



Science & Tech: August - December 2024

AI-Driven Cyber Risks

Context: AI advancements heightened **security concerns**, with major events like the **Paris Olympics** vulnerable to **cyberattacks**.

- AI-enabled **deep fakes** (manipulated videos, audio, and images) contribute to **disinformation** and **confusion** (E.g., Taiwan Election 2024).
- There has been an **exponential growth** in incidents of **cyber fraud**, **phishing**, **identity theft**, and other online threats.
- **Ordinary individuals** and **businesses** are particularly vulnerable, and **traditional defenses** such as **firewalls** and **antivirus programs** are often insufficient.

Cyber Attack Examples

- **CrowdStrike Outage (2024):** A Microsoft Windows glitch caused disruptions to global flight operations and the stock exchange.
- **WannaCry Ransomware (2017):** Infected over 230,000 computers in 150 countries.
- **Shamoon Virus (2017):** Targeted oil companies, causing significant damage.
- **Petya Malware (2017):** Affected banks and infrastructure across multiple countries.
- **Stuxnet Worm (2010):** Targeted Iran's nuclear program, showcasing cyber weapon potential.

Responses and Solutions

- **Government Actions:** Efforts are underway to address digital threats, but private sector responses lag.
- **Corporate Preparedness:** Companies need to improve their cybersecurity measures, including hiring chief information and security officers.
- **Awareness and Coordination:** Increased awareness and coordinated efforts are essential to combat digital threats, including disinformation and cyberbullying.

Ban on Fixed-Dose Combination (FDC) drugs

Context: The Health Ministry bans **156 Fixed-Dose Combination (FDC) drugs**, including Cheston Cold and Foracet. 499 FDCs have been banned since 2014, with 328 banned in 2018 alone.

About FDC drugs

- FDCs are medications that combine **two or more active ingredients** in a **single dosage form**, such as a **pill or capsule**, or **shot**.
- FDCs simplify treatment by **reducing the number of pills**, thereby improving **adherence to medication**, particularly for **chronic conditions** like **tuberculosis** and **diabetes**.

Examples of Banned FDCs

- **Enzyme Combinations:** For gastrointestinal issues.
- **Anti-allergic combinations:** Such as levocetirizine with nasal decongestants.



- **Skin Condition Treatments:** Like menthol with aloe vera or silver sulfadiazine with other agents.
- **Migraine and Nausea:** Combinations of migraine medication with anti-nausea drugs.
- **Menstrual and Anti-Fibrotic:** Mefenamic acid with tranexamic acid.
- **Erectile Dysfunction:** Sildenafil combined with other drugs for blood vessel relaxation.

Current Status and Implications

- Despite the ban, these FDCs may **remain available** for some time as companies **clear existing stocks**.
- Consuming these banned FDCs is **unlikely to cause immediate harm**, but they may not provide the expected therapeutic benefits.

Reasons for the Ban

- **Irrational Combinations:** The banned FDCs were deemed irrational because they contain ingredients that **do not work well together** or are **unnecessary** for the patient's condition.
- **Therapeutic Ineffectiveness:** The government found these FDCs lacked **therapeutic benefits**.
- **Antibiotic Resistance:** To reduce the **misuse of antibiotics**, which can lead to **increased resistance**.
- **Pricing Evasion:** Some FDCs were created to **circumvent pricing controls** on essential medicines.
- **Increased Regulation:** New clinical trial rules require the central drug regulator to approve FDCs as new drugs, reducing irrational combinations.
- **Historical Concerns:** A **2012 parliamentary panel** highlighted issues with FDC approvals, leading to a review and ban of many irrational drugs.

BioE3 Policy

Context: Union Cabinet approved Department of Biotechnology's proposal '**BioE3** (Biotechnology for Economy, Environment and Employment) **policy** for fostering **high-performance biomanufacturing**.

- **High-performance biomanufacturing** is the ability to produce products from medicine to materials, address farming and food challenges, and promote the manufacturing of bio-based products through the integration of advanced biotechnological processes.
- **BioE3 Policy** aims to **catalyse a technological revolution** by developing products ranging from medicines to sustainable materials using advanced biotechnological processes.

Focus Areas

- The **six thematic verticals** of the policy are:
 1. **High-value bio-based chemicals, biopolymers, and enzymes:** Substances created using biological processes that have various industrial applications.
 2. **Functional foods and smart proteins:** Create healthier and more sustainable food options.
 3. **Precision biotherapeutics:** Development of advanced medicines tailored to individual needs.
 4. **Climate-resilient agriculture:** Enhance agricultural practices to adapt to climate change.
 5. **Carbon capture and utilization:** Methods to reduce greenhouse gases and repurpose them.
 6. **Futuristic marine and space research:** Advance exploration and technological innovations.

Drug-Resistant Fungal Infection

Context: The rise of drug-resistant fungal infections caused by *Trichophyton indotineae* (ring worm/jock itch) is becoming a significant health challenge.

- *Trichophyton indotineae* was **first** identified in India in 2019.

Challenges

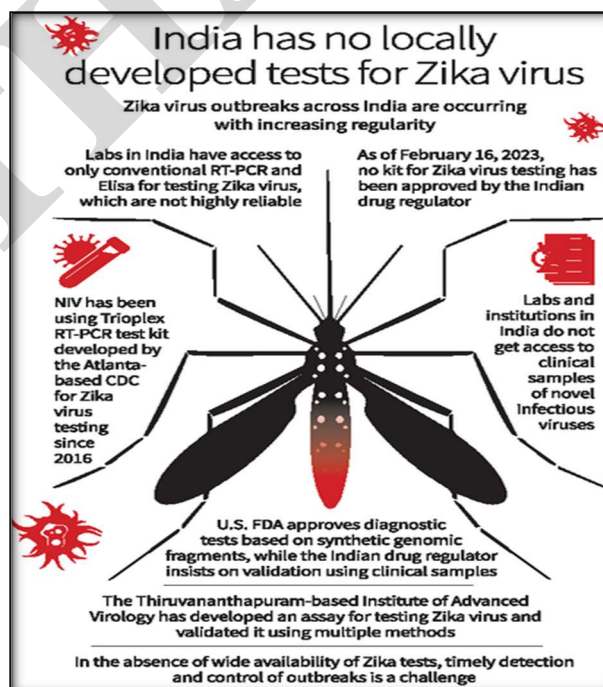
- **Misuse of Topical Steroids:** Excessive use exacerbates resistance, making infections harder to treat.
- **Misdiagnosis:** Often mistaken for eczema or other skin conditions, leading to **delayed and ineffective treatment**, worsening individual conditions, and increasing **community risk**.
- **Drug Quality:** **Poor quality** of drugs lead to **suboptimal dosing** and treatment failure.
- **Side Effects:** Alternative antifungals can cause gastrointestinal issues, liver toxicity, and drug interactions.

Way Forward

- ✓ **Accurate diagnosis:** **Clinical examination** and **laboratory tests** (Fungal cultures, molecular diagnostics).
- ✓ **Awareness:** Inform healthcare providers/patients about the risks and management of drug-resistant infections and follow **preventive measures** (keeping skin dry, avoid sharing personal items).
- ✓ **Comprehensive skin care** and **proper hydration** are crucial for treatment efficacy.
- ✓ Follow **prescribed treatments**, maintain a **healthy lifestyle**, and **boost immunity**.

Triplex RT-PCR Test

Context: Institute of Advanced Virology, Thiruvananthapuram has developed and validated a Zika test as an alternative for Triplex RT-PCR test.





- **Trioplex RT-PCR test** is developed by US Centers for Disease Control and Prevention, (CDC) and granted emergency use authorisation by the U.S. FDA.
- It can detect **dengue, chikungunya** and **zika** viruses as it is designed to make accurate diagnoses by addressing the issue of cross-reactivity among these viruses.
- National Institute of Virology is still relying on **U.S. CDC's Trioplex RT-PCR kits** for Zika virus testing, as **no zika test kits** have been approved by the **CDSCO** due to its requirement for clinical sample validation.
- As a result, timely detection and control of outbreaks become a problem.
- The **zika assay** developed by IAV is **inexpensive** and can be used for surveillance, both in people and mosquitoes, in addition to testing patient samples. Wider availability will help in the quicker development of suitable assays to address the issues of mutation.

Earth Observation Satellite-08

Context ISRO's latest Earth Observation Satellite, 'EOS-08', was launched by the **Small Satellite Launch Vehicle (SSLV)-D3** from Satish Dhawan Space Centre, Shriharikota.

- **EOS-08** will operate in a Circular **Low Earth Orbit** at an altitude of 475 km & has a mission life of **1 year**.
- **Objectives:** Designing and developing a **microsatellite**, creating **payload instruments** compatible with the microsatellite bus, and incorporating **new technologies** required for future operational satellites.
- Built on the **Microsat/IMS-1** bus, it carries three payloads: **Electro Optical Infrared Payload (EOIR)**, **Global Navigation Satellite System-Reflectometry payload (GNSS-R)**, **SiC UV Dosimeter**.

Applications

- **EOIR:** Satellite-based surveillance, disaster monitoring, environmental monitoring, fire detection, volcanic activity observation, disaster monitoring.
- **GNSS-R:** Ocean surface wind analysis, soil moisture assessment, cryosphere studies over the Himalayan region, flood detection, inland water body detection.
- **SiC UV Dosimeter:** It monitors UV irradiance at the viewport of the Crew Module in the Gaganyaan Mission and serves as a high-dose alarm sensor for gamma radiation.

Findings from Chandrayaan-3 Mission

Context: Almost a year after its historic landing on the Moon, Chandrayaan-3 has yielded significant scientific findings.

Key Findings

- **Uniform Terrain:** The area surrounding Chandrayaan-3's landing site is relatively uniform. This is a notable observation, as it contrasts with Earth's varied surface, which is shaped by tectonic activity.
- **Support for Lunar Magma Ocean (LMO) Hypothesis:** The findings lend strong support to the hypothesis that the Moon's crust formed layer by layer from a primordial ocean of magma.
- **Mineral Stratification:** Heavier minerals, rich in silicon and magnesium, settled at deeper layers, while lighter minerals, composed of calcium and sodium, formed the upper crust.
- **Crustal Mixing:** The data suggest a "**mixing**" of the **Moon's crustal layers**, likely caused by a massive **asteroid impact** bringing magnesium-rich materials from the deeper layers to the surface.



Impact on Future Missions

- **Future Lunar Missions Planning:** Chandrayaan-3's findings will help design and strategize upcoming missions, particularly targeting the Moon's south pole.
- **Calibration Point:** The uniform surface near the south pole can be used as a reference point for accurate remote sensing measurements in future explorations.
- **Crustal Mixing Insights:** Analysis of crustal mixing offers a new understanding of the Moon's geological history and its evolutionary processes.

India's Space Missions

Context: The President of India graced the **first National Space Day** celebration on **August 23, 2024**. Over the last decade, the space sector contributed ₹20,000 crore to India's GDP.

Challenges

- **Limited Access to Technology:** international laws and politics have caused difficulties for ISRO in obtaining the newest space technology. This has slowed down programs like Chandrayaan-3.
- **Financial Challenges:** ISRO still has a far smaller budget than NASA and ESA. This lowers ISRO's capacity to invest in new technology, restricting large projects.
- **Talent Shortage:** ISRO faces challenges in recruiting and retaining highly competent space scientists and engineers due to their high demand in India and beyond.
- **Bureaucratic Delays:** The lengthy approval processes and bureaucratic regulations imposed by the government frequently hamper the progress of ISRO's initiatives.
- **Growing Satellite Traffic:** Challenges due to the crowded orbital environment, with 11,330 satellites and 36,500 pieces of debris larger than 10 cm orbiting Earth as of June 2023.

Missions (2023-2024)

- **Aditya L1 Mission:** Launched on Sept 2023, it entered orbit around the Earth-Sun Lagrange point (L1) in and completed its first orbit in 2024. It successfully studied a solar storm.
- **Gaganyaan TV D1 Mission:** In Oct 2023, the Crew Escape System (CES) was successfully demonstrated in an abort mission as part of India's human spaceflight mission.
- **XPoSat Mission:** Launched on Jan 1, 2024, it aims to study polarised radiation from celestial objects using the XSPECT and POLIX instruments
- **INSAT-3DS Mission:** Launched on February 17, 2024, using the GSLV, the mission focused on meteorological observations and building credibility for future missions like NISAR.
- **RLV-TD (Reusable Launch Vehicle) Tests:** In March and June 2024, ISRO conducted landing experiments (LEX-02 and LEX-03) using a RLV called Pushpak to simulate landing conditions from space.
- **SSLV (Small Satellite Launch Vehicle):** Successfully launched EOS-08 and SR-0 Demosat on August 16, 2024, marking the completion of SSLV's development.

Future missions

- **Gaganyaan Mission:** It represents India's **first human spaceflight program**.



- **Next Generation Launch Vehicle (NGLV):** A heavy-lift launch vehicle to replace PSLV and GSLV is under development, and the project proposal has been submitted for Union Cabinet approval.
- **Lunar Exploration Roadmap:** It include a crewed lunar mission and long-duration moon surface missions by 2040 in collaboration with NASA's Lunar Gateway under the Artemis program.
- **NSIL (NewSpace India Ltd.) Missions:** SpaceX will launch the GSAT-20/GSAT-N2 satellite in 2024, while LVM-3 production will proceed through a public-private partnership.
- **Private Space Sector Growth:** The support for Agnikul Cosmos and Skyroot Aerospace will continue alongside IN-SPACe regulatory updates to enhance private sector participation and foreign investment.

Polygraph Test

Context: The CBI conducted **polygraph tests** in the Kolkata doctor rape-murder case.

- A **polygraph**, or a **lie detector test**, is a device or procedure that measures and records several physiological indicators such as **blood pressure, pulse, respiration, and skin conductivity** while a person is asked and answers a series of questions.
- This test is based on the concept that physiological responses when a person is lying are distinct from those when they are telling the truth.
- It is **not completely accurate** as it depends on the analysis and assumptions of the polygraph operator.
- According to the **Indian Evidence Act, 1872**, polygraph test results are **not considered conclusive evidence**, but they can be used as **corroborative evidence** to support other evidence.
- NHRC guidelines mandate that polygraph tests require the accused's voluntary, informed, and recorded consent, with proper documentation.
- Additionally, statements from these tests are **not considered confessions**, and judges must consider factors such as detention duration and interrogation techniques when assessing the test results.
- **Selvi vs State of Karnataka Case 2010:** The SC ruled that involuntary narco/lie detector tests breach an individual's mental privacy & violate the right against self-incrimination under **Article 20(3)** of IC.
 - ❖ Article 20(3) states that **"No person accused of any offence shall be compelled to be a witness against himself.**

Narco-Analysis

- It is a technique involving intravenous **administration of a drug** (such as sodium pentothal, scopolamine and sodium amytal) to induce a semi-conscious state in order to **obtain information** from a person.
- Although the accused's statement **isn't considered evidence**, any physical evidence found as a result of voluntary test results may be admissible under the Evidence Act of 1872.

Brain Mapping

- It is a study based on the **analysis of brain function** recorded by electrodes placed on the surface of the skin covering the head and face to reveal guilty knowledge.
- Its results have **no legal sanctity** but can help in the investigation.



Axiom-4 Mission

Context: India shortlists two astronaut-designates for the upcoming **Axiom-4 Mission** to the International Space Station (ISS).

- A National Mission Assignment Board has recommended two Gaganyatris, **Captain Shubhanshu Shukla** and **Captain Prasanth Balakrishnan Nair** for the Mission.
- Captain Shukla will become the second Indian to travel to space, following Wing Commander (Retired) **Rakesh Sharma**, who was the **only Indian** to have gone to space in **1984**.
- **Axiom Space** is an American privately funded space infrastructure provider.
- The Mission is in collaboration with **NASA** and will be the **fourth flight** of Axiom Space.
- It **benefits India's** Gaganyaan Mission, **strengthens ISRO-NASA cooperation**, and demonstrates the viability of **commercial space stations**.

GAURAV Bomb

Context: Defence Research and Development Organisation (DRDO) has carried out successful maiden flight test of **1,000 kg class Long-Range Glide Bomb, GAURAV** from **Su-30 MK-I** platform of the Indian Air Force (IAF) off the coast of **Odisha**.

- After being launched, the glide bomb steers towards the target using **highly accurate hybrid navigation scheme** with a combination of **INS** and **GPS data**.
- It has been designed and developed indigenously by the **Research Centre Imarat (RCI), Hyderabad**.

INS Arighaat

Context: India's second nuclear-powered ballistic missile submarine, **INS Arighaat**, was commissioned into service at Visakhapatnam.

- **INS Arighaat** will further **strengthen India's nuclear triad**, enhance nuclear deterrence, establish strategic balance and peace and play a decisive role in the country's security.
- It retains the same reactor and dimensions of **INS Arihant**, but has technological upgrades with systems and equipment conceptualized, designed and manufactured **indigenously**.
- It can travel at a maximum speed of up to 24 knots when submerged and 1215 knots on a surface level.
- It can carry twelve **K-15 Submarine Launched Ballistic Missiles (SLBM)** with a **range of over 3500 kms**.
- It is propelled by 83 MW pressurized light-water reactors and can be submerged for extended periods.

INS Arihant

- It was the **first nuclear-powered ballistic missile submarine** commissioned in **August 2016**.
- It has a displacement of 6,000 tonnes and is powered by an 83 MW light-water reactor with enriched uranium. It is armed with a 750-km-range K-15 Submarine Launched Ballistic Missile (SLBM).

Indian Nuclear Triad



- It is a **3-sided military-force structure** consisting of ICBMs (land-based nuclear missiles), SSBNs (nuclear-missile-armed submarines) and Strategic Bombers.
- India is among very few countries (**United States, Russia, China, India, and Pakistan**) which have achieved the capability of **nuclear triad**.
- Spreading the country's extensive nuclear arsenals across various weapons platforms and dimensions would provide a **Credible Minimum Deterrence**.

SIG 716 rifles

Context (TH): The **Ministry of Defence** signs a repeat order for 73,000 **SIG 716** rifles.

- The SIG716 is an **assault rifle** manufactured by **SIG Sauer**, which has an **effective range of 600 m** and is more capable and reliable than the **INSAS** in use.
- Its **robust design** and capability make it **ideal for long-range engagements**. It also has the capability to **penetrate tougher targets**.
- Its **gas piston system enhances reliability** and **reduces maintenance needs**, a significant advantage in hostile environments or during extended operations.
- Additionally, the **modularity of the SIG 716** allows for easy adaptation to various roles making it extremely versatile for armed forces and specialized tactical units.
- It is used as a **DMR (Designated Marksman Rifle)**, a medium-range precision rifle, or as an individual long-range weapon useful in mountain combat or areas with vast open spaces.

Indian Small Arms System (INSAS)

- It is a **family of infantry arms** consisting of an **assault rifle and a light machine gun (LMG)** whose development began in the **mid-1980s**.
- These weapons were developed **indigenously** by the **Armament Research and Development Establishment** and manufactured by the Ordnance Factories Board at its various factories.
- It was the standard infantry weapon of the Indian Armed Forces for almost three decades.

Tarang Shakti Exercise 2024

Context: The **IAF** is **hosting** its **largest multilateral exercise, Tarang Shakti**, in two phases at Sullur (TN) in August and Jodhpur (RJ) in September.

- Out of 18 countries, Germany, France, Spain, the UK, Australia, Bangladesh, Greece, Singapore, the UAE, and the US are participating with air assets.
- **Indian Navy** is participating in Phase-1 with **Mig-29K carrier-borne fighters**.
- **Germany** will deploy its **A400M transport aircraft**.
- **Aim:** To build **mutual trust**, enhance **interoperability**, and showcase India's indigenous industry, demonstrating "**Atmanirbharta**" through its indigenous platforms (Light Combat Aircraft, Advanced Light Helicopter, Light Combat Helicopter).

Perseid meteor shower

Context: The **Perseid meteor shower** to brighten night sky, especially in the northern hemisphere.

- **Perseid meteors** are **debris** left behind by the comet **Swift-Tuttle** that rains down over the Earth from space at a particular time of year.
- They appear to come from between the constellations of **Camelopardalis** and **Persus**, from which they get their name.
- During its peak, they can produce more than **60 meteors per hour**.
- When the debris fragments hit Earth's atmosphere, the air in front of them becomes compressed, generating heat and causing the fragments to burn up, resulting in **bright streaks** across the sky.

Tanager-1

Context: **Tanager-1**, a **satellite** developed by a coalition of companies and organisations, including **NASA's Jet Propulsion Laboratory**, was launched aboard a **SpaceX Falcon 9** rocket.

- Notably, the launch has come just months after MethaneSAT launched in March and is capable of monitoring emissions across 130,000 square kilometres per day.

Purpose

- It will use imaging spectrometer technology to track methane and carbon dioxide emissions by identifying the plume of gases and measuring hundreds of wavelengths of light that are reflected by earth's surface.
- Different compounds in the planet's atmosphere including methane and carbon dioxide absorb different wavelengths of light, leaving **spectral "fingerprints"** that the imaging spectrometer can identify.
- These **infrared fingerprints** can potentially **accelerate the mitigation efforts** by enabling researchers to pinpoint and **quantify strong greenhouse gas emissions**.

Imaging Spectrometer

- It is an **instrument** used in hyperspectral imaging & imaging spectroscopy to acquire a **spectrally-resolved image of an object**, usually to support analysis of the composition the object being imaged.
- The principle of operation is **same as that of the simple spectrometer**, but special care is taken to **avoid optical aberrations** for better image quality.
- They are used specifically for measuring the **spectral content** of light and electromagnetic light.
- **Examples:** Filtered camera, whiskbroom scanner, integral field spectrograph and so on.

Gestational Diabetes

Context: The 18th Annual Conference of the 2024 Diabetes in Pregnancy Study Group India (DIPSI), held in New Delhi.

Major Recommendations

- **Prevention of onset of diabetes:** Particularly gestational diabetes (GDM), to combat non-communicable diseases (NCDs).



- **Screening:** Women for glucose intolerance at eight weeks of pregnancy to detect early gestational glucose intolerance (EGGI).
- **Address the impact of hyperglycemia** (raised blood glucose), a common effect of uncontrolled diabetes, during pregnancy on the fetus, which can lead to NCDs later in life.
- **Collaboration:** With healthcare professionals and families to ensure **euglycemia** (blood glucose level is within the normal range).

Gestational Diabetes Mellitus (GDM)

- GDM: Glucose intolerance that develops or is first diagnosed during pregnancy.
- Affecting **15% of global pregnancies**, the prevalence in India ranges from 3.8-17.9%.
- **Symptoms:** No symptoms, or they may be mild (thirst, frequent urination).
- **Risk factor for developing GDM:** Increased body weight, decreased physical activity, first-degree relative with diabetes mellitus, Low HDL, Past cardiovascular diseases.
- **Consequences:** Increases the risk of developing type 2 diabetes in women, and obesity, insulin resistance, and type 2 diabetes in children.
- **Treatment:** Diet modifications, exercise, and glucose monitoring.

Monkey Pox (Mpox)

Context: WHO Director-General declares **Mpox** outbreak a **public health emergency of international concern (PHEIC)**.

- It is a **rare zoonotic viral disease** belonging to the *Poxviridae* family and the *Orthopoxvirus* genus, which includes other poxviruses such as smallpox and cowpox virus and has affected over 115 countries.
- **Symptoms:** Rash, fever, sore throat, headache, muscle aches, back pain, and swollen lymph nodes.

Transmission

- **From animal to humans:** Eating products made of infected animals, direct contact with body fluids.
- **Person to person:** Direct contact with rashes or body fluids, infectious skin or lesions, kissing, touching, oral and penetrative vaginal or anal sex.

Variants of Mpox

1. Clade I/Congo Basin clade

- Clade I is **largely sporadic and potentially zoonotic** with a **fatality rate of less than 4%**.
- Clade I leads to **more severe disease and death** than Clade II.

2. Clade Ib

- It was first reported in the **Democratic Republic of the Congo** in **2023** and has been spreading through sex and other types of close contact.
- Children under 15 years is **the most affected**, constituting **80% of all the deaths** with the largest case fatality rate in children aged less than one year.
- It caused **unprecedented** human-to-human transmission **in a short period**.



3. Clade II/West African clade

- Clade II was behind the **global mpox outbreak in 2022** and is primarily found in **West Africa**, particularly in Nigeria and surrounding regions.

Treatment

- There is **no specific treatment** or vaccine available for this infection and is treated with supportive care.
- Three **smallpox vaccines** (MVA-BN, LC16 and OrthopoxVac) have been approved for prevention.
- Infected persons or animals should be **quarantined for 30 days**.

Way Forward

- **Molecular surveillance**, development of indigenous capacity for vaccine manufacturing, raising awareness, improving surveillance and response and avoid contact with wild animals especially those which can spread the disease such as monkeys.

Public Health Emergency of International Concern (PHEIC)

- It is a formal **declaration** by the **WHO** of an extraordinary event, determined to constitute a public health risk to other States and will require a coordinated international response.
- There have been **8 PHEIC declarations** since 2006, including **Zika, COVID, Ebola and Swine flu**.

World Health Organisation (WHO)

- It is a **specialized agency** of the **United Nations** responsible for international public health.
- **HQ: Geneva, Switzerland**; established in **1948** and has 194 member states including **India**.

COVID-19 XEC Variant

Context: The **XEC variant**, a hybrid sublineage of **Omicron**, has spread to 27 countries and is considered **more contagious**, though vaccines remain effective against it.

- It accounted for **16-17% of cases in Denmark and Germany** and **11-13% in the UK and Netherlands**.
- **Symptoms:** Fever, Sore throat, Cough, Loss of smell, Loss of appetite, Body ache.

OpenAI o1

Context: OpenAI has introduced its new AI model, **OpenAI o1**, as part of **Project Strawberry**.

Key Features of OpenAI o1

- **Reasoning Capabilities:** It excels in complex tasks across **science, coding, and mathematics**, using reinforcement learning to approach problems from multiple perspectives and learn from mistakes.
- **Performance Benchmarks:** Demonstrated impressive performance, achieving an **83% success rate in the International Mathematics Olympiad** qualifying exam, compared to **13% by GPT-4o**.

Model Variants:

o1-preview: The full-featured version **designed for complex reasoning tasks**.

o1-mini: A cost-effective and faster version tailored for **coding tasks, priced at 80% less than the o1-preview**, making it accessible to a broader range of developers.



ABHED Lightweight Bulletproof Jackets

Context: The DRDO and IIT Delhi have developed **lightweight bulletproof jackets** named **ABHED (Advanced Ballistics for High Energy Defeat)**.

- **Materials Used:** Polymers and **indigenous boron carbide ceramic** material.
- **Design Basis:** Characterisation of materials at high strain rates, followed by modelling and simulation in collaboration with DRDO.
- **Protection:** Modular design with front and rear armours providing 360-degree protection.

AL NAJAH V Military Exercise

Context: The Indian Army contingent departed for the **5th edition** of the **India-Oman Joint Military Exercise AL NAJAH**, to be held at Rabkoot Training Area in Salalah, **Oman**.

- The contingent comprises 60 personnel from a **Mechanised Infantry Regiment** and other support units.
- It is a **biennial exercise** alternating between India and Oman since **2015**.
- **Objective:** To enhance the **joint military capability** of both sides in conducting **counter-terrorism operations** under **Chapter VII** of the **UN Charter**.
- The exercise will specifically concentrate on **operations in desert environments**.

Anti-Submarine Warfare Shallow Water Craft

Context: The **Indian Navy** marked a significant milestone with the simultaneous launch of **Malpe** and **Mulki**, of the **Anti-Submarine Warfare Shallow Water Craft (ASW SWC)** project.

- These are fourth and fifth ships in a **series of eight** being constructed by **Cochin Shipyard Limited (CSL)**.
- They are named after **strategically important ports** along India's coastline.

Technical Specifications and Operational Capabilities

- The ships are equipped with indigenously developed, state-of-the-art **underwater sensors**.
- **Maximum speed:** 25 knots. **Operational endurance:** Up to 1800 nautical miles.

Anti-Submarine Warfare Shallow Watercraft (ASW-SWC)

- Perform Anti-submarine operations in **coastal waters**, **Low-Intensity Maritime Operations**, and **Mine Laying Operations**. Also equipped with capabilities for the **search-and-attack unit (SAU)**.
- The ASW SWC ships will have over **80% indigenous content**.

Chamran-1 Satellite

Context: **Iran** successfully launched its **Chamran-1 research satellite** into orbit.

- The Chamran-1 satellite, weighing **60 kilograms**, was placed into a **550-kilometer orbit** and is designed to test "**hardware and software systems for orbital manoeuvre technology**".
- The **Ghaem-100 rocket**, which carried the latest satellite, is manufactured by the Aerospace Force of the Revolutionary Guard. It is the **country's first three-stage solid-fuel satellite** launcher.
- The Western nation views Iran's space program as a potential cover for developing ICBM capabilities.



- *Intercontinental ballistic missiles (ICBMs) have a range **greater than 5,500 kilometers** and are primarily designed to deliver nuclear warheads. They can carry **conventional, chemical, and biological weapons**, although the latter types have rarely been deployed on ICBMs.*
- **US, Russia, China, France, India, the United Kingdom, Israel, and North Korea** are known to possess operational ICBMs, with **Pakistan** being the **only nuclear-armed state that does not have them**.

Joint Doctrine for amphibious operations

Context: Chief of Defence Staff General released the **joint doctrine** for amphibious operations.

- The amphibious capability empowers the armed forces to conduct a “**multitude of operations**” in the **Indian Ocean Region**, both during **war and peace**.
- It focuses on jointness and integration of armed forces especially during amphibious operations.
- Such operations **integrate** virtually all types of **land, sea, and air forces** into a coordinated military effort.

Kalvari Submarine Escape Training Facility (Vinetra)

Context: **Vinetra** was commissioned at **INS Satavahana**, Visakhapatnam. It is designed to help train the crew of **Kalvari-class submarines** on emergency escapes.

- Part of India’s **Aatmanirbhar Bharat** programme. Focuses on indigenisation of defence technology.
- **INS Satavahana**, a surveillance vessel, was the **first ship of its class**, commissioned in **1988**.

Madras Observatory

Context: The **Madras Observatory**, established in **1792** by the **East India Company**, is a testament to India's intertwined history of science, colonialism, and innovation.

- Known as the **Greenwich of the East**, the Madras Observatory was **India's first modern public observatory** with modern equipment. It was shut down in 1931.
- **John Goldingham**, the observatory’s first official astronomer, established the “**Madras Time Zone**” in 1802, later becoming the **official time for Indian Railways**.

Removing Toxic Chromium Using Sunlight

Context: Researchers have developed a method to remove toxic **chromium** from wastewater using **sunlight as a catalyst** and **microfluidic technology**.

- This technique converts toxic hexavalent chromium (Cr(VI)) to **less harmful** trivalent chromium (Cr(III)).
 - According to **WHO**, the **tolerable concentrations** of hexavalent and trivalent chromium in drinking water are limited to **0.05 mg/L** and **5 mg/L**.
 - **Microfluidic technology** can precisely **control and manipulate a small amount of fluid** on the microscale, typically in submillimetres in confined and limited environments.
- **Advantage:** This method is cost-effective and leverages **renewable energy**.



Palomar 5 cluster

Context: Researchers have detected over 100 black holes in the Milky Way's **Palomar 5-star cluster**.

- It was discovered by **Walter Baade** in **1950**. These clusters are regarded as '**fossils**' of the early Universe.
- **Tidal stream:** The cluster has a large star stream extending over 30,000 light-years.

Tidal streams

- These are **long, thin distributions of stars pulled away** from their **parent clusters** or **dwarf galaxies**.
- The **Gaia mission** has mapped nearly **two billion stars**, allowing astronomers to identify and analyse these **tidal streams** with unprecedented accuracy.

Polaris Dawn: 1st privately-funded spacewalk mission

Context: SpaceX launched its **Polaris Dawn mission** carrying a **four-member civilian crew** for the **first spacewalk** by **non-professional astronauts**. It is the first of three testing and development missions under the **Polaris Program**.

- The Polaris Program seeks to demonstrate important operational capabilities that will serve as building blocks to help further human exploration to the Moon, Mars, and beyond.

Spacewalk

- A spacewalk or an "**extravehicular activity**" is a period of activity spent outside a spacecraft by an astronaut in space. The **first-ever spacewalk** was carried out in **1965**, by a **Soviet cosmonaut**.
- Currently spacewalks are usually done outside the International Space Station.

Porphyron

Context: Astronomers have discovered two massive **energy jets, Porphyron**, from a supermassive black hole **7.5 billion light-years away**. Porphyron extends about **23 million light-years**, approximately **140 times** the **diameter** of the Milky Way galaxy.

Key findings

- **Record Size:** Jets surpass the previous record by 30%, detected using the LOFAR radio telescope network.
- **Composition:** Jets are **high-energy particles** (electrons, positrons) and magnetic fields moving at near-light speed, fueled by continuous matter inflow.
- **Cosmic Impact:** Jets output energy equal to trillions of stars, influencing star formation, planet habitability, and cosmic energy distribution.
- **Astrophysical Implications:** The discovery shows that black hole jets' influence extends beyond galaxies, suggesting that more such structures exist.

How these Jets are Formed

- Emerges on falling of **material into the black hole** on interacting with **strong magnetic fields**.
- These magnetic fields **help launch** and **shape the jets**, which can **travel vast distances into space**. They are powered by **energy from the black hole** and its surrounding **accretion disc**.



Project 200

Context: Bellatrix Aerospace, a Bengaluru-based space startup, has unveiled **Project 200**.

About Project 200

- It is an innovative satellite designed to operate at an **Ultra-Low Earth Orbit (ULEO)** of 180-250 km
- Its **Advanced Propulsion technology** would allow it to operate without **deorbiting** due to drag.
- **Applications:** High-resolution Earth observation, telecommunications, and scientific research satellites.

Advantages of operating At ULEO

- Communication **latency** is **reduced** by half. **Image resolution** is improved by 3X.
- A substantial magnitude reduces satellite cost.
- Minimal Radiation Exposure can extend their operational lifespan and reliability.

Radio Jet & Interstellar Gas

Context: Indian Institute of Astrophysics (IIA) researchers find evidence of **interaction** between a **radio jet** and **interstellar gas** around the black hole at the centre of the dwarf galaxy.

- The **Department of Science and Technology** has **challenged the idea** that only large, powerful galaxy jets, which control star formation, have Active Galactic Nuclei (AGN) powered by massive black holes.
- This interaction was detected using data from multiple ground and space-based telescopes, including the Chandra X-ray Observatory, Gemini-North, Hubble Space Telescope, ALMA (Atacama Large Millimeter/submillimeter Array)
- **Radio jets:** Its charged particles ejected at nearly the speed of light from the regions around supermassive black holes

- **Gemini-North Telescope:** It is located in **Hawaii and Chile**.
- **Hubble Space Telescope:** It is a project of international cooperation between **NASA** and the European Space Agency (ESA), has been instrumental in capturing high-resolution images of the universe.
- **UltraViolet Imaging Telescope (UVIT):** Part of India's AstroSat mission, UVIT is designed for imaging in the **ultraviolet** regime. It provides high-resolution images and has been operational since 2015. It includes star formation in the galaxy and nearby galaxies, star formation history of the universe, and studies of hot stars in globular clusters.
- **Atacama Large Millimeter/submillimeter Array(ALMA):** It is located in the **Atacama Desert of northern Chile**, which observes electromagnetic radiation at millimetre & submillimeter wavelengths.
at the centres of some galaxies.
- **Interstellar Gas:** It is found in the space between the stars within galaxies. It primarily comprises hydrogen and helium, with traces of other elements.

Fibrin: Perpetrator of COVID Complications

Context: A new study has found that **fibrin** is the perpetrator of long COVID symptoms.

Fibrinogen and Fibrin

Fibrinogen

- Fibrinogen is a **soluble glycoprotein** produced by the **liver** and found in **blood plasma**.
- It is the precursor of fibrin. It plays a crucial role in **blood clotting** (coagulation).



Fibrin

- Fibrin is an **insoluble protein**. It's formed when fibrinogen is converted by an enzyme called **thrombin**.
- Fibrin forms a mesh-like structure that traps blood cells and platelets, creating a **stable blood clot**.

COVID-19 and Blood Clotting

- The respiratory and neurological complications of COVID-19 are mainly due to **thrombo-inflammation**.
- In thrombo-inflammation, **thrombosis** (blood clotting inside blood vessels) and inflammation occur simultaneously. This is why **blood thinners** are important for managing COVID-19 complications.
- The new study found that fibrinogen and fibrin **actively bind** to the **SARS-CoV-2 spike protein**, driving inflammation and complications in the lungs and brain.
- *The fibrin-spike protein interaction **isn't responsible** for the **rare clotting** issues **from adenovirus-based vaccines**. Instead, these complications are linked to the adenovirus component and are not seen in other spike protein-based vaccines.*

Helicobacter pylori (H. pylori)

Context: Need for efforts to be taken to eradicate *Helicobacter pylori* (*H. pylori*).

- *H. pylori* **bacteria** grow in the protective **mucus layer** of the **stomach lining**, where they are **less exposed** to the highly **acidic juices** produced by the stomach. It can also be found in **stool, saliva, and plaque** on the teeth.
- It produces **ammonia**, which helps protect it from stomach acid and enables it to disrupt and penetrate the mucus layer.
- **Symptoms:** It causes redness and inflammation in the stomach lining (**gastritis**), and painful **sores** called peptic ulcers. It can also lead to **stomach cancer**.
- **Transmission:** It can be transmitted from **person to person**.

New blood group system: MAL

Context: A **new blood group** system, **MAL**, has been identified. The research identified the **AnWj antigen's genetic basis**, marking the **47th known blood group system**. The AnWj antigen, a **surface marker on red blood cells**, was first discovered in **1972** but remained poorly understood.









- More than **99.9%** of the population is **AnWj-positive**, meaning their blood contains the antigen, while those who are **AnWj-negative** face severe **risks** if given AnWj-positive blood during **transfusions**. Common reasons for lacking this antigen are illnesses like cancer or certain blood disorders.
- MAL protein plays a vital role in keeping **cell membranes stable** and aiding in **cell transport**.
- AnWj antigens **do not appear in newborns** but develop soon after birth.
- ***Antigens** are molecules capable of stimulating an immune response. Each antigen has distinct surface features, resulting in specific responses. They are composed of proteins, peptides, and polysaccharides. It induces the immune system to produce antibodies against it.*

Blood group system

- Antigen makeup is the key factor in determining blood type. They reside on the surface of the **red blood cells**, serving as built-in protection devices for your blood supply.

- These substances are **designed to identify foreign cells** and **trigger immune responses** that produce **antibodies** in the plasma to attack potential invaders. The **presence or absence** of antigens on the red blood cells and corresponding antibodies in your plasma defines the blood group.

ABO BLOOD GROUP SYSTEM

BLOOD GROUP	A	B	AB	O
RED BLOOD CELL TYPE				
ANTIGENES IN RED BLOOD CELLS	A ANTIGEN	B ANTIGEN	A AND B ANTIGEN	NONE
ANTIBODIES IN PLASMA			NONE	 

Presbyopia Treatment

Context: Newly approved eye drop PresVu will reduce dependency on reading glasses for individuals with **presbyopia**.

Presbyopia

- **Definition:** Presbyopia is an **age-related eye condition** that typically begins around **age 40**.
- **Cause:** Results from **hardening** of the **eye's lens** and **decreased flexibility** of the ciliary muscles.

Symptoms:

1. Difficulty reading small text
2. Holding reading materials farther away
3. Headaches and eyestrain

Impact: Affected individuals often require reading glasses or contact lenses for management.

PresVu

- **Active Ingredient: Pilocarpine** — contracts the iris muscles, helping improve focus on close objects.
- **Technology:** PresVu utilises "**advanced dynamic buffer technology**" to adapt to the pH level of tears, ensuring consistent efficacy and safety for long-term use.
- **Temporary:** The effects of PresVu are **temporary**, lasting approx. **Four to six hours**.

Clostebol

Context: **International Tennis Integrity Agency** lifted the doping ban on Jannik Sinner. He was tested positive for low levels of the banned anabolic agent **Clostebol**.

- **Clostebol** or **4-chlorotestosterone** is a weak synthetic **anabolic-androgenic steroid (AAS)** with potential use as a **performance enhancing drug**. It is detectable in urine.
- It is currently **banned** by the **World Anti-Doping Agency** and **International Olympic Committee**.
- It can also be used for ophthalmological and dermatological use in humans (as Clostebol acetate) and to **improve animal growth** in cattle.

International Tennis Integrity Agency (ITIA)

- It is an upgraded version of **Tennis Integrity Unit** (2008-2020), which was established in **2021**.
- **HQ: London (UK)**. It is responsible for safeguarding the integrity of professional tennis worldwide.



- **Functions:** Prevention, education and drug testing activities, intelligence gathering and investigation of competition manipulation

World Anti-Doping Agency (WADA)

- It is a foundation initiated by the **International Olympic Committee** based in **Canada** to promote, coordinate, and monitor the fight against drugs in sports.
- It was set up on **10 November 1999** and its headquarters is in **Montreal, Canada**.
- It is responsible for the **World Anti-Doping Code**. India's **National Anti-Doping Agency** adopts it.

International Olympic Committee

- It was established on **23 June 1894** as an **international, non-profit, non-governmental organization** to encourage and support the promotion of ethics in sports as well as education of youth through sports.
- It is an **apex authority** of the worldwide modern Olympic movement which organizes the modern Olympic Games and Youth Olympic Games, held in summer and winter, **every four years**.

Digital Dementia

Context: Using digital devices for more than four hours may lead to **digital dementia**.

- **Digital dementia** refers to a **decline in cognitive abilities**, particularly memory, due to **excessive reliance on digital devices** such as smartphones and computers.
- Excessive use of digital technology has caused information overload, leading to **shorter attention spans** and **reduced focus** in younger people.
- This can potentially increase the risk of dementia, Alzheimer's, and other forms of memory loss.
- **Symptoms:** Short-term memory loss, inability to recall words, difficulty in multitasking.
- Excessive screen time can **also affect sleep, mood, brain function** and **increase social isolation**.

Functional Magnetic Resonance Imaging (fMRI)

Context: fMRI can reveal depression subtypes and treatments that could work.

- **Functional MRI (fMRI)** is a type of MRI scan that maps brain activity by tracking blood oxygen levels in different areas of the brain by using an extremely powerful magnet, radio waves and computer processing to generate highly detailed 3D pictures of the brain. There is **no radiation risk**.
- The machine can capture abnormal electrical activity in the brain and identify the subtype of depression.

Biomarker (Signature Molecule)

- Also known as a **molecular marker**, it is a biological molecule that may be used to see how well the body responds to a treatment for a disease or condition.
- High cholesterol levels are a common biomarker for heart disease risk.
- Various types of molecules, such as DNA (genes), proteins or hormones, can serve as biomarkers.

Anti-Depressants

- They are used to treat major depressive disorder, anxiety disorders, chronic pain and addiction.
- Sertraline, Venlafaxine XR, Escitalopram fluoxetine, Paroxetine, Citalopram, Vortioxetine, Vilazodone, Duloxetine, Levomilnacipran, and Desvenlafaxine are most commonly used anti-depressants.

AI-Generated Synthetic Medical Images

Context: There has been an increase in **AI-generated synthetic medical imaging**. **Synthetic images** are like **"this person does not exist"** images, where the AI creates images of non-real people.

What are Synthetic medical images?

- **Generated by:** It is generated by AI or computer algorithms without being captured by traditional imaging devices such as MRI, CT scans, or X-rays.



- These images serve as **alternatives to real** medical images. It creates brand-new radiological images or medical scans that seem real **but aren't** based on **real** patient data.

BharatGen

Context: Recently, Govt launched **BharatGen**, a pioneering initiative in generative AI designed to revolutionise public service delivery and boost citizen engagement.

- **Agency:** **IIT Bombay** under the **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** of the **Department of Science and Technology (DST)**.

Features

- **Multilingual:** It can generate high-quality text and multimodal content in various Indian languages.
- **Bhartiya data set-based building:** It uses selected datasets on India's linguistic and cultural diversity.
- **Open-source platform:** Using AI not only for industrial and commercial purposes but also to address national priorities like cultural preservation and inclusive technology development.
- **Data efficient learning ecosystem:** It will develop effective models with minimal data.

Europa Clipper mission

Context: **NASA** is set to launch the **Europa Clipper mission** to explore **Jupiter's moon Europa**, one of the most promising places to find **habitable conditions** beyond Earth.

- It involves placing a spacecraft in orbit around Jupiter to conduct a detailed investigation of Europa.
- Europa shows **strong evidence** of having an ocean of **liquid water** beneath its icy crust.
- Europa Clipper is the **largest spacecraft NASA** has ever developed for a **planetary mission**. The spacecraft **will orbit Jupiter** and conduct **49 close flybys** of Europa to collect data.

Solar arrays: These are groups of solar panels linked to produce electrical power. These arrays are combined with additional components, such as an inverter and a battery, to create a full solar system.

Astrobiology: Scientific study investigating the possibility of life beyond Earth, exploring environments on other planets and moons where life could exist and the origin and evolution of life on Earth.

Subsurface Ocean refers to an ocean beneath a celestial body's surface like Europa. It is typically shielded by a thick layer of ice or rock and provides a potential habitat for extraterrestrial life.

Ice-penetrating Radar: This technology penetrates through ice layers to study the structures beneath. It is used to examine the thickness of ice sheets and map features like subsurface oceans.

Moonlight Programme

Context: The **European Space Agency (ESA)** launched its **Moonlight Lunar Communications and Navigation Services (LCNS)** programme.

Its initial services will begin by the end of **2028**, and is expected to be **fully operational** by **2030**.

The programme will have a constellation of about **five lunar satellites**, allowing accurate autonomous landings, high-speed communication, & surface mobility.



Objective: Offer coverage at the **Moon's South Pole**, a key area for many missions owing to lighting conditions and the potential presence of water ice within craters that perpetually remain in the shadows

As part of the Moonlight program, ESA working with **NASA** and Japanese space agency **JAXA** on **LunaNet** (framework for **lunar communication and navigation standards**) to ensure compatibility with upcoming lunar infrastructures and technologies.

Space Pollution

Context: Scientists recently discovered that **soot** and **aluminium oxides** from **rocket** and **satellite** launches **might damage** the **ozone layer** and **magnetic field**.

Space competition has intensified again, leading to a **sharp rise** in rocket and satellite **launches**. In the past 15 years, rocket launches have **tripled**, and the **number of satellites** in orbit has increased **tenfold**.

Environmental Impact of Rocket and Satellite Launches

Space debris: The amount of space debris, including decommissioned satellites and spent rocket stages, has doubled in the last decade.

Upper Atmosphere Warming: Modern rockets, fuelled by fossil fuels, produce soot by-products, which could absorb heat and potentially increase Earth's upper atmosphere temperature.

Ozone depletion: According to Geophysical Research Letters, **Satellite burning** and **rising aluminium oxide** levels may **disrupt** the **planet's thermal balance**, damaging **ozone**.

Earth's Magnetic Field: The **US National Oceanic and Atmospheric Administration** (NOAA) concluded that forming **metallic ash** in the **stratosphere** due to satellite **re-entries** could weaken Earth's magnetic field, allowing more cosmic radiation to reach its surface.

Perchlorates: Solid rocket boosters often contain **highly toxic perchlorates**, a class of highly toxic chemicals that can contaminate soil and water.

Ground contamination: Contamination near the launch sites is a documented issue that impacts local ecosystems and potentially human health.

Water vapour: High-altitude water vapour emissions can have a warming effect by contributing to the greenhouse effect. However, the magnitude of this effect is still being researched.

Noise Pollution: Rocket launches generate significant noise pollution, impacting wildlife and potentially human communities near launch sites. While not a global problem, it is a localised environmental concern.

X-Band Radar

Context: The **Ministry of Earth Sciences** approved an **X-band radar** to be installed in **Wayanad**.

X-Band radar

An X-band radar is a radar that emits radiation in the **X-band** of the **electromagnetic spectrum**: 8-12 GHz, corresponding to wavelengths of around **2-4 cm**.

Because they operate at a **smaller wavelength**, X-band radars are **more sensitive** and can **detect smaller particles** than other radar bands. It allows the radar to produce images of **higher resolution**.

Applications: Weather monitoring, air traffic control, maritime vessel traffic control, defence tracking, vehicle speed detection for law enforcement, etc.

NISAR

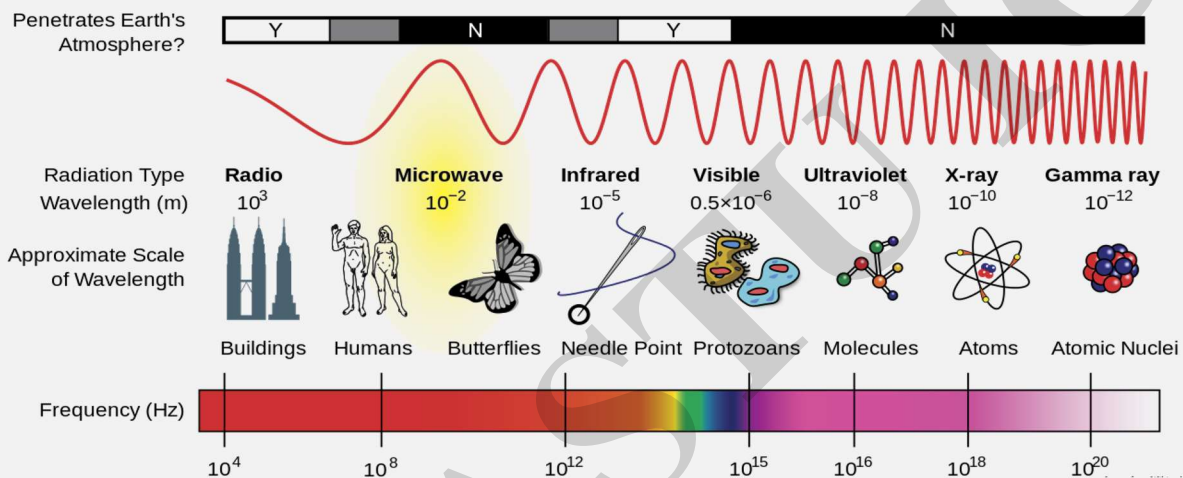
NASA and the Indian Space Research Organisation (ISRO) are developing a satellite called **NISAR**, short for '**NASA-ISRO Synthetic Aperture Radar**'.

It will use radar imaging to produce a high-resolution map of the Earth's land masses.

Its payload consists of an **L-band radar** built by NASA and an **S-band radar** built by ISRO. Together, they will track and record changes in the earth's various natural processes.

It is expected to be launched onboard an **ISRO GSLV Mk II** rocket in **2025**.

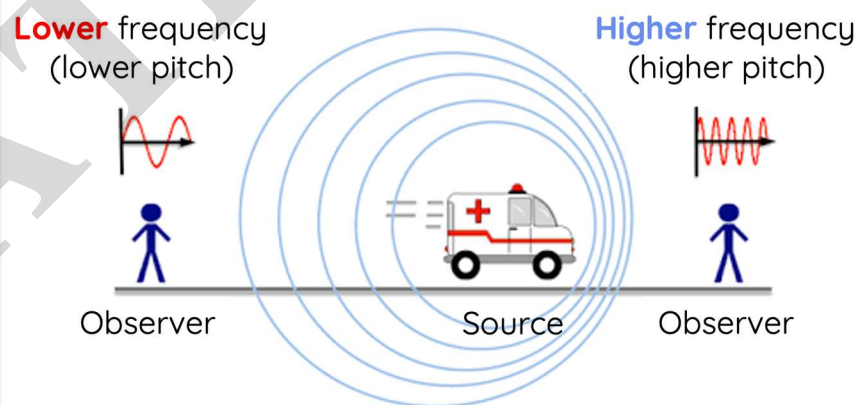
Radar



Radar is short for '**radio detection and ranging**'. It uses **radio waves** to determine the distance, velocity, and physical characteristics of objects around the device.

Working: The radar transmits a focused pulse of **microwave energy** at an object. The object echoes part of the emitted signal back to the device, where a receiver tracks and analyses it.

Doppler Radar



Weather radar, also known as a **Doppler radar**, is a **remote sensing instrument** and is capable of **detecting particle type** (rain, snow, hail, insects, etc), intensity, and motion.

It uses the **Doppler effect** to gather velocity data from the particles that are being measured.



The Doppler effect is the **change in frequency of sound waves** as their source moves towards and away from a listener.

Applications: Monitoring weather conditions and anticipate new wind patterns, storm formations, etc.

Sarvam-1

Context: Indian AI startup **Sarvam AI** has launched **Sarvam-1**, the **first LLM** optimised specifically for **Indian languages**.

Sarvam-1 is **open-source** and supports up to **ten Indian languages**, including Bengali, Gujarati, Hindi, Kannada, Malayalam, Marathi, Oriya, Punjabi, Tamil, and Telugu, in addition to English.

It falls under the category of **small language models (SLMs)**, which have parameters of **less than ten billion**, as opposed to large language models (LLMs)

It offers 4 to 6 times **faster inference speeds**, making it suitable for deployment in **production environments**, including edge devices with limited computing resources.

ADITI 2.0 and DISC Scheme

Context: Recently, the **Defence Minister** launched **ADITI 2.0**, the second edition of **Acing Development of Innovative Technologies** and the 12th edition of Defence India Start-up Challenges (**DISC-12**) during **DefConnect 4.0**.

Aim: Develop 30 critical and strategic deep-tech defence technologies within the proposed timeframe.

Eligibility: Start-ups can receive a grant-in-aid of up to Rs 25 crore for research, development, and innovation in defence technology.

Technology Watch Tool: Aims to bridge the gap between the expectations and requirements of the modern Armed Forces and the capabilities of the defence innovation ecosystem.

Defence India Start-up Challenge (DISC)

Aim: To support Start-ups, MSMEs (Micro, Small, and Medium Enterprises), and Innovators to develop prototypes and commercialise products/solutions for National Defence and Security.

Launched by: **Ministry of Defence** in partnership with Atal Innovation Mission (AIM) in 2018.

Eligible Participants: Start-ups, Indian companies, individual innovators, and academic institutions.

Innovations for Defence Excellence (iDEX)

iDEX was launched in **2018** to modernise the Defence Industry. It acts as an executive arm of the Defence Innovation Organization (DIO).

It engages MSMEs, start-ups, individual innovators, R&D institutes, and academia.

Nuclear powered ballistic Submarine (S4)

Context: India's fourth nuclear-powered ballistic missile submarine (SSBN), **S4***, was launched.

S4* is **bigger** than **INS Arihant (S2)** which was developed under the **Advanced Technology Vessel programme**. S4* carries the advanced **3,500 km** range submarine-launched **ballistic missile K-4**.

First Three Submarines: INS Arihant (S2), INS Arighaat (S3), **Aridhman (S4)**, currently undergoing sea trials and is expected to be commissioned next year).



With successful return of **INS Arihant's 1st deterrence patrol** India completed its **nuclear triad** in **2018**.

Basic principles of India's nuclear doctrine

It is based on **Credible Minimum Deterrence (CMD)** and a **No-First-Use (NFU)** policy.

Credible Minimum Deterrence (CMD): It emphasises maintaining a nuclear arsenal **sufficient to deter** adversaries but **not excessively large**.

No First Use (NFU): India commits to not using nuclear weapons **unless first attacked** by an adversary using nuclear weapons.

Advanced Technology Vessel (ATV) Project

Initiated in the 1980s to develop indigenous **nuclear-powered ballistic missile submarines (SSBNs)**.

This idea gained momentum after the 1971 **Indo-Pakistani War**, which highlighted the need for a strong nuclear deterrent. The project saw its first major success with the launch of **INS Arihant**.

Predator MQ-9B and Hellfire missile

Context: The **Cabinet Committee on Security** approved acquiring 31 Predator drones MQ-9B.

MQ-9B

High Altitude Long Endurance UAV manufactured by **General Atomics**. It can fly for **35-40 hours** at altitudes over 40,000 feet. It can carry **four Hellfire missiles** and around **450 kgs of bombs**.

With a **range** of about **1,800 km**, it is capable of automatic take-offs and landings.

Two variants: **Sky Guardian** and **Sea Guardian**. The **MQ-9B** drone is a variant of the **MQ-9 "Reaper"** used to launch a modified version of the **Hellfire missile**.

Hellfire Missile

It is a multi-mission, multi-target **American** missile developed for anti-armour use and later developed for precision drone strikes against other target types.

Can be launched from **air, sea, ground** platforms.

Other variants of it are '**Longbow**' and '**Romeo**'. It has a **range** of **7.1–11 km**, depending on trajectory.

SIMBEX 2024

Context: 31st edition of the **Singapore-India Maritime Bilateral Exercise (SIMBEX)** scheduled at the Eastern Naval Command at **Visakhapatnam**.

SIMBEX, which began as '**Exercise Lion King**' in 1994, has evolved into one of the most significant bilateral maritime collaborations between the **Indian Navy** and the **Republic of Singapore Navy**.

THAAD

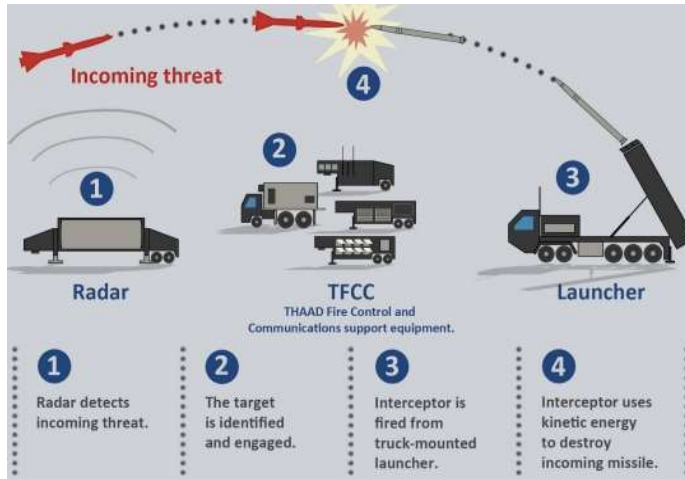
Context: USA to send **THAAD (Terminal High-Altitude Area Defence) defence battery system** to Israel. A THAAD battery comprises 95 soldiers, six truck-mounted launchers, 48 interceptors (eight per launcher), radar surveillance and radar, and a tactical fire component.

THAAD is a **mobile surface-to-air interceptor** designed to shoot down incoming **ballistic missiles** during the "**terminal (final) phase**" of their flight.

Developed by: Lockheed Martin Corporation.

It can target missiles both **inside** and **outside** the atmosphere (endoatmospheric and exoatmospheric).

It defends against **short, medium and intermediate-range ballistic missiles**, making it highly adaptable to various types of missile threats.



Range: 150 to 200 kilometers.

Components:

- 1. Interceptor:** Destroys incoming missiles using impact force.
- 2. Launch vehicle:** Mobile trucks that carry and launch the interceptors.
- 3. Radar:** Tracks and detects threats from 870 to 3,000 km.
- 4. Fire control system:** Coordinates the launching and targeting of interceptors.

It does **not** carry **explosive warheads**. Instead, it destroys targets using **kinetic energy**, meaning it hits incoming missiles with force rather than detonating a warhead.

Gliese 229B

Context: Gliese consists of two brown dwarfs, now designated **Gliese 229Ba** and **Gliese 229Bb**.

These two objects orbit each other closely, separated by 16 times the distance between the Earth and the moon, completing an orbit every 12 days.

They circle a small dwarf star located **19 light-years** from our solar system in the constellation **Lepus**.

About Brown Dwarfs

Brown dwarfs are sub-stellar objects that have **masses between** those of **stars and planets**, generally between 10 and 90 times the mass of Jupiter.

They **form the same way as stars**, from collapsing clouds of gas and dust, but they **don't have** enough **mass** to start **nuclear fusion**, which powers real stars. Hence, can be considered **wannabe/failed stars**.

They are formally defined as objects that can burn a heavy form of hydrogen, called **deuterium**, but **not** the most **common basic form of hydrogen**.

Because of their **low temperatures** and small sizes, brown dwarfs have extremely **low luminosities**.



Jiangmen Underground Neutrino Observatory (JUNO)

Context: The **JUNO** in **China** is slated to start operations in **2025**.

One of JUNO's primary goals is to determine the **mass hierarchy** of neutrinos, which involves identifying which types of neutrinos are the lightest and heaviest.

The facility's core feature is a massive **600-tonne spherical detector** outfitted with thousands of **light-detecting tubes**. This detector will be enclosed in a **12-storey cylindrical pool** of water.

Multi-purpose Research: The observatory will detect reactor neutrinos from nearby nuclear power plants, observe supernova neutrinos, study atmospheric and solar neutrinos, and investigate geo-neutrinos from the Earth's interior.

International Collaboration: France, Germany, Italy, Russia, the U.S., and Taiwan.

Eight products from Assam received GI Tag

Context: Eight products from **Assam** received the **GI Tag**.

About products

Products	Description
Bodo Jou Gwran	Rice beer variant.
Maibra Jou Bidwi	Rice beer prepared by fermenting half-cooked rice with less water.
Bodo Jou Gishi	Fermented rice-based alcoholic beverage.
Bodo Napham	Fermented fish prepared anaerobically in a tightly sealed container.
Bodo Ondla	Rice powder curry flavoured with garlic, ginger, salt, and alkali.
Bodo Gwkha	Bitter-sour curry prepared during the Bwisagu festival.
Bodo Narzi	Semi-fermented food prepared with jute leaves, a rich source of Omega 3 fatty acids, vitamins and essential minerals, including calcium and magnesium.
Bodo Aronai	Finely woven cloth often draped over the shoulder.

About Bodo Tribe

Bodo is the **largest plain tribe of Northeast India**. They are found in **Assam** and **Meghalaya**.

According to the 2011 census, Bodo is the **largest ethnic group** in **North-East India**.

The tribe is one of the largest among the **Indo-Mongoloid origin** of Tibeto-Burmese languages.

Bodos are the single largest community among the notified Scheduled Tribes in Assam. Part of the larger umbrella of Bodo-Kachari, the Bodos constitute about **5-6% of Assam's population**.

Mapping of Fruit Fly Brain

Context: Scientists have successfully **mapped** the **entire brain** of an **adult fruit fly**.



Previously, a **tiny worm** was the **only adult animal** to have had its **brain entirely reconstructed**, with just 385 neurons. The **new fly map** is “the **first complete map of any complex brain**”.

Human brain has 86 billion neurons.

Why Does the Fruit Fly Have So Much Scientific Importance?

Fruit flies breed rapidly, with a **new generation** emerging **every 10-12 days** under optimal conditions.

Genetic Research: It shares many **similarities** with the **human genome**. They have been used to study **inheritance, gene function, and genetic mutations**.

The team **tested** the **simulated brain** by seeing the response of it to food.

About Neurobiology

It is the branch of biology focuses on studying the **nervous system**, including the brain, spinal cord, and neural circuits.

Key Areas of Study

Neural Anatomy: Examines the nervous system's structure, including neurons & neural circuits.

Neural Physiology: Studies nerve cells function & communication (electrical and chemical signals).

Neural Pathology: Investigates diseases and disorders of the nervous system, such as Alzheimer's, Parkinson's, and multiple sclerosis.

Murine typhus

Context: **Murine typhus** was diagnosed in **Kerala**. It is an infectious disease caused by the flea-borne **bacteria *Rickettsia typhi***. Also known as **endemic typhus, flea-borne typhus** or **fever**.

Reservoirs: **Rodents** like rats. The disease is transmitted to humans through the **bites of infected fleas**. Disease-carrying fleas can also live on other **small mammals**, including pets such as cats and dogs. **Once a flea is infected**, it can **spread** the disease for the **rest of its life**. It does **not spread** from **one person to another** or from **person to flea**.

Symptoms: Fever, headaches, body aches, joint pains, nausea, vomiting, stomach aches and rashes.

No vaccine is currently available against the disease. Antibiotic **doxycycline** is considered effective.

Vitiligo

Context: A recent Kannada film draws attention to **vitiligo**.

Vitiligo is a long-term **skin disorder** that results in the loss of pigment in patches, causing white areas to appear on the skin. It is **not contagious**. Affects between 0.5 – 2% of the global population.

Cause: It arises due to the **malfunction** or **destruction** of **melanocytes**, the cells responsible for producing **melanin**, the **pigment** that gives **skin** its **colour**.



It could result from **autoimmune responses**, **genetic predispositions**, and **environmental factors** (UV radiation, chemical exposure, etc). It results in **depigmented patches** that may occur anywhere on the body, including the **skin**, **hair**, and even the **lining of the mouth**.

Does **not** have a **permanent cure**. Treatments aim to manage symptoms and restore skin pigmentation.

New Method to Treat Brain TB

Context: A new method can **target the brain directly**. Traditional treatments involve high doses of **oral anti-TB drugs**, which often fail to achieve efficiency due to the **blood-brain barrier (BBB)**.

*The **blood-brain barrier (BBB)** is a selective **semi-permeable membrane** between the **blood** and the **interstitium of the brain**, allowing cerebral blood vessels to regulate molecule and ion movement between the blood and the brain.*

Scientists used **chitosan-based nanoparticles** to deliver **TB medicines** directly to the **brain via the nose**, **bypassing the BBB**. These particles were then made into slightly larger **clusters** called **nano-aggregates**; they can hold TB drugs like **isoniazid (INH)** and **rifampicin (RIF)**.

Chitosan's **mucoadhesive properties** enable nano-aggregates to adhere to the nasal mucosa, enhancing drug release and prolonging their effectiveness.

It could be applied to treat other brain infections, neurodegenerative diseases (like Alzheimer's and Parkinson's), brain tumours, and epilepsy by enabling efficient drug delivery to the brain.

Chitosan - Based Nano Particles (ChNPs)

Chitosan (a **natural carbohydrate polymer** with numerous ideal properties, **nontoxic**, **biodegradable**, and **bioadhesive**) has been extensively used in pharmaceutical sciences and other sectors.

Drug Delivery: They can be used to deliver drugs in the gastrointestinal, ophthalmic, nasal, sublingual, transdermal, and vaginal tracts. ChNPs can also be used to deliver **hormones**.

Food: ChNPs can enhance the **shelf life of foods** by increasing their **antimicrobial activity**. They can also **stabilise antioxidants** like vitamins and tea polyphenols, reducing lipid or protein oxidation.

Cosmetics: ChNPs can be used as **hydrating** agents in cosmetics.

Agriculture: ChNPs can deliver **fertilisers**, pesticides, and plant growth promoters.

Respiratory Syncytial Virus (RSV)

Context: WHO **Maternal Vaccine** and **Antibody Shot** to Prevent **RSV** in Infants.

About Respiratory Syncytial Virus (RSV)

Infects the **lungs** and **respiratory tract**.

Symptoms: Mild, **cold-like symptoms**. It can lead to pneumonia or bronchiolitis in severe cases.

Transmission: The virus spreads through respiratory droplets when an infected person coughs or sneezes. It can also spread by touching surfaces contaminated with the virus and touching the face.

Risk Groups: It can be severe for infants, especially premature babies, older adults, and individuals with chronic heart or lung disease or weakened immune systems.

Available Vaccines and Antibodies



Pfizer's Abrysvo: Only available RSV vaccine for pregnant women in the U.S., Europe, Japan, and Canada.

Sanofi and AstraZeneca's Beyfortus: The only approved antibody shot for infants and toddlers in the U.S., U.K., and other countries. However, its supply has been limited.

Stereotactic Radiation Therapy (SRT)

Context: SRT can help treat **prostate cancer** that has spread to other parts of the body.

Prostate cancer is a type of cancer that begins in the **prostate gland**, which is a small, walnut-sized gland in **men** that produces seminal fluid.

About Stereotactic Radiation Therapy (SRT)

It is an advanced form of radiotherapy that uses **high doses without** involving the **surgery** of highly focused **radiation beams** to destroy cancer cells precisely, **minimising damage** to surrounding tissues.

Comparison with Traditional Radiation: It can treat cancer in fewer sessions (one to five sessions over one to two weeks) compared to conventional radiation therapy (20 to 40 sessions over weeks or months).

Reduced Side Effects: SRT has shown **lower impacts on sexual function** when compared to prostatectomy (surgical removal of the prostate).

Bone Ossification Test

Context: A Mumbai court has recently ordered a **bone ossification test** to determine if one of the accused in the murder case of a political leader is a **minor or not**.

It is a medical procedure used to **estimate a person's age** by analysing **development & fusion of bones**.

Ossification refers to the **process** by which bone **tissue is formed**. It starts during **fetal development** and continues until full skeletal maturity is reached. Different bones ossify at different stages of life.

The test involves taking X-rays of specific bones, such as the clavicle, sternum, pelvis, and wrist. These bones are chosen because they undergo significant changes as a person ages.

The test provides an **estimated age** range rather than an **exact age**. **Individual variations** in bone maturation can affect the results.

MicroRNA (miRNA)

Context: Scientists **Victor Ambros** and **Gary Ruvkun** have been awarded the **2024 Nobel Prize for Medicine** for discovering **microRNA**. It was first discovered in **1993**.

About MicroRNA (miRNA)

MicroRNAs (miRNAs) are **short, non-coding RNA** molecules, usually about 22 nucleotides long, that regulate gene expression at the post-transcriptional level.

It typically **binds to complementary sequences** in messenger RNA (**mRNA**), leading to **mRNA degradation** or inhibition of translation, thereby **silencing gene expression**.

Applications of miRNA

Disease Biomarkers: They can be **biomarkers** for various diseases, including cancer. Their **stable** presence in body fluids makes them ideal for **non-invasive diagnostic tests**.



Therapeutics: These therapies aim to **inhibit** or **replace dysregulated miRNAs**. This can help correct abnormal gene expression patterns associated with diseases.

Gene Regulation Studies: miRNAs are valuable tools for **studying gene regulation** mechanisms, helping scientists understand complex biological processes and pathways.

Agriculture: It can be utilised in **crop improvement** by regulating gene expression to enhance resistance to pests and environmental stress or increase crop yield.

Novel Molecules to Treat Alzheimer's Disease

Context: Indian Researchers have designed and synthesised **novel molecules** through **synthetic**, computational, and in-vitro studies for treating **Alzheimer's Disease (AD)**.

Current AD treatments include **Memantine**, and three **anti-cholinesterase drugs** have limitations of short-term benefits and serious side effects.

A new method called a "**one-pot, three-component reaction**" created new molecules with high success rates. These **novel molecules** effectively inhibit cholinesterase enzymes to treat AD symptoms.

'One Day One Genome' Initiative

Context: Department of Biotechnology (DBT) and Biotechnology Research and Innovation Council (BRIC) introduced the 'One Day One Genome' initiative to harness India's microbial potential.

Aim: To highlight the unique **bacterial species** found in India and emphasise their critical roles in the environment, agriculture, and human health.

Coordinated by: BRIC-National Institute of Biomedical Genomics (NIBMG), an institute of the Department of Biotechnology.

Key Features of the 'One Day One Genome' Initiative

Daily Genome Sequencing: Conducting daily sequencing of bacterial genomes to reveal and harness the vast microbial potential within India.

Freely Accessible Data: Offering annotated bacterial genome data that is freely accessible to the public.

Comprehensive Information: Providing detailed graphical summaries, infographics, and genome assembly/annotation information for each genome sequenced.

Research Support: Enhancing research in environmental management, agricultural development, and human health through comprehensive genome data.

Public and Scientific Engagement: Encouraging public and scientific community engagement to foster innovation and benefit society.

Chemical Weapons Convention (CWC)

Context: Indian Chemical Council (ICC) wins 2024 Organisation for the Prohibition of Chemical Weapons (OPCW)-The Hague Award.

It honours those who advance the objectives of the **Chemical Weapons Convention (CWC)** by promoting chemical safety, disarmament, and global security.

The OPCW won the Nobel Peace Prize in **2013** for its efforts to eliminate chemical weapons.



About The Chemical Weapons Convention (CWC)

Objective: Prohibits development, use & stockpiling of chemical weapons & mandates their destruction.

Establishment: It came into effect in **1997**. Presently, 193 States parties.

Non-signatories: **Egypt, North Korea, and South Sudan** have **neither signed nor ratified** the CWC.

Implementing Body: The OPCW implements CWC, which is headquartered in **The Hague**, with a mission to achieve a **world free of chemical weapons**.

It conducts audits of chemical facilities globally. It is more comprehensive than the 1925 Geneva Protocol.

Open Membership: Any nation can join the CWC if it fulfils the requirements.

Indian Chemical Council (ICC)

It is the premier national organisation under **Ministry of Commerce & Industry**, representing all sectors of India's chemical industry, including organic and inorganic chemicals, plastics, and petrochemicals.

It represents over **80%** of India's \$220 billion chemical industry.

India's First Long-Range Hypersonic Missile

Context: DRDO successfully conducted the flight trial of **India's first long-range hypersonic missile** from Dr. A.P.J. Abdul Kalam Island, off the coast of Odisha.

About the Long-Range Hypersonic Missile

It was designed to carry various payloads for ranges **greater than 1,500 km** for the Armed Forces.

It was developed by Dr. A.P.J. Abdul Kalam Missile Complex laboratories, Hyderabad, along with various other DRDO laboratories and industry partners.

What is Hypersonic Missile?

It is an advanced weapon system capable of travelling at speeds **five times the speed of sound**. Their range typically varies between 6,125 km/h (**Mach 5**) and about 24,140 km/h (Mach 20).

Unlike ballistic missiles, hypersonic missiles are highly manoeuvrable, allowing them to **change their flight path** and precisely target specific locations.

They can carry conventional or nuclear warheads, making them versatile for different types of missions.

US, Russia, China and **India** are at the forefront of hypersonic missile development. Other countries like France, Germany, Japan, & Australia also work on hypersonic weapons technology.

Types of Hypersonic Weapons

Hypersonic Glide Vehicles (HGVs): These vehicles are launched from a rocket. It can Glide towards their target after reaching the upper atmosphere.

Hypersonic Cruise Missiles: It is powered by air-breathing high-speed engines, known as **scramjets**. Achieve sustained hypersonic speeds during flight to their target.

Advantages of Hypersonic Missiles

Responsive Long-Range Strike Capability: Hypersonic missiles can quickly and accurately strike distant, defended, or time-critical targets, such as mobile missile launchers.



Enhanced Penetration: Using only kinetic energy (the energy derived from their high-speed motion), they can destroy unhardened targets and penetrate underground facilities.

Indian Hypersonic Missile Programme

A program aimed at showcasing and advancing hypersonic technologies, including the development of scramjet engines.

Dual Capable Missiles: Development of **hypersonic cruise missiles** that can carry both conventional and nuclear warheads.

World Intellectual Property Indicators (WIPI) Report 2024

Context: India has secured a spot in the **top 10** countries worldwide for patents, trademarks, and industrial designs, according to the World Intellectual Property Organization (WIPO) 2024 report.

The **Indian patent office** granted 149.4% more patents in 2023, a 15.7% increase compared to the previous year.

About WIPI Report

It is a **biennial** publication by the **WIPO** that provides a comprehensive analysis of global intellectual property (IP) activity, drawing on data from national and regional IP offices and the WIPO itself.

The report covers various IP categories, including patents, trademarks, industrial designs, utility models, microorganisms, plant variety protection, and geographical indications.

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

It is the **head** of the Indian government agency that **manages patents, designs, and trademarks**.

It is part of the **Ministry of Commerce and Industry** and has offices in **Mumbai, Kolkata, Chennai, and New Delhi**.

It is responsible for administering the **Patents Act of 1970**, the **Designs Act of 2000**, and the **Trade Marks Act of 1999**, and advising the government on matters related to these acts.

The CGPDTM also heads the following offices: Trade Marks Registry, Geographical Indications Registry, Copyrights Office, Patent Information System (PIS), and Rajiv Gandhi National Institute of Intellectual Property Management (RGNIPM).

India's first analogue space mission

Context: India's first Mars and Moon **analogue mission** at **Leh** in Ladakh has been inaugurated.

Organisations involved: ISRO, AAKA Space Studio, University of Ladakh, IIT Bombay, and Ladakh Autonomous Hill Development Council.

Objective: To simulate life in an interplanetary habitat. For the next 21 days, an **analogue astronaut** will reside within the habitat. It is part of ISRO's **Gaganyaan program**.

***Analogue missions** are field tests in locations similar to extreme space environments. And astronauts participating are referred to as **analogue astronauts**.*

Why Ladakh was chosen?

The mission site was chosen as it closely **resembles Martian** and **lunar** surfaces, offering a natural laboratory for testing habitat sustainability, life support systems, and the human experience of isolation.

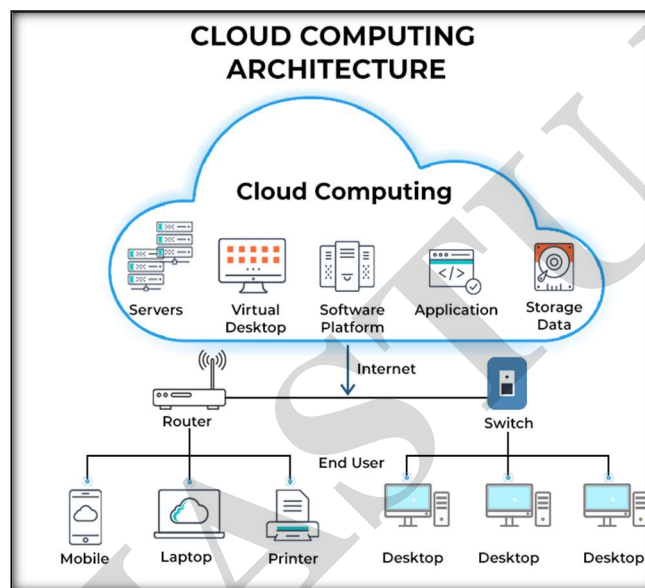
The **Diurnal shifts** from **15°C to -10°C**, which simulate the thermal challenges of extraterrestrial environments, enabling testing of the habitat's thermal insulation.

Ladakh's **oxygen levels** are only **40%** of sea level, allowing researchers to test life support systems for low-pressure conditions similar to Mars.

Cloud Computing - Types, Applications & Challenges

Context: RBI plans to launch a pilot programme in 2025 offering **local cloud data storage** to financial firms at affordable prices.

Cloud Computing



Cloud computing distributes computer services such as servers, storage, databases, networking, software, analytics, and intelligence through the Internet ("**the cloud**") to enable quicker innovation, more flexible resource allocation, and cost savings.

It eliminates the need for individuals and businesses to self-manage physical resources themselves, and only pay for what they use.

Types of Cloud Computing

Categories: Deployment Models and Cloud Computing Services.

Deployment Models

Public Cloud: Services are delivered over the Internet and **accessible to authorised users**. The cloud provider manages all hardware and software components. Examples include **Amazon Web Services (AWS)** and **Microsoft Azure**.

Private Cloud: Exclusively used by a single organisation and runs on a private network. Access is **limited to internal users** and can be on-premises or hosted by third-party providers. E.g, **VMware Cloud**.

Hybrid Cloud: Combines elements of both public and private clouds, allowing for **on-premises storage of sensitive data** while utilising the public cloud for less sensitive information.

Multi-Cloud: Involves using services from multiple cloud providers within one architecture, offering various features and functions from different vendors.



Cloud Computing Services

Service Model	Description	Applications	Examples
Infrastructure as a Service (IaaS)	Provides on-demand access to IT infrastructure services such as compute, storage, networking, and virtualisation. Offers highest control over IT resources, similar to traditional on-premises IT resources.	Web hosting, big data analysis, high-performance computing, e-commerce platforms, mobile app backends	Amazon EC2 Services, MeghRaj Initiative (Gov cloud)
Platform as a Service (PaaS)	Offers hardware and software resources needed for cloud application development, allowing companies to focus on application development without managing infrastructure.	Application development, business process management (BPM), business analytics and intelligence, automated backup and disaster recovery	Microsoft Azure App Service, AWS Elastic Beanstalk, Aadhaar authentication services
Software as a Service (SaaS)	Delivers a full application stack as a service, including infrastructure, maintenance, and updates, typically for end-user applications managed by the service provider.	Customer relationship management (CRM), enterprise resource planning (ERP), email and communication, content management systems (CMS)	Microsoft Office 365, Dropbox, Google Workspace, GSTN, DigiLocker, AEPS, BHIM

Applications of Cloud Computing

Media Streaming: Platforms like **Netflix** and **Spotify** host streaming services for video and music.

Virtual Meetings: Services like **Microsoft Teams** host virtual meetings and conferences.

Secure Storage: Cloud services like **Dropbox** and **Google Drive** offer secure and easily accessible data storage from anywhere.

Telemedicine: Cloud-based apps, like **Teladoc**, facilitate remote medical consultations and services.

Online Marketplaces: E-commerce platforms use cloud computing to host and manage online stores.

Public Records Management: Secure cloud databases, such as those used by the **National Archives and Records Administration (NARA)** in the US, manage public records.

Device Management: Platforms like IBM Watson, manage and analyse IoT device data and operations.

Cloud Computing in India

Growth in SaaS: India is the second-largest SaaS market after the US. Indian SaaS companies are projected to grow 20-25% annually, aiming for \$35 billion in ARR by 2027.

Hybrid Cloud Adoption: Increasing adoption of hybrid cloud models, combining private and public clouds for flexibility and cost optimisation.

Data Centers Expansion: Investment by Indian companies like Reliance Jio and Bharti Airtel in building large-scale data centres for cloud and edge computing services.

Healthcare Transformation: Pivotal during the COVID-19 pandemic, enabling telemedicine services and remote diagnostics.

E-commerce Scalability: Platforms like Flipkart and Amazon India use cloud services to handle traffic spikes during festive seasons and sales.

Cloud Computing in Indian Governance

E-Gram Panchayat: The ePanchayat initiative enhances internal govt operations in village Panchayats.

DigiLocker: Public cloud-based storage for digitally verified documents. Over 57.13 million users and 4.27 billion issued documents.

National Highway Authority of India (NHAI): Fully digital with a cloud-based, AI-powered big analytics platform. Cloud-based data lake with GIS tagging for easy retrieval of project data.

Indian Railways on Cloud: The **largest rail network in Asia** and the second-largest worldwide. Cloud technology is implemented to manage railway data and reduce revenue loss.

Kisan Suvidha: Portal to provide farmers with instant, relevant information on weather, market prices, and agricultural practices.

eHospital: Cloud-based healthcare project for streamlined healthcare management. Unique identification number for patients, enabling access to medical history.

National Initiatives: Supports initiatives like Swachh Bharat Mission, e-Hospital, National Scholarship, My-Gov, and e-Transport.

Government e-Marketplace (GeM): Multi-cloud architecture ensuring scalability. It serves over 50,000 buyer organisations and has over 19 lakh products and 80,000 services listed.

S3WaaS: SaaS-based service empowering dist administrators to create & deploy scalable websites easily.

Challenges of Cloud Computing

Security: Concerns about data breaches, API exploitation, credential theft, authentication issues, and unclear practices by cloud providers handling sensitive data.

Cost Unpredictability: **Pay-as-you-go** models and resource scaling can lead to unpredictable expenses, with additional charges from using multiple cloud services.

Lack of Capability and Expertise: Finding qualified professionals to manage cloud technologies is challenging, and organisations struggle to keep up with rapid technological advancements.

IT Governance: Limited control over cloud infrastructure complicates IT governance, risk management, compliance, and maintaining data quality.

Compliance: Ensuring regulatory adherence when using third-party cloud storage is difficult, with the actual location of data playing a crucial role in compliance.

Management of Multiple Clouds: Handling various cloud environments divides focus and resources, complicating overall management due to the distinct characteristics of each cloud.

Building a Private Cloud: Developing and managing private or hybrid clouds is complex & demanding.

Cloud Migration: Transferring data or applications to the cloud poses technical challenges and expenses, especially for large datasets.

Instrument Landing System (ILS)

Context: Dense smog disrupted flight operations at several airports in India due to poor visibility, highlighting gaps in pilot training for Category III **Instrument Landing Systems (ILS)**.

Understanding CAT I/II/III Approaches in Aviation

It represents different levels of precision instrument approaches based on **visibility & decision height**.

CAT I: The basic form of ILS, requiring a decision height of at **least 200 feet** and a runway visual range of 550 meters or more.

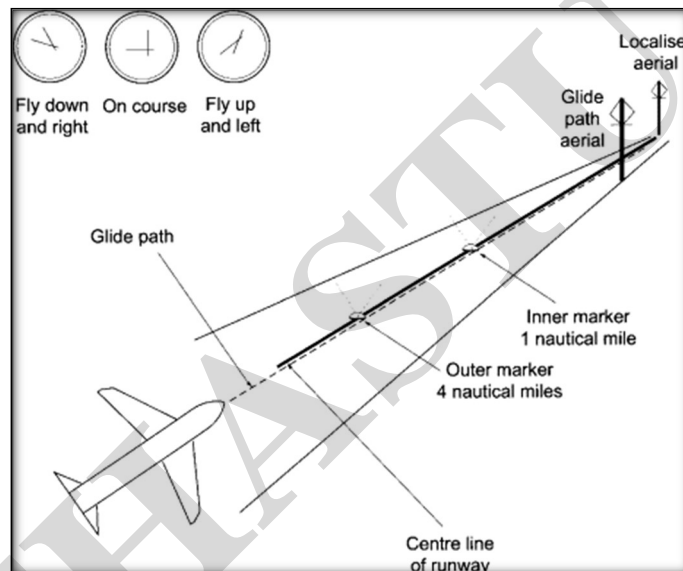
CAT II and CAT III: These offer **lower minimums for visibility** and decision height, with CAT III allowing for almost **zero visibility** landings in some cases.

About Instrument Landing System (ILS)

Purpose of ILS: The ILS is a specific **ground-based radio navigation system** that provides pilots with accurate information about their aircraft's glide path and alignment with the runway.

Azimuth Guidance: ILS provides **horizontal guidance** (azimuth) to pilots. Azimuth refers to the horizontal angle between a reference direction (the runway) and a line to the aircraft.

Vertical Descent Profile: ILS also provides the **correct vertical descent profile**, informing pilots whether the aircraft is too high or too low relative to the runway.



Components of the ILS

Localiser (LOC): The LOC antennae, typically located at the far end of the runway, transmit two narrow intersecting beams that guide the aircraft horizontally to the runway centerline.

Glide slope (GS): The GS antennae, usually located along the middle of the runway, transmit intersecting beams that provide the optimum vertical descent position.

Categories of ILS

Decision Height (DH) and Runway Visual Range (RVR): ILS approaches are categorised based on DH and RVR. DH is the lowest altitude a pilot can rely solely on ILS. The landing must be aborted if RVR is below a threshold at DH.

CAT IIIB Operations: Currently, six Indian airports (Delhi, Lucknow, Jaipur, Amritsar, Bengaluru, and Kolkata) are equipped to handle CAT IIIB operations.

Global Standards: Unlike India, some international airports like New York's John F. Kennedy Airport support CAT IIIC landings, which allow landings in zero visibility conditions.

Nanomaterial Coating

Context: Scientists have developed a **biodegradable, hydrophobic nanocoating** material that can slow the release of chemical fertilisers, boosting their efficiency and promoting sustainable agriculture.

This innovation aims to improve nutrient use efficiency, reduce fertiliser doses, and mitigate environmental impacts associated with excessive chemical fertiliser use.

Developed by the **Institute of Nano Science and Technology (INST), Mohali.**

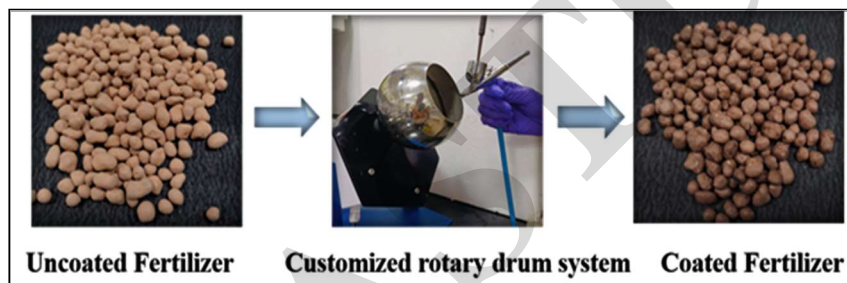
Mechanism of the Nanocoating

Hydrophobic Properties: By adjusting the hydrophobicity of the coating, researchers can control the release rate of nutrients to match the specific growth phases of crops.

Stable Coordination Bonds: The coating employs anionic clay as a reinforcement, forming stable coordination bonds that enhance mechanical stability and prevent premature nutrient release.

3D Nanostructure Advantage: The 3D structure of the natural polymers in the coating, including self-assembling amyloid fibrils, provides durability, biodegradability, and efficient nutrient encapsulation.

Key Benefits of the Nanocoated Fertiliser



Reduced Fertiliser Doses: The controlled-release system reduces the amount of fertiliser required without compromising crop yield.

Yield Enhancement: Studies show that the nanocoated fertiliser improves the yield of staple crops like rice and wheat, providing higher output from lower input.

Environmental Benefits: This technology reduces pollution by minimising fertiliser leaching, interacting with soil and water systems, and preserving soil health.

Life Cycle Assessment: The biodegradable nature of the coating ensures that no harmful residues are left in the soil.

Cost-Effective Solution: Reducing fertiliser doses directly benefits farmers by lowering input costs.

Institute of Nano Science and Technology (INST)

It is an autonomous institution established in 2013 under the Department of Science and Technology.

It was established under the umbrella of **Nano Mission** to boost research and development in the field of Nanoscience and Nanotechnology in India.

The aim is to generate processes, technologies and devices directed towards national priorities especially in sectors like Agriculture, defence, healthcare, energy, environment and water.



Silicon-Carbon Batteries

Context: Silicon-carbon batteries, used in new flagship Android smartphones, offer higher energy density and faster charging compared to traditional lithium-ion batteries.

What are Silicon-Carbon Batteries?

Silicon-carbon batteries are an advanced type of battery technology that uses a **silicon-carbon composite** for the **anode** instead of the traditional graphite used in lithium-ion batteries.

This allows for **higher energy storage capacity** and improved performance.

Difference Between Silicon and Lithium-Ion Batteries

Feature	Silicon-Carbon Batteries	Lithium-Ion Batteries
Anode Material	Silicon-carbon composite	Graphite
Energy Density	Higher energy density	Lower energy density
Charging Speed	Faster charging capabilities	Standard charging speed
Battery Life	Potential for reduced battery life due to silicon swelling	Generally stable battery life
Manufacturing Cost	Higher manufacturing costs	Lower manufacturing costs
Environmental Impact	More sustainable (silicon is abundant)	Less sustainable (limited resources for lithium and cobalt)

Storm Shadow and Oreshnik Missiles

Context: In the recent Ukraine-Russia war, Ukraine used **Storm Shadow missiles** against Russia, prompting Russia to retaliate with its **Oreshnik hypersonic missile**.

About Storm Shadow Missile

Naming: Known as '**Storm Shadow**' in the UK and '**SCALP-EG**' in France.

Type: Low-observable, long-range, air-launched cruise missile.

Development: Jointly developed by the UK and France.

Range: More than **250 kilometers**.

Target: Designed to strike high-value stationary targets such as airbases, radar installations, communication hubs, and port facilities.

Guidance Systems: Uses inertial navigation, GPS, and terrain referencing for low flight.

Targeting: Equipped with an infrared camera to match the target with a stored image.

Operated by: Eurofighter Typhoon, Rafale, Mirage 2000 and Tornado.

Service: Used by the air forces of Egypt, **India**, Italy, Greece, Saudi Arabia, Qatar, and UAE.



About Oreshnik Missiles

Type: Intermediate-range ballistic missile (IRBM).

Developed by: Russia.

Payload: Can carry both nuclear and conventional warheads.

Range: Estimated to have a range of around 5,500 kilometres.

First Use: Deployed in combat for the first time in 2024 during the Russo-Ukrainian War.

Based on: The RS-26 Rubezh intercontinental ballistic missile (ICBM).

Manoeuvrability: Hypersonic speeds and mid-flight manoeuvrability make it difficult to intercept.

Intercontinental Ballistic Missiles (ICBMs) are designed to deliver nuclear or conventional warheads over distances exceeding 5,500 kilometres, enabling them to strike targets across continents. In contrast, Intermediate-Range Ballistic Missiles (IRBMs) have ranges between 3,000 and 5,500 kilometres, making them suitable for regional deterrence and theatre-level operations.

ToxicPanda

Context: Cybersecurity researchers discovered a new Android malware (**ToxicPanda**) that aims to steal money from bank accounts. It targeted users in Southeast Asia.

It is a financial-focused trojan derived from an earlier malware family known as **TgToxic**.

It bypasses the bank's security measures by enforcing "identity verification and authentication, combined with behavioural detection techniques applied by banks to identify suspicious money transfers."

WOH G64 Star

Context: Scientists have captured a zoomed-in image of a star WOH G64 outside our galaxy for the first time. It is located in the **Large Magellanic Cloud (LMC)**, a small satellite galaxy of the Milky Way.

The image was captured using the **Very Large Telescope Interferometer (VLTi)** of the **European Southern Observatory (ESO)** in Chile. It consists of four **8-metre diameter telescopes**.

The VLTi incorporates an advanced interferometer called **GRAVITY**, which combines light from the telescopes, achieving the resolution equivalent to a much larger telescope.

Size: It's diameter is approximately 2,000 times that of the Sun.

Features: The star appears surrounded by an **egg-shaped cocoon** of gas and dust. This cocoon was likely formed when WOH G64 expelled its outer layers in recent years.

Current Stage: The star is in the **final stages of its lifecycle**, as indicated by the newly captured image.

Black Hole Triple System

Context: Scientists have identified a unique **black hole triple system** in space for the **first time**. The black hole, named **V404 Cygni**, was detected while analysing a collection of celestial observations.

Situated in the constellation **Cygnus**, **V404 Cygni** has a mass about **nine times that of our Sun**.



It may have formed through the “**direct collapse**” process, where the star caves in after expending all its fuel but does not explode.

About the Black Hole Triple System

It comprises a **black hole** at its **centre**, currently **consuming a small star** spiralling very close to it. There is also a **second star**, which appears to be circling the black hole but is actually **far away**.

Many black holes discovered until now have been part of **binary systems**, consisting of a black hole and a secondary object (such as a star or another black hole).

But the black hole triple not only has one star which orbits the black hole about every 6.5 days, but also a more far-off star which orbits it every 70,000 years.

Equine Piroplasmosis

Context: The Indian Council of Agricultural Research - National Research Centre on Equines (ICAR-NRC Equine) in Haryana has achieved the **status of a World Organisation for Animal Health (WOAH) Reference Laboratory** for Equine Piroplasmosis.

The Department of Animal Husbandry and Dairying (DAHD), which is part of the Ministry of Fisheries, Animal Husbandry, and Dairying, has facilitated this designation.

What are Equine Animals?

"Equine" refers to animals in the **horse family**, scientifically known as *Equidae*. This group includes Horses, Donkeys, Mules (hybrids of horses and donkeys), and Zebras.

In India, Uttar Pradesh, Rajasthan, Gujarat, and Haryana have the highest equine populations.

About Equine Piroplasmosis Disease

It is a **tick-borne disease** caused by **protozoan** parasites *Babesia caballi* and *Theileria equi*.

Transmission and Spread: The disease is spread by bites of **infected ticks**, which become infected when they ingest blood from an infected animal. It can also be spread through contaminated blood.

Indian Council for Agricultural Research

It is an **autonomous** organisation established in 1929 under the Department of Agricultural Research and Education (DARE), **Ministry of Agriculture and Farmers Welfare**.

Headquarter: New Delhi

It is an apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country.

Union Minister of Agriculture is the **ex-officio President** of the ICAR Society.

{Prelims – Sci – Bio – Diseases} Sjögren's Syndrome

Context: Sjogren's Syndrome was in the news recently.

Sjögren's Syndrome is an **autoimmune disease** where the immune system damages the glands that produce moisture. It is pronounced "**SHOW-gren's syndrome**."

Affected Areas: Long-term dryness on Eyes (Tears), Mouth (Saliva), Nose, Throat, Vagina.



Symptoms: Dry or itchy eyes, Dry mouth, sores, or thick saliva, Vaginal dryness, Dry skin, Dry nose and frequent nosebleeds, Dry throat and frequent coughing.

Causes: Exact cause is **unknown**. It can develop independently or triggered by other health conditions.

Risk Factors

Certain groups are more likely to develop Sjögren's Syndrome:

1. Women and those assigned female at birth (more than 90% of cases).
2. People with other autoimmune diseases.
3. People aged between 45 and 55.
4. Those with a biological relative who has Sjögren's Syndrome.

Complications

Increased risk of oral and eye infections.

Abnormal liver or kidney function.

Lymphomas (cancer in lymph nodes).

Lung issues that resemble pneumonia.

Neurological problems cause weakness or numbness.

Treatment of Sjögren's Syndrome

Managing Sjögren's syndrome focuses on alleviating symptoms, as there is **no cure**. Healthcare providers will tailor a treatment plan to **help minimise its impact** on daily life and improve overall quality of life.

Eye Dryness

Artificial Tears: To keep eyes moist, eye drops, prescription drops or lubricants may be recommended.

Punctal Plugs: An ophthalmologist can perform minor surgery to close some or all tear ducts, helping retain natural tears for a longer duration.

Mouth Dryness

Saliva Substitutes: Over-the-counter saliva supplements or prescriptions can help stimulate saliva production. Chewing gum and sipping water throughout the day.

Special Dental Products: Due to an increased risk of dental issues, more frequent cleanings, fluoride treatments, and prescription toothpaste or mouthwash may be necessary.

Vaginal Dryness

Vaginal Moisturisers/Lubricants: Over-the-counter or prescription lubricants can help maintain vaginal moisture daily or during sexual intercourse.

Hormone Therapy: Supplemental estrogen may be prescribed to address vaginal dryness resulting from hormonal imbalances.

Thai Sacbrood Virus

Context: The **Thai sacbrood virus** is one of the greatest threats facing the **Asiatic honey bee**.



About Thai Sacbrood Virus (TSBV)

It is a variant of **sacbrood virus (SBV)**, a **viral** disease affecting **honey bee colonies**.

First observed in **Thailand** in 1976. In **1991-92**, it destroyed more than 90% of the then-existing bee colonies in **south India** and reemerged in 2021 in **Telangana**. Also reported in **China** and **Vietnam**.

It kills bees when they are **larvae**, thereby reducing the population of bee colonies.

It causes an uneven brood pattern with **discoloured, sunken** or **perforated cappings** scattered throughout the brood.

About Asian Honeybee (*Apis cerana*)

It is primarily found in **South Asia**, including **India**, Sri Lanka, Nepal, and Southeast Asia, encompassing Thailand, Vietnam, and Indonesia.

It is one of the region's most domesticated bee species. Known for its resilience and adaptability, it plays an important role in **agriculture**.

They are known for their docile nature and effective colony defence mechanisms, including the ability to **thermoregulate their hives** by fanning their wings.

It produces highly valued honey for its medicinal properties and nutritional benefits.

*India hosts over 700 bee species, including four indigenous honeybees: Asiatic honey bee (*Apis cerana indica*), giant rock bee (*Apis dorsata*), dwarf honey bee (*Apis florea*), and stingless bee (*sp. Trigona*).*

Government Initiatives for Honey Bees Conservation

National Beekeeping & Honey Mission (NBHM)

Objective: Promote holistic growth of the beekeeping industry for income and employment generation, enhance agricultural/horticultural production, and develop infrastructural facilities.

Key Components: Setting up **Integrated Beekeeping Development Centres (IBDCs)**, honey testing labs, bee disease diagnostic labs, custom hiring centres, Api-therapy centres, nucleus stock development, and empowerment of women through beekeeping.

Madhukranti Portal

Objective: Facilitate online registration and support for beekeepers.

Features: Provides a platform for beekeepers to register, access resources, and receive support for beekeeping activities.

Honey FPOs (Farmer Producer Organizations)

Objective: Support enhancement of beekeepers' collective marketing and production capabilities.

Benefits: Helps beekeepers access better markets, improve production techniques, and increase income.

Candidatus Phytoplasma: Microbe Affecting Sesame Fields

Context: Researchers identified a new microbe **Candidatus Phytoplasma**, responsible for a peculiar disease affecting the sesame **fields** of Midnapore in **West Bengal**.

The disease causes sesame plants to revert from their flowering and fruiting stage to their vegetative state, with white flowers turning green.



Characteristics of Candidatus Phytoplasma

It is a **cell wall-lacking bacteria** produced in plants' nutrient-rich phloem and sieve cells.

These bacteria are transmitted primarily through **phloem feeder** insects (leafhoppers, plant-hoppers, psyllids, and dodders).

They infect many commercially valuable crops like *Catharanthus*, tobacco, maize, and grapevine causing disfigurement and virescence of floral parts.

Importance and Historical Background of Sesame

Sesame, often called the **Queen of Oil**, is one of the oldest oilseed crops, with remnants found in **Harappa** and **Mohenjodaro**.

It is highly valued for its **medicinal properties**, containing antioxidants that are beneficial for heart health.

Not commonly used as a **principal edible oil** in India.

IL-35-Immunotherapy

Context: **IL-35** (a specific **protein**), a new **immunotherapy treatment** that could help manage Type 1 and autoimmune diabetes, was discovered.

IL-35 works by:

Regulating immune cells called **macrophages**, T-cells, and regulatory B-cells play a role in controlling immune responses.

Preventing immune cells from attacking **pancreatic beta cells** is important for insulin production.

Lowering certain **immune cells** that produce inflammatory chemicals reduces inflammation in the pancreas — a major factor in type 1 and autoimmune diabetes.

Autoimmune Diabetes is type 1.5 diabetes that occurs when the body's immune system mistakenly attacks and destroys the insulin-producing cells in the pancreas.

Kodo Millet

Context: Ten wild elephants died in Madhya Pradesh's **Bandhavgarh Tiger Reserve**. The deaths were suspected to be caused by **mycotoxins** associated with **Kodo millet**.

What is Kodo Millet?

It is also known as **Kodra** and **Varagu** and is a **staple food** for many **tribals**.

It is grown in India, Pakistan, the Philippines, Indonesia, Vietnam, Thailand, and West Africa.

Major producer states: Madhya Pradesh, Gujarat, Karnataka, Chhattisgarh, and parts of Tamil Nadu.

Hardest crops: Drought-tolerant with high yield potential and excellent storage properties.

Nutritional benefits: Rich in vitamins and minerals, **gluten-free**, easy to digest, and a great source of antioxidants. It might have anti-carcinogenic properties and beneficial dietary fibre.

Why Do Kodo Millets Become Poisonous?

Environmental conditions: Spring and summer conditions can lead to fungal infections.



Fungal infection: Ergot, a **parasitic fungal endophyte**, grows in the ear heads of Kodo millet. **Mycotoxin cyclopiazonic acid (CPA)** is one of the mycotoxins associated with kodo millet seeds.

Mycotoxins are toxic substances produced by certain types of fungi (moulds) that grow on crops and foodstuffs under specific conditions.

Impact of Toxic Grain on Animals

Nervous and cardiovascular systems: Symptoms include vomiting, giddiness, unconsciousness, small and rapid pulse, cold extremities, shaking limbs, and tremors.

Liver dysfunction: Degeneration, necrosis, and lesions of the myocardium.

Gastrointestinal disorders: Inflammation and damage to the gastrointestinal tract.

Lucy – Oldest Human Fossil

Context: Fifty years after its discovery, the 3.2 million-year-old skeleton, **Lucy**, remains crucial for human evolution theory.

About the Lucy

Lucy is the **collection** of several hundred **pieces of bone fossils** representing 40 % of the skeleton of a female hominin species *Australopithecus afarensis*.

Discovered in 1974 in **Ethiopia**, Lucy is one of the **oldest** and **most complete** fossil skeletons of any adult, erect-walking human ancestor.

Lucy stood about 4 feet tall, and her **small brain size** was similar to that of a **chimpanzee**, but she walked upright on two legs, a key characteristic of human ancestors.

Lucy's discovery is important because her bones show a mix of human-like walking and ape-like features. Her nearly complete skeleton helps scientists learn about look & behaviour of our early ancestors.

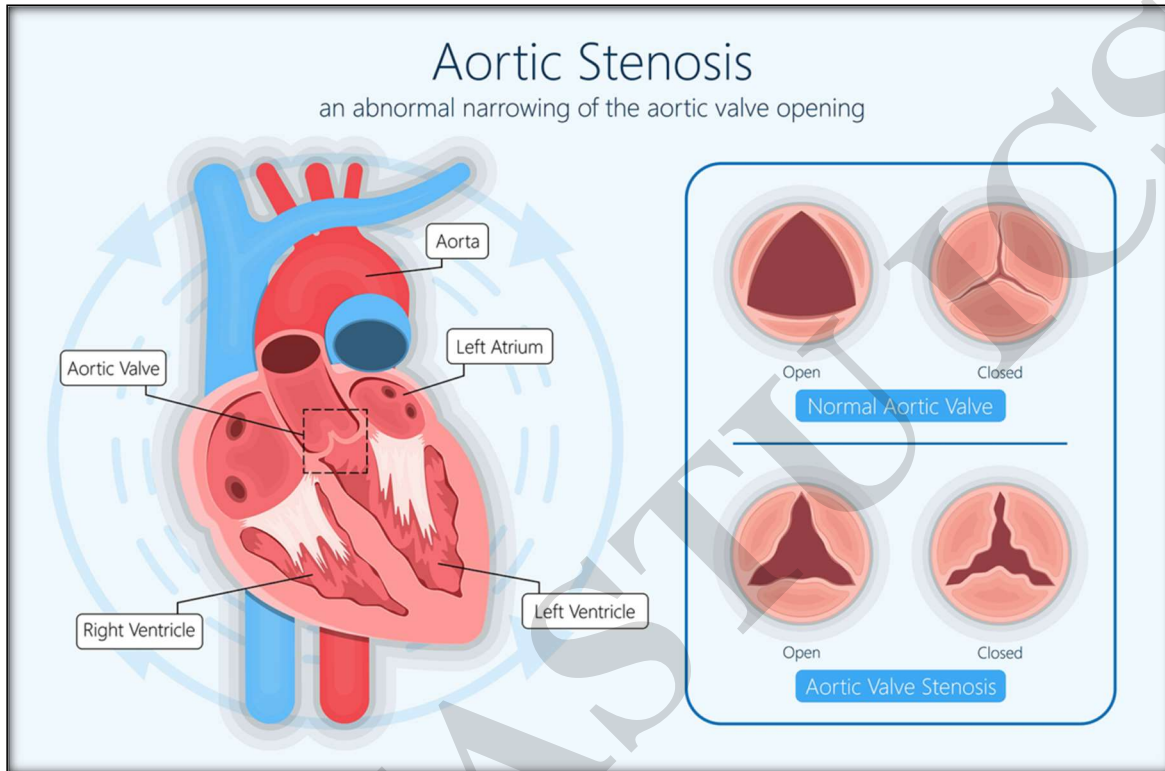
Stages of species in Human Evolution

Stage	Key Characteristics	Locations Found
Dryopithecus	Ancestors of humans and apes; lived in dense forests; likely herbivores.	China, Africa, Europe, India
Ramapithecus	Thick tooth enamel, strong jaws, shorter canines; used hands for food and defence; lived in grasslands.	Shivalik (Punjab), Africa, Saudi Arabia
Australopithecus	Lived on the ground; used stones as weapons; walked upright; 4 feet tall.	South Africa
Homo Erectus	Large brain capacity; used quartz tools; possibly used fire; lived in communities and caves.	Java, China
Homo Sapiens Neanderthalensis	Evolved from Homo Erectus; two sub-species; hunted large animals like mammoths.	Europe
Homo Sapiens Sapiens	Smaller jaws, pronounced chin, rounded skull; brain capacity ~1350 cc; started creating art.	Europe

Aortic Stenosis

Context: **Insulin resistance** can be a risk factor for **heart valve disease**, such as **aortic stenosis**.

The aortic valve is important for **maintaining blood flow** from the heart's lower left chamber (**left ventricle**) to the **aorta**, the primary artery delivering blood to the body.



When the aortic valve **narrows**, a condition known as **aortic stenosis**, blood flow becomes **restricted**.

Over time, the heart's left ventricle has to pump **harder to push blood** through the narrowed aortic valve.

This strain can cause the ventricle to thicken, enlarge, and weaken. If untreated, it can lead to heart failure.

Main Cause: Aortic stenosis is most commonly caused by **atherosclerosis**, where **calcium buildup** occurs on the aortic valve over time. These calcium deposits, often associated with ageing, make the valve tissue stiff, narrow, and unyielding.

Symptoms: Chest pain, fluttering heartbeat, Shortness of breath, dizziness or light-headedness, even fainting, Difficulty walking short distances.

Vitamin D Toxicity

Context: A study on the health and chemical profiles of hospitalised patients with **high calcium levels** found that **vitamin D toxicity** is one of the causes of the rise in such cases.

What is Vitamin D?

Vitamin D is a group of **fat-soluble secosteroids** responsible for increasing **intestinal absorption** of **calcium**, **magnesium**, and **phosphate**.



The most significant compounds in this group are **vitamin D3** (cholecalciferol) and **vitamin D2** (ergocalciferol). It is essential for **bone health**, **immune function**, and overall well-being.

Sources: Sunlight, Fatty fish, egg yolks, mushrooms, **cheese**, etc.

About Vitamin D toxicity

Vitamin D toxicity, also known as **hypervitaminosis D**, occurs when the body has excessively high levels of vitamin D. This condition can lead to **elevated calcium levels** in the blood, known as **hypercalcemia**.

Tolerable Upper Intake Levels (UL): The safe daily upper limit for vitamin D for most adults is **4,000 IU**. **Toxicity** is usually associated with intakes **exceeding 10,000 IU/day** over an extended period.

Symptoms: Nausea and vomiting, Weakness and fatigue, Frequent urination leading to dehydration, Confusion and disorientation, Bone pain, Kidney damage due to high calcium levels.

Excessive sun exposure doesn't cause vitamin D toxicity. Too much vitamin D from your diet alone rarely leads to vitamin D toxicity.

Treatment of Vitamin D Toxicity

Discontinuing vitamin D supplements.

Hydration to help flush out excess calcium.

Diuretics to increase urine production and reduce calcium levels.

Medications like **corticosteroids** to lower calcium levels.

Bayraktar Akinci

Context: Turkey has tested firing of **supersonic missile** from the **Bayraktar Akinci drone**.

Bayraktar Akinci is a **high-altitude long-endurance (HALE)** unmanned combat aerial vehicle (UCAV) manufactured by the Turkish defence company Baykar.

It is capable of conducting operations that are performed with fighter jets. It carries electronic support systems, dual satellite communication systems, air-to-air, collision avoidance & synthetic aperture radar.

It is equipped with **dual artificial intelligence avionics**, which supports signal processing, sensor fusion, and situational awareness in real-time. It can also be used in **air-to-ground & air-to-air** attack missions.

Other Features: Error-Resilient System Architecture, Cross-Redundant Ground Control Station, precise auto take-off and Landing with built-in Sensor Fusion, and Fully Autonomous Take-Off and Landing Independent of Ground Control Systems.

Conversion of Waste Heat to Electricity

Context: A **new material** with a high potential for **converting waste heat to energy** is developed by introducing **twisted layers** in **ferrecrystals** (a unique class of **misfit-layered compounds**).

Thermoelectric Energy Conversion

Thermoelectric energy conversion captures and converts **waste heat** from sources like industrial processes in chemical, thermal, steel plants, petroleum refineries, and vehicle exhaust **into electricity**.

The process is measured using the **thermoelectric figure of merit (ZT)**, which evaluates a material's efficiency in converting heat into electricity.

What are Misfit Layered Compounds (MLCs)?

MLCs are **2D superlattice** materials composed of **alternating layers** with distinct atomic structures.

They have weaker bonding along the stacking direction due to structural misalignment.

This misalignment results in a '**misfit**' between the layers, which weakens bonding along the stacking direction but can block heat transport due to rotational disorder between the layers.

Characteristics of Ferrecrystals

Ferrecrystals are a unique class of MLCs with rotational disorder between layers.

This twisting reduces heat conduction, making them excellent heat blockers.

These properties are particularly advantageous for thermoelectric applications.

***Two-dimensional (2D) Superlattice Materials** have alternating layers of two or more different structures, engineered at the atomic level, with each layer typically just a few atoms thick.*

Dark Comet

Context: NASA researchers have discovered more **dark comets**, **Oumuamua-like** objects. Oumuamua was the **first interstellar object** to enter our Solar System, discovered in **2017** by **NASA**.

A **dark comet** is a celestial object that looks like an **asteroid** but moves through space like a **comet**.

The new dark comets are discovered by the **Dark Energy Camera (DECam)** on a large telescope in Chile.

These are unlike typical comets, which are icy bodies that form glowing tails when approaching the Sun. Instead, dark comets **behave like comets but lack the bright tails**.

Dark comets are small & spin quickly, scattering gas and dust in all directions, making them hard to see.

It follows long, elliptical paths, coming close to sun before travelling back to outer regions of solar system.

There are two main groups of dark comets, **smaller ones** in the inner solar system and **larger ones** in the outer solar system.

Studying dark comets can provide insights into the early solar system, the origins of Earth's water and even the ingredients for life.



AgeXtend: AI-based Platform

Context: Researchers from Indraprastha Institute of Information Technology, Delhi, developed an **AI-based platform** named **AgeXtend** to identify **age-defying molecules** rapidly.



Efficiency in Identification: Compared to traditional research methods, it **reduces the time** required to identify viable molecules with **geroprotective** (age-defying) properties.

Identification of Molecules: Accurately identified benefits of known compounds, such as **metformin** (a diabetes drug) & **taurine** (an amino acid), even without prior knowledge of these compounds.

Predictive Capabilities: It uses AI to predict and identify compounds with anti-ageing properties, assess their safety, and understand their biological effects.

*Geroprotectors are substances that delay or reverse ageing processes, promoting healthspan and longevity. Examples include **metformin** (known for its anti-diabetic and longevity properties) and **rapamycin** (used in immunosuppression and ageing studies).*

Archaea

Context: Scientists have discovered the survival strategies of **Archaea**, ancient organisms that use **toxin-antitoxin (TA) systems to defend** against **harsh conditions**.

Archaea, meaning "**ancient things**" in Greek, are some of Earth's oldest life forms. Belongs to **Eukaryotes**.

TA systems are found in **bacteria** and **archaea**, indicating their importance in evolution, though their roles in archaea are not fully understood.

Key Points of the Research

The study examined the survival of **S. acidocaldarius**. This organism lives in **volcanic pools** heated to **90 °C** on Barren Island in the **Andaman and Nicobar** Islands and other volcanic regions worldwide.

During heat stress, a stress-activated protease (yet to be identified in archaea) breaks down the VapB4 protein, which inhibits the activity of the **VapC4 toxin**. Once VapB4 is degraded, the VapC4 toxin is released, preventing protein production.

This inhibition of protein production is part of a survival strategy, helping cells become "**permanent cells**" during stress. These permanent cells rest, conserve energy, and avoid making damaged proteins, aiding their survival until conditions improve.

DHARINI Brain Atlas

Context: IIT Madras researchers have unveiled a "**DHARINI**", a detailed **3D map** of five developing baby brains from the **second trimester**. It **explains** the **rapid growth** during this critical stage.

This **free-to-access** map is the **largest & only one** capturing the developing brain at such an early stage.

It can help to detect possible **brain disorders** like autism. Additionally, the findings could shed light on changes in the adult brain linked to **mental health conditions** such as **depression** or **bipolar disorder**.

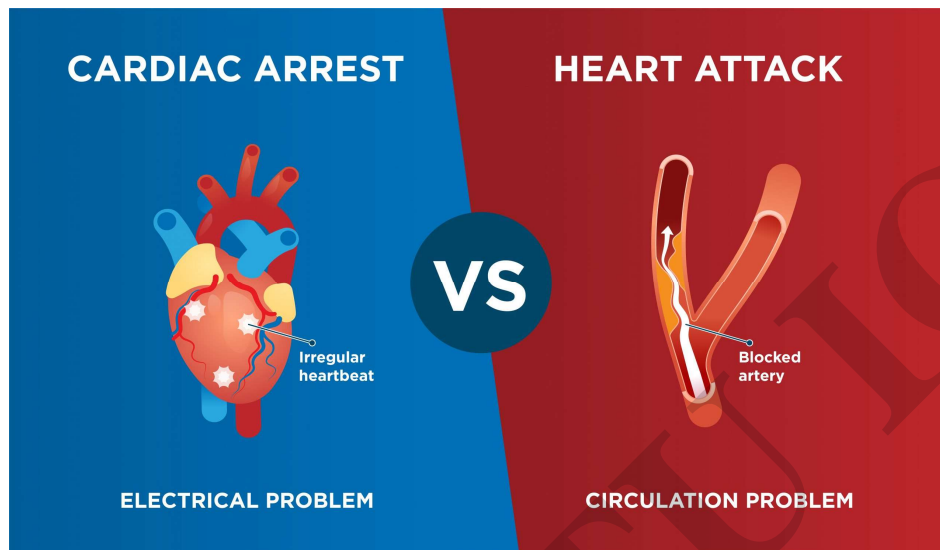
The only other publicly available brain atlas capturing the brain of an **adult woman** was released by the **US Allen Institute for Brain Science** in **2016**.

HOW THE BRAIN ATLAS WAS CREATED

- ▼ Researchers from IIT Madras used the brains of five still-borns in the second trimester – at weeks 14, 17, 21, 22, and 24 of pregnancy
- ▼ The brains were frozen and thinly sliced using complex robotic instrumentation
- ▼ These thin, transparent slices were then stained and microscopically imaged in extreme detail
- ▼ The digitised images were then put together to create a 3D map – offering a rare insight into the insides of a foetal brain

Difference Between Sudden Cardiac Arrest & Heart Attack

Context: A young Indian CEO dies of sudden cardiac arrest at the age of 42. His death sparked concerns about whether younger Indians are at risk.



Aspect	Sudden Cardiac Arrest	Heart Attack
Definition	A condition where the heart stops beating due to irregular heart rhythms (arrhythmia).	A condition caused by blockages or clotting in arteries that restrict blood flow to the heart.
Cause	A malfunction of heart's electrical system leads to ventricular fibrillation .	Plaque buildup or clot formation in coronary arteries.
Impact on the Heart	The heart cannot pump oxygenated blood; blood flow to brain is poor .	Damage to heart muscle due to restricted blood supply.
Time to React	Immediate action, such as CPR within 2 minutes is required to increase survival chances.	It can be identified with ECG changes and treated if admitted in time.
Symptoms	Sudden fainting, loss of consciousness, no warning.	Persistent discomfort in chest, jaw, neck; shortness of breath; weakness.
Fatal Timeframe	Fatal within 8 minutes without intervention; brain damage in 5 minutes.	Survival rate exceeds 90% if treated promptly.
Prevalence	Happens in asymptomatic individuals or those with a history of arrhythmias or structural heart issues.	Commonly linked to coronary artery disease with visible symptoms.

Dinga Dinga Virus

Context: The outbreak of the **Dinga Dinga virus** has affected women and girls in Uganda.

The illness is locally known as 'Dinga Dinga' (meaning '*shaking like dancing*'), and patients experience **high fever**, extreme weakness and **uncontrollable body shaking**.

The symptoms of Dinga Dinga are reminiscent of the **Dancing Plague of 1518**, where people in Strasbourg danced uncontrollably for days due to an unknown cause.

Cause: The exact cause of this virus remains **unknown**. Speculations range from viral infections to environmental factors, but no definitive cause has been identified yet.

Current Treatment: Health officials treat the illness with antibiotics, and most patients recover within a week of medical care.

Extrachromosomal DNA (ecDNA)

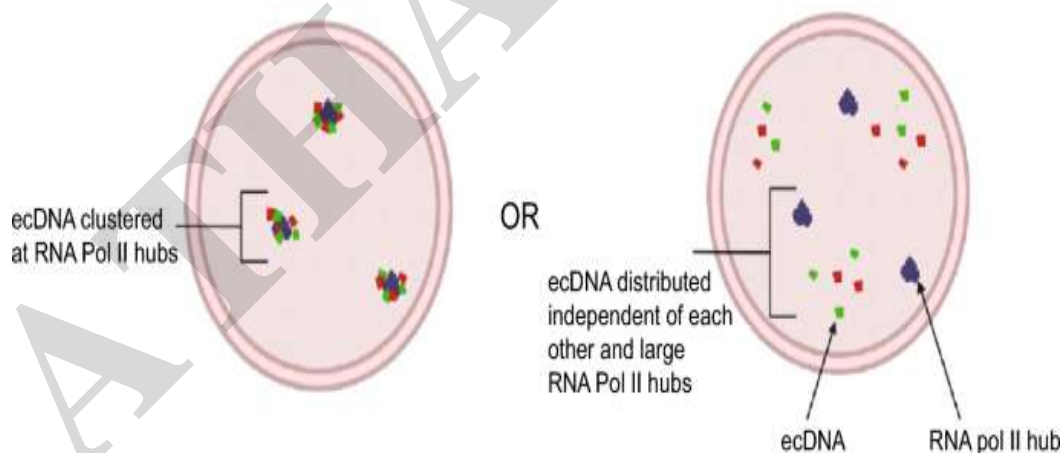
Context: A recent study has shown that **Extrachromosomal DNA (ecDNA)** is present in approximately **50% of cancer types** and is important in **tumour evolution** and **genetic heterogeneity**.

ecDNA are circular fragments of DNA **located outside chromosomes**, present in **nucleus of cancer cells**.

It contains **amplified oncogenes**, which drive cancer progression and form "hubs" to enhance oncogene expression, promoting tumour growth.

It is created by **DNA damage**, chromosomal rearrangements, or errors during cell replication.

It was first discovered in cancer cells about 50 years ago but was initially considered unimportant due to its low prevalence (1.4% of tumours). Advances in genomic techniques revealed its presence (40% of cancer cell lines and up to 90% of patient-derived brain tumour samples).



Recent Studies and Findings

Factors like **smoking**, exposure to certain substances, and genetic mutations can lead to **DNA damage** and the **formation of ecDNA**. It was found in **17% of tumour samples**, more prevalent in liposarcomas, brain tumours, & breast cancers.

Violation of Mendel's Law: **Mendel's Law** of Independent Assortment states that genes on different **chromosomes** are **inherited independently** and passed **randomly to offspring**.

Clustered Inheritance of Genes: ecDNA defies this law by grouping genes and transmitting them as clusters during cell division.

Neoantigens

Context: The Russian mRNA vaccine under development can be “personalised” based on the genetic analysis of each person’s tumour to identify mutations called **neoantigens**.

What are Neoantigens?

Neoantigens are **newly formed antigens** that arise from **mutations in cancer cells**. Unlike normal antigens, neoantigens are **unique to cancer cells** and not found in healthy cells.

This makes them **ideal targets** for **cancer immunotherapy** because they help the immune system recognise and attack cancer cells without harming normal tissue.

How do Neoantigens Work?

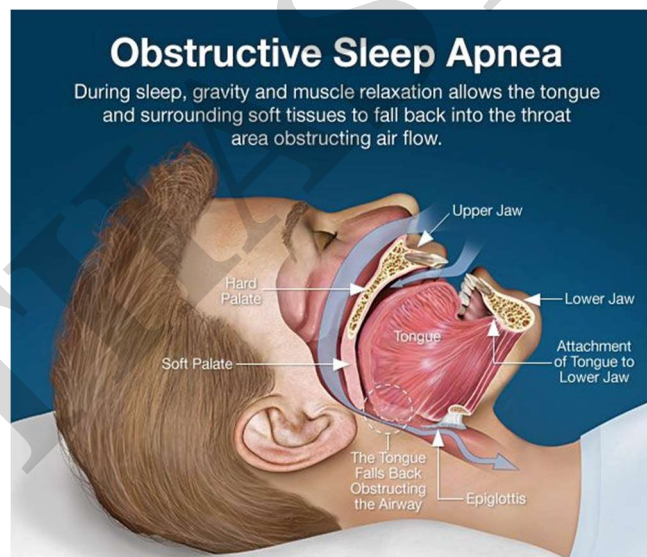
They are presented on the surface of cancer cells by molecules called **human leukocyte antigens (HLA)**.

When immune cells, such as T cells, recognise these neoantigens as “non-self,” they initiate an immune response specifically targeting the cancer cells.

Obstructive Sleep Apnea

Context: U.S. approves first drug treatment for obstructive sleep apnoea (OSA).

The drug Zepbound is approved for people who are obese or overweight and have a related health condition, such as type 2 diabetes, high cholesterol or high blood pressure.



Zepbound works by activating receptors of hormones secreted from the intestine to reduce appetite and food intake. Studies show that by reducing body weight, Zepbound also improves OSA.

About Obstructive Sleep Apnoea

It is a common **sleep disorder** that occurs when the **throat muscles relax** and **narrow the airway during sleep**, leading to interrupted breathing.

Symptoms: Frequent wakeups in the middle of the night, pauses in breathing while asleep, snoring, night sweats, feeling restless, and excessive daytime sleepiness.



Risk factors: Obesity, large neck size, being middle-aged or older, abnormalities in the head and neck's soft and bony tissue structure, developing high blood pressure, having a stroke or heart attack.

Treatment: Lifestyle changes, continuous positive airway pressure machine, oral appliances, surgery.

Hydroxymethanesulphonate

Context: A study reveals that aerosol particles in supercooled states during extreme winters enable the formation of **hydroxy-methane-sulphonate (HMS)**, a **component of PM2.5 particles**.

HMS is a **secondary aerosol**, a byproduct formed through the chemical interaction of **formaldehyde** and **sulfur dioxide** in the presence of **liquid water**, particularly in aerosol particles.

Factors that Promote Formation

Very low temperatures: **Supercooling** in extremely low temperatures (less than 30° C) allows **water to remain liquid**, a site for HMS formation.

Sulphate (SO₂⁴⁻) and ammonium (NH₄⁺): This comes from **sulphur dioxide** and other pollutants (mostly from **sulphur fuels**). At normal temperature, Ammonium ions in gaseous form balance the Sulphate ions. However, at lower temperatures, Ammonium ions cannot escape the liquid aerosol particles, providing a fertile site for HMS.

Environmental Impacts

Air pollution: HMS is a component of fine particulate matter (**PM2.5**), which worsens air quality.

Influences cloud formation: It affects the formation and properties of **clouds**, which can alter weather patterns and climate.

Radiative properties: Changes in cloud properties can influence the **Earth's radiative balance**, potentially impacting climate change.

Particle Pollution

Particle pollution, also known as **particulate matter (PM)**, is a mixture of **solid particles** and **liquid droplets** suspended in the air.

Categories of PM:

PM10 to 2.5: Particles with diameters ranging from 2.5 to 10 micrometres (µm).

PM2.5: Ultrafine particles with diameters less than 2.5 µm, capable of penetrating deep into the lungs, reducing lung function, aggravating asthma, etc.

Trichloroethylene (TCE) & Perchloroethylene (PCE)

Context: The **US Environmental Protection Agency (EPA)** announced **final bans** on manufacturing, processing, and using trichloroethylene and perchloroethylene.

Uses: Industry solvents, **stain removers**, degreasers, **dry cleaning**. These are linked to severe health issues like **kidney cancer**, **non-Hodgkin lymphoma**, **cardiac defects** and **bladder cancer**.

*The **Cancer Moonshot**, launched by then-US President Joe Biden, aims to prevent more than 4 million cancer deaths by 2047.*