-secure key sharing** using quantum mechanics.
- C-DOT is India's telecom R&D body under the **Department of Telecommunications**.

## Quantum Echoes Algorithm

- Google's quantum processor **Willow** has achieved the first "verifiable" **quantum advantage**, meaning it can outperform classical computers in practice.
- Using a special measurement called **out-of-time-order correlator (OTOC)**, Willow ran the **Quantum Echoes** algorithm 13,000 times faster than the best classical supercomputer.
- This algorithm tracks how information spreads in a quantum system and can help study atomic interactions, with potential applications in **drug discovery and materials science**.
- The results are **verifiable**, meaning other quantum computers or experiments can confirm them.
- Willow works with **entangled particles**, where the state of one particle is instantly linked to another, even far apart, allowing extremely fast and complex calculations that classical computers cannot match.

## Gamma-Ray Bursts



- New research suggests that **gamma-ray bursts (GRBs)** from tiny "**black hole morsels**" formed during massive black hole collisions could help reveal **quantum gravity**.
- **Gamma-Ray Bursts (GRBs)** are the universe's most powerful explosions, brief but incredibly bright flashes of **high-energy light from distant galaxies**, often signaling the **birth of black holes** from collapsing massive stars or the **merger of neutron stars**, lasting from milliseconds to minutes and releasing immense energy
- They occur in two forms:
  - 👉 **Long GRBs (>2 sec):** From collapsing massive stars/supernovae, creating a black hole; common and seen in distant galaxies.
  - 👉 **Short GRBs (<2 sec):** From mergers of neutron stars or neutron star-black hole pairs; rarer and usually closer.
- **Black hole morsels** are hypothetical, tiny, extremely **hot micro-black holes** created during black hole mergers, which may evaporate quickly and emit intense gamma rays.
- In physics, **quantum mechanics** describes particles, atoms, energy at extremely small scales but it does not include gravity whereas **general relativity** describes gravity, space, time, planets, black holes — but it is not quantum (extremely small scale).
- **Quantum gravity** is the future theory of physics that tries to **combine quantum mechanics** (rules of the very small: atoms, particles) with **general relativity** (Einstein's theory of gravity and spacetime).
- **Quantum gravity** suggests that **spacetime might be made of tiny "grains,"** which could make high-energy and low-energy light travel at slightly different speeds.
- **Gamma-Ray Bursts help test this** by sending mixed-energy light across billions of years—if the photons arrive at different times, it hints at quantum gravity; if not, spacetime is likely smooth.

## Extreme Nuclear Transients (ENTs)

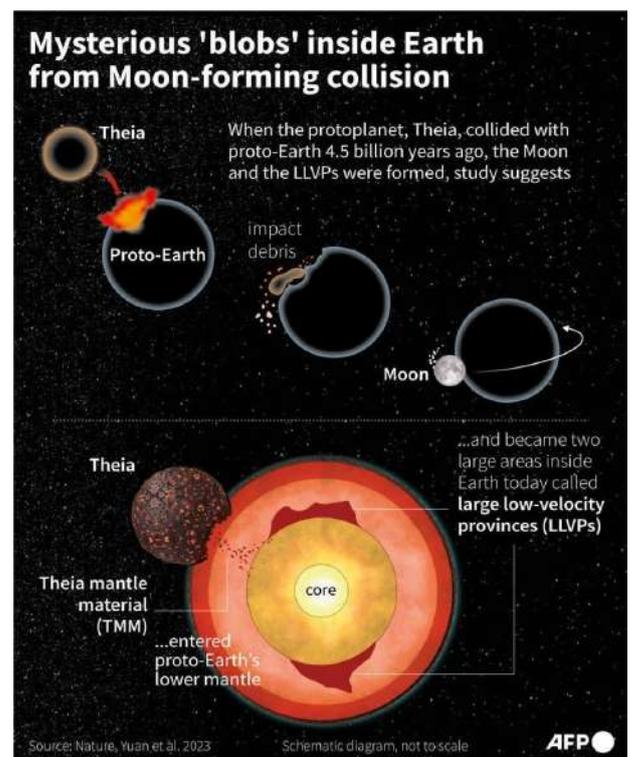
- Astronomers have identified a new class of cosmic events called **Extreme Nuclear Transients (ENTs)**.
- These occur when a star ventures **too close to a supermassive black hole**.
- The black hole's **gravity pulls much more strongly** on the side of the star nearest to it, stretching it into a thin shape—a process called **spaghettification**—and eventually tearing it apart.
- This releases enormous amounts of energy.
- The term “**nuclear**” refers to the star itself being destroyed, while “**transient**” highlights that the event is short-lived compared to the lifespan of stars or galaxies.
- ENTs produce **extremely energetic bursts of radiation**, making them the **most powerful explosions since the Big Bang**.
- Although the main event is brief, the debris from the destroyed star can **continue interacting with surrounding space**, emitting radiation in certain wavelengths, like radio, for **years** after the initial explosion.
- This discovery helps astronomers study **black hole behavior, stellar destruction, and extreme cosmic energy releases** in unprecedented detail.

## Tritium

- Recently, a global study has confirmed that the **Japan's Fukushima Daiichi Nuclear Power Plant's tritium wastewater release poses negligible risk**.
- Tritium is the only **radioactive isotope of hydrogen** which has the same number of protons and electrons as hydrogen but has 2 neutrons, whereas regular hydrogen does not have any.
- It occurs **naturally** from cosmic ray interactions in the upper atmosphere and is also produced in **nuclear reactors** and weapon tests.
- With a half-life of **12.33 years**, it beta decays and becomes Helium-3 ( $^3\text{He}$ ).

- Chemically behaves like hydrogen and forms tritiated water (HTO) when interacted with oxygen.
- Uses include as fuel in nuclear **fusion reactors** (paired with deuterium), **boost nuclear weapons** yield (thermonuclear weapons), **glow-in-the-dark lighting, emergency signs, runway lights**, and as a **tracer in biomedical research** for diseases like cancer and heart conditions.

## Theia



- Recent research suggests that Earth and **Theia**, a Mars-sized planetary body, were neighbors in the early Solar System.
- **Theia** was a Mars-sized protoplanet in the early Solar System that is, according to **Giant-Impact Hypothesis**, believed to have collided with the young Earth about 4.5 billion years ago.
- The impact allowed Earth to absorb Theia's iron core, while the ejected debris later **formed the Moon**.
- Studies indicate that Theia may also have contributed to Earth's **water and chemical composition**.
- **Similar oxygen isotopes** in Earth's mantle and lunar rocks support the idea that both contain mixed material from Earth and Theia.

## Silicon Carbide

- Researchers at **IIT-Madras** successfully extracted **silicon carbide (SiC)** from simulated lunar soil.
- **Silicon carbide (SiC)**, also known as carborundum, is an extremely hard, synthetically produced crystalline compound of silicon and carbon
- It is an efficient heat conductor, chemically resistant and can be used as a semiconductor.
- The current research opens the **possibility of producing SiC on Moon** that can help build lunar habitats for humans in the future
- The researchers used a **lunar stimulant** that mimics the composition of the Moon's highland terrain, which is rich in **silicon, aluminum, and calcium**.
- ★ Moon has two distinct terrains - the plains, known as **maria (plural for mare)**, and highlands and the **highlands are rich in silicon** (among other elements such as aluminium and calcium).
- However, the Moon lacks significant **carbon to produce SiC**, so researchers propose **using CO<sub>2</sub> exhaled by astronauts** as a carbon source.
- The researchers propose using the **Sabatier process** to first convert the **CO<sub>2</sub>** to methane
- and water using hydrogen.
- Then, the highland regolith on the moon can be **heated with methane** at high temperatures, leading to a reaction that forms silicon carbide.

## Lower Sodium Salt Substitutes

- The WHO recommends **lower-sodium salt substitutes (LSSS)** and reducing sodium intake to **less than 2 g/day** to prevent cardiovascular diseases.
- High sodium intake causes **1.9 million deaths annually**

- **Potassium chloride (KCl)**, a naturally occurring mineral, is used as a **salt substitute** as it helps lower hypertension.
- While sodium intake is excessive globally, potassium intake remains below the WHO-recommended **3510 mg/day**, making KCl a promising alternative
- However, **low-NaCl with KCl salts** are **costlier** than regular salt.
- Also, KCl poses risks for those with kidney disease, heart conditions, or certain medications.
- Excess intake may cause **hyperkalemia**, leading to irregular heartbeats, muscle weakness, or cardiac arrest.

## Black Plastics

- Black Plastic made headlines as a recent study claimed that the **material contained toxic flame retardants** which could be leaching into food at hazardous levels.
- Black plastic is often made from **recycled electronic waste** such as computers, TVs, and appliances.
- The issue is that these electronics typically contain substances such as the **flame retardant bromine, antimony and heavy metals** such as lead, cadmium, and mercury.
- The study found that these products contained a flame-retardant chemical called **decabromodiphenyl ether (BDE-209)** that had been linked to potential human health risks and was phased out in the US more than a decade ago.

Harmful flame retardants (FRs) used in electronics were found in **black plastic household products**—including toys and kitchen utensils—likely due to recycled content.

**Presumed FR Source**

**FRs Detected**

- 17 out of 20 products analyzed contained brominated and/or organophosphate FRs.
- Most frequently detected compounds included TBBPA, BDE-209, 2,4,6-TBP, FDP, BDP, and DEOPE.
- Items containing polymers used in electronics had significantly higher FR levels.

TBBPA, BDE-209, 2,4,6-TBP, DEOPE, TBP, TAZ, BDP, FDP, & TPMP are of high concern and have been intentionally used in electronics. This study found 271 concentrations up to 22,750 mg/kg in food serviceware, hair accessories, kitchen utensils, and toys.

Trade-Free FUTURE VU

## Lanthanum-Doped Silver Niobate

- Indian researchers have found that injecting the rare-earth element **lanthanum** into **silver niobate nanoparticles** significantly boosts the performance of supercapacitors.
- Silver niobate (AgNbO<sub>3</sub>) nanoparticles are primarily used as a material for next-generation **supercapacitors** and have significant potential in other energy-related applications like energy storage.
- This process increases the **nanoparticles' surface area** and electrical conductivity, leading to remarkable results: the material achieved 118% energy retention after extensive use and a perfect 100% coulombic efficiency (virtually no energy loss).
- **Lanthanum (La)** is a soft, silvery-white chemical element with atomic number 57.
  - It is the first element and prototype of the lanthanide series, a group of 15 chemically similar elements often called **rare-earth metals**.
- It is highly **reactive**, especially with water and acids, and tarnishes quickly when exposed to air.

A **supercapacitor**, also known as an ultracapacitor, is an energy storage device that can rapidly store and release large amounts of electrical energy.

Unlike a traditional battery that stores energy through a chemical reaction, a supercapacitor stores energy **electrostatically** on the surface of its electrodes

## Intercrystals

- Researchers have discovered a **new class of materials called Intercrystals** which has unique electronic properties that could power future technologies.
- Intercrystals exhibit a **hybrid** of crystalline and quasicrystalline properties.
- They are formed by **stacking ultrathin atomic layers**, like twisted graphene on hexagonal boron nitride, at slight angles, creating a **“moiré” pattern** that significantly alters electron behavior.

- This misalignment of layers induces **unique quantum phases** not found in regular crystals, opening new possibilities for electronics and quantum technologies
- This idea comes from a field called **twistronics**, where twisting layers of materials at precise angles can create new and unusual electronic behaviors.
- Intercrystals could help **develop advanced technologies** like super-efficient electronics, very sensitive sensors, and parts for quantum computers

## Isobutanol

- India is now exploring **isobutanol-diesel blending** as an alternative to ethanol, with a pilot project underway to assess its technical and economic feasibility.
- Isobutanol is a **four-carbon alcohol (C<sub>4</sub>H<sub>10</sub>O)** **flammable, colorless and widely used as a solvent in industries such as paints and chemicals**.
- Its key features are:
  - **Higher Flash Point:** Less volatile and safer than ethanol, lowering fire risks.
  - **Better Blending with Diesel:** Compared with ethanol, isobutanol blends more effectively with diesel without requiring extensive chemical modifications.
  - **Versatile Feedstock:** Like ethanol, it can be produced from sugarcane syrup, molasses, and grains through microbial fermentation.
- Isobutanol is also being explored as an **independent fuel and in Compressed Natural Gas (CNG)-isobutanol flex-fuel** options for tractors and agri-machinery.
- However, **isobutanol has a lower cetane number** (how quickly and efficiently the fuel ignites after injection into the engine cylinder), which can cause engine knock.

## 2D Materials

- NITI Aayog's Frontier Tech Hub, in collaboration with IISc Bengaluru, released the 4th edition of **Future Front Quarterly Insights** on **2D materials**.
- 2D materials are ultra-thin materials just **one atom thick**, such as graphene, **Molybdenum Disulfide (MoS<sub>2</sub>)**, and **Tungsten Disulfide (WS<sub>2</sub>)**.
- These materials are **superconductors**, conducting electricity and heat better than copper, and are around 200 times stronger than steel while remaining flexible.
- Their **tunable band gaps** make them ideal for next-generation semiconductors, and they can host **qubits** for quantum computing.
- A tunable band gap means that the **energy difference** between a material's valence band (where electrons normally reside) and **conduction band** (where electrons can move freely) can be adjusted or engineered.
- In semiconductors, this band gap **determines electrical conductivity** and how the material interacts with light.
- **Flexible and transparent**, they are suited for foldable and wearable electronics.
- Applications include **2D transistors that extend Moore's Law**, atom-thin memristors for neuromorphic computing, ultra-thin LEDs, photodetectors, and solar cells, as well as **bulk uses** in aerospace, water filtration, coatings, batteries, and EV supercapacitors.

## Sintered Rare Earth Permanent Magnets (REPM)

- The Union Cabinet approved a **₹7,280-crore scheme** to promote the manufacturing of **Sintered Rare Earth Permanent Magnets (REPMs)**.
- **Sintered** refers to a **manufacturing process** where powdered material is **heated below its melting point** until the particles **fuse together** to form a solid piece
- REPMs are the **strongest commercial permanent magnets**, made from rare earth elements like **neodymium, praseodymium, and dysprosium** (e.g., NdFeB alloys).

- REPMs are used in **electric vehicle motors, wind turbines, electronics, aerospace, and defense**.
- They offer **high magnetic strength, compact size, superior performance, and heat resistance**, enabling smaller, more efficient, and powerful devices.

## Silica Gel Desiccant



- Silica gel sachets, labeled **"Do Not Eat,"** are commonly found in packaged goods.
- These small, translucent beads are made of **porous silicon dioxide** (it is essentially a synthetic form of sand) and **act as a desiccant**, absorbing excess moisture to prevent damage like corrosion, decay, or mold growth.
- The **"Do Not Eat" warning** is primarily due to a **choking hazard** (especially for children) and not toxicity (**most types are non-toxic, unlike silica dust**).
- The gel is **hydrophilic** and draws moisture into its nano-scale pores.
- Although often discarded, these desiccants can be easily reactivated and reused
- By heating the sachets at around **120°C (250°F)** for a couple of hours, the trapped moisture evaporates, making them effective again.

## Auramine O

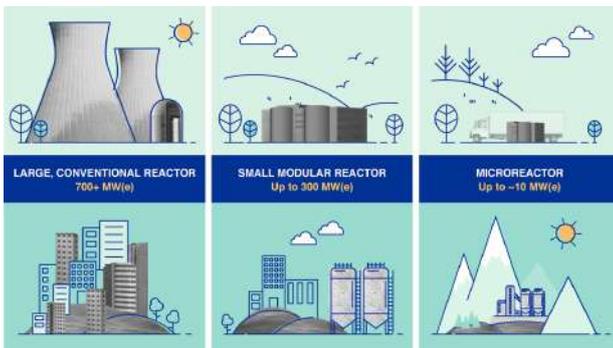
- Auramine O has again been **detected in food products** to colour turmeric, spices, milk, and sweets in various parts of India
- Auramine O is a **cheap synthetic industrial yellow dye** (diarylmethane group) that is **toxic and possibly carcinogenic** (International Agency for Research on Cancer (IARC)), causing liver damage, DNA mutations, and skin/respiratory irritation.

- Its **industrial use** includes textile and leather processing, printing inks, paper manufacturing, and certain microbiological staining procedures.
- Since it is **not a permitted food colour**, its use is **banned under the Food Safety and Standards Regulations (FSSR)**.

India has dealt with **multiple waves of dye-related adulteration** for nearly four decades, from **metanil yellow** in turmeric, **rhodamine B** in cotton candy and curry masala, **Sudan dyes** added to spices, **Argemone oil** mixed with mustard oil, **calcium carbide** used to ripen fruits, **urea** added to milk to thicken it, **mineral oil** mixed with edible oils to **chalk powder** added to flour

## ENERGY & NUCLEAR TECHNOLOGY

### Small Modular Reactors (SMRs)



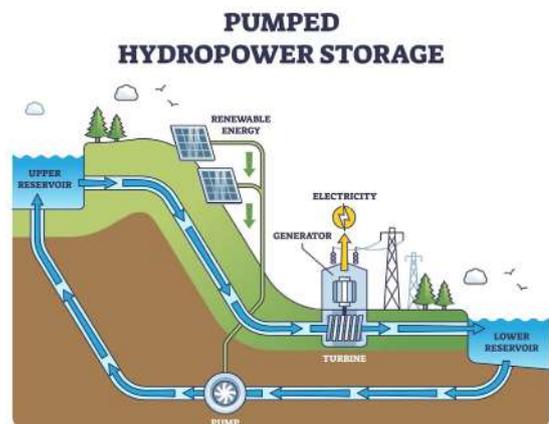
- The Government announced a ₹20,000 crore **Nuclear Energy Mission** to develop indigenous **Small Modular Reactors (SMRs)**, aiming to operationalize at least five by 2033.
- SMRs are advanced small nuclear reactors with capacities of **30MWe to 300MWe**, compared to conventional reactors that produce **500 MW or more**.
- Their modular design allows factory assembly, reducing costs and enabling flexible deployment.
- There are four SMR types based on coolants: **light water, high-temperature gas, liquid metal, and molten salt**.
- Globally, two SMR projects are operational: **Akademik Lomonosov** (Russia, floating unit, 35MWe) and **HTR-PM** (China, grid-connected since December 2023).

### International Thermonuclear Experimental Reactor (ITER)

- Prime Minister Narendra Modi recently visited the International Thermonuclear Experimental Reactor (ITER) in France with President Emmanuel Macron.

- ITER, a **global collaboration of 33 nations**, aims to demonstrate fusion as a large-scale, carbon-free energy source.
- Under development since 2005, it plans to begin **deuterium-tritium fusion by 2039**, generating 500 MW of power.
- Though it **won't produce electricity**, its success could pave the way for future fusion energy use.
- Around 200 Indian scientists and companies like L&T, Inox India, TCS, and HCL Technologies are involved in the project.
- **Fusion is superior to fission** as it produces more energy, uses abundant hydrogen isotopes, and generates no long-lived radioactive waste.
- It is **inherently safer**, with no risk of meltdowns, and does not emit greenhouse gases.
- Additionally, fusion **fuel cannot be weaponized (unlike uranium in fission)**, reducing proliferation risks, making it a cleaner and more sustainable energy source.

### India's first Variable Speed Pumped Storage Plant

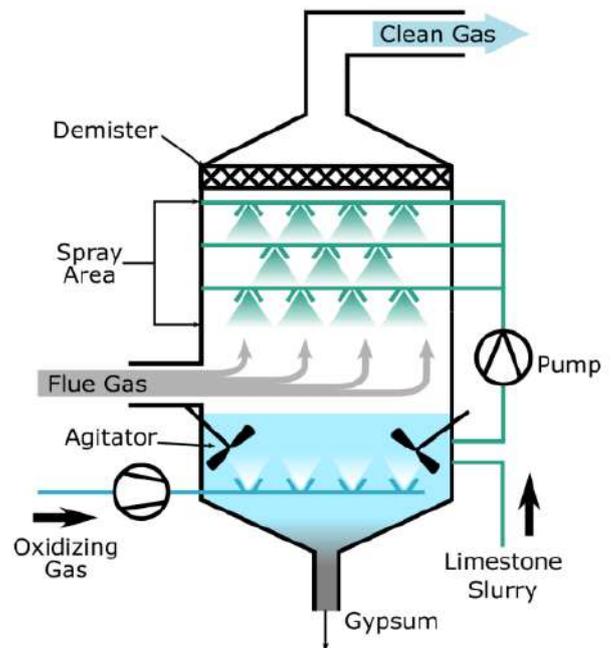


- India's first Variable Speed Pumped Storage Plant (PSP) at **Tehri, Uttarakhand**, has commenced commercial operation with a 250 MW unit.
- Variable Speed Pumped Hydroelectric Storage aims to use the **extra generated renewable energy for pumping water uphill to a reservoir**, which acts like a "natural battery," sometimes referred to as a water battery.
- When needed, the water is released to the hydropower plant downhill, so gravity is responsible for most of the energy.
- Flowing water spins turbines, which activate generators to produce electricity.
- In the Variable Speed Operation, the plant **can adjust turbine speed**, allowing precise control of pumping and generation, improving efficiency and grid support.

## Vanadium Flow Battery at NTPC

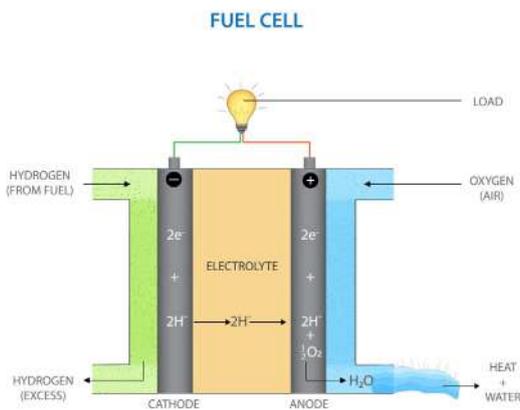
- India has inaugurated its first **MWh-scale Vanadium Redox Flow Battery (VRFB)** system—a 3 MWh installation at **NTPC NETRA, Greater Noida**—marking a major step in long-duration energy storage.
- Developed by **NTPC's R&D centre**, the VRFB offers an **alternative to lithium-ion batteries**, using **liquid vanadium electrolyte** instead of scarce materials.
- Vanadium Redox Flow Batteries (VRFBs) **last much longer (20–25 years) with almost no capacity loss**, are far **safer** due to their **water-based, non-flammable electrolytes**, and can be **easily scaled up** by simply adding more electrolyte tanks.
- They also **tolerate 100% charge-discharge cycles** without degradation and use a stable **single-element chemistry**.
- These features make **VRFBs ideal for long-duration storage** needed for renewable energy integration, while **lithium batteries remain better for compact, lightweight uses** like electronics and electric vehicles.
- India **has far more vanadium resources than lithium**, thus reducing import dependency too.
- Indian Bureau of Mines estimates **nearly 24.6 million tonnes** of vanadium-bearing ores primarily in **Odisha, Karnataka, Maharashtra, Arunachal Pradesh**.
- Vanadium is **mostly present as a by-product** in iron ore deposits.

## Flue Gas Desulphurisation



- The Union Environment Ministry's 2015 policy mandated that **all 537 coal-fired plants** in India install **Flue Gas Desulphurisation (FGD) systems** to reduce sulphur dioxide (SO<sub>2</sub>) emissions.
- However, a study by the **National Institute of Advanced Studies (NIAS)** recommended limiting this requirement to plants using imported or high-sulphur coal, as 92% of Indian coal has low sulphur content.
- **Flue Gas** refers to the gases emitted from a chimney, flue, or stack after the combustion of fossil fuels like coal, oil, or natural gas in industrial processes like power generation or manufacturing.
  - These gases can contain pollutants, including carbon dioxide (CO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter.
- **Flue Gas Desulphurisation (FGD)** is a process used to remove sulfur dioxide (SO<sub>2</sub>) from the flue gases of power plants and other industrial sources.
- FGD systems typically come in two main types:
  - ★ **Wet FGD:** Uses an alkaline slurry, usually made of limestone and water, to absorb and neutralize sulfur dioxide.
  - ★ **Dry FGD:** Uses dry reagents, such as lime or sodium-based compounds, to absorb SO<sub>2</sub> from the flue gases
- Study also found that Installing FGD in all plants would **increase power and freshwater consumption**, leading to an additional 69 million tonnes of CO<sub>2</sub> emissions

## Proton Exchange Membrane Fuel Cell



- The Centre for Fuel Cell Technology (CFCT) at ARCI, an autonomous institute under the Department of Science and Technology, has developed a **fuel cell-based uninterrupted power supply** for telecom towers.
- Utilizing **PEM (Proton Exchange Membrane) Fuel Cells**, this clean energy solution offers reliable backup power during grid outages, featuring quick start-up and low-temperature operation as a viable alternative to diesel generators.
- **PEMFCs generate electricity with only water vapor as a byproduct**, providing an environmentally friendly, high power density, and compact solution that **runs on storable hydrogen fuel** and requires less maintenance than traditional backups.
- Their **operation involves** an electrochemical reaction where hydrogen is oxidized at the anode, protons travel through a membrane, and react with oxygen at the cathode to produce electricity and water.

## ENVIRONMENT, CLIMATE & POLLUTION

### Faecal Coliform Bacteria

- **The Central Pollution Control Board (CPCB)** has released data on the assessment of water quality at the Sangam confluence in Prayagraj in Uttar Pradesh.
- High levels of **faecal coliform (microbes from human and animal excreta)** were found in river water in which crores of people took holy dip during the Maha Kumbh.
- **Faecal coliforms** are a group of bacteria, including **Escherichia coli (E. coli)**, found in the intestines of warm-blooded animals.
- Their presence in water indicates contamination by human or animal waste, posing a risk of disease-causing pathogens.
- The maximum permissible **limit of fecal coliform should be 2500 MPN/100mL** and BOD should be 3 mg/L.
- Data released by the CPCB shows that on Makar Sankranti (January 14), the fecal coliform levels were over 4 times (11,000 MPN/100mL) the permissible limits.

### Smog-Eating Technology

- Delhi is testing “**smog-eating**” **photocatalytic coatings** to reduce air pollution.
- These coatings, mainly made of **Titanium Dioxide (TiO<sub>2</sub>)**, can be applied on roads, pavements, and buildings.
- When exposed to sunlight, TiO<sub>2</sub> acts as a **photocatalyst, converting harmful gases** like NO<sub>2</sub> and VOCs into less harmful substances such as nitrates, CO<sub>2</sub>, and water.
- This **low-maintenance, passive technology** works continuously and can integrate into existing infrastructure.
- However, these coatings have **limitations** such as reduced effectiveness in humid, low sunlight or shaded areas, surface wear and durability issues, limited impact without large-scale coverage, and potential accumulation of by-products like nitrates.
- Also, the evidence of **Particulate Matter (PM) reduction is weak**.

## Soilification Technology

- The Central University of Rajasthan has successfully grown wheat in western Rajasthan's deserts using **Soilification technology**.
- Soilification is a **biotechnology-based process** that converts loose, infertile sand into a soil-like medium suitable for agriculture.
- It uses **bioformulations** (beneficial microbes and nutrients) and **polymers** to improve soil structure, water retention, and fertility, enabling crop growth in arid and desert regions.
- The method resulted in **54% higher yields** for wheat, bajra, guar, and chickpea, while reducing irrigation cycles from 5–6 to 4.
- **Globally**, similar techniques are used in Israel's Negev Desert, China's Loess Plateau, and the Middle East to combat desertification and enable sustainable agriculture in arid regions

## Phthalates and Cardiovascular Deaths

- A new study has found that daily **exposure to phthalates** has been related to over 13% deaths in the world due to heart disease in 2018, among those aged 55-64.
- **Phthalates** are a group of chemical compounds primarily used to make plastics like **polyvinyl chloride (PVC)** more flexible, durable, and long-lasting.
- India had the highest count at 103,587 deaths, followed by China and Indonesia.
- The study focused on a kind of **phthalate called 'di-2-ethylhexyl phthalate (DEHP)**.
- DEHP is used for making plastics in items, such as **food containers, softer** and others.
- Data, including those from urine samples, was analysed to discern amounts of products formed due to a chemical breakdown of the phthalate.
- Exposure to this compound has been studied to **trigger inflammation in the heart's arteries**, which, over time, is associated with increased risk of heart attack or stroke

## Black Plastics

- Black Plastic made headlines as a recent study claimed that the **material contained toxic flame retardants** which could be leaching into food at hazardous levels.
- Black plastic is often made from **recycled electronic waste** such as computers, TVs, and appliances.
- The issue is that these electronics typically contain substances such as the **flame retardant bromine, antimony and heavy metals** such as lead, cadmium, and mercury.
- The study found that these products contained a flame-retardant chemical called **decabromodiphenyl ether (BDE-209)** that had been linked to potential human health risks and was phased out in the US more than a decade ago.



## Orbiting Carbon Observatory (OCO)



- Recently, the Trump administration asked to shut down NASA's Orbiting Carbon Observatories (OCO) program.
- OCOs are a series of dedicated **Earth remote sensing satellites** that were designed **specifically to observe atmospheric CO2 from space** in order to better understand the characteristics of climate change.
- The first mission of the series failed soon after launch in February 2009.
- A replacement satellite, **OCO-2**, was launched in July 2014, was built **based on the original OCO mission** to minimise cost, schedule, and performance impacts.

- In 2019, a third mission, **OCO-3**, was **sent to the International Space Station (ISS)** to further enhance the observation of atmospheric CO<sub>2</sub>.
- NASA and other agencies have used the data from this

to create **high-resolution maps of plant growth around the world** that's useful to farmers, useful to rangeland and grazing and **drought monitoring and forest mapping** and all kinds of things, in addition to the CO<sub>2</sub> measurements.

## AGRICULTURE & FOOD TECHNOLOGY

### Nano Urea

- A study found that **nano-urea** reduced **protein content** in **rice and wheat** grains by **35% and 24%**, respectively.
- Promoted by **IFFCO**, nano-urea is a **foliar spray** alternative to conventional **urea**, which is heavily subsidized in India.
  - A **45-kg bag** costs **₹3,000** but is sold at **₹242** to farmers, providing **20 kg of nitrogen**.
  - IFFCO claims **500 ml of nano-urea** can replace **52 kg of nitrogen per hectare**.
- Unlike conventional **urea**, applied to **roots**, **nano-urea** is sprayed on **leaves** at **two flowering stages**.
- Study showed that the nano-urea spray proved ineffective, leaving the plants reliant on existing soil nutrients, thus likely resulting in reduced crop yields.
- New formulations with **8% and 20% nitrogen** also failed to **increase yields**.

### Bollgard-3

- Ahead of Punjab's cotton sowing season, there's **high demand for the unapproved Bollgard-3**, a Monsanto-developed Bt cotton variety.
- Bollgard-3 cotton variety has 3 *Bacillus thuringiensis* (Bt) proteins **Cry1Ac, Cry2Ab, and Vip3A** for improved pest resistance against **whiteflies and pink bollworms**, which have severely impacted yields and reduced cotton cultivation in the region.
- **Bacillus thuringiensis (Bt)** is a soil-dwelling bacterium with potent insecticidal properties.
- While **Bollgard-1 and -2 are ineffective** against these pests that arrived in Punjab in 2015-16 and 2018-19, respectively.

- The **Cotton Association of India** highlights Brazil's success with Bollgard-5, achieving significantly higher yields (2400 kg/hectare vs. India's 450 kg/hectare) due to its protection against multiple pests and weeds.

### Animal-Based Biostimulants

- The **Union Agriculture Ministry** has withdrawn approval for 11 **animal-derived biostimulants** due to religious and dietary concerns.
- **Biostimulants** are substances or microorganisms (or combinations) applied to crops—usually as sprays or soil additives—to enhance nutrient uptake, improve growth, yield, quality, and stress tolerance.
- They **do not supply nutrients** directly like fertilisers, nor do they control pests like pesticides..
- The withdrawn products, **previously cleared by Indian Council of Agricultural Research (ICAR)**, included protein hydrolysates from sources like chicken feathers, pig tissue, bovine hide, and cod scales, used on crops such as paddy, tomato, potato, cucumber, and chilli.
- Biostimulants are **regulated under the Fertiliser (Inorganic, Organic or Mixed) (Control) Order, 1985 (FCO)** amended in 2021.

### Aflatoxin

- Indonesia has stopped importing Indian groundnuts due to **aflatoxin** contamination — a poisonous substance made by fungi **Aspergillus flavus** and **A. parasiticus**.
- They produce **aflatoxins** as a **defence mechanism** to survive stress — such as heat, drought, or attacks from other microbes or insects.

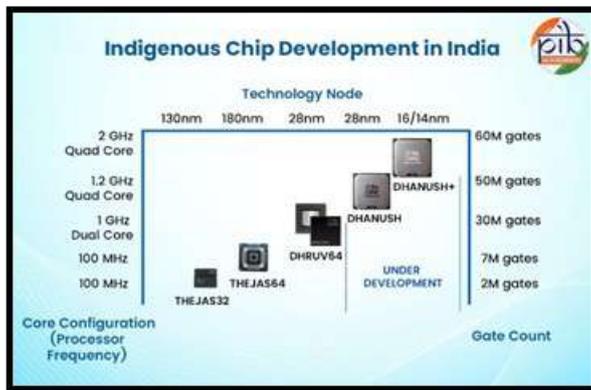
- These fungi **grow easily** in hot, humid climates and can infect crops like groundnuts, maize, rice, and spices before or after harvest.
- Aflatoxins are **heat-stable** and can survive in a wide **pH (1.7–9.3)** and temperature range (**12–48°C**).
- They are **carcinogenic**, damaging the liver and immune system, and cannot be detected by sight,

smell, or taste.

- Because of their health risks, countries follow strict **Codex Alimentarius** (international food safety standards by the FAO and WHO) and **WTO-SPS (Sanitary and Phytosanitary Agreement)** standards to control contamination and ensure food safety in trade.

## DEFENCE & AEROSPACE TECHNOLOGY

### DHRUV64



- The **Ministry of Electronics and IT (MeitY)** has launched **DHRUV64**, a fully indigenous **64-bit, dual-core (1.0 GHz) microprocessor** developed by **C-DAC** under the **Microprocessor Development Programme (MDP)**.
- It is the **third chip** under the **Digital India RISC-V (DIR-V) programme**, following **THEJAS32** and **THEJAS64**.
- Featuring **superscalar execution, out-of-order processing**, and advanced **FCBGA packaging**, **DHRUV64** is designed for **5G, automotive electronics, industrial automation, IoT, and consumer devices**.
- The **DIR-V programme** aims to develop a **homegrown semiconductor ecosystem** using **open-source RISC-V architecture**, reducing import dependence and enhancing India's **strategic electronics capabilities**.

**C-DAC** (Centre for Development of Advanced Computing) is India's premier R&D organization in IT&E (Information Technologies & Electronics) under the Ministry of Electronics & IT. It focuses on **national tech capabilities**, advanced computing (like supercomputing/GPUs), AI, Big Data, e-Governance, and offers **Post-Graduate courses** via exams like C-CAT for IT professionals

### Srjanam Rig

- India's first **indigenous Automated Biomedical Waste Treatment Plant, Srjanam**, was launched at **AIIMS New Delhi** by the Union Minister of Science and Technology.
- Developed by **CSIR-NIIST**, this eco-friendly rig disinfects biomedical waste without incineration, neutralizing pathogens and odors.
- With a daily **capacity of 400 kg**, it can initially process 10 kg of degradable medical waste.
- Once validated, it awaits full-scale implementation approval.
- India generates 743 tonnes of biomedical waste daily, posing a major disposal challenge.

### Integrated Air Drop Test (IADT-1)

- Recently, **Indian Space Research Organisation (ISRO)** successfully conducted its first Integrated Air Drop Test (IADT-1) for the **Gaganyaan mission**.
- It aimed to validate the **performance of the parachute-based deceleration system** for the **Crew Module (CM)** of the **Gaganyaan mission** in a real-world scenario.
- It was a **critical exercise** to validate the parachute system that will bring back astronauts safely under the **Gaganyaan mission**.
- The test involved collaborations between **ISRO, Defence Research and Development Organisation (DRDO), the Indian Air Force, Indian Navy, and Indian Coast Guard**.

## Gaganyaan mission:

- It is **India's first human spaceflight program**, aiming to **send a crew of 3 astronauts to Low Earth Orbit (LEO) at 400 km** for 3 days and return them safely to Earth.
- It is launched in **Human-Rated Launch Vehicle (HLVM3)** which is a modified version of ISRO's LVM3 rocket, **including solid, liquid, and cryogenic stages**, re-configured to meet human rating requirements.
- It will place **India among the elite group of nations (US, Russia, China)** with human spaceflight capability.



## ARTIFICIAL INTELLIGENCE, COMPUTING & DIGITAL TECH

### Graphics Processing Unit (GPU)

- Various AI models have been in news trained on **Graphics Processing Unit (GPU)**
- **The Ministry of Electronics and Information Technology's** IndiaAI Mission seeks to make a cluster of 18,693 GPUs available virtually to start-ups and researchers.
- Graphics Processing Unit (GPU) is a specialized **processor originally designed to render images and graphics** efficiently for computer displays.
- GPUs are characterized by their **high parallel processing power**, which allows them to **perform thousands of computations simultaneously**.

CPU	GPU
Central Processing Unit	Graphics Processing Unit
4-8 Cores	100s or 1000s of Cores
Low Latency	High Throughput
Good for Serial Processing	Good for Parallel Processing
Quickly Process Tasks That Require Interactivity	Breaks Jobs Into Separate Tasks To Process Simultaneously
Traditional Programming Are Written For CPU Sequential Execution	Requires Additional Software To Convert CPU Functions to GPU Functions for Parallel Execution

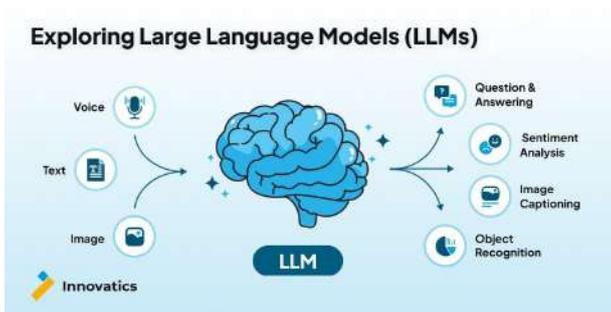
### AI Hallucinations

- **OpenAI** (the company that released ChatGPT) recently found that its latest models — **o3 and o4-mini** — generate more errors than its older models.
- Such **instances** where artificial intelligence models (like ChatGPT) generate information that is false, incorrect, or fabricated, but presented confidently as if true is called **AI hallucinations**.
  - These are errors where the AI “hallucinates” facts, details, or answers that don't exist or are misleading.
- ChatGPT, o3, o4-mini, Gemini, Perplexity, Grok and many more are all examples of what are known as **large language models (LLMs)**.
- These models essentially **take in text inputs and generate synthesised outputs** in the form of text.
- LLMs are able to do this as they are built using massive amounts of digital text taken from the Internet.
- LLMs are always making a guess while giving an output and they **do not know for sure what is true and what is not**.
- As a result LLMs may provide inaccurate text, and they may give inaccurate outputs, thereby hallucinating.

## Surya AI

- Recently, NASA has launched Surya, an **advanced artificial intelligence model** designed to transform space weather prediction.
- It is **developed by NASA alongside IBM** and trained on **nine years of Solar Dynamics Observatory data**.
- It offers **early and accurate forecasts of solar flares, eruptions and coronal mass ejections (CMEs)**.
- It **uses machine learning** to analyse vast solar data sets and unlike traditional models, it detects subtle solar activity patterns and **predicts eruptions up to two hours in advance**.
- This improves forecast accuracy and lead time, **offering better preparedness against space weather threats**.
- Its **open-source nature** encourages researchers worldwide to develop new applications and improve forecasting.
- **Note : Coronal Mass Ejections** are large expulsions of plasma and magnetic fields from the sun's atmosphere:the corona, that propagate outward into interplanetary space which disrupts satellites, powergrids etc

## Large Language Models (LLMs)



- A recent government working paper suggested that **AI large language models (LLMs)** like **ChatGPT** should, by default, have access to freely available online content.
- LLMs are **artificial intelligence systems** that understand and generate human language by processing vast amounts of text using **deep learning**, allowing them to recognize patterns, interpret content, and perform tasks like answering questions, summarizing text, translating languages, and writing.

- Examples include **ChatGPT (OpenAI), Bard (Google), Llama (Meta), Bing Chat (Microsoft), and GitHub Copilot (for coding)**.
- LLMs are applied in **sentiment analysis, customer service, chatbots, online search, and DNA research**, but face challenges such as **high computational needs, ethical concerns, and context limitations**.

**Note:** Deep learning is a type of **artificial intelligence** where computers use **layers of virtual “neurons”** to learn patterns from large amounts of data. It can **recognize images, understand speech, or process language** without being explicitly programmed.

## Light-based Computers

- Recent research shows that optical fibres, usually used to transmit data, can also perform AI computations.
- The mechanism uses **light’s non-linear behavior**—a phenomenon where strong light waves interact and change each other’s paths, allowing calculations to happen directly in the fibre.
- **Light-based computing or Photon computers uses photons** instead of electrons, making it much faster, more energy-efficient, and capable of handling large amounts of data simultaneously.
- **It enables near-instant calculations**, low heat generation, parallel processing using different light colours, and **high accuracy** in tasks like **image recognition**.
- By replacing electronic transistors with **photonic logic gates** and using **waveguides** to transmit information at the speed of light, these systems dramatically reduce problems associated with heat generation, electrical resistance, and signal propagation delays in traditional chips.

## Indigenous Vikram 32-Bit Microprocessor

- Recently, the Union Information and Broadcasting Minister unveiled India’s **first fully indigenously developed 32-bit processor** called Vikram-32.

- VIKRAM-32 was developed by **ISRO's Vikram Sarabhai Space Centre, Trivandrum and Semiconductor Laboratory (SCL)**, Chandigarh.
- It is an **advanced version of the indigenously developed 16-bit VIKRAM1601**, which was used in ISRO launch vehicle avionics since 2009.
- Fabricated using **180 nm CMOS** tech, VIKRAM-32 is designed to work in **extreme conditions** (-55°C to +125°C), withstand vibration, radiation etc.
- The **180nm node** VIKRAM-32 cannot be compared with modern smartphone processors that use **3–5 nm** chips, making it much slower and less power-efficient, but more reliant.
- **NASA** uses the **RAD750** and its successor **RAD5545**, radiation-hardened versions of IBM's PowerPC chips, built on **45 nm** technology.
- **China** has developed the **Loongson** and **Feiteng (Phytium)** processors for aerospace and defence, using **28 nm and below** technology.



## Dark Patterns

- The **Central Consumer Protection Authority (CCPA)** reported that 26 digital platforms have removed **“dark patterns”**—deceptive website or app designs that manipulate users into unintended decisions.
- Coined by UX designer **Harry Brignull** in 2010, dark patterns exploit cognitive biases. Common types include:
  - ☞ **False Urgency:** Creating fake time pressure, e.g., “Only 1 seat left!”
  - ☞ **Basket Sneaking:** Adding extra products or services at checkout without consent.
  - ☞ **Confirm Shaming:** Guilt-tripping users into agreeing or subscribing.

- ☞ **Forced Action:** Compelling users to perform unrelated tasks to proceed.
- ☞ **Subscription Trap:** Easy to subscribe but hard to cancel.
- ☞ **Interface Interference:** Hiding important information or buttons.
- ☞ **Bait and Switch:** Promoting one offer but delivering another.
- ☞ **Nagging:** Persistent reminders or pressure to take action.
- ☞ **Hidden Costs/ drip pricing:** Revealing extra charges only at the final stage of purchase.
- ☞ **Disguised Ads:** Ads designed to look like regular content, such as articles or reviews.

- The **CCPA** is a statutory body under the **Ministry of Consumer Affairs, Food and Public Distribution**, established under the **Consumer Protection Act, 2019**.

## Global Artificial Intelligence (AI) City Index 2025

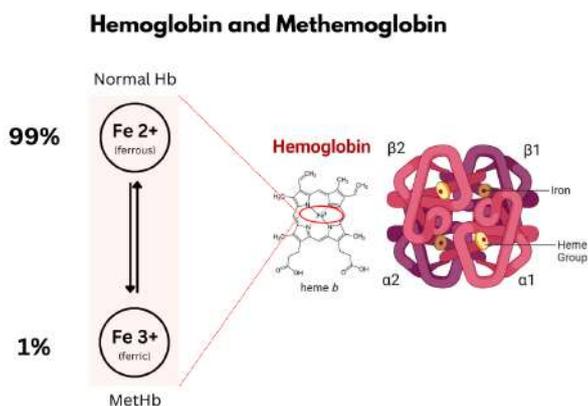
- Recently, Bengaluru has secured the 26th rank in the Global Artificial Intelligence (AI) City Index 2025, emerging as India's top AI R&D and data centre hub.
- It is a **global benchmarking report** that evaluates cities on their capacity, investment, and innovation in artificial intelligence and published by market research firm **Counterpoint Research**.
- It aims to identify and rank leading global urban centres driving AI development across R&D, infrastructure, governance, and real-world AI use.
- **India's Performance in AI City Index 2025:**
  - ☞ Bengaluru ranked 26th globally; India's top AI city with a vibrant startup and data ecosystem.
  - ☞ Mumbai and Delhi leverage AI in traffic and public security, with growth potential.
  - ☞ Other Indian cities in top national ranks include Chennai and Kolkata.
  - ☞ Report flags need for a stronger AI roadmap and regulatory frameworks in India.
- **Top Five Global Rankings** of Global AI City Index are **Singapore, Seoul, Beijing, Dubai, and San Francisco**.

## Bombay Blood Group

<p><b>SIGNIFICANCE</b></p> <ul style="list-style-type: none"> <li>▶ Bombay blood group is rare because only one out of 10,000 humans is born with it</li> <li>▶ Para Bombay blood group is even rarer type of Bombay blood group</li> <li>▶ A father-son duo with Para Bombay blood group found in Nagpur</li> </ul>		<ul style="list-style-type: none"> <li>▶ This means, people with this rarest blood group are there in Vidarbha</li> <li>▶ In case they need blood transfusion, blood of exactly same group is must for them</li> <li>▶ Directory of people with rare blood groups is maintained at national-level</li> </ul>
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- In a rare and complex medical procedure, a 30-year-old woman with the extremely rare **'Bombay' (hh) blood group** underwent a **successful kidney transplant** in India.
- First identified in Bombay in 1952, the blood group is exceptionally rare, occurring in approximately **one in 10,000 Indians and only one in a million people globally**.
- Also known as **'hh' or 'Oh' blood group**, people with this type **lack the H antigen**, making them incompatible with all standard blood types, including O-negative, complicating both transfusions and organ transplants.
- The Bombay phenotype is inherited in an **"autosomal recessive manner,"** requiring two copies of the hh allele from each parent to exhibit the BBG phenotype.

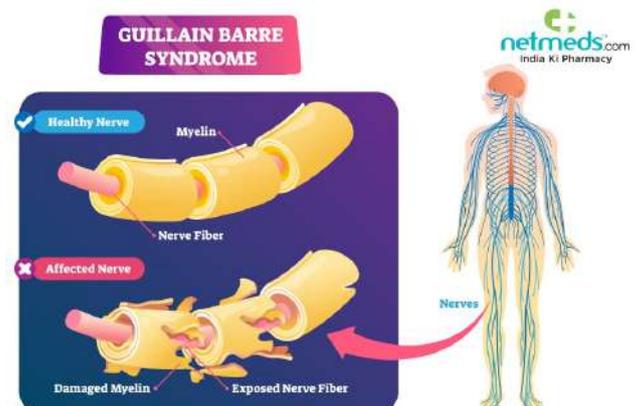
## Methemoglobinemia



- The Central Ground Water Board (CGWB) annual assessment found excessive **nitrate (NO<sub>3</sub><sup>-</sup>)** in groundwater.
- Nitrate levels above 45 mg/L pose health risks, especially **methemoglobinemia (Blue Baby Syndrome)**.
- When **nitrate** is ingested, it is converted into **nitrite (NO<sub>2</sub><sup>-</sup>)** by bacteria in the body.
- This nitrite then **oxidizes the iron (Fe<sup>2+</sup>) in hemoglobin to Fe<sup>3+</sup>**, forming **methemoglobin**, which cannot bind and transport oxygen effectively.
- Infants have lower levels of **methemoglobin reductase** (responsible for converting methemoglobin back to hemoglobin) in their RBCs or erythrocytes and are consequently more vulnerable to these agents than adults.

## Guillain Barre Syndrome

- Pune reported an outbreak of **Guillain-Barré Syndrome (GBS)** with 73 cases.
- GBS is a rare **autoimmune neurological disorder** where the immune system attacks the **peripheral nerves**, damaging the **myelin sheath**—an insulating layer that helps nerve signals travel efficiently.
- This leads to **muscle weakness and potential paralysis**.
- GBS can affect any age but is more common in **adults and males**, with an incidence of **1-2 per 100,000** people.
- According to the **WHO**, infection with **Campylobacter jejuni** (a cause of gastroenteritis) is a major risk factor, along with **viral infections and vaccinations**.



## KM3NeT (Cubic Kilometre Neutrino Telescope)

- Scientists using the KM3NeT have detected a **high-energy neutrino**, a ghostly subatomic particle, marking a major step in understanding cosmic events.
- KM3NeT** (Cubic Kilometre Neutrino Telescope) is a **European** research infrastructure located at the bottom of the Mediterranean Sea designed to detect high-energy neutrinos.
- It consists of two large neutrino detectors placed at the bottom of the Mediterranean Sea:
  - ARCA (Astroparticle Research with Cosmics in the Abyss)** – Located 3.4 km deep near Sicily, Italy it is designed to detect high-energy neutrinos from cosmic sources.
  - ORCA (Oscillation Research with Cosmics in the Abyss)** – Situated 2.4 km deep near Provence, France, it focuses on studying low-energy neutrinos and their oscillations.

- Neutrinos** are nearly massless, chargeless subatomic particles that interact very weakly with matter, making their detection extremely challenging.
- KM3NeT detects the **Cherenkov radiation** produced when neutrinos interact with water molecules, helping scientists study cosmic events like supernovae and black holes.

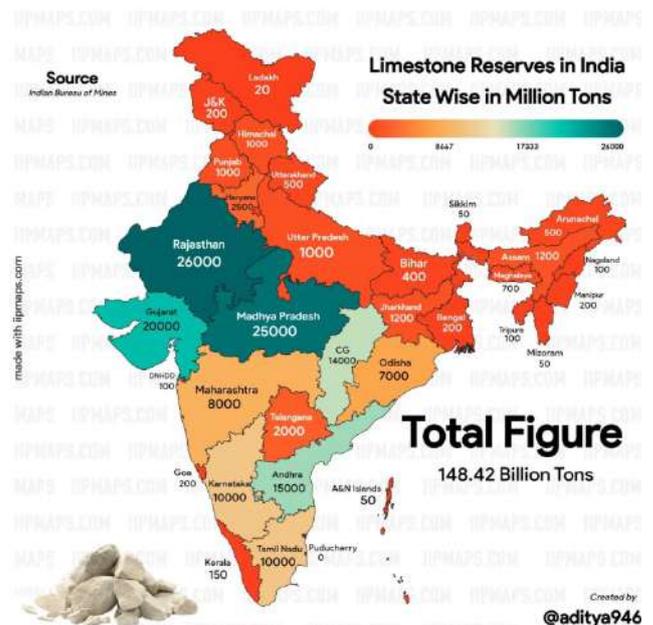
## Limestone - Major Mineral

- The **Ministry of Mines** has classified all limestone as a **major mineral**.
- Previously, limestone could be minor or major depending on its use.
- This **change will make business easier**, allowing lease holders to sell or use limestone freely.
- In India, minerals are classified as **major** or **minor** under the MMDR Act, 1957.
- Major minerals** (e.g., coal, iron ore, limestone) are centrally regulated for large-scale industrial use with higher royalties.

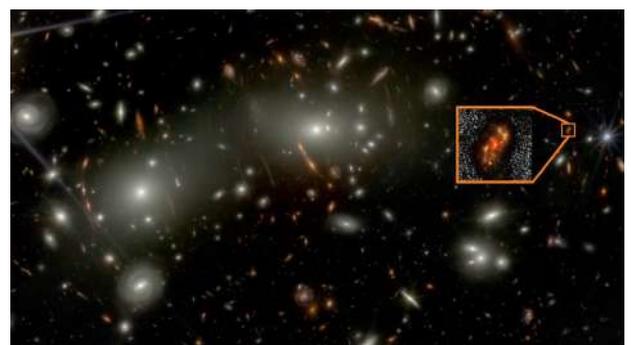
- Minor minerals** (e.g., sand, gravel, building stone) are state-regulated for local or small-scale use, with simpler procedures and lower royalties.

### About limestone:

- A sedimentary rock mainly of **calcium carbonate (calcite) or dolomite**.
- Often contains **visible fossils**, shell fragments, or fine grains.
- Colors:** gray, white, yellow, or brown; soft and easily scratched.
- Can **transform into marble** under geological changes.
- Used widely in architecture for walls, trim, veneer, and as a base material; less used for sculptures due to softness.



## Alaknanda Galaxy



- Researchers at the **National Centre for Radio Astrophysics (NCRA) – Tata Institute of Fundamental Research (TIFR), Pune**, have discovered a spiral galaxy named **Alaknanda** using **NASA’s James Webb Space Telescope (JWST)**.
- Located about **12 billion light-years away**, it formed when the universe was only **~1.5 billion years old**, or around 10% of its current age.
- Alaknanda is a textbook spiral galaxy, featuring **two well-defined arms around a bright central bulge** and spanning roughly **30,000 light-years** in diameter.
- It exhibits intense stellar activity, forming stars at a rate of **~60 solar masses per year**.
- The discovery is significant as it provides insights into **early galaxy formation and the emergence of spiral structures shortly after the Big Bang**, while also highlighting **India’s contribution to global astronomy** through NCRA-TIFR and JWST collaborations.
- Spiral galaxies like Alaknanda and the **Milky Way** typically consist of a central bulge with older stars (and often a supermassive black hole) surrounded by a rotating disk with spiral arms containing gas, dust, and young stars.

## NATIONAL SCIENCE INFRASTRUCTURE & AWARDS

### National Geospatial Mission

- The Finance Minister announced the launch of a National Geospatial Mission in the Budget 2025-26 allocating an amount of Rs 100 crore.
- The Mission aims to **develop foundational geospatial infrastructure and data**, a move aimed at modernising land records, **aid urban planning** and promoting earth observation systems.
- **Geospatial refers to data associated with a specific location on the Earth’s surface**, which is crucial for positioning systems and adding layers of information on a map.
- The government has allocated **Rs 100 crore** for the National Geospatial Mission.
- The initiative also aims **to address challenges related to land disputes** and inefficient land use, which have long hindered growth in various regions.

★ **Vigyan Shri (VS)**- recognises exceptional work in **specific fields**

★ **Vigyan Yuva–Shanti Swarup Bhatnagar (VY-SSB)**- acknowledges **young scientists below 45 years** who have demonstrated remarkable achievements

★ **Vigyan Team (VT)**- celebrates **collaborative contributions** by groups of researchers or innovators.

- It covers **13 domains** including **Physics, Chemistry, Biological Sciences, Engineering, Medicine, and Space Science**.
- The selection process involved a rigorous review conducted by a high-level committee **chaired by the Principal Scientific Adviser** to the Government of India, and included Secretaries of Science Departments, Heads of Science Academies, and domain experts.
- Eminent **physicist Jayant Vishnu Narlikar**, who passed away in May this year, was announced the recipient of the **Vigyan Ratna**, an award for lifetime contribution.

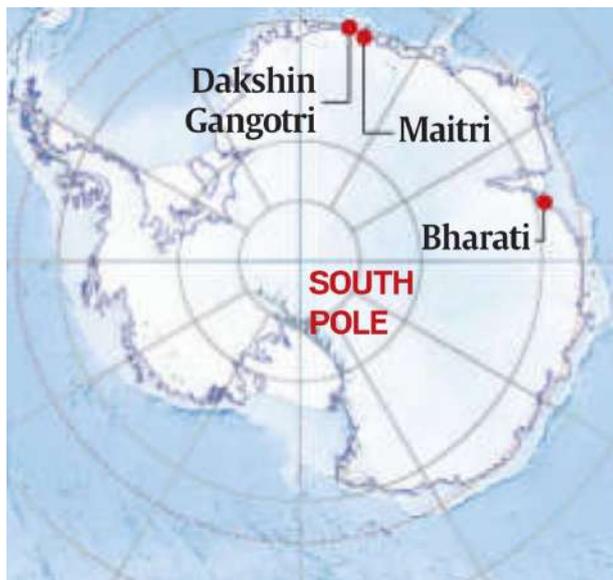
### Rashtriya Vigyan Puraskar 2025

- The Government of India has announced the **Rashtriya Vigyan Puraskar 2025**, the **country’s highest recognition** for exemplary and inspirational contributions in the fields of **science, technology and innovation**.
- The Puraskar are conferred in four categories
  - ★ **Vigyan Ratna (VR)**- honours **lifetime contributions** to science and technology

### Maitri II Antarctic Research Station

- The Finance Ministry has approved **Maitri II, India’s fourth research station in eastern Antarctica**, expected to be ready by January 2029.
- The **National Centre for Polar and Ocean Research (NCPOR)** under the Ministry of Earth Sciences will manage the station and related missions.

- India's Antarctic research began in the early 1980s.
- Its first base, **Dakshin Gangotri**, operated briefly.
- Currently, **Maitri** (since 1989) and **Bharati** (since 2012) support scientific research in Antarctica, which holds 75% of the world's freshwater under thick ice sheets. Maitri is located in the **Schirmacher Oasis**, a 20 km ice-free area, and includes living quarters, fuel stations, a pump house, and modular units.
- **Maitri II will be larger and designed as a green station**, using solar power in summer and wind energy year-round.



- **Maitri (1989):** Maitri is India's second permanent research station in Antarctica, established in 1989 which is located in the rocky mountainous Schirmacher Oasis, and India also created a freshwater lake nearby, called Lake Priyadarshini.
- **Bharti (2012):** Located about 3,000 km east of Maitri, the 'Bharati' research station lies between Thala Fjord and Quilty Bay.
- **Himadri (2008):** Located in Ny-Ålesund, Svalbard, Norway, serving as a base for scientists studying climate, glaciology, and atmospheric processes in the Arctic region.



## Maitri Research Station

- India plans to **replace its old Maitri Research Station in Antarctica** with the larger, greener, and renewable-energy-powered Maitri-II by 2032.
- Operated by the Goa-based **National Centre for Polar and Ocean Research (NCPOR)**, the new station will have automated instruments to relay data to India.

## India's Other Research Stations in Antarctica and Arctic:

- **Dakshin Gangotri (1983):** Dakshin Gangotri, established under the Indian Antarctic Program in 1983, was India's first scientific research base in Antarctica, but it was submerged in ice and decommissioned in 1990.