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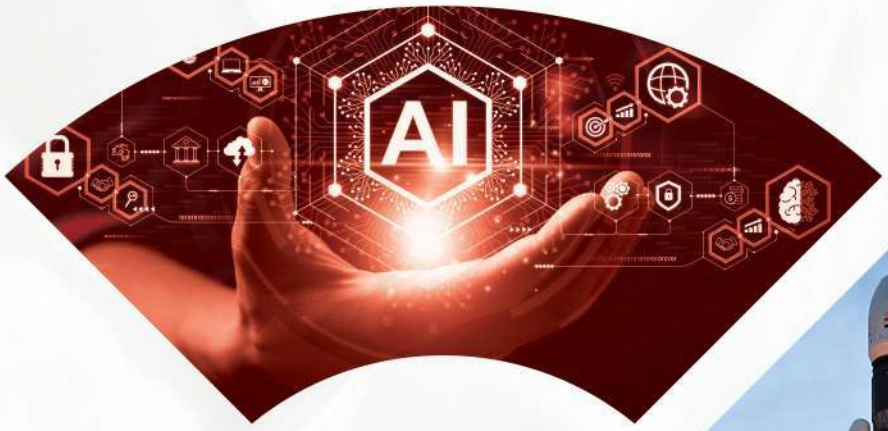
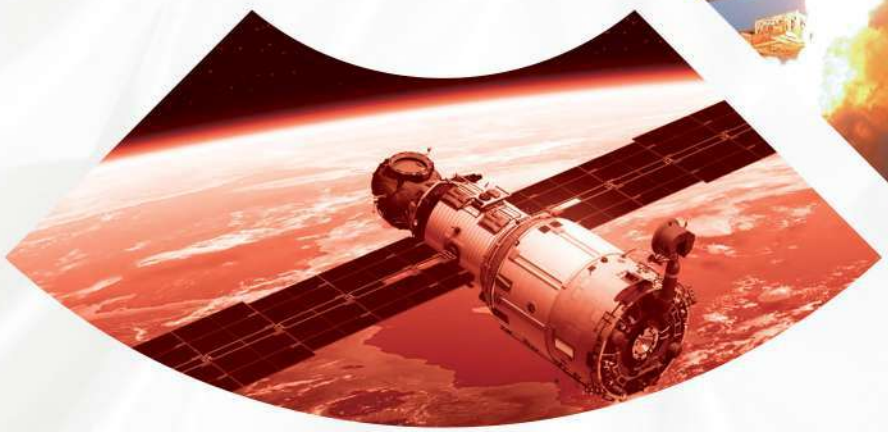
Prelims Precise Compilation
Volume II





SCIENCE & TECHNOLOGY

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Toppers in Top 100

P K Sidharth Ramkumar
2024

Meera K
2021

Sidharth B
2017

Dilip K Kainikkara
2022

Hamna Mariyam
2017

Sreelakshmi Ram
2019

Vishnu Sasikumar
2024

Anand
2016

Arya V M
2023

Archana P P
2024

Safna Nazarudeen
2020

Nandanaa G P
2025

Renjina Mary V
2019

Sonnet Jose
2025

Dr. Arun S Nair
2020

Alfred O V
2022

Hari Kallikkat
2018

Benjo P Jose
2024

Aparna M B
2021

Dheenah Dastageer
2021

Akhil V Menon
2022

Arjun Mohan
2019

Kasturi Sha
2024

Fabi Rasheed
2024

Reenu Anna Mathew
2025

Malini S
2023

Devi Nandana
2020

Annie George
2024

Devika Priyadersini
2025

Kiran P B
2022

Preface

Fortune IAS Academy presents **'Prelims Precise'** , a monthly current affairs magazine through which we make prelims current affairs revision precise and effective.

This magazine is a comprehensive resource that condenses the significant news of each month into distinct sections such as polity and governance, economic development, science & technology, among others.

Each content is organised with the why in news context followed by its explanation.

Fortune Prelims Precise is available to all Prelims cum Mains batch students (2024) as part of the course study material. **It can be purchased from Fortune IAS Academy for Rs. 75 per issue**.

Test your preparation with January 2026 Monthly Current Affairs quiz here

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Doomsday Clock

- The hands of the Doomsday Clock were moved **85 seconds to midnight**, the closest the world has ever been to global catastrophe in its estimation.
- **Reasons cited** are failure of leadership, worsening nuclear threats, climate change, and AI risks.
- The **Doomsday Clock** is a symbolic indicator created in **1947** by the **Bulletin of the Atomic Scientists (BAS)** to convey how close humanity is to self-inflicted global catastrophe, with **midnight representing doomsday**.
- The **Bulletin of the Atomic Scientists** is a **non-profit organization founded in 1945 at the University of Chicago** by scientists involved in the Manhattan Project (**U.S.–led scientific and military programmes (1942–1946)** to develop the **world's first atomic (nuclear) weapons** during World War II).
- The clock is **not calculated mathematically**; instead, it is set annually by the **BAS Science and Security Board**, in consultation with Nobel laureates, based on expert assessment of risks to global stability.
- The Doomsday Clock is **displayed** at the Bulletin of the Atomic Scientists' offices in the lobby of the Keller Center at the **University of Chicago.**
- The Doomsday Clock has been reset **28 times since 1947**, and **last year 2025** Position was **89 seconds** to midnight (1 minute, 29 seconds).

Bacillus Subtilis

- **Kerala** officially declared Bacillus subtilis as 'State microbe'.
- Bacillus subtilis, commonly known as the **'Hay Bacillus'**, is a **non-pathogenic, probiotic, Gram-positive**, rod-shaped **bacterium** found primarily in soil and the gastrointestinal tract of humans, animals and has the **ability to produce and secrete antibiotics**.
- It is **famous for its ability to form tough, protective endospores, allowing it to survive extreme environmental conditions** like heat and drought.
- It is **categorized as GRAS (Generally Regarded As Safe) by global food authorities** and is a key ingredient in t**raditional fermented foods** like the Japanese Natto.
- It is non-pathogenic **but can contaminate food and be considered an opportunistic pathogen among the immuno-compromised**.
- They are **used on seeds, vegetables, and plants as a fungicide** because of their ability to produce antibiotics and **it inhabits in the root system of the plant competing with disease causing organisms**.

Ammonia spikes in Yamuna

- **Ammonia spikes** in the Yamuna have become a **chronic winter issue** causing water toxicity, generally occurring between 15 and 22 times a year.
- In winter, there is reduced water flow in Yamuna due to **low rainfall and lower upstream water releases** (from barrages and reservoirs) further reduce river flow, so untreated sewage and industrial effluents become more concentrated, leading to ammonia spikes.

- Importantly Ammonia **causes toxicity**, but the **froth in the Yamuna is mainly due to phosphates and surfactants** from untreated sewage and detergents.
- Ammonia is a **colourless, pungent gas composed of nitrogen and hydrogen with the formula NH3** and the **simplest stable compound** of these elements.
- It is **highly soluble in water**, forming ammonium hydroxide, an alkaline solution and has **density which is less than air**.
- It is **produced naturally from decomposition of organic matter**, including plants and animals and is **manufactured mainly by the Haber–Bosch process** (from nitrogen and hydrogen).
- Also some plants, mainly legumes, in combination with **rhizobia bacteria, "fix" atmospheric nitrogen** to produce ammonia.
- The **exposure to high levels of ammonia in air may be irritating to a person's skin, eyes, throat, and lungs** and cause coughing and burns and t**o prevent the release of toxic fumes, ammonia should not be mixed with other chemicals (like chlorine bleach**).
- It is a **basic building block for ammonium nitrate fertilizer** and also **used as a refrigerant, stabilizer, neutralizer, and purifie**r — particularly in food transport and water treatment applications.

Voice over WiFi (VoWiFi) Services

- Recently BSNL announced the **nationwide rollout of Voice over WiFi (VoWiFi),** also known as Wi-Fi Calling.
- While this is a new, nationwide offering from BSNL, it is **not new to India**, as private operators like Airtel and Jio have offered it for several years.
- Voice over WiFi (VoWiFi) is a technology that **allows users to make and receive voice calls and SMS over a Wi-Fi network** instead of a mobile network.
- When **mobile signal is weak**, your **phone routes calls** and messages through a Wi-Fi connection to **your telecom operator's core network using secure internet protocols**.
- To the user, it works like a normal call—same number, no extra app, and seamless switching between Wi-Fi and cellular networks when available.

Key Features of VoWiFi:

- **IMS-Based Integration:** VoWiFi uses IP Multimedia Subsystem (IMS) technology to route calls, allowing it to function as a carrier-native service.
- **Seamless Handover:** Calls can transition automatically between Wi-Fi and mobile networks (VoLTE) without dropping, provided both services are enabled.

- It **enables uninterrupted communication in signal-dark zones** particularly in rural and indoor environments, **provides clearer and more stable voice calls** compared to fluctuating cellular networks and **maintains strong protection using SIM-based encryption and authentication**.

Candida Auris

- The drug-resistant **fungal species** Candida auris is **turning more deadly** and is spreading globally, according to a study led by Indian researchers.
- **Candida auris** is a multidrug-resistant fungal pathogen causing **severe, often fatal infections** in hospitalised and immunocompromised patients.
- **C. auris** is **not a major threat to healthy individuals** (but can carry it to others) but poses a severe risk to those with weakened immune systems or serious underlying conditions.
- First identified in 2009, it has emerged as a global health threat due to **high mortality (30–60%), resistance to treatment, persistence on skin and medical devices.**
- Candida auris **spreads mainly through direct contact** with infected or colonised people and contaminated surfaces or medical equipment, especially in healthcare settings, including via invasive devices like catheters or ventilator tubes.
  - It **does not spread through the ai**r and is usually carried on the skin.
- **C. auris** is hard to diagnose, often requiring specialised tests like MALDI-TOF MS and is sometimes misidentified as other infections.

Bio-bitumen

- India has become the **first country to commercially produce bio-bitumen** for road construction, a **green alternative to petroleum bitumen** made from **agricultural residues like rice straw**.
- It can replace **20–30% of conventional bitumen (binder used in road construction)**, is **environment-friendly, cost-efficient, and field-tested** (e.g., 100 m road on Jorabat–Shillong Expressway, Meghalaya).
- **Bio-bitumen is produced by converting biomass**—such as agricultural waste (rice straw, stubble), lignin, or vegetable oils—into a sustainable binder through processes like **pyrolysis**, which thermally decomposes organic material in **low-oxygen environments.**
- The resulting **bio-oil is then refined**, polymer-modified for improved viscosity and stability, and often blended with conventional bitumen for use in road construction.
- Bio-bitumen **reduces fossil fuel use, curbs air pollution, and converts crop waste into infrastructure material**, helping address stubble burning.

Note: Bitumen is a **black, sticky hydrocarbon** used as a **binder in roads and for waterproofing**. It is primarily **made from crude oil** during the **refining process**. It is the **heavy, sticky residue left after lighter fractions (like petrol, diesel, and kerosene) are removed**

Dust EXperiment (DEX)

- ISRO has confirmed that an **interplanetary dust particle (IDP)** enters Earth's atmosphere roughly **every 16 minutes**, based on measurements from India's first cosmic dust detector Dust EXperiment (DEX).
- India's **Dust Experiment (DEX)**, developed by the **Physical Research Laboratory (PRL) under the Indian Space Research Organisation (ISRO)**, is the country's first instrument designed to detect **high-speed interplanetary dust particles (IDPs)** in Earth orbit.

Interplanetary Dust Particles (IDPs) are **microscopic shrapnel from comets and asteroids** that form our atmosphere's mysterious "meteor layer" and these **can be analyzed to gain insights into their origins, formation mechanisms**, and the processes that occurred in early solar and presolar environments.

- It was flown onboard the **Polar Satellite Launch Vehicle (PSLV) Orbital Experimental Module (POEM)** during the **PSLV-C58 XPoSat mission**, launched on **January 1, 2024**.
- The instrument, weighing about **3 kilograms**, operates at an altitude of **~350 km** and detects microscopic dust impacts using the **hypervelocity detection principle**, recording signals generated by high-speed collisions.
- Observations from DEX provide insights into the **meteor layer** and help scientists understand the **origins, formation mechanisms, and early solar system processes** of comets and asteroids.

Traditional Indelible Ink

- **Maharashtra's** State Election Commission has decided to **revert to traditional indelible ink** after complaints that **marker-pen ink** used in municipal polls could be wiped off.

Indelible ink is a **permanent marking ink applied on a voter's finger after voting** to indicate that the person has already exercised their franchise and cannot vote again.

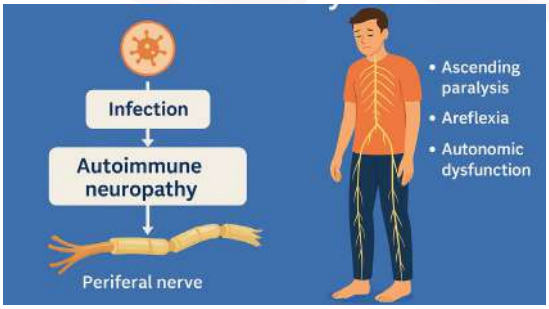
- **India began using indelible ink in 1962** (Third General Election) as a simple, low-cost and effective method to prevent impersonation and repeat voting.
- The **ink contains silver nitrate**, which reacts with the skin and light to leave a dark mark and the **stain fades only as the outer layer of skin wears away** and it also contains a dye to make it clearly visible.
- It is **manufactured exclusively by Mysore Paints and Varnish Limited, a Karnataka** government undertaking, using a closely guarded formula developed by India's National Physical Laboratory.
- The company supplies indelible ink for elections across the country and, with approval from the Election Commission and the Government of India, **has also exported it to several countries, including Afghanistan, Cambodia, Kenya, Mongolia, Nepal and Nigeria**.

Ethylene Glycol (EG)

- **Telangana** recently issued a **stop use notice** for a batch of Almont-Kid Syrup contaminated with t**oxic Ethylene Glycol (EG).**
- Ethylene Glycol (EG) is a **colorless, odorless, sweet-tasting, and water-soluble organic compound** that is **commonly used in a variety of industrial applications**.
- It is a **slightly viscous liquid** usually produced by the **reaction of ethylene oxide with water**; it is the **simplest member of the glycol family** of organic compounds with **chemical formula C2H6O2**, and it **is a diol** (a compound containing two hydroxyl groups).
- It is **primarily used as an antifreeze** and **coolant in automotive and industrial applications** due to its ability to significantly lower the freezing point of liquids and also **used as an ingredient in hydraulic fluids, printing inks, and paint solvents**.
- It is **also used as a reagent in making polyesters, explosives, alkyd resins, and synthetic waxes** and it is **highly poisonous**; animals or humans that drink the solution become very ill and may die.
- Ethylene glycol (EG) or diethylene glycol (DEG) can enter syrups when **cheap industrial solvents are substituted for safe excipients** like glycerin, through **contaminated raw materials**, or via **cross-contamination from inadequately cleaned equipment**.

Guillain-Barre Syndrome

- A **Guillain-Barré Syndrome (GBS) outbreak** in **Madhya Pradesh's** Neemuch district has caused two deaths in Manasa.
- GBS is a **rare autoimmune neurological disorder** where the immune system attacks the peripheral nerves, causing numbness, tingling, muscle weakness, and sometimes paralysis.
- It often f**ollows infections** (particularly from Campylobacter jejuni)**, vaccination, or surgery.**



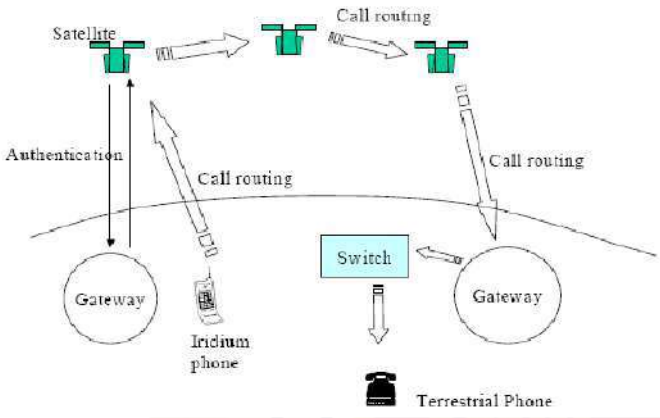
Human Papillomavirus (HPV) Vaccination

- **India** plans to launch a nationwide **Human Papillomavirus Vaccine (HPV vaccine)** programme to prevent **Cervical Cancer** in adolescent girls.
- **Human papillomavirus (HPV)** is the most common **sexually transmitted infection (STI),** affecting nearly all sexually active people at some point, often without symptoms.
- While **most infections clear on their own within** 1-2 years, persistent high-risk strains can cause **cancers** (cervical, anal, throat) and low-risk strains cause **genital** warts.
- While it is mostly spread through sexual contact, **very rarely it can pass** from mother to baby during childbirth or via contact with contaminated surfaces.
- **Persistent infection** with high-risk types (especially HPV-16 and HPV-18) can cause abnormal **changes in the cells of the cervix**.
- Over **10–15 years**, these abnormal cells may gradually **turn into cancer** if not detected or treated early.
- Factors that increase the risk include **early sexual activity, multiple sexual partners, weak immunity, smoking, and lack of regular cervical screening**.
- The vaccine will mainly target **girls around 14 years old**, as it works best before exposure to the virus and can reduce cervical cancer risk by **about 90–95%**.
- The HPV vaccine is a **recombinant vaccine**, meaning it is made using **genetic engineering to produce harmless viral proteins** that trigger immunity without using the whole virus.

Note:The **cervix** is the lower, narrow part of the uterus that **opens into the vagina, a**cting as a crucial, muscular, and fibrous gateway in the female reproductive system. It produces **mucus** to protect against infections and facilitates fertility by allowing sperm to enter the uterus. **During pregnancy, it remains closed** to protect the baby, later dilating for childbirth

Satellite Phone

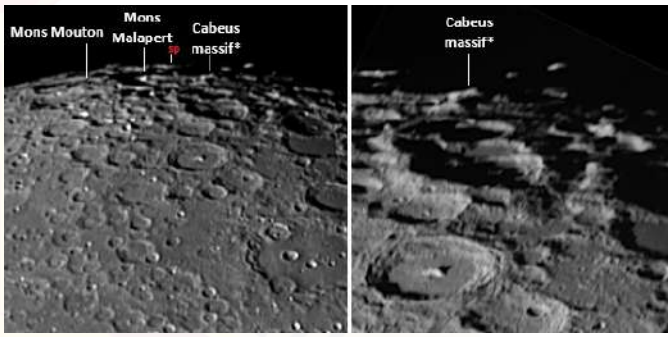
- Security agencies have flagged the illegal use of **undeclared satellite communication devices** by vessels in Indian waters, citing national security concerns.
- A satellite phone (satphone) is a **communication device that connects directly to orbiting satellites instead of terrestrial mobile towers**, enabling **communication in remote or off-grid areas** such as oceans, deserts, and disaster zones.
- By **relaying signals through Geostationary (GEO) or Low Earth Orbit (LEO) satellite** systems to ground stations and other users, these phones facilitate communication, also it **requires a clear line-of-sight to the sky for effective transmission**.
- It provides **Global/Remote Coverage**, **Widely used for distress and safety operations** and also **provides basic functions like Voice calls, SMS**, and limited data services.
- Its limitations include **high cost, limited data speed, line of sight requirement** (Poor performance indoors or in dense terrain) and **signal delay**.



Moon's Mons Mouton

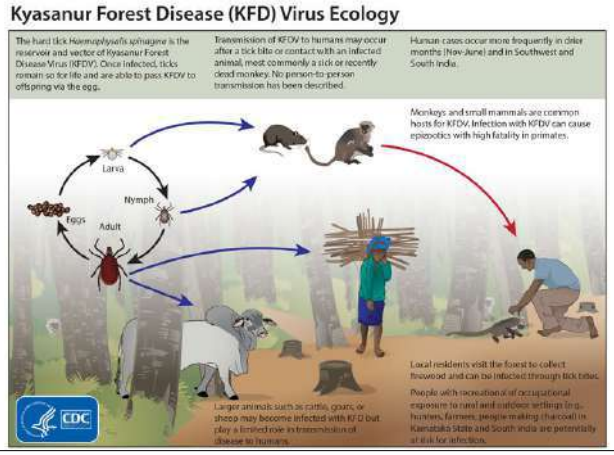
- ISRO's Space Applications Centre has identified a safe landing site near **Mons Mouton** for **Chandrayaan-4**, India's first lunar sample return mission.
- Mons Mouton is a large, flat-topped mountain near the Moon's south pole, named after NASA mathematician **Melba Roy Mouton** by the IAU.
- It lies close to the **South Pole–Aitken Basin**, one of the largest and oldest impact basins in the Solar System, formed by ancient asteroid impacts.
- The site is suitable for landing due to **gentle slopes, few boulders, and adequate sunlight,** and it offers valuable scientific insights into the Moon's early formation and impact history.

Note: **Shiv Shakti Point** is the official name of the landing site of **India's Chandrayaan-3 mission**, located near the **Moon's South Pole** at approximately 69.37°S, 32.32°E. Named following the successful landing on August 23, 2023, the International Astronomical Union (IAU) approved the name "Statio Shiv Shakti" in March 2024.



Kyasanur Forest Disease (KFD)

- India has started Phase I human trials of a fully indigenous **Kyasanur Forest Disease (KFD) vaccine**, developed under an ICMR-led collaboration.
- KFD is a **tick-borne viral hemorrhagic fever** first identified in Karnataka, causing high fever, weakness, muscle pain, and sometimes fatal complications.
- It is endemic to the **Western Ghats** (Karnataka, Tamil Nadu, Kerala, Goa, Maharashtra) and spreads via **tick bites** or contact with infected animals, especially monkeys; there is **no human-to-human transmission**.
- No specific cure exists, and the **fatality rate is 3–10%** without prompt medical car

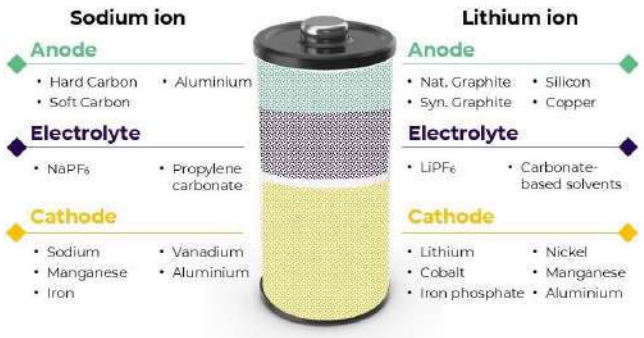


Sodium-ion battery

- India is re-evaluating its battery strategy amid rising **concerns** over critical mineral dependence, import vulnerability, and supply security linked to **lithium-ion batteries.**
- Sodium-ion (Na-ion) batteries are **cost-effective, and safe alternatives to lithium-ion batteries**, utilizing abundant sodium resources (e.g., sea salt) for energy storage.
- They offer **rapid charging, excellent low-temperature performance, and a longer lifespan**, making them ideal for electric vehicles (EVs), grid storage, and solar applications.

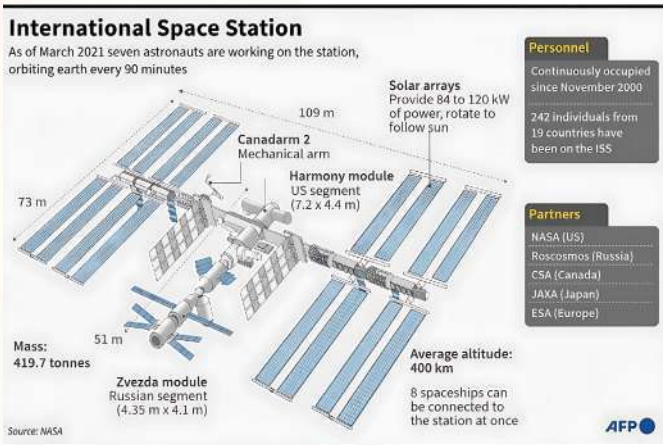
Sodium-Ion Batteries vs Lithium-Ion:

- **Energy Density:** Historically, **SiBs had lower specific energy because sodium is heavier than lithium**.However, modern layered transition-metal oxide cathodes in SiBs are now approaching the energy density of Lithium Iron Phosphate (LFP) batteries.
- **Safety Profile**: **SiBs are intrinsically safer**. They exhibit significantly lower peak temperatures during thermal runaway events compared to lithium-ion cells.
- **Transportation Benefits:** Unlike lithium-ion batteries, which are dangerous goods and must be shipped at ~30% charge, **SiBs can be stored and transported at zero volts without degradation.This eliminates fire risks during transport** and lowers logistical costs.



International Space Station (ISS)

- The **International Space Station (ISS) is planned to be de-orbited in 2030** in a controlled re-entry over a remote ocean area, bringing an end to the longest-running era of continuous human presence in low Earth orbit.
- The ISS is a multinational, permanently crewed orbital laboratory and research facility, **orbiting about 400 km above Earth**.
- It is operated through an **international partnership of five space agencies**: **NASA** (USA), **Roscosmos** (Russia), **ESA** (Europe), **JAXA** (Japan), and **CSA** (Canada) - totally representing 15 nations, serving as a platform for scientific experiments in medicine, materials, and climate science
- The assembly **began in 1998** with the launch of the first module Zarya on 20 November 1998 and **continuous habitation started with Expedition 1 in November 2000**.
- The **station orbits Earth roughly every 90 minutes,** traveling at about 8 kilometers per second (28,000 kmph)

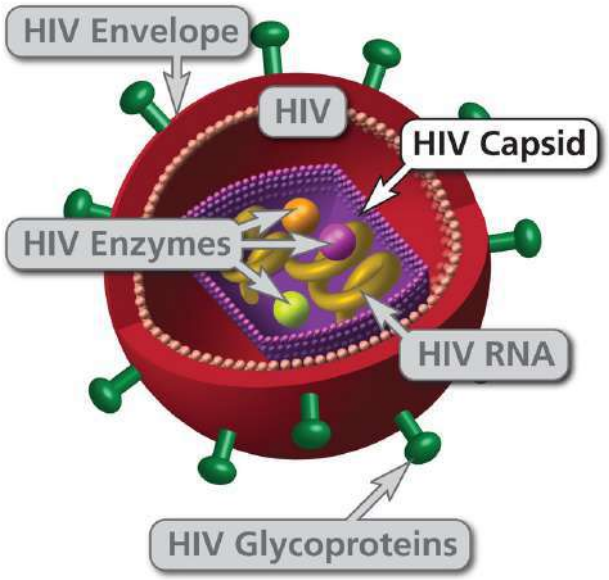


Graphics Processing Unit (GPU)

- Graphics Processing Units (GPUs) are in focus as they have become the b**ackbone of modern AI systems**, cloud computing, and high-performance digital infrastructure.
- **GPUs** are **specialized processors** designed to perform thousands of simple calculations simultaneously, making them ideal for **parallel processing** tasks.
- Unlike **CPUs** (Central Processing Units), which have a few powerful cores optimized for sequential, complex tasks, GPUs have hundreds or thousands of smaller cores that handle **many operations at once**, such as processing large datasets, rendering images, or performing matrix operations in AI.
- In functioning, a GPU **transforms 3D geometry into a 2D image** by calculating vertex positions, rasterizing shapes into pixels, applying textures and shading, and then sending the final output to a display.

- This ability to execute **massive numbers of repetitive tasks concurrently** makes GPUs much faster than CPUs for graphics rendering, AI computations, scientific simulations, and cryptocurrency mining.
- While a CPU acts like a versatile "general-purpose brain" for the computer, a GPU is a **specialized parallel processor** designed for **speed and efficiency in data-heavy task**

Capsid



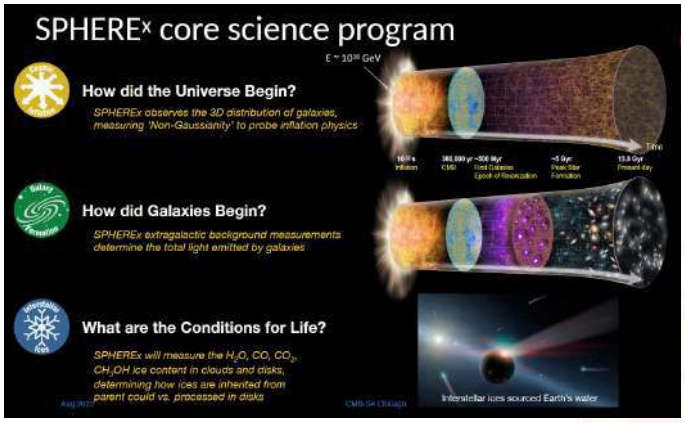
- A study revealed that **Human immunodeficiency virus (HIV)** must damage its own **protective capsid** to evade the drug Lenacapavir, highlighting the **capsid as a crucial weak point** for developing effective antiviral treatments.
- HIV is an RNA retrovirus that contains two identical single-stranded RNA molecules and **attacks the human immune system,** specifically CD4 cells, and if untreated can progress to **AIDS**.
- The **capsid** is a protective shell made of **proteins that surrounds the virus's genetic material** (RNA and essential enzymes like reverse transcriptase, integrase), keeping it **safe until it enters a human cell.**
- Once HIV enters human cells it **uses an enzyme called reverse transcriptase** to convert its RNA into DNA.
- This newly synthesized DNA is then **integrated into the host cell's genome by an enzyme called integrase**, turning the host into a factory that produces new viral particles that exit the cell to infect others.
- The study saw that the virus must damage its own capsid to escape drugs like Lenacapavir, **medicines that stabilize or block the capsid can prevent HIV from replicating**, potentially leading to stronger, longer-lasting antiviral therapies.
- This also opens the door for **developing drugs against other viruses with similar capsid structures**, making it a promising approach in antiviral research.

Aluminium Phosphide poisoning

- Doctors at **PGIMER, Chandigarh** have achieved a global first by successfully treating **aluminium phosphide (Celphos) poisoning** using **intravenous lipid emulsion (ILE) therapy**.
- Aluminium phosphide is a widely used **pesticide** that releases **phosphine gas** when it comes into contact with water or moisture in the air.
- This gas is highly toxic and attacks the cells in the body, **disrupting energy production in organs** and causing symptoms like nausea, vomiting, difficulty in breathing, pulmonary edema, heart problems, convulsions, and even death.
- Poisoning with this chemical is **common in agricultural states** such as Punjab, Haryana, and Uttar Pradesh, often due to accidental or intentional ingestion.
- **ILE therapy works** by injecting a special f**at solution into the bloodstream, which absorbs and neutralizes fat-soluble toxins like phosphine,** reducing their effect on organs and giving patients a better chance of survival.

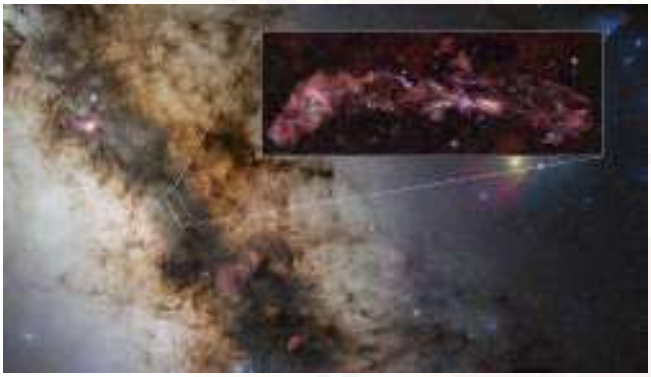
SPHEREx Mission

- NASA's **SPHEREx** mission recently observed the interstellar comet **3I/ATLAS**, the third such object known to pass through our solar system.
- An **interstellar comet** is a comet that originates from outside the solar system, traveling through interstellar space before entering our Sun's neighborhood.
- Launched in 2025, **SPHEREx** is an infrared space telescope mapping the entire sky to study **cosmic origins, large-scale structures, and the distribution of water and organic molecules**.
- It surveys in optical and near-infrared light, complementing telescopes like **JWST, Euclid, and the Roman Space Telescope** with its unique all-sky infrared coverage.



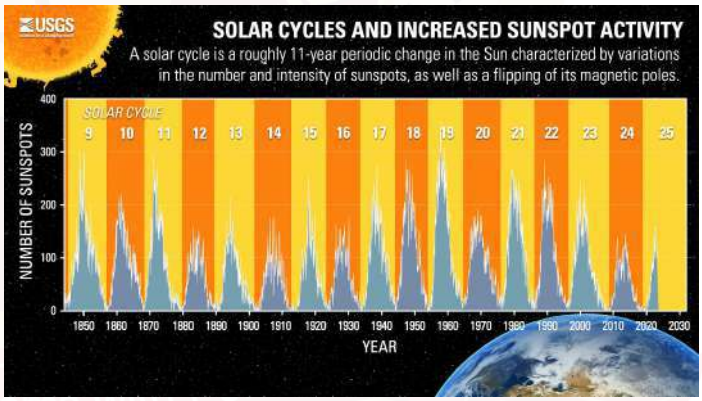
Alma Telescope

- Astronomers recently captured a detailed image of the **Milky Way's central region** using **ALMA (Atacama Large Millimeter/ submillimeter Array)** in Chile.
- ALMA is a **66-antenna telescope** that studies some of the coldest objects in the Universe by detecting **millimetre and submillimetre radiation** (between infrared and radio waves).
- Using **interferometry**, its antennas work together to pinpoint and analyze cosmic signals from stars, planets, and galaxies.
- Located on the **dry Chajnantor plateau**, ALMA is the largest ground-based astronomy project in the world.

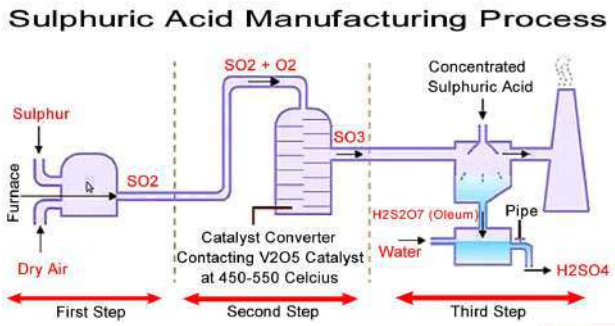


Solar Peak

- **NASA** observed a powerful **X-class solar flare**, the most intense category of solar storms, captured by the **Solar Dynamics Observatory**.
- **Solar Flares** are sudden, intense bursts of energy and radiation released from the Sun's surface, usually near **Sunspots** where magnetic activity is strong.
- They emit large amounts of **X-rays, ultraviolet radiation, and charged particles**, which can disturb space weather and affect satellites, radio communication, and power systems on Earth.
- Solar flares are classified by intensity into **A, B, C, M, and X classes**, with **X-class flares** being the strongest and capable of causing major disruptions.
- Such strong flares usually occur during the **Solar Maximum**, the peak phase of the **Solar Cycle**, an approximately **11-year cycle** of changing solar magnetic activity.
- During this cycle, solar activity gradually rises from **Solar Minimum** (when the Sun has very few eruptions) to Solar maximum, when the Sun shows many **Sunspots**—cooler dark regions that act as centres of eruptions.
- At this stage, the frequency of **Coronal Mass Ejections (CMEs)** and solar flares increases significantly.
- During the peak, the **Sun's magnetic poles reverse**, and then activity slowly declines back toward solar minimum, completing the cycle.
- The current 11-year period of solar activity is called the **Solar Cycle 25** which began in December 2019 and is projected to last until 2030.
- It represents the **25th cycle since 1755** which despite initial predictions that it would be weak has exceeded expectations, showing higher solar activity than the previous, weak Cycle 24.



Oleum



- A major **oleum (aka fuming sulfuric acid)** leak at a chemical unit in Palghar, Maharashtra, forced the evacuation of over 2,600 people.
- Oleum, a mix of **sulfur trioxide (SO_3)** in concentrated **sulfuric acid (H_2SO_4)**, forms dense white fumes on contact with moist air.
- Highly corrosive and a strong dehydrating agent, it can irritate eyes, skin, and the respiratory tract; large leaks produce fine sulfuric acid mist hazardous over wide areas.
- Produced via the **Contact Process**, oleum is used in sulfuric acid production, explosives like **TNT**, and organic chemistry.

OPU–IVF–ET Technology

- Scientists at the **Indian Veterinary Research Institute (IVRI), Bareilly**, produced five healthy **Sahiwal calves** from a single donor cow using **OPU–IVF–ET** technology (**Ovum Pick-Up, In Vitro Fertilization, Embryo Transfer**).
- **OPU–IVF–ET Procedure:**
  - **Ovum Pick-Up (OPU):** Eggs are retrieved non-surgically from ovarian follicles using transvaginal ultrasound.
  - **In Vitro Fertilization (IVF):** Eggs are matured in the lab (~24 hours) and fertilized with specialized semen to form embryos.
  - **Embryo Transfer (ET):** Embryos are implanted into a synchronized surrogate or cryopreserved for future use.
- IVRI achieved **over 47% blastocyst (early embryo stage) rates**, with non-stimulated egg recovery and the ability to cryopreserve embryos, enabling one elite cow to produce many offspring annually.
- **Sahiwal cows**, a prized indigenous **Zebu breed from Punjab and Haryana**, yield ~12 litres of high-quality milk per day, are heat-tolerant, and hardy.

SRY Gene Screening

- The **International Olympic Committee (IOC)** now requires **SRY gene** screening for all female elite athletes.
- The **SRY gene** (**Sex-determining Region Y**) is a segment of DNA found on the **Y chromosome** that acts as a biological switch for male development.
- It triggers **testes formation**, which produces testosterone, leading to male traits like muscle growth and body hair.
  - **Without it (as in XX females)**, the embryo develops female reproductive organs.
- The screening test ensures fair competition by **identifying athletes with male-level physiological advantages.**
- It is a **one-time test** for international-level athletes, with exceptions for conditions like **Complete Androgen Insensitivity Syndrome (CAIS)**, where athletes cannot process testosterone and remain eligible for the female category.

AI Tokens

- The AI industry is increasingly shifting toward **tokenomics**, where the **cost per token** has become a key metric for global competition among models.
- The AI industry is thus now competing based on **how cheaply and efficiently models process text**.

- Tokens are the **smallest units of data processed by Large Language Models (LLMs)**; unlike humans who read full words, **AI breaks text into tokens**, which may be a single character, a whole word, or part of a word.
- The **cost per token** matters because every task (chatting, coding, translation) uses tokens
- **Different languages need different numbers of tokens**, and each model can only handle a limited amount at once (called the **context window**).
- By processing tokens, AI understands language structure, which helps it generate correct sentences and code.

Understanding LPG and LNG

- India is facing a significant energy crisis as the West Asia war has disrupted 54% of its LPG and 30% of its LNG supplies through the Strait of Hormuz.

Liquefied Petroleum Gas (LPG):

- It is a **flammable mixture of hydrocarbon gases**, primarily **propane and butane** which is produced as a **byproduct of crude oil refining** and natural gas processing.
- It is stored in pressurized cylinders at room temp , heavier than air (sinks to the ground) and **transported mostly by road/trucks in cylinders/tankers** and has a **higher risk of fire** if leaked (accumulates).
- It is **extensively used as cooking fuel in households (cylinders)** also **used for high-heat processes like metal cutting, welding, and food processing**.

Liquefied Natural Gas (LNG):

- It is **primarily methane** that has been **cooled to extremely low temperatures (below -160°C) through a cryogenic process** and it is **liquefied mainly for long-distance transport across oceans** where pipelines are not feasible, as its liquid volume is 600 times smaller than its gaseous form.
- It is **stored in specialized cryogenic tanks**, **lighter than air** (disperses quickly) and **transported mostly by specialized cryogenic ships** and generally **safer than LPG**.
- It **fuels gas-based power plants**, acts as a primary bridge to move natural gas from producing countries to consuming countries and can also be **converted back to gas for PNG (households) and CNG (transport)**.

Biologics

- The Union Budget 2026 announced the **Biopharma SHAKTI** strategy to boost domestic production of **biologics and biosimilars** and promote non-animal testing models.
- **Biologics** are complex medicines made from **living organisms** (such as proteins, vaccines, or antibodies) using biotechnology, and are used to **treat diseases** like cancer and autoimmune disorders.
- They are **large, structurally complex,** usually given via injection/IV, highly sensitive to environmental conditions, and enable **targeted (precision) treatment** but may trigger immune responses.
- **Biosimilars** are highly similar versions of already approved biologics, developed after the original product's patent expires, with **no meaningful difference in safety or effectiveness.**
- Unlike biologics (original products), biosimilars are typically **more affordable alternatives** but not exact copies due to the complexity of living systems

NavIC's Atomic Clock Failure

- ISRO recently reported that the **atomic clock on the IRNSS-1F satellite has failed**, leaving only three satellites of the NavIC constellation in function.
- Atomic clocks, using **Rubidium or Cesium vibrations**, are vital for navigation, as tiny timing errors can cause meter-level location inaccuracies.
- **NavIC** (Navigation with Indian Constellation), originally called **IRNSS** the (Indian Regional Navigation Satellite System), is **India's independent, regional satellite navigation system**.
- The **primary goal** is to provide reliable position, navigation, and timing services over India and a region extending approximately **1,500 km around its borders**, ensuring strategic independence from foreign systems like the American GPS.
- NavIC is **designed as a constellation of 7 operational satellites** 3 satellites in geostationary orbit (GEO) and 4 in inclined geosynchronous orbit (GSO).

- A **minimum of four satellites is needed** to provide continuous, accurate 3D real-time positioning, velocity and timing (PVT) services over India.

- The **first-generation satellites**, like IRNSS-1A, launched in July 2013, that used 3 **Swiss-made SpectraTime rubidium clocks** each, similar to those used by Europe's Galileo system, have all failed.

- Due to failures, ISRO has been launching **replacement satellites (NVS series)** to maintain the constellation.

- The new generation **NVS series satellites** (starting with NVS-01, launched in May 2023) use **indigenous rubidium atomic clocks** developed by ISRO's **Space Application Centre**, Ahmedabad.

- **NavIC offers two services**: **Standard Positioning Service (SPS)** for civilian use, interoperable with GNSS, and **Restricted Service (RS)**, an encrypted channel for authorized users including the military, using **L1 (1575.42 MHz)**, **L5 (1176.45 MHz)**, and **S Band (2498.028 MHz).**

HALEU-Thorium Fuel

- A study in **Current Science** questions the use of **High-Assay Low-Enriched Uranium-Thorium (HALEU-Thorium) fuel** in India's reactors, which had been proposed earlier.

- India's nuclear program mainly uses **Pressurised Heavy Water Reactors (PHWRs)** with natural uranium fuel and heavy water (deuterium oxide, D_2O) as coolant and moderator.

- **High-Assay Low-Enriched Uranium (HALEU)** is uranium enriched to 5–20% Uranium-235, higher than the 3–5% in conventional fuel.

- **HALEU-Thorium** combines enriched uranium with thorium, which can produce fissile Uranium-233 for long-term energy.

- The U.S. commercial version, **Advanced Nuclear Energy for Enriched Life (ANEEL)**, is designed for advanced reactors and **Small Modular Reactors (SMRs)**, offering higher energy output and less radioactive waste.

- But study by **Bhabha Atomic Research Centre (BARC) scientists** says that HALEU-Thorium can reduce the effectiveness of **shutdown rods**—safety devices made of neutron-absorbing materials that quickly stop the nuclear reaction—**requiring major reactor redesigns,** making it impractical for immediate use.

Extracellular RNA

- Recently, scientists reported that extracellular RNA **(exRNA) from bacteria** can persist in disinfected drinking water.

- exRNAs are RNA molecules outside cells, found in fluids like blood and saliva, and include **coding RNAs**, which carry instructions to make proteins (like mRNA), and **non-coding RNAs**, which regulate genes or assist in protein synthesis (like tRNA, rRNA, miRNA).

- They may be **free or carried by proteins or vesicles** like exosomes.

- exRNAs **mediate cell-to-cell communication,** aiding immune responses, tissue repair, and development.

- They are studied as **biomarkers**—biological indicators of health or disease—since cancer cells can release exRNAs to promote tumor growth.

Waste Foundry Sand

- The **Institute of Indian Foundrymen (IIF)** and **CSIR-Central Road Research Institute (CSIR-CRRI)** partnered to use **waste foundry sand (WFS)** in road construction.

- A **foundry** is a factory that **produces metal castings** by melting metal, pouring it into a mold, and allowing it to solidify to create specific shapes

- Waste Foundry Sand (WFS) is the **leftover sand from metal casting in foundries** after it has been **used to mold or shape molten metal.**

- It is typically **high-quality silica sand.**

- Its **type and properties** depend on the casting process and the binder used:

  - **Clay-bonded sand** – common in iron and steel foundries.
  - **Chemically bonded sand** – used for cores requiring high strength.

- WFS is **generated in large amounts** and can cause **environmental problems** if disposed of, but it can be reused in road construction, bricks, and other sustainable applications.

World's First Permanent Nuclear Waste Vault

- Finland is developing **Onkalo**, the world's first permanent underground repository for highly radioactive nuclear waste, located on **Olkiluoto Island**.
- It will store spent nuclear fuel for up to **100,000 years** at a depth of about **400–450 metres** in 1.9-billion-year-old stable bedrock.
- The facility uses a **multi-layer passive safety system**: waste is sealed in **metal canisters**, encased in **corrosion-resistant copper,** surrounded by **bentonite clay** to block water, and finally **isolated by natural bedrock**.
- Once sealed, it requires **no active human monitoring** and is designed to remain stable even through long-term geological changes.
- Onkalo can store about **6,500 tonnes of Finland's nuclear waste** and is considered a global model for long-term nuclear waste disposal in low-carbon energy systems.
- **Nuclear energy** is a cornerstone of Finland's electricity system, often accounting for **approximately 39–40% of total generation.**

Artemether-Lumefantrine

- The WHO has approved a **child-friendly formulation of artemether-lumefantrine** for treating **acute uncomplicated malaria caused by Plasmodium falciparum.**
- It is the first antimalarial designed specifically for **newborns and infants weighing 2–5 kg**, addressing a major treatment gap in malaria care.
- The drug is a **dispersible, sweet-flavoured tablet** that ensures accurate dosing and reduces administration errors in infants.
- Its safety and effectiveness were confirmed through the **CALINA trial** in African countries, showing therapeutic efficacy similar to that in older children.
- The formulation was developed by **Novartis** in partnership with the **Medicines for Malaria Venture (MMV)**.

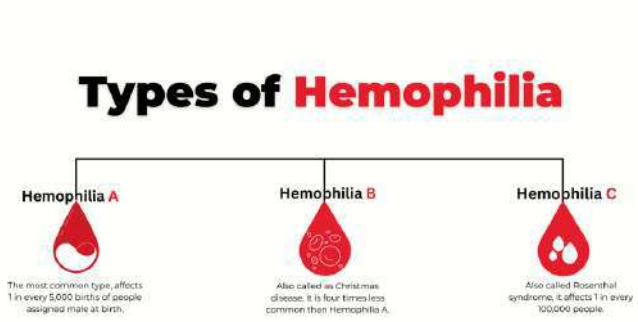
SAF-Blended fuel

- The Government of India has amended the **ATF (Regulation of Marketing) Order, 2001** to include **Sustainable Aviation Fuel (SAF)** under its regulatory framework.
- SAF is a **renewable, drop-in aviation fuel** (fuel that can be used in existing engines and infrastructure **without any modifications**) made from crops, waste, and other bio-based feedstocks, and is c**hemically similar to conventional aviation turbine fuel (ATF).**
- India has set indicative SAF blending targets for international flights: **1% by 2027, 2% by 2028, and 5% by 2030**, aligning with global efforts such as those of the EU and UK.
- Several countries are actively using Sustainable Aviation Fuel (SAF)-blended fuel, primarily in the **EU, UK, US, Japan, and Singapore,** with mandates driving adoption to cut emissions, often blended at 10%–50% with conventional jet fuel.

Haemophilia

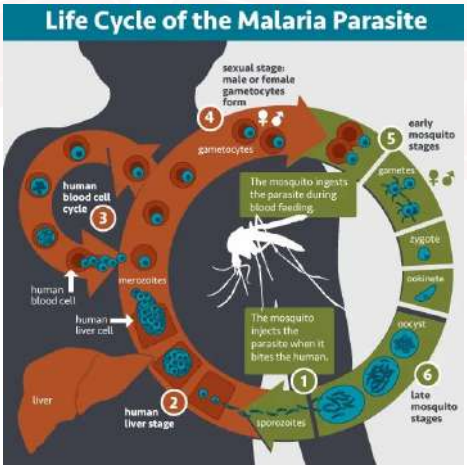
- The WHO has proposed a resolution to improve treatment for **haemophilia**, noting that India has the **second-largest number of cases in the world (about 1.4 lakh)**.
- Haemophilia is a **genetic blood disorder** where the blood does not clot properly due to missing clotting factors.
- **Clotting factors** are proteins in blood that help stop bleeding by forming a clot at the injury site.
- In haemophilia, these factors are missing—mainly **Factor VIII (Haemophilia A)** or **Factor IX (Haemophilia B)**—so blood does not clot properly, causing prolonged bleeding even from minor injuries.

- It **mainly affects males** because it is linked to the **X chromosome**, while females are usually carriers.
- It can cause **prolonged bleeding**, especially internal bleeding in joints and muscles.
- There is **no permanent cure**, but it is managed through **replacement of clotting factors**, preventive treatment, and emerging gene therapy.



GM Mosquitoes

- A landmark study in Tanzania under the **"Transmission Zero" initiative** found that **genetically modified (GM) mosquitoes** can block **Plasmodium falciparum** (malaria parasite) transmission in real-world conditions.
- GM mosquitoes work in two main ways: **population suppression** (reducing mosquito numbers by affecting survival or fertility) and **population modification/replacement** (making mosquitoes resistant to malaria so they cannot transmit the parasite).
- This approach is **highly targeted compared to chemical insecticides**, as it affects only specific species like **Anopheles gambiae.**
- However, **concerns remain** about ecological impacts, including possible disruption of food chains if mosquito populations are significantly reduced.



CAFE-III Norms

- The Indian government and automobile industry have reached a consensus on **CAFE-III (Corporate Average Fuel Efficiency Phase III)** norms, aimed at reducing carbon emissions from the transport sector and improving vehicle efficiency.
- CAFE norms are framed by the **Bureau of Energy Efficiency (BEE)** under the **Energy Conservation Act, 2001**, and require automobile manufacturers to meet fleet-wide CO_2 emission limits.
- CAFE-III will be implemented from **2027 to 2032**, encouraging the production of fuel-efficient vehicles and faster adoption of EVs, hybrids, and alternative fuels in line with India's net-zero target for 2070.
- A key feature is the **removal of special relaxations for small cars**, creating a uniform regulatory framework across vehicle segments.
- The system also uses **"super credits"**, where cleaner vehicles like **electric vehicles, hybrids, and flex-fuel models** are given higher weightage to reduce an automaker's overall average emissions.
- Performance will be assessed using the **Modified Indian Driving Cycle (MIDC)**, a laboratory test standard for measuring fuel efficiency and emissions.

Memristor

- Scientists have developed a new **hafnium-based memristor** that **mimics brain synapses** by processing and storing data in the same device.
- A **synapse** is a specialised junction between **neurons** where **they communicate with each other,** muscles, or glands, allowing the transmission of electric or chemical signals.
- They **enable nervous system functions** like movement, memory, and learning through neurotransmitter release across a tiny gap (synaptic cleft)
- A **memristor** is an **electronic component** that can **"remember" the amount and direction of current** that has previously flowed through it.
- Unlike a normal resistor, its **resistance changes based on past electrical activity** and **retains that state** even when power is switched off.

- Because it stores this history, it can **act like a memory device** and is useful in building systems that mimic learning and brain-like behavior.
- The new device uses **hafnium oxide (with strontium and titanium)** and is designed to replicate how **synapses** strengthen or weaken based on signal timing, similar to the human brain.
- By combining memory and processing in one place, it **reduces data transfer between components**, making **computing more energy-efficient** and potentially cutting AI energy use by over 70%.

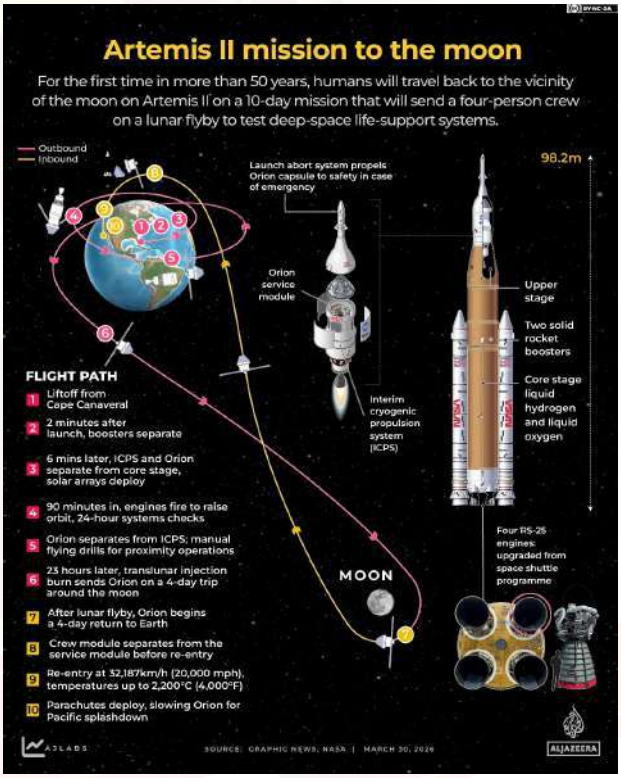
Hafnium is a **silvery transition metal (Hf, atomic number 72)**, chemically similar to zirconium. It is mainly used in **semiconductors and nuclear reactors** due to its excellent insulating and neutron-absorbing properties.

Coal Gasification

- The Indian government is planning financial incentives for foreign investment in **coal gasification projects**.
- **Coal gasification** is a process that converts coal into **synthesis gas (syngas)**—a mix of carbon monoxide, hydrogen, carbon dioxide, and methane—through high-temperature oxidation instead of burning.
- It helps **reduce air pollution** compared to direct coal burning, improves energy efficiency, and supports energy security by lowering dependence on imported oil and gas.
- It also **enables diversification of coal use** in industry while supporting the transition toward cleaner energy systems.
- India has **large coal reserves** but faces challenges such as **high ash content** in coal and deep coal reserves and is also under pressure to reduce pollution from direct coal burning.

Artemis II Mission

- Artemis II is **NASA's first crewed mission** in the Artemis program and the **first human lunar vicinity mission since Apollo 17 (1972)**.
- It follows the **uncrewed Artemis I (2022)** and is a **10-day test flight** of the Space Launch System (SLS) and Orion spacecraft, focusing on validating deep-space and life-support systems.
- The **Orion capsule,** named **Integrity** by the crew, carries up to **four astronauts** and is built with over 300,000 components tested for deep-space operation.
- Unlike Apollo 8, **Artemis II will not enter lunar orbit**; it will fly around the Moon's far side and travel over 4,000 miles beyond it, setting a **new record for the farthest distance humans have traveled** from Earth (surpassing Apollo 13).
- **India signed the Artemis Accords on June 21, 2023**, becoming the 27th country to join the U.S.-led international framework for sustainable and peaceful lunar exploration.

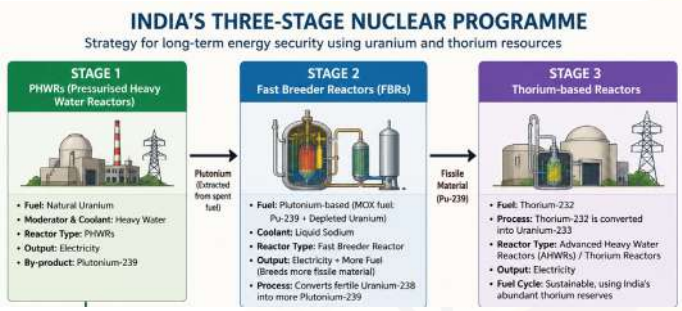


V2V Communication Technology

- The Government of India **plans to introduce Vehicle-to-Vehicle (V2V) communication** to improve road safety.

- PHWRs use **natural uranium** as fuel and **heavy water (D2O)** as both coolant and moderator.

- The PFBR is a **fast breeder reactor** designed to produce more fissile fuel than it consumes.
- It operates using **MOX fuel**, a mixture of Plutonium-239 and depleted uranium.
- The reactor uses **liquid sodium as a coolant**, which has **excellent heat transfer** properties and **does not slow down neutrons,** thereby maintaining them in a fast state and enabling the breeding of additional fuel.



Hypervitaminosis

- Recent reports emphasize that the **belief that vitamins are safe in all quantities is false**, with **over-supplementation** leading to toxicity.
- **Hypervitaminosis (vitamin toxicity)** refers to the excessive accumulation of vitamins in the body, leading to toxic effects.
- It is most commonly associated with **fat-soluble vitamins such as Vitamins A, D, E, and K,** because they are stored in body tissues and are not easily excreted.
- The **condition may arise due to** excessive use of dietary supplements, self-medication, or prolonged high-dose vitamin therapy.
- **Vitamin A toxicity** can cause liver damage and bone abnormalities, while excess **Vitamin D** may lead to hypercalcemia and kidney stones.
- In contrast, **water-soluble vitamins such as Vitamin B and C generally have a lower toxicity** risk since excess amounts are usually eliminated through urine.