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SCIENCE AND TECHNOLOGY

Volume - I

Current Affairs for Prelims 2026
(April 2025- September 2025)



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PREFACE

Concise Prelims Current Affairs 2026

Current Affairs-Sine QuaNon of UPSC Preparation

Proficiency in Current affairs is sine non qua for UPSC preparation. It is the basic foundation of any aspirant 's preparation. Knowledge and skill to relate current news with UPSC syllabus is quintessential part of the preparation.

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- Systematic segregation of monthly news in tandem with syllabus
- Contextual relation of topic in news with UPSC news.
- Brief and crisp explanation
- Extremely precise information which will make revision easy

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Space for Notes:

National Institute of Virology (NIV)

Why in News?

The National Institute of Virology (NIV) shared H5N1 genome data from a two-year-old girl with the GISAID database after facing criticism for delayed sharing, highlighting the need for timely data release.

Description:

- **Establishment:**
 - The National Institute of Virology (NIV) was established in **1952** in **Pune, Maharashtra**.
 - It was initially set up as the **Virus Research Centre (VRC)** under the **Indian Council of Medical Research (ICMR)**.
- **Function:** It is India's premier institute for **research in virology**, including work on **emerging viral infections, vaccine development, and diagnostic techniques**.
- **Role in COVID-19:** NIV played a key role during the **COVID-19 pandemic** by **isolating the SARS-CoV-2 virus**, developing **diagnostic kits**, and supporting the production of vaccines like **Covaxin** (with **Bharat Biotech**).
- **International Recognition:** NIV is designated as a **WHO Collaborating Centre for Arbovirus Reference and Research and High Containment Laboratory Operations**.
- **BSL-4 Laboratory:** NIV houses India's first **Biosafety Level-4 (BSL-4)** laboratory, capable of handling **high-risk pathogens** like the **Ebola virus**.

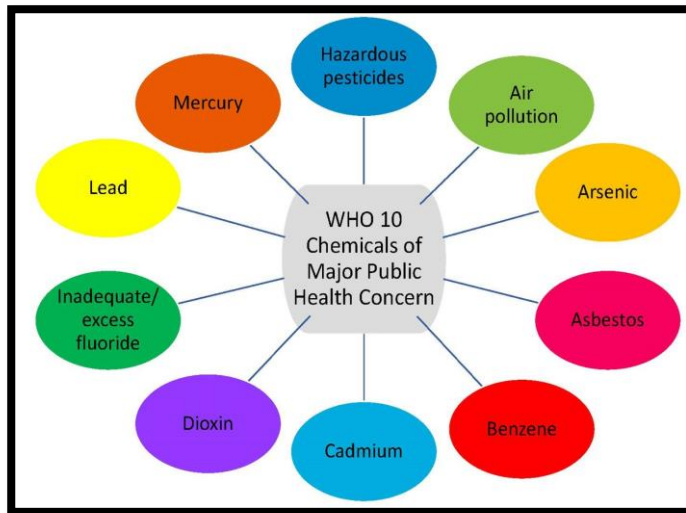
Lead Poisoning

Why in News?

Bangladesh faces a lead poisoning crisis due to informal battery recycling, affecting 35 million children, with severe health and economic consequences, prompting urgent regulatory action.

Description:

1. **Highly Toxic Metal:**
 - No safe level of exposure (**WHO**).
 - Affects nerves, blood, and organs.
2. **Severe Health Impacts:**
 - Causes **brain damage, anemia, and kidney failure**.
 - Leads to **developmental issues in children**.
3. **Common Sources:**
 - **Lead-based paints, contaminated water, batteries, and industrial waste**.
 - **Adulterated food** (e.g., turmeric with lead chromate).
4. **Global & Indian Impact:**
 - **1 in 3 children globally affected (UNICEF, 2020)**.
 - **275 million Indian children** have high blood lead levels.
 - **5% GDP loss in India** due to health & productivity impact.
5. **Regulations in India:**
 - **Leaded petrol banned (2000)**.
 - **FSSAI limits lead in food**.
 - **PVC pipes & battery recycling rules (2021-22)**.


Space for Notes:

Axiom-4 Mission (Ax-4)

Why in News?

Indian astronaut Shubhanshu Shukla will pilot the Axiom-4 mission to ISS in May 2025, becoming the first Indian in space in 40 years.

Description:

- **Ax-4** is the **fourth private astronaut mission** to the International Space Station (ISS).
- The mission is organized by **Axiom Space** in collaboration with **NASA**.
- The crew will launch aboard a **SpaceX Dragon spacecraft**.
- Launch site: **NASA's Kennedy Space Center, Florida**.
- Duration: The crew will spend **up to 14 days** aboard the ISS.
- **Mission activities** include:
 - **Scientific experiments**
 - **Technology demonstrations**
 - **Educational outreach**
- **Research areas:**
 - **Materials science**
 - **Biology**
 - **Earth observation**
 - **Other innovative fields**
- The mission will send the **first Indian astronaut** to the ISS, as part of a joint effort between **NASA and ISRO**.
- It also includes the **first astronauts from Poland and Hungary** to stay aboard the ISS.

CDS says 'military doctrine' to be out in three months

Why in News?

Chief of Defence Staff (CDS) General Anil Chauhan announced that India is working on a "military space doctrine", likely to be released in 2–3 months.

Description:

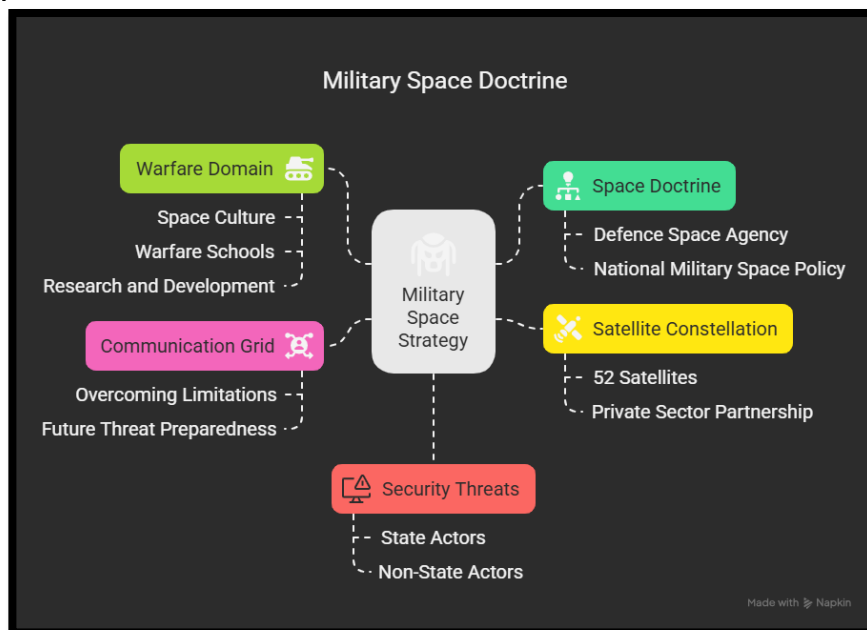
- **Military Space Doctrine:**
 - Being developed by the Defence Space Agency, that will provide strategic direction for space as a domain of warfare.
 - Accompanied by a National Military Space Policy.

Space for Notes:

- Space as a Warfare Domain:
 - CDS highlighted the emergence of space as a new domain of warfare.
 - Emphasised the need for:
 - Developing a “space culture”.
 - Establishing dedicated warfare schools.
 - Conducting research and doctrinal development.
- 52-Satellite Constellation:
 - Govt. has approved a constellation of 52 satellites for defence.
 - 31 satellites to be built by the private sector.
 - To be used for: Intelligence, Surveillance and Reconnaissance
 - Partnership between ISRO and private sector.
- Satellite Communication Grid:
 - Being developed to overcome current limitations.
 - Aims to prepare for future threats and improve communication infrastructure.
- Security Threats:
 - Military space operations are key to identifying threats from:
 - State and non-state actors
 - Threats may go beyond space-based vulnerabilities

Background context:

- The Defence Space Agency (DSA) was set up in 2019 as a tri-services agency.
- Space is increasingly being recognized as the fifth domain of warfare, after land, air, sea, and cyber.


Digital Arrest
Why in News?

Operation Chakra V is in the news because the CBI recently arrested four individuals involved in a large-scale digital arrest scam. This action was part of a nationwide crackdown on cyber frauds, during which 12 locations across 5 states were searched. One victim was extorted of ₹7.67 crore, highlighting the growing threat of online financial frauds and the need for stronger cyber vigilance.

Description:

- Digital Arrest is a new cybercrime tactic where fraudsters impersonate law enforcement officials (e.g., police, CBI) and trick victims into believing they've committed a serious crime. The criminals may claim the victim is under 'digital arrest' and force them to remain visible on video platforms until they pay a ransom. Victims are often told they must self-quarantine or remain at home until payment is made.

Preventive Measures:

- **Cyber Hygiene:** Regularly update passwords, software, and enable two-factor authentication.
- **Avoid Phishing:** Don't click on suspicious links or download unknown attachments.
- **Secure Devices:** Use antivirus software, and keep systems up to date.
- **VPNs:** Use trusted VPNs for secure connections and avoid free ones.
- **Secure Communication:** Encrypt sensitive communications and avoid sharing personal information publicly.
- **Awareness:** Increase public awareness about these scams to prevent falling victim.



Space for Notes:

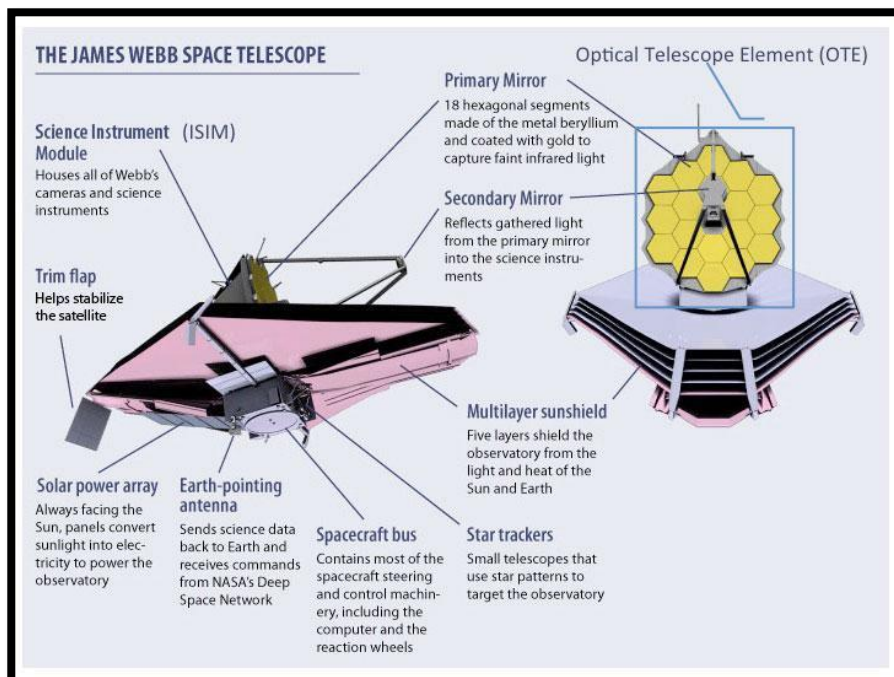
James Webb Space Telescope (JWST):

Why in News?

Scientists using the James Webb Telescope detected dimethyl sulfide (DMS) on exoplanet K2-18 b, a potential biosignature gas, marking the strongest indication of possible life beyond Earth.

Description:

- **Launch and Collaboration:** JWST was launched on December 25, 2021 and is a collaborative project by NASA, the European Space Agency (ESA), and the Canadian Space Agency (CSA).
- **Infrared Observation:** JWST is optimized for infrared astronomy, allowing it to detect the faint light from the earliest galaxies, stars, and exoplanets.
- **Advanced Design Features:** It has a 6.5-meter segmented primary mirror made of 18 gold-coated beryllium segments, and a five-layer sunshield to maintain cryogenic temperatures (~40 Kelvin) essential for infrared observation.
- **Orbit Location:** JWST is positioned at the Sun-Earth Lagrange Point 2 (L2), about 1.5 million km from Earth, providing stable and uninterrupted views of space.
- **Key Scientific Objectives:** Its goals include studying galaxies formed after the Big Bang, evolution of galaxies, star and planet formation, and exploring exoplanets for signs of life.



Ice-Nucleating Particles (INPs)

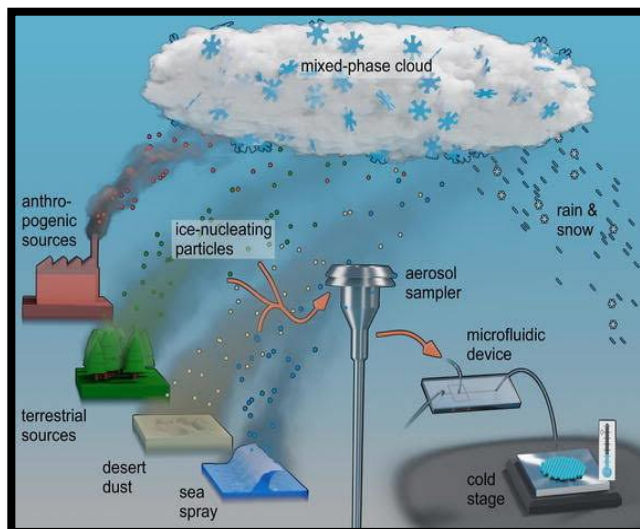
Space for Notes:

Why in News?

India's first atmospheric monitoring station to study cloud formation has been established in Udhampur, Jammu & Kashmir, to improve understanding of Ice Nucleating Particles (INPs) and enhance rainfall predictions.

Description:

- **Definition:** Ice-Nucleating Particles (INPs) are microscopic particles that act as "seeds" for ice crystal formation in clouds at sub-zero temperatures.
- **Importance in Climate:** INPs influence cloud formation, precipitation patterns, and radiation balance, thereby playing a key role in regional and global climate modelling.
- **Sources:** They originate from both **natural sources** (like dust, plant debris, sea spray) and **anthropogenic sources** (like industrial emissions and biomass burning).
- **ICE-CRUNCH Project:** The Indo-Swiss ICE-CRUNCH initiative at Nathatop aims to study INPs and Cloud Condensation Nuclei (CCN) to improve understanding of atmospheric processes in the North-Western Himalayas.
- **Significance for India:** Understanding INPs is crucial for monsoon prediction, glacier dynamics, and climate adaptation strategies, especially in sensitive Himalayan ecosystems.



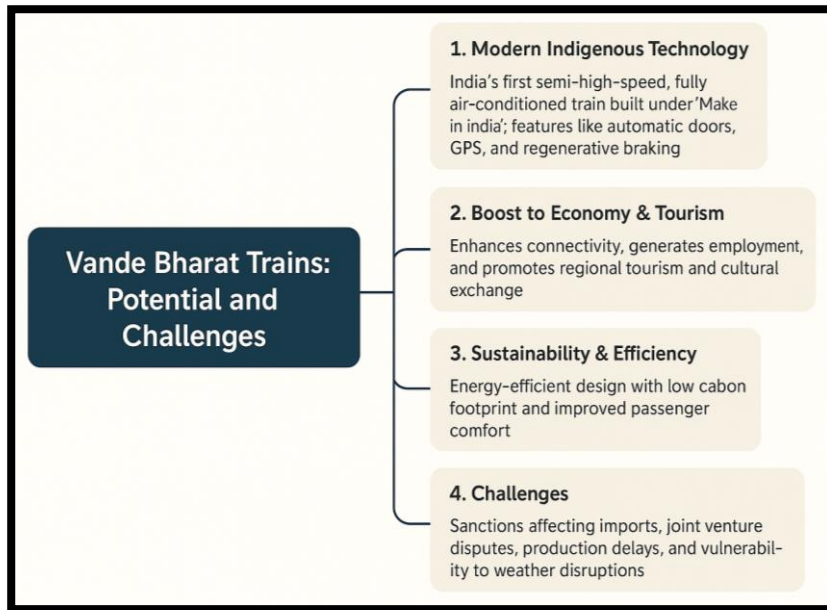
Vande Bharat Trains

Why in News?

A safety report by the Commissioner of Railway Safety highlights that Vande Bharat trains are vulnerable to accidents from cattle run-overs due to lighter front coaches. It recommends fencing and safety upgrades. Despite concerns, officials defend the train's design, asserting it meets global standards and remains safe for operation.

Description:

- **Modern Indigenous Technology:** India's first semi-high-speed, fully air-conditioned train built under 'Make in India'; features like automatic doors, GPS, and regenerative braking.
- **Boost to Economy & Tourism:** Enhances connectivity, generates employment, and promotes regional tourism and cultural exchange.
- **Sustainability & Efficiency:** Energy-efficient design with low carbon footprint and improved passenger comfort.
- **Challenges:** Sanctions affecting imports, joint venture disputes, production delays, and vulnerability to weather disruptions.
- **Way Forward:** Resolve JV issues, diversify supply chains, train skilled workforce, and use data analytics for efficient route planning.


Space for Notes:

Anti-Satellite Weapons (ASAT)

Why in News?

India and the EU are exploring collaboration on space policy, focusing on responsible behaviour, regulating ASAT and RPO threats, and developing a global framework to ensure satellite safety and space security.

Description:

1. **India's Mission Shakti (2019):** India became the **fourth country** (after the USA, Russia, and China) to successfully demonstrate ASAT capability by destroying a satellite in **low Earth orbit**.
2. **Two Main Types:** ASATs are classified into **kinetic** (physical destruction using missiles or collisions) and **non-kinetic** (cyber-attacks, jamming, lasers) methods.
3. **Global Players:**
 - **USA:** Bold Orion air-launched ballistic missile
 - **Russia:** Nudol missile
 - **China:** SC-19 ASAT missile
 - **India:** Developed its own ASAT missile for Mission Shakti
4. **Strategic Importance:** ASAT weapons help in **national security, deterrence**, and the **protection of critical satellite infrastructure**.
5. **Ground, Air, and Space-Based:** ASATs can be launched from **land installations, aircraft**, or even **space platforms**, depending on the system design.

Remote Sensing

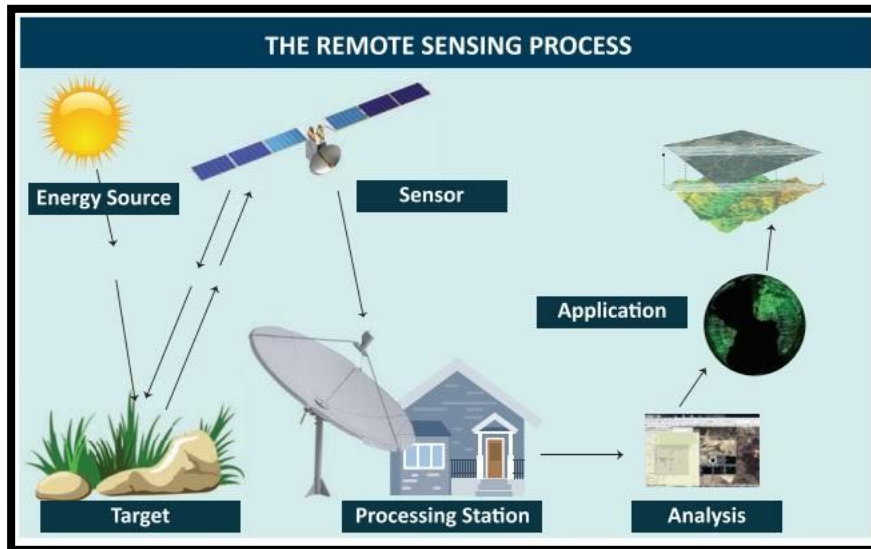
Why in News?

ISRO, using its CROP framework and satellites like EOS-04 and RISAT-1A, forecasted India's wheat production at 122.724 million tonnes for 2025, enhancing crop monitoring during the Rabi season.

Description:

1. **ISRO's CROP Framework:** ISRO's Comprehensive Remote Sensing Observation on Crop Progress (CROP) uses satellites like EOS-04, EOS-06, and RISAT-1A with Synthetic Aperture Radar (SAR) to monitor wheat production and crop health in real-time during the Rabi season.
2. **Types of Remote Sensors:**
 - **Passive Sensors:** Detect natural energy (e.g. reflected sunlight).
 - **Active Sensors:** Emit their own signal (e.g. SAR) and measure reflections – used in satellites like RISAT.

3. **Remote Sensing Process Steps:** Involves energy source (Sun), interaction with target, sensor detection, data transmission, image processing, and application in fields like agriculture, ocean monitoring, disaster management, etc.
4. **India's Remote Sensing Institutions:**
 - NRSC (National Remote Sensing Centre) for data acquisition and processing.
 - IIRS (Indian Institute of Remote Sensing) under ISRO for training and research.
5. **Applications in Agriculture & Environment:**
 - Crop area estimation, yield forecasting, soil moisture analysis, greenhouse gas tracking, and mapping chlorophyll content.

Space for Notes:


SpaDeX Mission (Space Docking Experiment)

Why in News?

ISRO successfully completed the second docking of its satellites SDX01 and SDX02 under the SpaDeX mission, making India the fourth nation to achieve satellite docking in space.

Description:

About SpaDeX:

- **Type:** Technology demonstration mission by ISRO
- **Purpose:** To demonstrate and validate:
 - Spacecraft rendezvous, docking, and undocking in low-Earth orbit (LEO)

Launch Details:

- **Launch Vehicle:** PSLV-C60
- **Launch Date:** 30 December 2024
- **Orbit:** 460 km circular orbit, 45° inclination
- **Satellite Mass:** ~220 kg each

Objectives:

Primary Objective:

- Demonstrate autonomous docking and undocking capability in orbit

Secondary Objectives:

- Transfer of electric power between docked spacecraft
- Test composite spacecraft control systems
- Conduct payload operations after undocking

Significance:

- India becomes the 4th country to demonstrate satellite docking (after USA, Russia, and China)
- Paves the way for:
 - Human spaceflight
 - Sample return missions
 - Building and operating an Indian space station

Rafale M jets

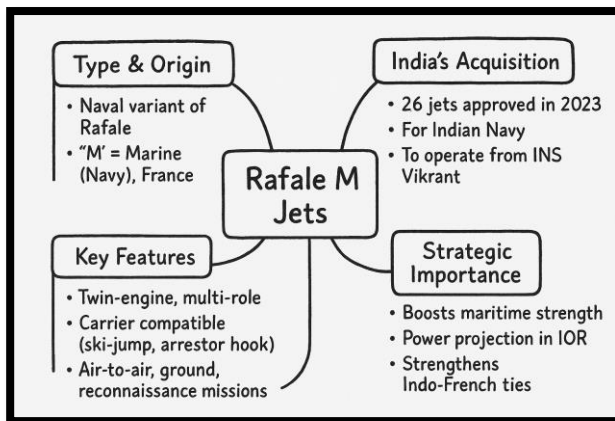
Space for Notes:

Why in News?

The government approved a ₹63,000-crore deal to procure 26 Rafale-M jets from France for the Indian Navy, enhancing carrier-based air power ahead of indigenous fighter induction.

Description:

- **Naval Variant:** Rafale M is the carrier-based version of the French Rafale fighter jet, designed for operations from aircraft carriers.
- **Manufactured by:** Dassault Aviation, France; "M" stands for "Marine" (Navy in French).
- **India's Deal:** India approved the purchase of **26 Rafale M jets** in 2023 for the Indian Navy to be deployed on **INS Vikrant**.
- **Key Features:** Twin-engine, multi-role fighter capable of air-to-air, air-to-ground, and reconnaissance missions; compatible with ski-jump launches and arrestor hooks.
- **Strategic Importance:** Enhances India's maritime combat power, supports Make in India through offsets, and strengthens Indo-French defense ties.



Indian Navy's Maiden Initiatives: IOS Sagar & AIKEYME

Why in News?

India and African nations began the inaugural AI-KEYME maritime exercise off Tanzania to enhance regional maritime security, interoperability, and cooperation, aligning with India's MAHASAGAR vision.

Description:

Objective:

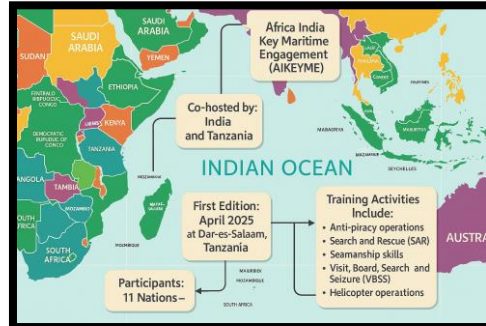
- To strengthen the Indian Navy's role as the 'Preferred Security Partner' and 'First Responder' in the Indian Ocean Region (IOR).
- To promote the vision of **MAHASAGAR** – Mutual and Holistic Advancement for Security Across the Regions.

Indian Ocean Ship (IOS) Sagar:	Africa India Key Maritime Engagement (AIKEYME):
• Ship Involved: INS Sunayna (Offshore Patrol Vessel). • Deployment Area: Southwest Indian Ocean Region. • Joint Crew: Includes personnel from India and nine Friendly Foreign Countries: ◦ Comoros, Kenya, Madagascar, Maldives, Mauritius, Mozambique, Seychelles, Sri Lanka, South Africa.	• Co-hosted by: India and Tanzania. • First Edition: April 2025 at Dar-es-Salaam, Tanzania. • Participants: 11 Nations – ◦ India, Tanzania, Comoros, Djibouti, Eritrea, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa. • Training Activities Include: ◦ Anti-piracy operations

Space for Notes:

- **Ports to be Visited:**
 - Dar-es-Salaam (Tanzania)
 - Nacala (Mozambique)
 - Port Louis (Mauritius)
 - Port Victoria (Seychelles)
 - Male (Maldives)
- **Mission Objective:** Conduct joint surveillance of Exclusive Economic Zones (EEZs).
- **Link to AIKEYME:** Participants will witness harbour phase activities of Exercise AIKEYME at Dar-es-Salaam.

- Search and Rescue (SAR)
- Seamanship skills
- Visit, Board, Search and Seizure (VBSS)
- Helicopter operations


DRDO's Mk-II(A) Laser-Directed Energy Weapon (DEW) System
Why in News?

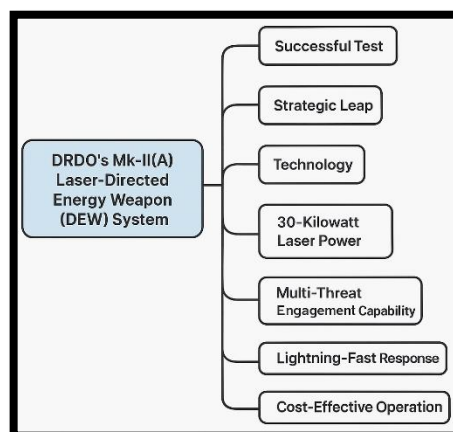
DRDO successfully tested the indigenously developed Mk-II(A) Laser-Directed Energy Weapon at the National Open Air Range in Kurnool, Andhra Pradesh, marking India's entry into elite laser weapon nations.

Description:

- **Successful Test:** Conducted on April 13, 2025, at the National Open Air Range, Kurnool.
- **Strategic Leap:** Places India among a select group of nations with advanced directed-energy weapon capabilities.
- **Technology:** Uses high-energy laser beams to neutralize aerial threats with speed and precision.

Key Features:

- **30-Kilowatt Laser Power:**
 - Delivers structural damage by cutting through materials.
 - Disables critical components like warheads and sensors.
- **Multi-Threat Engagement Capability:**
 - Neutralizes:
 - Fixed-wing drones
 - Swarm drones
 - Helicopters
 - Missiles
 - Surveillance systems
 - Effective Range: Up to 5 km.
- **Lightning-Fast Response:**
 - Engages and disables targets at the speed of light.
 - Achieves results within seconds.
- **Cost-Effective Operation:**
 - Costs comparable to a couple of litres of petrol per use.
 - Far cheaper than traditional missile-based defence systems.


Balikatan Exercise
Why in News?

The Balikatan Exercise 2025 is in news as 14,000 U.S. and Filipino troops begin joint live-fire military drills in the South China Sea to counter regional threats and strengthen defense ties.

Description:

- **Balikatan** means "shoulder-to-shoulder" in Tagalog, symbolizing military cooperation.
- It is an **annual joint military exercise** between the **United States and the Philippines**.
- The **2025 edition** is scheduled from **April 21 to May 9**, involving **14,000 troops** (9,000 U.S. and 5,000 Filipino).
- The drills include **live-fire exercises**, air, navy, and ground operations, and focus on **battle readiness and regional security**.
- Other countries like **Australia and Japan** are also participating, showcasing **multinational defense cooperation in the Indo-Pacific**.


Space for Notes:
INS Surat
Why in News?

Tensions rose after the Pahalgam terror attack; India's Navy tested a missile from INS Surat. Both Indian and Pakistani militaries are on high alert amid fears of escalation.

Description:

- INS Surat is the **fourth and final stealth guided missile destroyer** under **Project 15B**.
- Follows **INS Visakhapatnam**, **INS Mormugao**, and **INS Imphal**.
- An advanced version of **Kolkata-class destroyers** from **Project 15A**.

Key Features of INS Surat:

- India's first **AI-enabled warship**.
- Incorporates **indigenous AI solutions** for better operational efficiency.

Specifications:

- **Displacement:** 7,400 tonnes.
- **Length:** 164 metres.
- **Speed:** Over 30 knots (56 km/h) during sea trials.

Armaments and Capabilities:

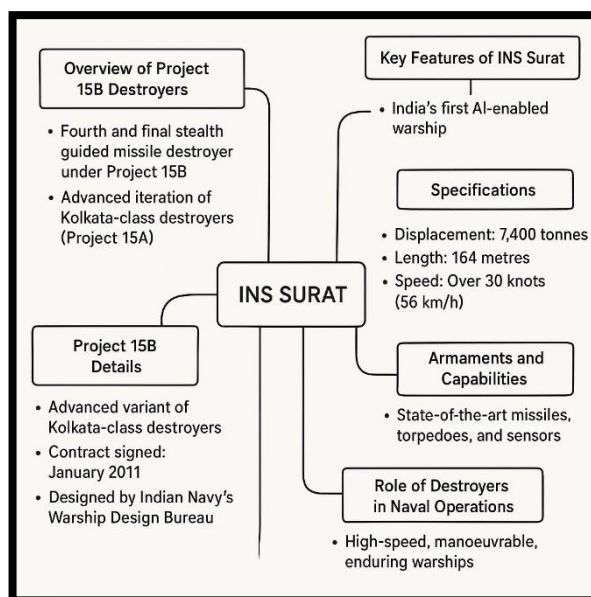
- Equipped with:
 - **Surface-to-air missiles**
 - **Anti-ship missiles**
 - **Torpedoes**
 - **Modern sensors for network-centric warfare**

Project 15B Details:

- Advanced variant of **Kolkata-class destroyers** (Project 15A).
- **Contract signed:** January 2011.
- **Designed by the Indian Navy's Warship Design Bureau.**
- **Built by Mazagon Dock Shipbuilders Ltd (MDL).**
- Named after **major Indian cities** representing four corners of the country.

Role of Destroyers in Naval Operations:

- **High-speed, manoeuvrable, and endurance-rich warships.**
- **Critical for offensive operations and network-centric warfare.**
- Enable integration of force elements using **advanced IT and communication systems**.



Space for Notes:

INS SURAT



Is the **fourth and last ship of Project 15B Destroyers**, the next generation stealth guided missile destroyers of the Navy

It is named after **Gujarat's commercial capital Surat**, which is the second largest commercial hub of western India after Mumbai

It's overall length is **163 METRE** and displacement of over **7,400 TONNE**

The ship has been built using **block construction methodology** that involves hull construction in two different locations and then joint together at one hub

It is likely to be **commissioned in 2024**



Pegasus spyware

Why in News?

The Supreme Court questioned petitioners on whether using Pegasus spyware for national security against anti-national elements is wrong, emphasizing the importance of knowing who it was used against.

Description:

- **Pegasus spyware** is a highly invasive surveillance tool developed by the **Israeli cyber-intelligence firm NSO Group**, designed to infiltrate smartphones and extract data without user consent.
- It uses "**zero-click**" and "**zero-day**" **vulnerabilities** to install itself without any interaction from the device owner, often through apps like WhatsApp, iMessage, or FaceTime.
- **NSO Group** claims it sells Pegasus only to government agencies for fighting terrorism and serious crime, but it has been allegedly used against **journalists, activists, and political leaders**.
- **Amnesty International** and investigative reports have linked Pegasus to surveillance in countries like **India, Saudi Arabia, Mexico, Morocco, and Hungary**, raising privacy and human rights concerns.
- In India, cybersecurity is governed by frameworks like the **Information Technology Act, 2000, National Cyber Security Strategy**, and the **Cyber Surakshit Bharat** initiative, with **CERT-In** as the key response agency.

Space for Notes:

Cyber Threat	Description
Malware	Malicious software designed to harm or exploit systems by infecting, disrupting, or gaining unauthorized access.
Phishing	Deceptive attempts to acquire sensitive information, often through fake emails, websites, or messages impersonating trusted entities.
Ransomware	Encrypts data and demands payment (usually in cryptocurrency) for its release, posing significant threats to data integrity.
DDoS Attacks	Overwhelms a system with a flood of traffic, causing service disruption by exhausting resources or bandwidth.
Man-in-the-Middle (MitM)	Intercepts and potentially alters communication between two parties, leading to unauthorized access or information theft.
SQL Injection	Exploits vulnerabilities in SQL databases by injecting malicious code, allowing unauthorized access or data manipulation.
Zero-Day Exploits	Attacks targeting undiscovered vulnerabilities in software before developers can create a patch, posing a serious and often potent threat.
Social Engineering	Manipulating individuals into divulging sensitive information through psychological manipulation or deception.
Insider Threats	Risks originating from individuals within an organization, either intentionally or unintentionally causing harm or data breaches.
Advanced Persistent Threats (APTs)	Prolonged and targeted cyber attacks often linked to espionage, aiming to infiltrate and remain undetected in a network.
Cross-Site Scripting (XSS)	Injects malicious scripts into web pages viewed by others, potentially compromising the security and privacy of users.
Credential Stuffing	Uses stolen usernames and passwords from one breach to gain unauthorized access to other accounts due to individuals reusing passwords.
Internet of Things (IoT) Threats	Exploits vulnerabilities in connected devices, potentially allowing unauthorized access or disruption of IoT networks.
Cryptojacking	Unauthorized use of a computer's resources for cryptocurrency mining, slowing down systems and consuming energy without the user's consent.
Wi-Fi Eavesdropping	Unauthorized interception of wireless communication, where attackers may capture sensitive data transmitted over Wi-Fi networks.

National Council of Science Museums (NCSM)

Why in News?

Saroj Ghose, father of India's science museum movement and former NCSM Director-General, passed away at 89. He played a key role in decentralizing science education via interactive museums.

Description:

- **Established:** 1978, based on Planning Commission Task Force recommendations (early 1970s).
- **Under:** Ministry of Culture, Government of India.
- **HQ:** Kolkata.
- **Autonomous body** engaged in science communication and education.

Background:

- **First Science Museum:** Birla Industrial and Technological Museum (BITM), Kolkata (1959) under CSIR.
- **Second:** Visvesvaraya Industrial & Technological Museum (VITM), Bangalore (1965).
- Both delinked from CSIR in 1978 to form NCSM.

Network:

- **Largest network of science centre's/museums globally.**
- **National-level centres:** Kolkata, Bangalore, Mumbai, Delhi.
- **Total museums:** 26 (6 National, 11 Regional, 9 Sub-regional/District level).

Objectives:

- Portray growth & applications of science & technology.
- Preserve historic scientific artifacts.
- Design and develop science exhibits & educational aids.
- Popularize science in rural and urban areas via exhibitions, lectures, camps, etc.
- Supplement school science education through out-of-school activities.
- Organize training for teachers, students, entrepreneurs, handicapped, housewives, etc.

Key Features:

- **Two-way communication:** Interactive exhibits & participatory activities.
- **Mobile Science Exhibitions:** 23 units operate nationwide to spread science in rural areas.


Tuberculosis (TB)
Why in News?

TB Elimination Campaign: PM Modi emphasized a “whole-of-government and society” approach to eliminate TB by 2025, reviewing progress of the National TB Elimination Programme (NTEP).

Space for Notes:

Description:
1. Cause & Type:

- **Bacterial disease** caused by **Mycobacterium tuberculosis**.
- Primarily affects the **lungs** (Pulmonary TB) but can affect other organs too (Extrapulmonary TB).

2. India's TB Burden:

- India has the **highest TB burden in the world**.
- As per **Global TB Report 2023 (WHO)**, India accounts for approximately **28% of global TB cases**.

3. Government Initiatives:

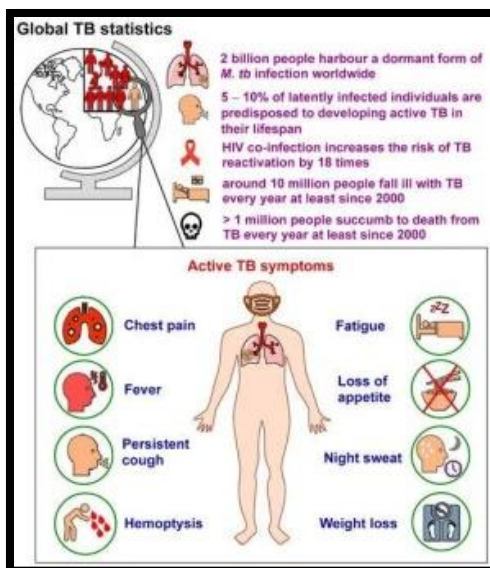
- **National Tuberculosis Elimination Programme (NTEP)** aims to eliminate TB in India by **2025** (5 years ahead of the global SDG target of 2030).
- Previously called **Revised National TB Control Programme (RNTCP)**.

4. Diagnosis & Treatment:

- Diagnosis through **Sputum test**, **CBNAAT (GeneXpert)**, and **Chest X-ray**.
- Treated with **Directly Observed Treatment Short-course (DOTS)** using anti-TB drugs (like Rifampicin, Isoniazid).

5. Nikshay Portal & Poshan Yojana:

- **Nikshay Portal**: Digital platform to track TB patients and treatment.
- **Nikshay Poshan Yojana**: Provides **nutritional support (Rs 500 per month)** to TB patients during treatment.


Germanium
Why in News?

India is engaging with China over export restrictions on germanium, a critical mineral for semiconductors and optics, after Indian industries raised concerns about supply disruptions and increased import costs.

Description:

- Element Characteristics:** Germanium is a lustrous, hard, silvery-white semi-metal with a crystal structure similar to diamond. It is known for its excellent semiconductor properties.
- Key Applications:** Used extensively in **fiber-optic cables**, **infrared imaging devices**, **solar cells**, and **semiconductors**. Its heat resistance and high energy conversion efficiency make it valuable in advanced technologies.
- Strategic Importance:** Germanium is listed as a **critical mineral** by India, the **European Union**, the **United States**, and **Japan** due to its significance in electronics, defense, and energy sectors.
- China's Dominance:** China accounts for approximately **60% of global germanium production**, making it the largest producer and exporter, influencing global supply chains.
- Defense and Space Use:** Germanium enhances the performance of **weapon systems** in harsh environments and is vital in **space and avionic technologies** due to its superior optical and electronic properties.

Space for Notes:

Starlink

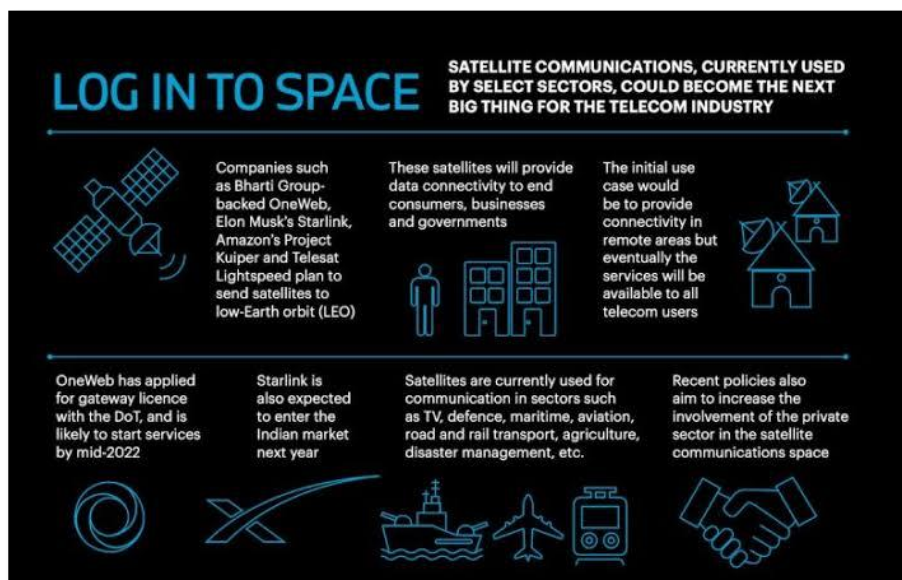
Space for Notes:

Why in News?

Elon Musk's Starlink received Indian government approval to offer satellite internet services, securing a GMPCS license, potentially revolutionizing rural connectivity and intensifying competition in the country's telecom sector.

Description:

1. Starlink is a satellite-based Internet service operated by SpaceX, aiming to deploy 42,000 satellites in low Earth orbit.
2. Starlink currently has around 7,000 satellites in orbit, providing coverage in over 100 countries.
3. By the end-2024, Starlink is expected to have 4.6 million users globally.
4. Starlink can provide Internet connectivity in remote areas where traditional methods like fiber-optic cables are unavailable.
5. India, with over 670 million people without Internet access, stands to benefit significantly from Starlink's broadband service.



Polar Satellite Launch Vehicle(PSLV)

Why in News?

ISRO's PSLV mission failed to place the Earth observation satellite EOS-09 into its intended orbit due to a snag in the third stage, marking a rare failure of the trusted rocket. This was ISRO's 101st mission and second setback in recent months, raising concerns ahead of upcoming high-profile missions like NISAR and Gaganyaan.

Description:

1. **Four-Stage Rocket:** PSLV is a four-stage launch vehicle using a combination of solid and liquid propulsion systems (PS1, PS2, PS3, PS4).
2. **Versatile Payload Capability:** It can launch satellites into various orbits—Polar, Sun Synchronous Polar Orbit (SSPO), and even Geostationary Transfer Orbit (GTO).
3. **Multiple Variants:** PSLV has five main variants—PSLV-G, PSLV-XL, PSLV-CA, PSLV-DL, and PSLV-QL—to accommodate different payload needs.
4. **Notable Missions:** It launched major missions like Chandrayaan-1, Mars Orbiter Mission, and Aditya-L1, mostly using the PSLV-XL variant.
5. **High Success Rate:** Since its first successful launch in **1994**, PSLV has become ISRO's most reliable and frequently used launch vehicle.

PSLV-C61 Mission Overview:	EOS-09 Satellite Overview:
• Mission Number: 63rd flight of PSLV; 27th in PSLV-XL configuration • Developed by: Indian Space Research Organisation (ISRO) • Objective: To launch EOS-09 into Sun Synchronous Polar Orbit (SSPO) Vehicle Specifications: • Height: 44.5 meters • Lift-off Mass: 321 tonnes • Configuration: Four-stage launch vehicle with alternating solid and liquid propulsion • Boosters: Six solid strap-on boosters Mission Outcome: • Failure due to stage 3 malfunction ◦ Cause: Drop in chamber pressure in the solid motor • Sustainability Measures: ◦ Orbit Change Thrusters (OCT) • Passivation of PS4 to reduce space debris	• Type: Remote Sensing Satellite (successor to EOS-04) • Objective: ◦ Provide high-resolution, all-weather Earth imagery using Synthetic Aperture Radar (SAR) ◦ Support sectors such as disaster monitoring, agriculture, forestry, and urban planning Key Features: • Launch Mass: 1696.24 kg • Payload: SAR for day/night and all-weather imaging • Mission Life: 5 years • Post-mission Disposal: Equipped with deorbiting fuel to comply with debris mitigation norms

Space for Notes:

Diabetes

Why in News?

A global study has found that Ozempic (semaglutide), originally a diabetes drug, can significantly improve and potentially reverse liver disease MASH. Published in The New England Journal of Medicine, the findings mark a breakthrough in treating metabolic liver conditions.

Description:

What is Diabetes?

- A **chronic disease** where the pancreas produces little or no insulin, or the body cannot use it effectively.
- **Insulin** is a hormone that regulates blood glucose levels.
- Ineffective insulin use leads to **hyperglycaemia** (high blood sugar).
- Long-term high glucose levels damage organs and tissues.
- Major causes of **blindness, kidney failure, heart attacks, stroke, and lower limb amputation**.

Types of Diabetes:

1. Type 1 Diabetes:

- Caused by the **immune system** destroying insulin-producing beta cells in the pancreas.
- Body produces little or no insulin.
- Requires **daily insulin injections**.
- Usually diagnosed in **children or young people** (formerly called juvenile diabetes).

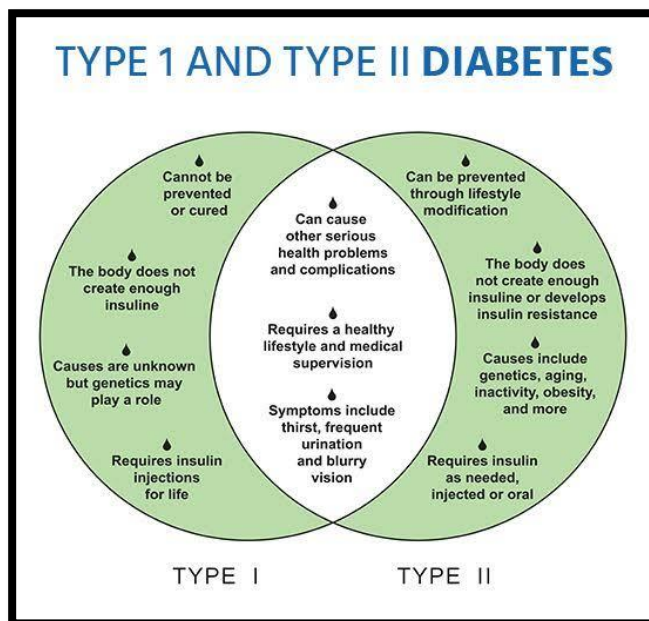
- **Symptoms:**
 - Excessive urination (polyuria)
 - Excessive thirst (polydipsia)
 - Constant hunger
 - Weight loss
 - Vision changes
 - Fatigue

2. Type 2 Diabetes:

- Results from **ineffective use of insulin** by the body.
- Accounts for **more than 95% of diabetes cases**.
- Strongly associated with **obesity and physical inactivity**.
- Symptoms similar to Type 1 but **less severe**, often diagnosed **late**.

3. Gestational Diabetes (GDM):

- Occurs during **pregnancy** with high blood glucose levels.
- Associated with **complications** for both **mother and child**.
- Usually **disappears after pregnancy**.
- Increases the risk of **developing Type 2 diabetes** later in life for both mother and child.



ISRO's Human Spaceflight Program: Gaganyaan & Ax-4 Mission

Why in News?

ISRO Chairman announced Gaganyaan's first uncrewed flight will launch by late 2025, while the Ax-4 mission will send Indian astronaut Shubhanshu Shukla to ISS in May 2025.

Description:

Gaganyaan Mission	Axiom-4 mission
Key Features: • India's first human spaceflight programme.	Mission Overview: • Organizer: Axiom Space (private US firm) in collaboration with NASA.

Space for Notes:

Space for Notes:

• Phases: ◦ Three uncrewed missions (G1, G2, G3) to test systems including humanoid Vyommitra. ◦ First crewed mission in early 2027. • Orbit Duration: 3 days in 400 km Low Earth Orbit. • Cost Estimate: ₹4,000 crores. Status Update: • 95% systems readiness, including propulsion. • 7,200+ tests completed. • Crew module, escape system, and life support systems developed indigenously. • SPADEX mission successful—enabled autonomous space docking. Significance: • Boosts Make in India in space. • Expected to multiply India's space economy 5x to USD 44 billion in 8 years. Related Project: Bharatiya Antariksh Station (BAS): • India's own space station post-Gaganyaan. • Timeline: Assembly to start in 2028; complete by 2035. • Design: To host 3 astronauts for long durations.	• Launch Vehicle: SpaceX Dragon spacecraft. • Launch Site: Kennedy Space Center, Florida. • Duration: Up to 14 days aboard the ISS. Crew Composition: • Includes astronauts from India, Poland, and Hungary (first time for each at ISS). Mission Objectives: • Scientific Research: ◦ Materials science ◦ Biology ◦ Earth observation ◦ Microgravity effects • Technology Demonstrations • Educational Outreach Relevance to Gaganyaan: • Supports human readiness, microgravity studies, and bio-research vital for long-duration Indian space missions. Key Prelims Takeaways: • Vyommitra: Robotic humanoid for uncrewed Gaganyaan missions. • SPADEX: Space docking experiment by ISRO (successful). • Ax-4: First Indian astronaut on ISS, via private US mission. • BAS: India's proposed independent space station by 2035. Gaganyaan + Ax-4: Complementary for building India's human spaceflight capability.
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Vyommitra
Why in News?

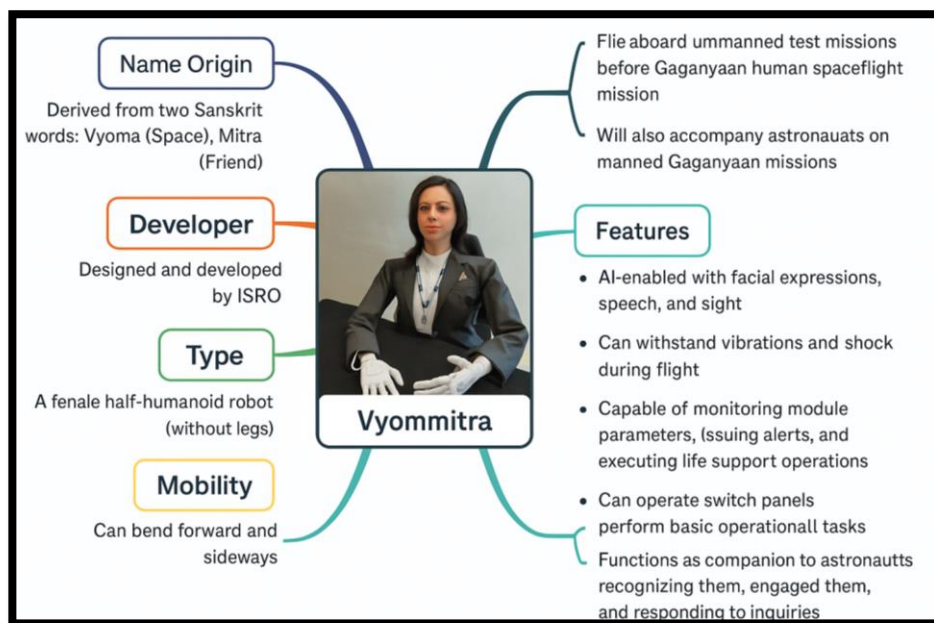
ISRO plans India's first manned Gaganyaan mission in early 2027, with prior uncrewed tests including a robot named Vyommitra, simulating crew roles and emergency protocols aboard the spacecraft.

Description:

- **Name Origin:** Vyommitra is derived from two Sanskrit words – Vyoma (Space) and Mitra (Friend).
- **Developer:** Designed and developed by ISRO (Indian Space Research Organisation).
- **Type:** A female half-humanoid robot (without legs).
- **Mobility:** Can bend forward and sideways.

Space for Notes:

- **Purpose:**
 - To fly aboard unmanned test missions before the **Gaganyaan** human spaceflight mission.
 - Will also accompany astronauts on **manned Gaganyaan missions**.
- **Features:**
 - AI-enabled with **facial expressions, speech, and sight**.
 - Can **withstand vibrations and shocks** during flight.
 - Capable of **monitoring module parameters**, issuing alerts, and executing **life support operations**.
 - Can **operate switch panels** and perform basic operational tasks.
 - Functions as a **companion to astronauts**:
 - Recognises astronauts
 - Engages in conversations
 - Responds to inquiries



China's Tianwen-2 Mission (to Retrieve Samples from Near-Earth Asteroid Kamo'oalewa)

Why in News?

China is set to launch its Tianwen-2 mission to collect samples from the near-Earth asteroid Kamo'oalewa, aiming to become the third country to return asteroid material to Earth.

Description:

China's Mission (Tianwen-2):

- **Objective:** To retrieve samples from near-Earth asteroid **469219 Kamo'oalewa**.
- **Mission Name:** Tianwen-2.
- **Launch Date:** Thursday (as per article date – 27 May 2025).
- If successful, **China** will become the **third country** (after the **USA** and **Japan**) to return asteroid samples to Earth.

Kamo'oalewa Asteroid:

- **Discovered:** 2016.
- **By:** Pan-STARRS 1 asteroid survey telescope, **Haleakala, Hawaii**.
- **Type:** Quasi-satellite of Earth (orbits the Sun but stays close to Earth).
- **Orbit:** Highly elliptical and inclined; mimics Earth's orbit.
- Possibly a **fragment from the Moon**, ejected after a collision (hypothesis by scientists).

Scientific Importance:

- Unusual spectrum and pattern of reflected light suggest:
 - Composition similar to **Moon rocks** (Apollo lunar samples).
 - Could confirm the hypothesis that Moon-Earth collision caused its formation.

Mission Technology: How Tianwen-2 Works

- Will use **"touch-and-go"** sampling (similar to NASA's OSIRIS-REx and Japan's Hayabusa2).
- **Robotic arms** will collect surface material.
- May also use a **"anchored ascent"** technique:
 - Probe anchors itself.
 - Drills for subsurface material.
 - Uses small thrusters to ascend and return.

Bharat Forecast System
Why in News?

Bharat Forecast System (IMD): IMD will adopt the high-resolution Bharat Forecast System, developed by IITM, enhancing precision in weather forecasting, particularly for cyclones and extreme rainfall, ahead of the upcoming monsoon season.

Description:

- It is India's first indigenously developed weather model.
- Developed by the Indian Institute of Tropical Meteorology (IITM), Pune.
- It is a deterministic model, meaning it provides a single-model-based output, unlike ensemble models which give multiple outputs.
- **Key specifications:**
 - Spatial Resolution 6 km × 6 km – the highest resolution globally for a national model.
 - Existing Model 12 km × 12 km – covers 144 sq km per forecast unit.
- **Coverage**– BFS can provide 6 km resolution forecasts for the tropical region that falls between 30 degrees South and 30 degrees North latitudes.
- The Indian mainland extends between 8.4 degrees North and 37.6 degrees North latitudes.
- **Forecast Accuracy**– Capable of predicting small-scale weather phenomena such as localized thunderstorms, cyclones, and extreme rainfall with much greater accuracy

International Space Station (ISS) mission
Why in News?

NASA announced AXIOM-4, likely launching June 8, to carry Indian astronaut Shubhang Shukla to the ISS. The mission marks India's growing collaboration with NASA and private space entities.

Description:

1. **Launch and Assembly:** The ISS's first module, Zarya, was launched on **November 20, 1998**, and the station was fully assembled by **2011**.
2. **International Collaboration:** The ISS is a joint project by five space agencies – **NASA (USA), Roscosmos (Russia), ESA (Europe), JAXA (Japan), and CSA (Canada)**.
3. **Orbit and Speed:** The ISS orbits Earth at an altitude of around **400 km** and travels at a speed of **28,000 km/h**, completing one orbit roughly every **90 minutes**.
4. **Scientific Objectives:** It serves as a **microgravity laboratory** for research in medicine, physics, biology, and materials science, aiding missions to the Moon and Mars.
5. **Future Outlook:** The ISS is expected to remain operational until **2030**, with the US and Europe committed to its usage, while **Russia has announced plans to build its own space station**.

Space for Notes:

Distributed Denial-of-Service (DDoS) Attack

Space for Notes:

Why in News?

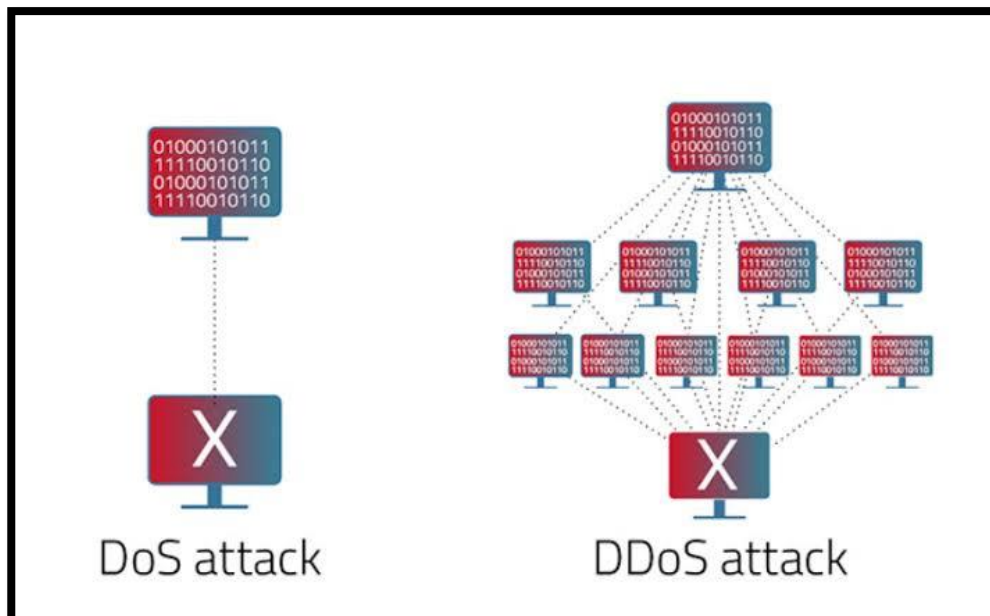
Finance Minister Nirmala Sitharaman reviewed banks' cybersecurity readiness amid border tensions, emphasizing anti-DDoS measures, operational preparedness, and uninterrupted banking services to counter potential cyberattacks and ensure financial stability.

Description:

- A DDoS attack is a malicious attempt to disrupt the normal traffic of a targeted server, service, or network.
- The goal is to overwhelm the target or its infrastructure with a flood of Internet traffic.
- It is considered a cybercrime because it prevents users from accessing online services and websites.
- DDoS attacks use multiple compromised systems to generate attack traffic.
- These systems can include computers and Internet of Things (IoT) devices.
- Unlike many cyberattacks, DDoS attacks do not try to breach a system's security.
- Instead, they aim to make services and websites unavailable to legitimate users.
- DDoS attacks can serve as a distraction to hide other malicious activities or to disable security devices.

How Does a DDoS Attack Work?

- DDoS attacks are executed using networks of Internet-connected devices.
- These devices are infected with malware and controlled remotely by attackers.
- Infected devices are called **bots** or **zombies**, and a network of these is called a **botnet**.
- The attacker sends remote instructions to the bots to launch the attack.
- Each bot sends requests to the target's IP address, overwhelming it.
- This flood of requests can crash or slow down the target, causing a denial of service.
- Since the bots are legitimate devices, it is difficult to distinguish attack traffic from normal traffic.



Chandrayaan-5 Mission

Why in News?

ISRO and JAXA are entering the design phase of Chandrayaan-5's lander and rover to explore lunar water, aiming for a 2027-28 launch, enhancing lunar surface and subsurface studies.

Description:
Key Highlights:

- **Objective:**
 - Deploy a **350 kg advanced rover** on the Moon.
 - Strengthen technologies for **future human landing missions by 2040**.
 - Collect extensive lunar surface data.
- **Collaboration:**
 - India-Japan joint mission, enhancing space research ties.
- **Features:**
 - **High-capacity lander** suitable for crewed missions.
 - Supports **sample return missions** and **safe landing technology demonstration**.
 - Builds upon achievements of Chandrayaan-3 and goals of Chandrayaan-4.

- 
- Chandrayaan-5 is part of the **LUPEX** mission, a joint effort by ISRO and JAXA to explore the **Moon's south pole**.
 - It will carry a **250 kg rover**, much larger than Chandrayaan-3's 25 kg rover, enabling better mobility and advanced experiments.
 - The mission will focus on detailed **mineralogical** and **geological studies**, including **water assessment** in permanently shadowed regions.

India's Second Spaceport:

- **Location:** Kulasekarapattinam, Thoothukudi district, Tamil Nadu.
- **Purpose:**
 - Dedicated for **Small Satellite Launch Vehicles (SSLVs)**.
 - Supports **direct southward launches** over the Indian Ocean.
 - Reduces dependency on Sriharikota.
- **Key Features:**
 - **2,350 acres'** area with **35 major facilities**.
 - **Launch capacity:** 24 satellites per year.
 - Strategic location for fuel-efficient launches.
 - **First SSLV launch planned in 2027.**

INSV Kaundinya
Why in News?

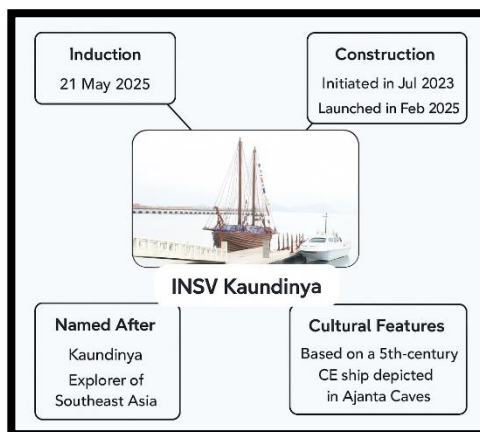
The Indian Navy inducted INSV Kaundinya, a stitched sail ship based on 5th-century Ajanta art, showcasing India's maritime heritage; it will undertake a historic transoceanic voyage.

Description:

- **Name:** INSV Kaundinya
- **Type:** Ancient stitched sail ship
- **Induction Date:** 21 May 2025
- **Inducted by:** Indian Navy at Naval Base, Karwar
- **Chief Guest at Induction Ceremony:** Shri Gajendra Singh Shekhawat (Minister of Culture)
- **Design Inspiration:** Based on a 5th-century CE ship depicted in **Ajanta Caves**
- **Construction Method:** Traditional stitching using **wooden planks, coir rope, coconut fibre, and natural resin**
- **Shipbuilding Team:** Artisans from **Kerala**, led by Shri Babu Sankaran
- **Keel Laying:** September 2023
- **Launch:** February 2025 in Goa
- **Project Partners:**
 - Ministry of Culture (Funding)
 - Indian Navy (Design & Technical Validation)
 - M/s Hodi Innovations (Shipbuilder)

Space for Notes:

- **Design Validation:**
 - Based on iconographic sources due to lack of blueprints
 - Hydrodynamic testing at IIT Madras, Department of Ocean Engineering
- **Cultural Features:**
 - **Sails:** Motifs of Gandabherunda and Sun
 - **Bow:** Sculpted Simha Yali
 - **Deck:** Harappan-style stone anchor
- **Named After:** Kaundinya, a legendary Indian mariner who sailed to Southeast Asia
- **Planned Voyage:** To retrace ancient maritime trade route from Gujarat to Oman (scheduled later in 2025)


Space for Notes:

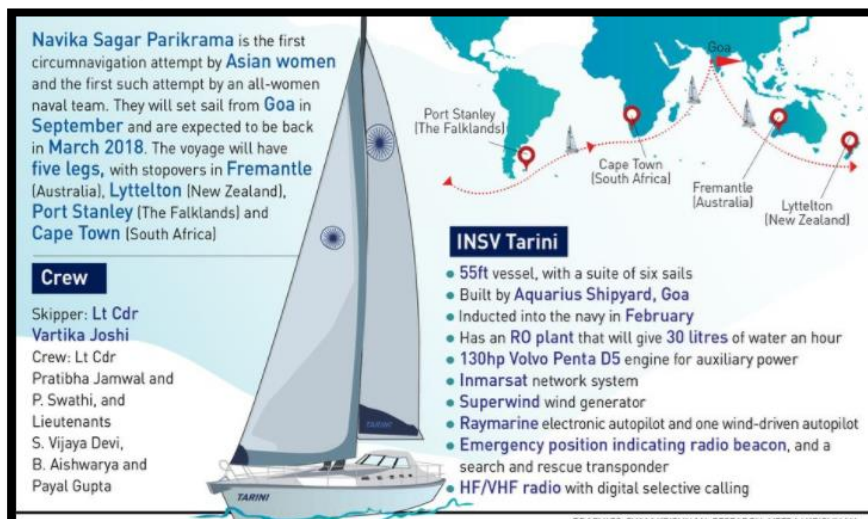
INSV Tarini

Why in News?

Two Indian Navy women officers aboard INSV Tarini are completing a historic 23,400-nautical-mile global circumnavigation in double-handed mode, marking India's first such female-led naval expedition.

Description:

1. INSV Tarini is a 56-foot sailing vessel indigenously built by Aquarius Shipyard Pvt. Ltd., Goa under the Make in India initiative.
2. It was inducted into the Indian Navy in February 2017 and is used for ocean sailing expeditions, including circumnavigation missions.
3. It is equipped with **advanced features** like a satellite communication system, Raymarine navigation suite, and emergency steering, making it capable of withstanding extreme sailing conditions.
4. INSV Tarini was used in Navika Sagar Parikrama I (2017-18) and now in Navika Sagar Parikrama II (2024-25) – both all-women circumnavigation missions promoting naval exploration and scientific research.
5. During Navika Sagar Parikrama II, INSV Tarini crossed Point Nemo, the Oceanic Pole of Inaccessibility, the most remote point on Earth in the South Pacific Ocean.



AMCA (Advanced Medium Combat Aircraft)

Why in News?

Defence Minister Rajnath Singh approved a competitive execution model for the indigenous AMCA fighter jet, allowing HAL and private industry to bid, accelerating India's fifth-generation aircraft development.

Description:

1. **Fifth-Generation Indigenous Fighter:** The AMCA is India's first indigenously designed fifth-generation stealth fighter jet, being developed by the Aeronautical Development Agency (ADA) under the DRDO.
2. **Stealth and Advanced Features:** It will feature stealth capabilities, an internal weapons bay, diverterless supersonic intake, and advanced avionics, enabling it to operate in contested airspace and modern warfare scenarios.
3. **Dual-Phase Development:** The project will be developed in two phases—AMCA Mk1 with GE F-414 engines and AMCA Mk2 with a more powerful indigenous engine, possibly co-developed with Safran (France).
4. **Execution Model with Industry Participation:** The project will follow an industry-partnership model where HAL and private sector companies will compete or collaborate for production, with equal opportunity, as approved by the Defence Minister.
5. **Strategic Timeline and Cost:** Approved by the Cabinet Committee on Security in March 2024, the AMCA project is estimated to cost ₹15,000 crores, with the first prototype expected by 2028-29, and production likely by 2032-33. Induction is targeted for 2034.

DSCA (Defense Security Cooperation Agency)
Why in News?

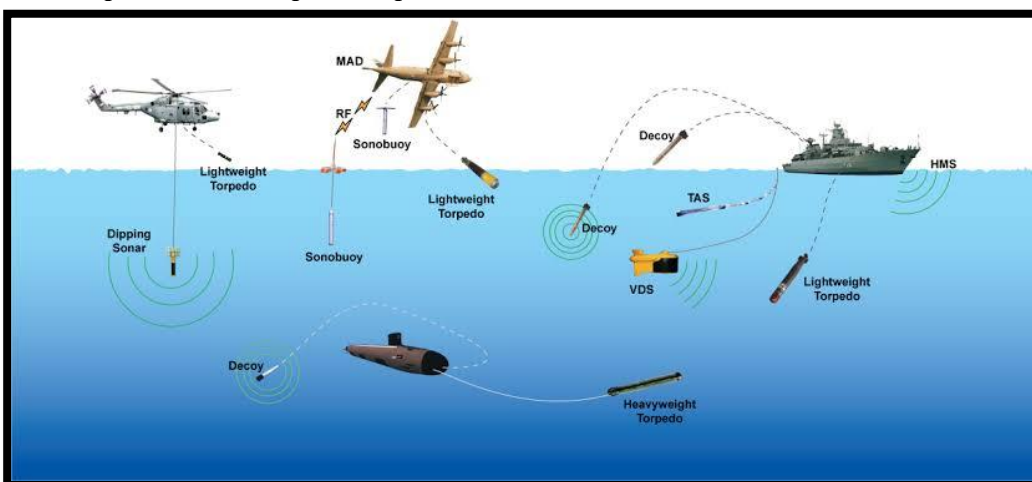
The U.S. has notified a potential \$131 million sale of maritime surveillance tech to India under IPMDA, supporting India's maritime security and strengthening Indo-Pacific strategic ties.

Description:

- DSCA is an agency under the U.S. Department of Defense.
- It is responsible for administering security cooperation and foreign military sales (FMS).

Functions of DSCA:

1. **Foreign Military Sales (FMS):** Facilitates the transfer of U.S. defense equipment, services, and training to foreign countries.
2. **Security Cooperation Programs:** Manages programs like Foreign Military Financing (FMF) to support allied nations' defense acquisitions.
3. **Training & Technical Assistance:** Provides defense training and operational assistance to partner nations.
4. **Military-to-Military Engagements:** Strengthens ties through joint exercises, personnel exchanges, and strategic dialogue.


SSLV – Small Satellite Launch Vehicle
Why in News?

HAL secured the ISRO bid to build SSLVs, enabling private manufacturing of small satellite launch vehicles after tech transfer. Aimed at boosting commercial satellite launches, NSIL will oversee 15 SSLV launches, supporting India's ambition in the global space economy.

Space for Notes:

Description:

1. **Developed by:** Indian Space Research Organisation (ISRO).
2. **Purpose:** Designed to launch **small satellites** into **Low Earth Orbit (LEO)**.
3. **Payload Capacity:** Up to **500 kg** to a **500 km** planar orbit.
4. **Stages:**
 - Three solid propulsion stages
 - One liquid-fueled Velocity Trimming Module (VTM) for precision injection
5. **Length:** **34 meters** **Diameter:** **2 meters**
6. **Lift-off Weight:** Approximately **120 tonnes**
7. **Launch Site:** **Satish Dhawan Space Centre (SDSC), Sriharikota**
8. **Key Features:**
 - Low cost
 - Quick turnaround time
 - Minimal ground infrastructure
 - Multiple satellite accommodation
 - Responsive launch capability (on-demand launches)
9. **Commercial Target:**
 - Meets growing global demand for small satellite launches
 - Competes in the small satellite launch vehicle market
10. **SSLV-D1 / EOS-02 Mission (Aug 2022):**
 - **First flight** of SSLV
 - Carried **EOS-02** and **AzaadiSAT**
 - **Failed mission:** satellites placed in **unstable elliptical orbit**
 - Cause: **VTM malfunction** due to **sensor failure**
11. **Future Use:**
 - Intended to complement PSLV for small payloads
 - Aimed at commercial satellite launches and private sector partnerships

Gene-Edited Sheep: Latest & First in India
Why in News?

India's first gene-edited sheep, a Kashmir Merino, was born in Srinagar using CRISPR-Cas9. Developed by SKUAST, it marks a leap in livestock biotechnology and muscle-growth research.

Description:

- India's first gene-edited sheep was born in December 2024 at SKUAST, Srinagar.
- Led by Prof. Riyaz Ahmad Shah and his team.
- The sheep is a Kashmir Merino breed, known for high-quality wool and meat.
- Gene-editing success was confirmed through gene sequencing.
- CRISPR-Cas9 technology was used.
- Targeted the myostatin (MSTN) gene, which limits muscle growth.
- Editing increased muscle mass by around 30%.
- Aims: improve meat production, disease resistance, and climate resilience.

Kashmir Merino Sheep:

- Developed in 1960 at Sheep Breeding & Research Farm, Reasi (Jammu).
- Crossbred from local breeds (Poonchi, Gaddi, Bakerwal) and exotic breeds (Australian Merino, Delaine).
- Dual-purpose breed: used for both wool and meat.
- Productivity is 3–4 times higher than local breeds.
- Well adapted to harsh climate and local disease conditions.

Space for Notes:

Milestones in Indian Animal Biotechnology:

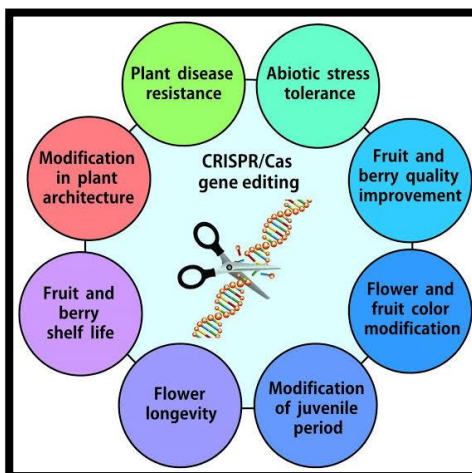
- SKUAST earlier cloned the world's first Pashmina goat, 'Noori', in 2012.
- Noori lived 11 years (2012–2023); created via somatic cell nuclear transfer.
- Gene-edited sheep embryo was lab-created, then transferred to a surrogate mother.
- Team failed three times before succeeding on the fourth try.
- The sheep weighed 3.15 kg at birth.

Future Plans:

- Next target: FGF5 gene (Fibroblast Growth Factor 5) to improve wool fibre quality.
- Long-term goal: Transgenics – combining cloning and gene-editing.
- Vision: produce therapeutic proteins (e.g., anti-cancer drugs) in animal milk.
- Animals may serve as pharmaceutical bio-factories in the future.

Broader Implications:

- Important for addressing rising meat and milk demand in India.
- Marks a shift from traditional crossbreeding to precision gene-editing.
- Complements India's development of gene-edited rice.
- Demonstrates India's growing capability in genomic and agri-biotech research.


S-400 Triumf Missile System
Why in News?

Russian Defence Minister Andrey Belousov assured India of on-time delivery of remaining S-400 air defence systems during talks with Rajnath Singh in Qingdao, highlighting bilateral defence ties and the critical role of S-400s in India's security strategy.

Description:

- **Origin:** Russia
- **Type:** Surface-to-Air Missile (SAM) System
- **Developer:** Almaz-Antey (Russia)

Key Features:

- One of the world's most advanced long-range air defence systems.
- Designed to counter aircraft, ballistic missiles, cruise missiles, UAVs.

Range & Altitude:

- **Max Range:** Up to 400 km.
- **Engagement Altitude:** 10 m to 30 km.

Missiles Used:

- **40N6:** Long-range (400 km)
- **48N6:** Medium-range (250 km)
- **9M96E2:** Short to Medium-range (120 km)
- **9M96E:** Short-range (40 km)

Radar Systems:

- **91N6E Big Bird:** Long-range 3D phased-array radar.
- **92N6E Grave Stone:** Fire-control radar for guidance.
- Integrated command centre: **55K6E module** for coordination.

Tracking & Engagement:

- Tracks up to 80 targets simultaneously.
- Engages up to 36 targets at once.
- Target interception speed: up to 4.8 km/second.

Space for Notes:

Mobility:

- Truck-mounted, fully mobile system.
- Deployment time: ~5 minutes (vs. 25 minutes for US Patriot).

Superiority Over Rivals:

- US Patriot: Max range ~180 km, speed ~1.38 km/s.
- THAAD: Single missile type with 150–200 km range.
- S-400 offers layered defence (40–400 km).

Strategic Importance for India:

- Contract signed in 2018 despite CAATSA risk (~Rs 35,000 crore for 5 squadrons).
- First unit delivered in 2021.
- 4 squadrons deployed in Pathankot, Rajasthan, Gujarat; remainder by 2025–26.
- Key for air defence against China and Pakistan.
- Deployment planned on the northeastern border for enhanced security.

Space for Notes:

Nomadic Elephant
Why in News?

The 17th India-Mongolia joint military exercise 'Nomadic Elephant' began in Ulaanbaatar, focusing on counter-terrorism, precision sniping, and UN-mandated operations in semi-urban and mountainous terrain.

Description:

- **Exercise Name:** Nomadic Elephant
- **Edition:** 17th edition
- **Venue:** Ulaanbaatar, Mongolia
- **Frequency:** Annual bilateral exercise between India and Mongolia
- **Initiated in:** 2006
- **Alternating Host Nations:** Held alternately in India and Mongolia
- **Last Edition:** Held in Umroi, Meghalaya, India (July 2024)
- **Objective:**
 - Enhance interoperability in **semi-conventional operations**
 - Focus on **semi-urban and mountainous terrain**
 - Conducted under **United Nations Chapter VII mandate**
- **UN Chapter VII:**
 - Authorizes military and non-military actions like **sanctions, blockades, and troop deployment**
 - Aimed at **international peace enforcement**
- **Additional Participation:**
 - India also takes part in **Exercise Khaan Quest**
 - **Khaan Quest** is a **multinational peacekeeping exercise** hosted by Mongolia

Arnala Ship
Why in News?

The Indian Navy will commission Arnala, its first indigenously built Anti-Submarine Warfare Shallow Water Craft, on June 18, enhancing coastal defence and promoting Aatmanirbhar Bharat in defence.

Description:

- 'Arnala' is the first of eight indigenously built Anti-Submarine Warfare Shallow Water Crafts (ASW SWCs) delivered to the Indian Navy.
- Designed by Garden Reach Shipbuilders and Engineers (GRSE), Kolkata.
- Constructed at L&T Shipyard, Kattupalli under a Public-Private Partnership (PPP).

Technical & Operational Details:

- Built according to Indian Register of Shipping (IRS) classification rules.
- **Length:** 77 metres.
- **Propulsion:** Largest Indian Naval warship powered by a **Diesel Engine-Waterjet propulsion system**.
- Over 80% of components are indigenously sourced.

Strategic Importance:

- Enhances India's capability in **shallow water anti-submarine warfare**.
- Supports **Aatmanirbhar Bharat** in defence manufacturing.
- Represents successful **public-private sector collaboration** in defence.

Role & Functions:

- **Underwater surveillance** in coastal zones.
- **Search and Rescue (SAR)** operations.
- **Low Intensity Maritime Operations (LIMO)**.
- **Coastal Anti-Submarine Warfare (ASW)**.
- **Advanced mine-laying capabilities**.

Symbolism:

- Named after the historic **Arnala Fort** off **Vasai, Maharashtra**.
- Symbolises India's rich **maritime legacy and heritage**.

Space for Notes:

Space for Notes:



INS Tamal

Why in News?

INS Tamal, the last Indian Navy warship built abroad, will be commissioned on July 1 in Russia. It has 26% indigenous components, including BrahMos missiles, and advanced stealth features.

Description:

- **Origin:** Part of the 2016 Indo-Russian agreement for 4 stealth frigates (2 built in Russia, 2 in India).
- **Builder:** Constructed in Russia; 2nd Russian-built ship after INS Tushil (commissioned December 2024).
- **Type:** Advanced stealth warship (frigate-class).

Advanced Features:

- **Speed & Range:**
 - Maximum speed: Up to 30 knots.
 - Operational range: ~3,000 km per mission.
- **Missile Systems:**
 - Armed with BrahMos supersonic cruise missiles.
 - Range: 300–400 km.
 - Speed: ~Mach 3 (supersonic).
 - Capability: Precision strikes on land and sea targets.
- **Anti-Submarine Warfare:**
 - Equipped with torpedoes and rocket launchers.
- **Helicopter Operations:**
 - Supports multi-role helicopters for surveillance, anti-submarine, and combat roles.
- **Stealth Features:**
 - Radar-evading design reduces detection.
 - Enhances survivability and surprise capability in modern naval warfare.


Space for Notes:

CERT-In (Indian Computer Emergency Response Team)

Why in News?

CERT-In fixed a vulnerability in AIIMS' ORBO website that exposed personal data of organ donors. The breach risked privacy under the DPDP Act, 2023. Discovered by an ethical hacker, the flaw was patched and acknowledged by CERT.

Description:

What is CERT-In?

- CERT-In is the national nodal agency for responding to cybersecurity incidents in India.
- It functions under the **Ministry of Electronics and Information Technology (MeitY)**.
- Operational since **January 2004**.
- Mandated under the **Information Technology (Amendment) Act, 2008**.

Key Functions:

Under the IT (Amendment) Act 2008, CERT-In is mandated to:

- **Collect, analyze, and disseminate** information on cyber incidents.
- Issue **forecasts and alerts** on cybersecurity threats.
- Take **emergency measures** for incident response.
- **Coordinate** national-level cyber incident response efforts.
- Release **guidelines, advisories, vulnerability notes, and white papers** on best practices.
- Issue **directions** and **seek information** from service providers, data centres, intermediaries, and corporates.

Who Does It Serve?

- Government, public and private sector entities.
- Also provides services for **individuals and home users**.

Legal & Constitutional Compliance:

- Disclosure of information is subject to **Indian constitutional laws**.

Latest Alert (Context):

- In May 2024, CERT-In issued a **high severity vulnerability alert** for **Google Chrome**.

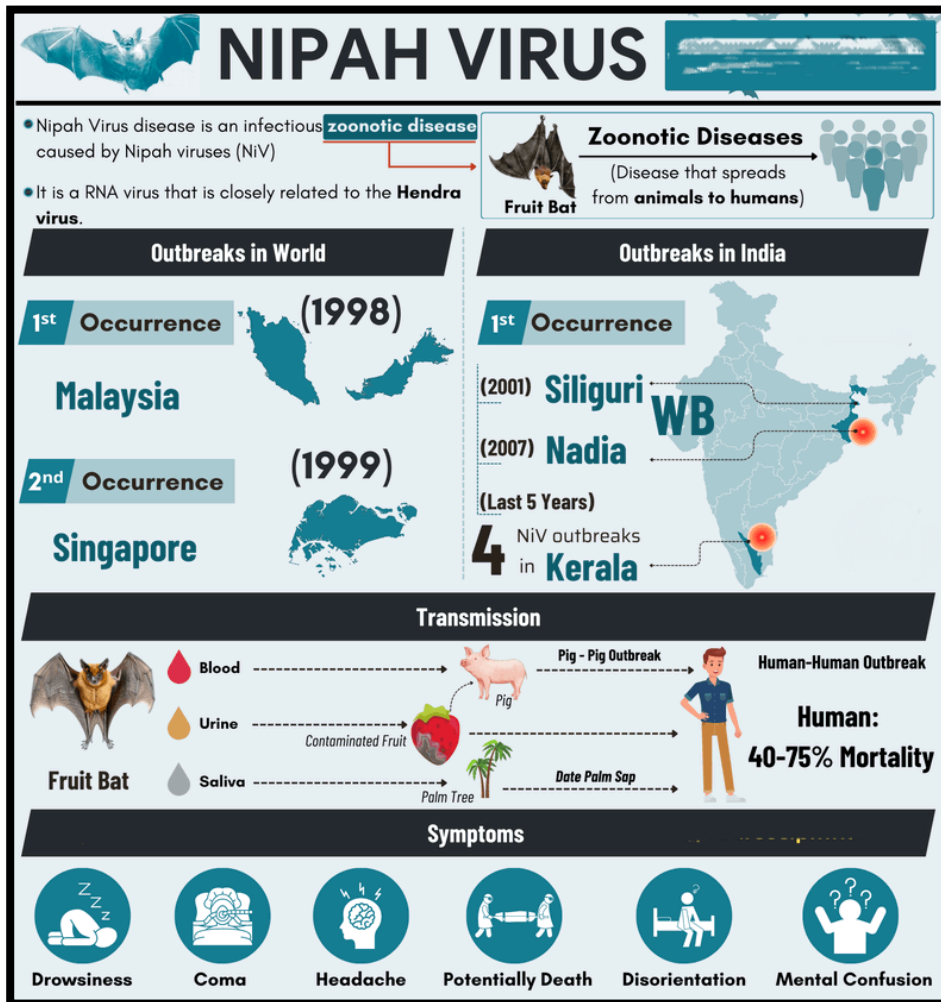
Nipah virus(NiV)

Why in News?

A Nipah virus death in Kerala's Palakkad district has triggered an alert in six districts. Health authorities have traced 46 contacts and placed 543 people under observation, intensifying surveillance to prevent further spread of the deadly bat-borne virus.

Description:

- **About Virus:** It is a zoonotic virus (transmitted from animals to humans) and can also be transmitted through contaminated food or directly between people.
- **Nature:** The organism that causes Nipah Virus encephalitis is an RNA or Ribonucleic acid virus of the family Paramyxoviridae, genus Henipavirus, and is closely related to Hendra virus.
- **Hosts:** NiV initially appeared in domestic pigs, dogs, cats, goats, horses, and sheep.
 - **Transmission:** It spreads through fruit bats (genus Pteropus). The virus is found in bat urine, feces, saliva, and birthing fluid.
- **Symptoms:** Causes encephalitic syndrome in humans, presenting with fever, headache, drowsiness, disorientation, mental confusion, coma, and potentially death.
- **Treatment:** Diagnosis can be established through real-time polymerase chain reaction (RT-PCR) from bodily fluids and antibody detection via enzyme-linked immunosorbent assay (ELISA).
- **Prevention:** No vaccines available for humans or animals.
- **WHO Response:** It has identified Nipah as a priority disease

Space for Notes:

Chronic Venous Insufficiency (CVI)
Why in News?

Former US President Donald Trump has been diagnosed with chronic venous insufficiency (CVI), a condition affecting blood flow in the legs. The diagnosis was made following swelling and bruising in his limbs. The White House confirmed that Trump remains in excellent health overall.

Description:

- A condition where **leg veins fail to efficiently return blood to the heart**.
- Caused by **damaged or weakened vein valves**, leading to **blood pooling in the legs**.
- Not usually life-threatening but can significantly **impact quality of life**.

Causes / Risk Factors:

- **Valve dysfunction** in the veins.
- **Overweight or obesity**.
- **Pregnancy**.
- **Family history** of venous disorders.
- **Past leg injuries or surgeries**.
- History of **blood clots (DVT)**.
- **Increasing age** – common in older adults.

Symptoms:

- **Leg pain or heaviness**.
- **Swelling (edema)** in lower legs/ankles.
- **Cramps**, especially at night.
- **Itchy or flaky skin**, skin discolouration.
- **Varicose veins**.
- **Leg ulcers**, particularly around the ankles.

Prevalence:

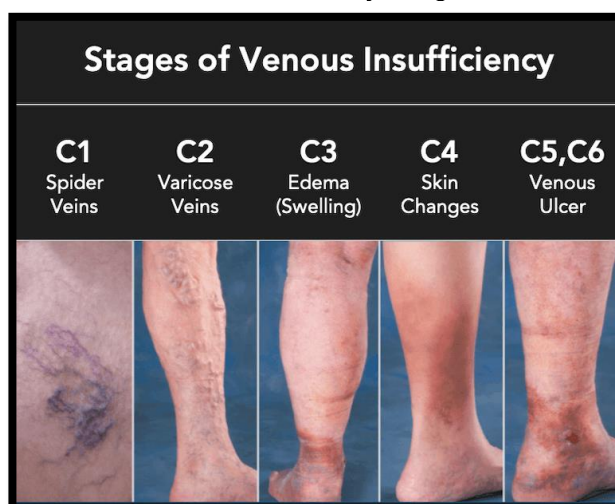
- Affects approximately **1 in 20 adults**.
- Risk increases **significantly with age**.

Treatment Options:

- Lifestyle Changes:**
 - **Regular physical activity** (walking, cycling).
 - **Leg elevation** above heart level.
 - **Weight loss** and a healthy diet.
- Medical Management:**
 - **Compression therapy:** Tight stockings or bandages to support veins.
 - **Medications** to improve venous tone and blood flow.
- Surgical/Procedural Options:**
 - **Sclerotherapy**, **laser therapy**, **vein stripping**, or **endovenous ablation** in severe cases.

Preventive Tips:

- Avoid long periods of **standing or sitting**.
- Wear **compression stockings** if at risk.
- Engage in **leg exercises** and maintain **healthy weight**.


Space for Notes:

NISAR – NASA-ISRO Synthetic Aperture Radar

Space for Notes:

Why in News?

ISRO successfully launched the NISAR satellite using GSLV-F16, marking the first India-US Earth observation mission. NISAR will use dual-frequency synthetic aperture radar to map Earth in high detail, aiding environmental monitoring, resource management, and disaster response.

Description:

Overview:

- **Type:** Earth Observation Satellite
- **Uniqueness:** First satellite with **dual-frequency SAR – L-band (NASA) & S-band (ISRO)**
- **Imaging Capability:** All-weather, day & night, high-resolution surface imaging

Organizations Involved:

- **NASA (JPL):**
 - L-band radar
 - Communication, GPS, and data systems
- **ISRO:**
 - S-band radar
 - Modified I-3K satellite bus
 - **Launch:** GSLV-F16
 - Ground segment & operations

Objectives:

- **Monitor:**
 - Land surface deformation (e.g., tectonics, landslides)
 - Glacier and ice sheet dynamics (cryosphere)
 - Agricultural patterns, forest biomass, and soil moisture
 - Coastal changes and wetland mapping
- **Support:**
 - **Disaster management**
 - **Climate change monitoring**
 - **Resource mapping**
 - Sustainable development initiatives

Key Features:

- **Dual-frequency SAR:** L-band (penetrates canopy & soil) + S-band (high resolution near surface)
- **12-metre Unfurlable Mesh Antenna**
- **SweepSAR Technology:** Wide 242 km swath with 12-day revisit time
- **High Spatial Resolution:** Detects changes < 1 cm
- **Global Coverage:** All-weather, 24x7 Earth imaging

India's Contribution:

- S-band radar payload
- Satellite bus (I3K)
- Launch vehicle: **GSLV-F16**
- Ground support & mission operations

Significance:

- **First-of-its-kind** dual-frequency SAR satellite
- Boosts **Indo-US space collaboration** (MoU signed in 2014)
- Enables real-time data for disaster response and environmental policy
- Supports **UN Sustainable Development Goals (SDGs)**

LIGO (Laser Interferometer Gravitational-wave Observatory)

Space for Notes:

Why in News?

The Department of Atomic Energy announced that construction of the LIGO-India observatory will begin in Maharashtra's Hingoli district in late 2025, aiming for completion by April 2030. It will be India's first gravitational wave detector, joining the global LIGO network.

Description:

- LIGO is an observatory that detects **gravitational waves**, which are ripples in spacetime caused by massive cosmic events.
- **Mechanism:** Uses a device called an **interferometer**, which measures the tiny distortions in spacetime as gravitational waves pass through.
- **Based on Einstein's Theory:** Predicted in **1916** under **General Theory of Relativity**. Einstein believed these waves were too weak to be detected.
- **Structure:**
 - Two detectors in the **USA**:
 - **Hanford**, Washington
 - **Livingston**, Louisiana
 - Work in unison to confirm signals.
- **Development Timeline:**
 - **1990:** Approved by NSF (USA)
 - **1999:** Construction completed
 - **2010–2014:** Major upgrades for sensitivity
 - **2015:** First detection of gravitational waves from black hole merger
- **First Detection (2015):**
 - Collision of two black holes (29 and 36 solar masses)
 - Event occurred **1.3 billion years ago**

LIGO-Virgo Collaboration:

- **Virgo Detector:**
 - Located in **Italy**
 - Adds a third point of observation for better triangulation of wave sources
- **Purpose:**
Helps confirm that the signal is not noise, by cross-checking among detectors.
- **Important Discovery (2020):** Detected a **black hole–neutron star collision**

LIGO-India:

- **Location:** **Hingoli**, Maharashtra (approx. 450 km from Mumbai)
- **Timeline:**
 - **In-principle approval:** February 2016
 - **Final approval:** Rs 2,600 crore cleared recently
 - **Expected Operational Year:** **2030**

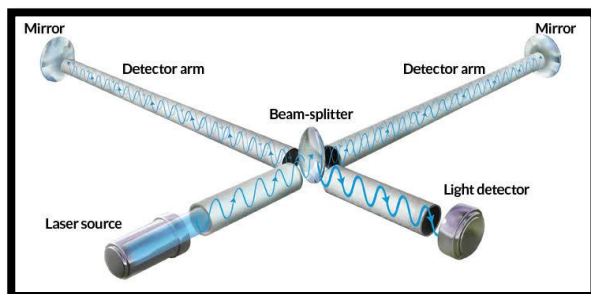
Collaboration:

- Joint effort by **DAE** and **DST**, Govt. of India
- In MoU with **US National Science Foundation (NSF)**

KAGRA Observatory:

- **Location:**
 - Gifu Prefecture, Japan
 - First Asian gravitational wave observatory

Key Feature: Built underground to reduce seismic noise


Space for Notes:
mRNA Vaccines
Why in News?

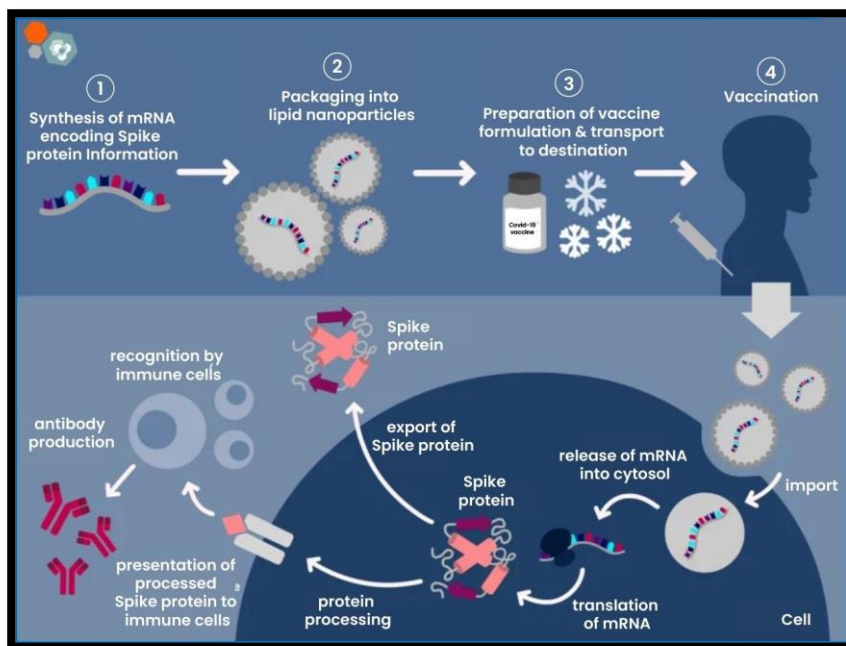
India's first indigenous mRNA-based cancer immunotherapy entered early human trials. Developed by ImmunoACT, it also holds potential against infectious diseases like Nipah and dengue, marking a breakthrough in personalized treatment and epidemic preparedness using cutting-edge mRNA technology.

Description:
mRNA Vaccines: How They Work:

- mRNA vaccines introduce a piece of mRNA that codes for a viral protein, typically found on the virus's outer membrane.
- Cells use this mRNA to produce the viral protein themselves.
- The immune system recognizes this foreign protein and produces antibodies against it.
- Antibodies remain in the body even after the pathogen is cleared, enabling a faster response upon re-exposure.
- These antibodies bind to and mark the pathogen for destruction, preventing infection or severe illness.
- After vaccination, if exposed to the virus, the immune system can rapidly neutralize it before it causes serious disease.
- The vaccine does not contain the actual virus; it cannot infect the recipient with the virus.

How Are mRNA Vaccines Made?

- Scientists first identify a target protein on the virus's surface that can trigger an immune response.
- The chosen protein must be distinct from human proteins to avoid attacking the body's own cells.
- They locate the DNA sequence that codes for this target protein.
- Using the DNA, they manufacture mRNA that carries instructions for making the viral protein.
- Once sufficient mRNA is produced, the DNA is broken down and removed.
- Only the purified mRNA is packaged in the final vaccine.
- This production method allows rapid and large-scale manufacture of mRNA in a short time.


Space for Notes:

IN-SPACe – Indian National Space Promotion and Authorisation Centre

Why in News?

IN-SPACe has granted Elon Musk's Starlink a license to provide satellite-based internet services in India. This approval allows Starlink to operate Low Earth Orbit (LEO) satellites, making it the third company to receive such authorization after OneWeb and Jio.

Description:

- **Established by:** Government of India (2020)
- **Nodal Ministry/Department:** Department of Space (DoS)
- **Type:** Autonomous, single-window agency
- **Purpose:** To enable, promote, authorise, and supervise the participation of Non-Governmental Entities (NGEs) in the Indian space sector.

Key Functions:

- Acts as a **facilitator between ISRO and private entities.**
- Authorises **private sector participation** in:
 - Development of **satellites and launch vehicles**
 - Provision of **space-based services**
 - **Use or co-development** of ISRO infrastructure
- Supports **startups, academia, and industry** through:
 - Access to testing and launch facilities
 - Promotion of innovation and R&D
 - Simplified regulatory approvals

Headquarters:

- **Location:** Bopal, Ahmedabad, Gujarat

Recent Update (May 2025):

- **Tamil Nadu** became the **third Indian state** (after Karnataka and Gujarat) to launch a **Space Industrial Policy** to attract private investments and support IN-SPACe's mission.
- **Key ISRO facilities in Tamil Nadu:**
 - **ISRO Propulsion Complex (IPRC)** – Mahendragiri, Tirunelveli (Cryogenic & Liquid Propulsion)
 - Upcoming **Spaceport** – Kulasekarapattinam, Thoothukudi
 - **Space Technology Incubation Centre (STIC)** – NIT Trichy

Space for Notes:
Starlink:

1. Starlink is a satellite-based Internet service operated by SpaceX, aiming to deploy 42,000 satellites in low Earth orbit.
2. Starlink currently has around 7,000 satellites in orbit, providing coverage in over 100 countries.
3. Starlink can provide Internet connectivity in remote areas where traditional methods like fiber-optic cables are unavailable.
4. India, with over 670 million people without Internet access, stands to benefit significantly from Starlink's broadband service.

Genetically Modified (GM) Crops
Why in News?

Confined field trials of two genetically modified (GM) maize varieties—herbicide-tolerant and insect-resistant—are set to begin at Punjab Agricultural University after approval from the GEAC and Punjab government, sparking opposition from GM-Free India over glyphosate concerns.

Description:

- Genetic Modification is the **insertion of a foreign gene** (usually with a desired trait) into the **DNA of an organism**.
- In plants, this is done to introduce traits like **pest resistance, herbicide tolerance, disease resistance, or improved nutritional quality**.

First GM Crop:

- **Flavr Savr Tomato (USA, 1994):** Developed to delay ripening and spoilage.

Most Common GM Crops (Worldwide):

- **Cotton, Soybean, Maize, Canola**
- **Traits:** Mainly herbicide tolerance and insect resistance.

Top 5 GM Crop Growing Countries (≈90% of global area):

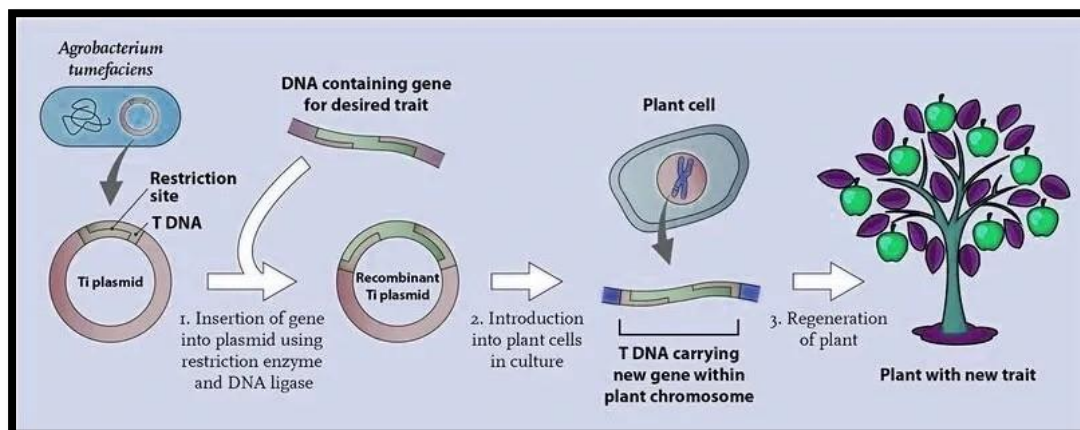
1. **USA**
2. **Brazil**
3. **Argentina**
4. **India**
5. **Canada**

Bt Technology:

- Derived from **Bacillus thuringiensis (Bt)**, a soil bacterium.
- Produces **Cry and Cyt toxins** which kill insects like **caterpillars, beetles, mosquitoes, etc.**
- Example: **Bt Cotton** (insect-resistant to bollworms)

Methods of Genetic Modification:

Method	Description
Agrobacterium tumefaciens	Soil bacterium used as a vector; carries desired gene via Ti-plasmid
Gene Gun (Biolistics)	DNA-coated gold or tungsten particles are shot into the plant cell
Electroporation	Uses electric pulses to open cell membrane and insert DNA
Microinjection	Physical insertion of DNA directly into nucleus using a micropipette

Space for Notes:

Advantages of GM Crops:

1. **Pest Resistance** → Reduces pesticide use (e.g., Bt Cotton)
2. **Virus Resistance** → Crops can be modified to resist specific viruses
3. **Drought Tolerance** → Helps conserve groundwater
4. **Herbicide Tolerance** → No need for tilling; prevents soil erosion
5. **Nutritional Enhancement** → e.g., **Golden Rice** (rich in β -carotene)
6. **Sustainability** → Encourages **no-till farming** (carbon sequestration)
7. **Biofortification** → Increases micronutrient content in crops
8. **Edible Vaccines, Phytoremediation, Biofuels** (from GM algae)

Disadvantages / Concerns:

1. **Health Risks** → Horizontal gene transfer may spread antibiotic resistance
2. **Superweeds** → Weeds become resistant to herbicides (e.g., glyphosate resistance)
3. **Pest Resistance** → Pests may adapt to Bt toxins
4. **Genetic Pollution** → Cross-breeding may reduce local biodiversity
5. **Impact on Pollinators** → Honeybee populations could be affected

Applications:

- **Golden Rice:** Biofortified rice with Vitamin A precursor
- **Edible Vaccines:** Express vaccine proteins in fruits or vegetables
- **Phytoremediation:** GM plants that detoxify pollutants
- **4th Gen Biofuels:** From GM algae and cyanobacteria

Regulatory Framework in India:

Body	Function
RDAC (Recombinant DNA Advisory Committee)	Monitors biotech developments nationally & globally
RCGM (Review Committee on Genetic Manipulation)	Oversees research and field trials; reviews safety
GEAC (Genetic Engineering Appraisal Committee)	Approves environmental release; under MoEFCC
SBCC (State Biotechnology Coordination Committee)	Implements and monitors GM safety measures at the state level

GM Crops in India – Status:

GM Crop	Status
Bt Cotton	Commercialised in 2002 (only GM crop approved for cultivation)
Bt Brinjal	Approved in 2009, but under moratorium since 2010
GM Mustard	Field trials allowed, but commercial cultivation not started
GM Maize, Chickpea, Tomato	Under various stages of field trials

Genome India Project

Space for Notes:

Why in News?

Gujarat launched India's first Tribal Genome Sequencing Project to enhance tribal healthcare by sequencing genomes of 2,000 individuals from 17 districts. The initiative aims to detect genetic disorders like sickle cell anaemia and develop personalized healthcare using genetic markers.

Description:

Launched by:

- Department of Biotechnology, Ministry of Science & Technology
- Launch Date: January 2020

Objective:

- Sequence whole genomes of 10,000 unrelated healthy Indians.
- Map India's genetic diversity for better disease prediction, precision medicine, and public health planning.

Sample Collection:

- Total Individuals Sequenced: 10,074
- Analyzed Data: 9,772 genomes
- Population Groups: 83 total
 - 30 tribal, 53 non-tribal
 - Represented India's major linguistic and ethnic groups.
- Sampling Strategy:
 - Samples from 100+ locations
 - Median: 159 samples/non-tribal group; 75 samples/tribal group
 - Included parent-child pairs to detect de novo mutations

Key Genetic Findings:

- 180 million mutations identified
 - 130 million in autosomes, 50 million in sex chromosomes
- 98% of genome is non-coding DNA
 - Many variants found here – useful for evolutionary and disease studies

Impact of Endogamy:

- All 83 groups practice endogamy (marriage within the group)
- Led to population-specific mutations
- Helps trace ancestry, identify disease-linked variants

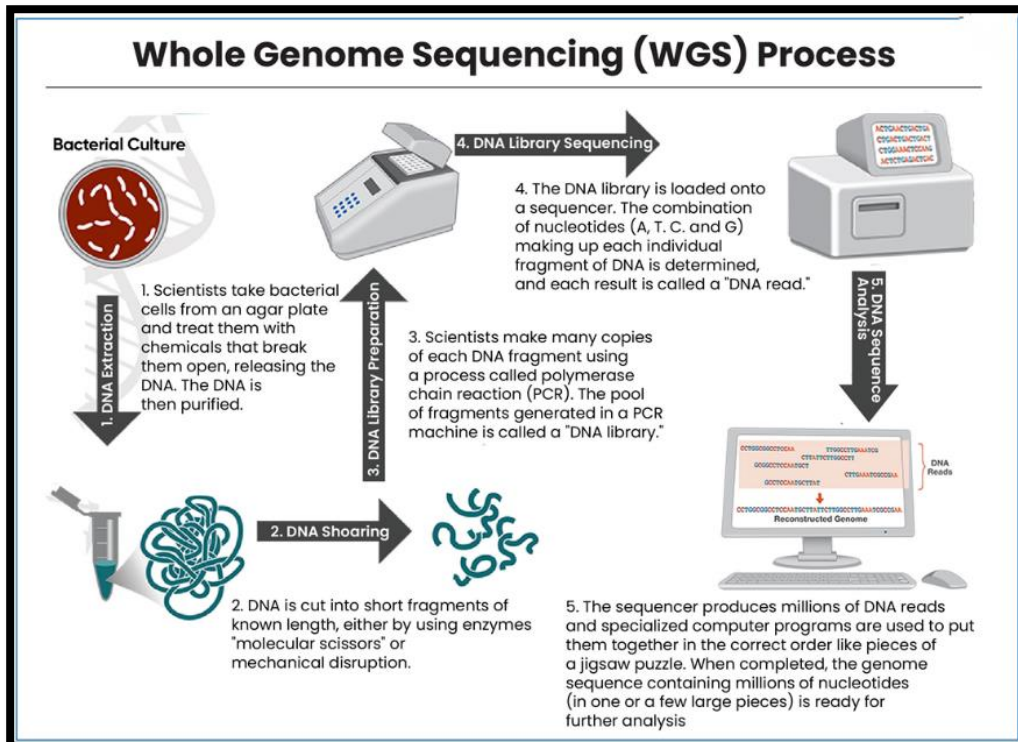
Medical Implications:

- Supports precision medicine tailored to Indian genomes
- Development of affordable diagnostic tools
- Enables early detection, prevention, and targeted treatment
- Fills gap in global studies that are largely Eurocentric

Key Institutions Involved:

- Centre for Brain Research, IISc Bengaluru
- Centre for Cellular and Molecular Biology, Hyderabad
- Institute of Genomics & Integrative Biology, Delhi
- National Institute of Biomedical Genomics, Kolkata
- Gujarat Biotechnology Research Centre, Gandhinagar

Space for Notes:



Akash Missile System

Why in News?

India successfully test-fired the Akash Prime missile in Ladakh and nuclear-capable Prithvi-II and Agni-I missiles off the Odisha coast, showcasing strategic deterrence and upgraded operational readiness amid heightened tensions near the Line of Actual Control (LAC).

Description:

- **Type:** Short Range Surface-to-Air Missile (SAM) system.
- **Purpose:** To protect **Vulnerable Areas (VAs)** and **Vulnerable Points (VPs)** from enemy air attacks.
- **Development:** Indigenously designed and developed by DRDO.
- **Production:** Manufactured by Bharat Dynamics Ltd. (BDL), Hyderabad.

Missile Features:

- **Propulsion:** Solid-fuel, ramjet engine.
- **Speed:** Mach 2.5 to 3.5 (approx. up to 4,200 km/h).
- **Range:** Operational range of 4.5 to 25 km.
- **Altitude Coverage:** Can target objects up to 18 km altitude.
- **Warhead:** Carries a 60 kg warhead (conventional or nuclear capable).
- **Kill Probability:**
 - Single missile: ~88%
 - Salvo of two missiles: ~99%

Radar & Targeting:

- **Radar Used:** Rajendra Radar
 - **Type:** 3D Passive Electronically Scanned Array (PESA) radar.
 - **Functions:** Detects range, azimuth, and altitude of aerial targets.
 - **Guidance:** Provides command guidance to missiles.

System Capabilities:

- **Modes:** Can engage targets in **Group Mode** or **Autonomous Mode**.
- **Guidance:** Digital autopilot + command guidance.
- **Self-Destruct Feature:** To reduce collateral damage if the target is missed.
- **Mobility:** Entire system mounted on **mobile platforms**.
- **ECCM:** Equipped with **Electronic Counter-Counter Measures**.
- **Automation:** Fully automatic with fast target response.
- **Architecture:** Open-system architecture for **future adaptability**.

Operation Mahadev
Why in News?

Three terrorists were killed in “Operation Mahadev” in Srinagar’s Lidwas area by the Army. Their suspected involvement in the April 22 Pahalgam attack, which killed 26 civilians, is under investigation. The encounter occurred in the dense Dachigam forest region.

Description:
Nature of Operation:

- A **joint counter-terror operation** in Jammu & Kashmir.
- Involved: **Indian Army (Chinar Corps)**, **CRPF**, and **J&K Police**.
- Launched in response to intelligence on terrorists involved in the **April 22 Pahalgam attack**.

Why the Name 'Mahadev'?

- Named after the **Mahadev peak** in the region.
- Reflects the **hilly terrain** and **religious connotation** of the area.

Key Details:

- **Location:** Lidwas area near **Dara and Harwan**, close to **Dachigam National Park**, ~20 km from Srinagar.
- **Dates:** July 27-28, 2025.
- **Forces involved:**
 - Indian Army: **24 Rashtriya Rifles & 4 PARA (SF)**
 - Central Reserve Police Force (CRPF)
 - Jammu and Kashmir Police (SOG)

How the Operation Unfolded:

1. **Intelligence Input:**
 - Signals of foreign terrorists detected in Dachigam forests.
 - Suspected connection to **Pahalgam massacre**.
2. **Local Inputs:**
 - Nomads and villagers noticed movement of unknown persons.
3. **Mobilization:**
 - Joint deployment of Army, CRPF, and J&K Police teams.
4. **Encounter:**
 - Contact made on **July 28 at 11 AM**.
 - **Three LeT terrorists** hiding in a forest hideout were **neutralized**.
5. **Recovery:**
 - Arms, ammunition, and **digital evidence** seized.
 - All terrorists confirmed to be **Pakistani nationals** (Lashkar-e-Taiba).

Pahalgam Attack Connection:

- **April 22, 2025:** **26 civilians** (including women & children) killed in Baisaran Valley, Pahalgam.
- Lashkar-e-Taiba (LeT) claimed responsibility.
- **Operation Sindoor** earlier targeted PoK terror camps.
- **Operation Mahadev** is a **follow-up** to eliminate internal handlers.

Space for Notes:

Strategic Importance of the Region:

- **Dara-Harwan-Dachigam belt:**
 - Dense forests, difficult terrain, minimal population.
 - Ideal for infiltration and terrorist hideouts.
- **Close to tourist hubs:** Pahalgam, Gulmarg, Srinagar.
- **Enhanced patrolling, technical surveillance, and community contacts.**

Official Statements:

- **Chinar Corps (via X):** "Contact established in General Area Lidwas. Three terrorists were neutralised. Operation continues."
- **SSP Srinagar:** Confirmed LeT affiliation of the slain terrorists.

Operation Mahadev: Why It Matters:

- **Elimination of foreign terrorists** within Indian territory.
- **Breakthrough in the Pahalgam terror attack case.**
- **Strengthened inter-agency coordination and local intelligence networks.**
- **Demonstrates India's zero-tolerance policy** towards terrorism.

Apache AH-64E Attack Helicopter
Why in News?

The Indian Army received its first batch of three Apache AH-64E attack helicopters from the U.S. at Hindon airbase. These advanced helicopters, to be deployed in Jodhpur, will enhance Army Aviation's combat capability along the Western border and high-altitude areas.

Description:
Key Facts:

- **Type:** Multi-role Combat Helicopter
- **Also Known as:** Apache Guardian
- **Country of Origin:** United States
- **Manufacturer:** Boeing
- **Used for:** Reconnaissance, precision strikes, close air support

IN Apache in Indian Defence:

- **IAF:** 22 AH-64E Apache helicopters operational
- **Indian Army:** 6 additional AH-64Es ordered in 2020; first batch to be delivered soon

Technical Features:

- **Length:** 17.8 m
- **Max Take-Off Weight:** 10,433 kg
- **Max Speed:** 300 km/h
- **Range:** 500 km

Advanced Capabilities:

- Open systems architecture with upgraded **navigation, sensors, and communication**
- Enhanced **infrared + night vision** integration
- **Greater thrust and lift**, digital operability, cognitive decision support

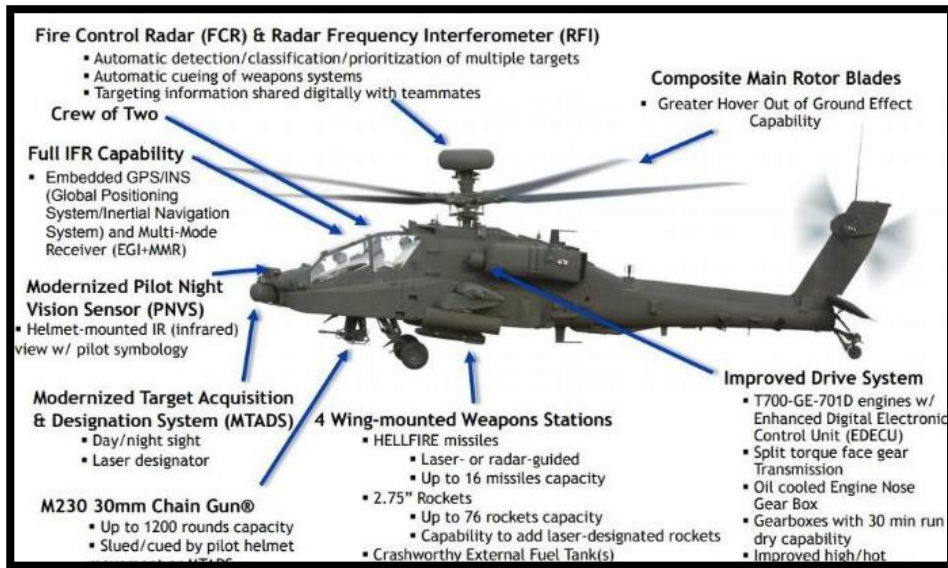
Weapons Payload:

- **30 mm M230 Chain Gun** – accurate high-rate fire
- Up to **16 AGM-114 Hellfire missiles** – anti-armour
- **Hydra 70 unguided rockets** and **Stinger air-to-air missiles**

Other Users:

Egypt, Israel, Japan, UK, Saudi Arabia, UAE, South Korea, Netherlands, etc.

Space for Notes:


Space for Notes:

MiG-21 Fighter Jets

Why in News?

The Indian Air Force will retire its MiG-21 Bison fighter jets in September 2025 after over six decades of service. A ceremonial send-off is planned at Chandigarh airbase, with Tejas Mk1A expected to replace the ageing fleet.

Description:

- **Origin:**
 - First supersonic fighter in the Indian Air Force (IAF).
 - Inducted in 1963.
 - Designed by the Mikoyan-Gurevich Design Bureau (OKB) of the Soviet Union.
- **Deployment & Numbers:**
 - Over 800 variants of MiG-21 inducted by IAF over the decades.
 - Known for being the backbone of the IAF for several decades.
- **Current Operational Squadrons (as of 2025):**
 - Two MiG-21 Bison squadrons remain:
 - No. 3 Squadron 'Cobras' – based in Bikaner.
 - No. 23 Squadron 'Panthers' – based in Suratgarh.
 - Both squadrons will be phased out by 2025.

MiG-21 Bison – Upgraded Variant:

- MiG-21 Bison is the upgraded version of the MiG-21bis.
- MiG-21bis was first inducted into the IAF in 1976.
- The first MiG-21 Bison was received by IAF in 2001, and the last in 2008.
- The upgrade improved:
 - Avionics
 - Radar systems
 - Weapons capabilities (including BVR – Beyond Visual Range missiles).

Earlier Versions:

- **MiG-21 FL:**
 - An earlier variant of the MiG-21 series.
 - Inducted in 1963.
 - Phased out in 2013.



Yard 12652 – INS Udaygiri (Project 17A Stealth Frigate)

Space for Notes:

Why in News?

INS Udaygiri, the second ship of Project 17A, was delivered to the Indian Navy on 01 July 2025 by Mazagon Dock Shipbuilders Limited (MDL), Mumbai.

Description:

Project 17A (P17A): A follow-on of the Shivalik-class (Project 17) frigates. Aimed at building advanced **multi-mission stealth frigates** with enhanced indigenous content.

- **INS Udaygiri (Yard 12652):**
 - 2nd of 7 P17A stealth frigates.
 - Built by MDL, Mumbai (others also by GRSE, Kolkata).
 - Delivered in record time of 37 months from launch.
- **Design & Features:**
 - Larger hull (+4.54%) vs Shivalik class.
 - Enhanced **stealth, sleek design, state-of-the-art weapons & sensors**.
 - Uses **CODOG propulsion**: Combined Diesel or Gas (diesel engine + gas turbine).
 - Equipped with:
 - **Supersonic Surface-to-Surface Missiles**
 - **Medium-Range Surface-to-Air Missiles**
 - **76 mm main gun**
 - **30 mm and 12.7 mm Close-In Weapon Systems (CIWS)**
 - Fitted with **Integrated Platform Management System (IPMS)**.
- **Legacy:**
 - Named after the old INS Udaygiri, a steam-powered frigate decommissioned in 2007.
- **Indigenous Content & Employment:**
 - Over **200 MSMEs** involved.
 - Major weapons/sensors from **Indian OEMs**.
 - **~4,000 direct jobs, ~10,000 indirect jobs** generated.
- **Strategic Role:**
 - Capable of operating in **Blue Water environments**, dealing with **conventional and non-conventional threats**.



Astra Missile

Why in News?

India successfully test-fired the indigenous Astra beyond visual range air-to-air missile from a Su-30 Mk-I aircraft off the Odisha coast. The missile, developed by DRDO, hit high-speed aerial targets with precision, validating its indigenous radio frequency seeker.

Description:

- **Name:** Astra
- **Type:** Beyond Visual Range Air-to-Air Missile (BVRAAM)
- **Indigenous:** Designed and developed entirely in India.

Key Features:

- **Range:** Exceeds 100 km.
- **Seeker:** Equipped with indigenous Radio Frequency (RF) seeker.
- **Launch Platform:** Su-30 Mk-I fighter aircraft.
- **Navigation:** Advanced guidance and navigation systems for precision targeting.
- **Accuracy:** Capable of pin-point accuracy in target engagement.

Development & Collaboration:

- Developed by Defence Research and Development Organisation (DRDO).
- Over 50 public and private sector industries contributed.
- Major partners include Hindustan Aeronautics Limited (HAL).

Target Trials & Validation:

- Tested against high-speed aerial targets at various ranges and angles.
- Successful destruction of targets in both test launches.
- Subsystems, including the RF seeker, functioned flawlessly.
- Flight data validated through Range Tracking instruments at Integrated Test Range (ITR), Chandipur.

Strategic Significance:

- Enhances Indian Air Force's air superiority capabilities.
- Boosts self-reliance in defence technology under 'Aatmanirbhar Bharat'.
- Competent alternative to foreign BVRAAMs like AMRAAM and Meteor.

Space for Notes:

Patriot Air Defence Missile System
Why in News?

The United States and European allies are sending Patriot air defence systems to Ukraine to strengthen its defence against Russian missile and drone attacks. Ukraine has used the system to intercept advanced threats, including Russia's Kinzhal hypersonic missile.

Description:

- **Full Form:** Phased Array Tracking Radar for Intercept on Target.
- **Type:** Mobile, all-altitude, all-weather, surface-to-air missile (SAM) system.
- **Role:** Intercepts enemy aircraft, tactical ballistic missiles, cruise missiles, and loitering munitions.

Origin and Manufacturer:

- Developed by **Raytheon Technologies Corporation (USA)**.
- In service with the **US Army** since the 1980s.

Deployment History:

- **Combat Proven:**
 - First used in the 1991 **Gulf War** (defending Saudi Arabia, Israel, Kuwait).
 - Used in **2003 US invasion of Iraq**.
- Widely exported to US allies:
 - Examples: Germany, Greece, Israel, Japan, Kuwait, Netherlands, Saudi Arabia, South Korea, Poland, Sweden, Qatar, UAE, Romania, Spain, Taiwan.

Key Features:

- **Battery Components:**
 - Phased Array Radar.
 - Engagement Control Station.
 - Up to 8 launchers (each with 4 ready-to-fire missiles).
 - Power and computer systems.
- **Radar Range:** Over 150 km.
- **Missile Range:** Up to 160 km (varies by interceptor type).
- **Altitude:** Intercepts targets >24 km.

Missile Variants:

- **PAC-2:**
 - Uses blast-fragmentation warhead.
- **PAC-3:**
 - Advanced “hit-to-kill” kinetic interceptor.
 - Higher precision; designed to destroy ballistic missile warheads.

Working Principle:

- Track-via-Missile (TVM) guidance system.
- Radar tracks target and missile.
- Mid-course corrections from the Engagement Control Centre.
- Can intercept aircraft, cruise missiles, tactical ballistic missiles.

Use in Ukraine War:

- **Context:**
 - Ukraine requested more Western air defences to counter Russian missile and drone attacks.
 - The US and European partners have sent Patriot systems and interceptors.
- **Capabilities in Ukraine:**
 - Successfully intercepted advanced threats (e.g., Russian Kinzhal hypersonic missile).
 - Enhances Ukraine’s layered air defence.


Space for Notes:

Biotechnology Career Advancement and Re-orientation (BioCARE) Programme

Why in News?

Seventy-five women scientists selected under the DBT Biocare programme (March 2025) are still awaiting funds and salaries, delaying their research projects. The Ministry cited a new fund disbursal policy as the reason, raising concerns over career setbacks.

Description:

- **Launched in 2011** by the Department of Biotechnology (DBT), GoI.
- **Objective:** Promote **women scientists** in Biotechnology & allied areas by supporting career development and re-entry into research after breaks.

Mandate:

- Support **unemployed / career-break women scientists** up to age **55 years**.
- Provide **first independent extramural research funding** as **Principal Investigator (PI)**.
- Build capacity for women to re-enter **mainstream science & research**.

Thrust Areas:

- **Animal & Marine Biotechnology**
- **Bioengineering & Biomaterials**
- **Medical Biotechnology**
- **Environmental Biotechnology & Bioenergy**
- **Plant & Agricultural Biotechnology**

Significance:

- Provides **fellowship + research grant** to women in STEM.
- Encourages **gender equity** in Science & Technology.
- Strengthens India's **biotechnology research ecosystem** by tapping underutilized talent pool.

Primary Amoebic Meningoencephalitis (PAM)

Why in News?

Recently, Kerala's health department has sounded an alert in Kozhikode district after three back to back cases of the rare primary amoebic meningoencephalitis (PAM) were reported in the region.

Description:

- **Definition:** A rare but highly fatal infection of the brain and meninges.
- **Causative Agent:**
 - **Naegleria fowleri** (popularly called the "brain-eating amoeba").
 - Free-living amoeba found in **warm freshwater and soil**.

Types of Amoebic Encephalitis:

1. **Primary Amoebic Meningoencephalitis (PAM):**
 - Caused by **Naegleria fowleri**.
 - **Rapid progression** → often fatal within days.
2. **Granulomatous Amoebic Encephalitis (GAE):**
 - Caused by **Acanthamoeba spp.** and **Balamuthia mandrillaris**.
 - Develops more slowly, but still deadly.

Transmission:

- Occurs in **shallow surface waters, warm freshwater bodies, and poorly maintained swimming pools, hot tubs, spas**.
- Entry through **nose** while:
 - Swimming
 - Diving
 - Jumping into infected water
- Amoeba invades **olfactory nerves** → **brain** → **meninges**.

Space for Notes:

Affected Population:

- Mostly young, active people.
- Higher risk in warm climates.

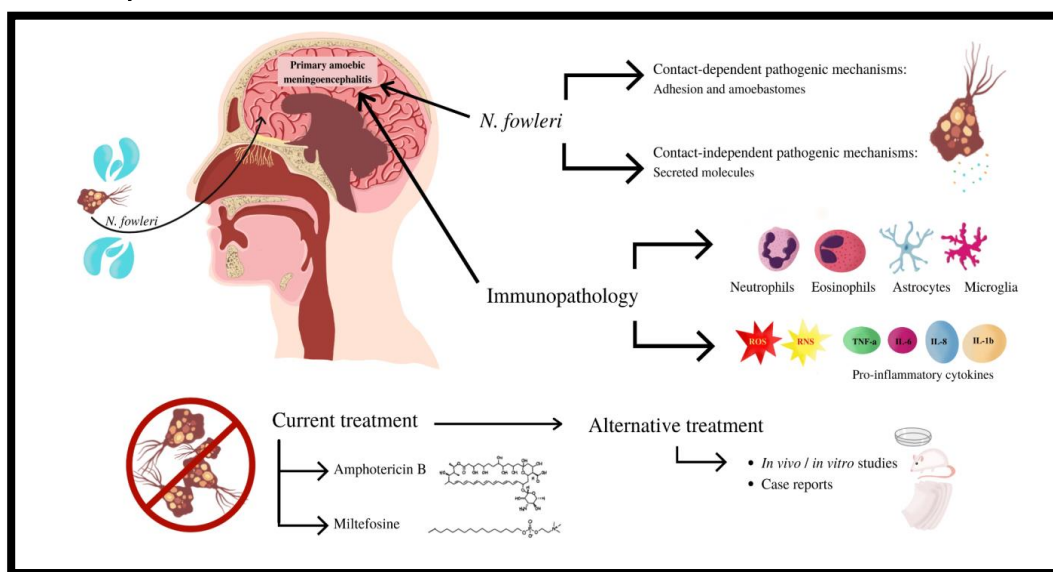
Symptoms:

- Early: sore throat, headache, frontal pain
- Later: hallucinations, nausea, vomiting, fever
- Rapid deterioration → coma & death

Mortality: Extremely high (>95%).

Treatment:

- Early diagnosis + aggressive therapy may help.
- Drugs tried: Amphotericin B, Miltefosine, Azithromycin.
- Recovery is rare.

Space for Notes:

Haemophilia A
Why in News?

India continues to face high under-diagnosis of haemophilia, with only 20% of estimated cases identified. The article highlights the shift in treatment from on-demand therapy to prophylaxis—a globally recognized gold standard—aimed at preventing bleeds and disability.

Description:
Haemophilia A:

- **Type:** Genetic/hereditary bleeding disorder
- **Cause:** Deficiency of clotting factor VIII
- **Effect:** Blood doesn't clot properly, leading to **excessive bleeding**, both external and internal.
- **Inheritance:** X-linked recessive disorder
 - Affects mostly males
 - Females are typically carriers, may show mild symptoms

Causes and Biology:

- Part of the **coagulation cascade**, involving 20+ clotting factors
- Deficiency in **Factor VIII** leads to **Haemophilia A**
- Caused by an **altered gene**, inherited from parents

Symptoms:

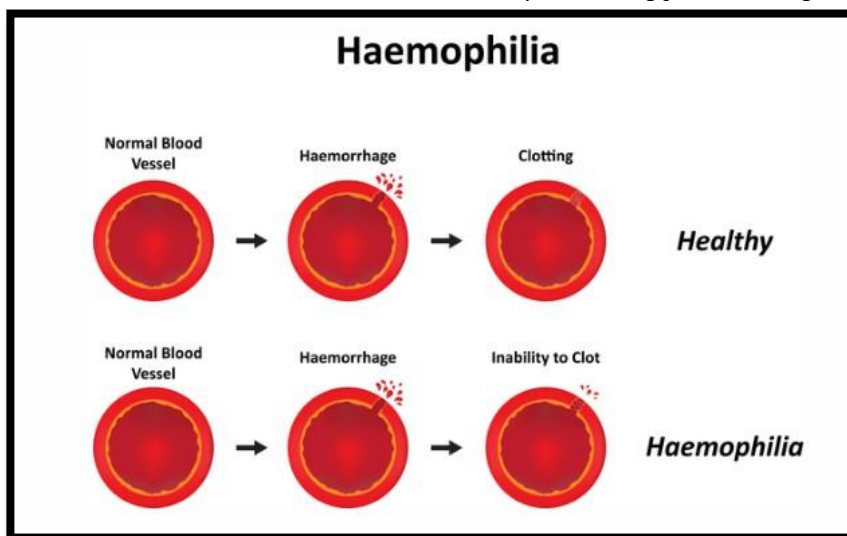
- **Prolonged bleeding**, especially after injury or surgery
- **Spontaneous internal bleeding**, often into joints (**hemarthrosis**) causing pain and swelling
- **Bleeding after circumcision** (early sign in infants)

Space for Notes:

- Other signs:
 - Blood in urine or stool
 - Easy bruising
 - Frequent nosebleeds
 - Gastrointestinal and urinary tract bleeding
 - Bleeding gums
 - Joint stiffness, swelling, and pain

Treatment:

- **Factor VIII replacement therapy**
 - Intravenous injection of concentrated clotting factor VIII
- **Prophylaxis:**
 - Regular/preventive replacement to **prevent bleeding episodes**
 - Can also be administered **subcutaneously** with newer non-factor products
 - Regarded as **gold standard treatment**
- **On-demand therapy:**
 - Used after a bleed occurs – less effective in preventing joint damage


Space-Based Solar Power (SBSP)
Why in News?

A King's College London study (2025) published in Joule estimated that SBSP could supply up to 80% of Europe's renewable energy needs by 2050.

Description:

- Concept: Satellites in **geostationary orbit** harvest continuous sunlight and beam it to Earth as **microwaves**.
- Ground stations convert microwaves into electricity.
- Based on **NASA-developed concepts**:
 - **Heliosat swarm design** (continuous mirror reflectors).
 - **Planar array design** (intermittent).

Advantages of SBSP:

- **Continuous solar power** → unaffected by day-night cycle or weather.
- **Higher solar radiation in space** (no atmospheric losses).
- **Zero-carbon, dispatchable power** → addresses intermittency problems of terrestrial solar/wind.

Challenges & Limitations:

1. **Scale of infrastructure:**
 - A single SBSP satellite: >1 km across.
 - Ground receiver station: >10 km across.
2. **Launch requirements:** Hundreds of launches needed for one satellite (for comparison: ISS took >40 flights).

3. High costs:

- Current launch, assembly, and maintenance costs are prohibitively high.
- ESA & The Guardian → cost-effectiveness unlikely **before 2050**.

4. Space-specific issues:

- Orbital congestion.
- Transmission interruptions.
- Microwave beaming variability.

Global Perspectives:

- **European Space Agency (ESA):** Exploring SBSP, but cites scale & cost barriers.
- **International Energy Agency (IEA):** Solar is fastest-growing renewable; SBSP discussed as a futuristic solution.
- **India:** ISRO has shown interest in wireless power transmission & solar satellite feasibility studies.

India's First Private Earth Observation (EO) Satellite Constellation

Why in News?

IN-SPACE approved a Pixxel-Space India-led consortium to set up India's first fully indigenous private earth observation satellite constellation under the PPP model, investing ₹1,200 crore for 12 satellites to boost geospatial intelligence and reduce foreign reliance.

Description:

1. Consortium & Investment:

- **Lead Organisation:** PixxelSpace India, Bengaluru.
- **Members:** Piersight Space, Satsure Analytics India, Dhruva Space.
- **Investment:** ₹1,200+ crore over 5 years.
- **Selection:** Chosen via competitive bid by IN-SPACE against three consortia.

2. Project Overview:

- **Objective:** Build India's first fully indigenous commercial EO satellite constellation.
- **Scale:** 12 advanced EO satellites under a Public-Private Partnership (PPP).
- **Technology:** Satellites equipped with panchromatic, multispectral, hyperspectral, and SAR sensors.

3. Applications:

- **Environmental & Social:**
 - Climate change monitoring
 - Disaster management
 - Agriculture and infrastructure planning
- **Strategic Uses:**
 - Marine surveillance
 - National security
 - Urban planning
- **Commercial:** Provide high-quality geospatial intelligence for global markets.

4. Significance for India:

- **Data Sovereignty:** Reduces dependency on foreign EO data.
- **Economic & Strategic Boost:** Strengthens India's leadership in space-based data solutions.
- **Industry Milestone:** First large-scale space project led entirely by a private Indian consortium.

5. Government & IN-SPACE Role:

- **PPP Framework:**
 - The government provides strategic, technical, and policy support.
 - Consortium handles satellite manufacturing, launch, ground systems, and commercialization.
- **Phased Deployment:** Constellation rollout over 4 years for service upgrades and coverage expansion.

Space for Notes:

Russia's MAX Messaging App

Why in News?

Russia launched MAX, a state-sanctioned messaging app, as part of efforts to control the internet and curb foreign influence. Amid increasing censorship and Western tech bans, this move is seen as a step toward a fully sovereign Russian internet.

Description:

- MAX is a **state-sanctioned messaging app** developed under the orders of President Vladimir Putin.
- It is part of Russia's effort to build a "**sovereign internet**", fully controlled by the Kremlin.
- The app is expected to be **pre-installed on all new smartphones** sold in Russia starting **September 2025**.

Features of MAX:

- Text & video messaging.
- Access to **government services**.
- Mobile payment integration.
- Servers hosted **within Russia**, allowing full government access.

Purpose and Intent:

- Curb the use of **foreign apps** like WhatsApp, Telegram, Facebook, etc., which are viewed as Western surveillance threats.
- Strengthen state control over **information flow, online discourse, and digital services**.
- Allow **FSB (Russian Federal Security Service)** potential access to user data under Russian law.

Strategic Context:

- Part of Russia's push for a **state-controlled digital ecosystem**, especially post-Ukraine war sanctions.
- In line with bans on **Meta platforms, Google, and TikTok** functionalities.
- Follows similar models seen in **China** (e.g., WeChat).

Experts' Concerns:

- May function as a **mass surveillance tool** ("digital gulag").
- Risks further **curtailing digital freedoms and human rights**.
- Could **replace WhatsApp** (used by 70%+ Russians), now expected to be **banned**.

PSLV-C61 / EOS-09 Mission

Why in News?

The failure analysis of ISRO's PSLV-C61/EOS-09 mission has been completed, identifying a third-stage snag as the cause. ISRO Chairman V. Narayanan stated the report will soon be submitted to Prime Minister Modi, describing the issue as "small."

Description:

On **19 May 2025**, ISRO's PSLV-C61 mission failed to place the **Earth Observation Satellite-09 (EOS-09)** into its intended **sun-synchronous polar orbit** due to a **glitch in the third stage** of the rocket.

About PSLV (Polar Satellite Launch Vehicle):

Feature	Details
Developed by	ISRO
Known as	"Workhorse of ISRO"
Total PSLV missions	101 (till PSLV-C61)
Uses	To place satellites in SSO, GTO, Navigation orbits
Successes	Chandrayaan-1 (2008), Mars Orbiter Mission (2013), PSLV-C37 (104 satellites in 2017)

Space for Notes:

Structure (4 stages):

1. **PS1:** Solid fuel with 6 strap-on boosters
2. **PS2:** Liquid engine (Vikas engine)
3. **PS3:** Solid fuel (failed in PSLV-C61)
4. **PS4:** Two liquid engines for final insertion

Variants:

- PSLV-XL (extended boosters)
- PSLV-DL (2 strap-ons)
- PSLV-QL (4 strap-ons)

→ Chosen based on payload size/orbit

EOS-09 (also called RISAT-1B):

Feature	Details
Type	Earth Observation Satellite
Payload	C-band Synthetic Aperture Radar (SAR)
Capability	All-weather, day & night Earth imaging
Resolution	Up to 1 metre, swath of 10–225 km
Applications	Agriculture, forestry, disaster mgmt, coastal security, defence
Orbit Intended	Sun-Synchronous Orbit (SSO)

LVM3 (GSLV Mk III) & Bluebird Satellite Mission
Why in News?

ISRO is set to launch the 6,500-kg U.S.-built Block 2 BlueBird communication satellite aboard LVM3 in late 2025. This marks a major Indo-U.S. space collaboration following the NISAR mission, and highlights ISRO's expanding commercial capabilities.

Description:

- ISRO is set to launch the **Bluebird satellite**, a large communication satellite developed by **AST SpaceMobile (USA)**, in **Feb–Mar 2025** using **GSLV**, most likely the **LVM3 (GSLV Mk III)**.
- This marks the **first heavy US satellite** to be launched by India – a strategic move in Indo-US space cooperation.

About LVM3 (Launch Vehicle Mark-3) – GSLV Mk III:

Parameter	Details
Developed by	ISRO (Indian Space Research Organisation)
Earlier Name	GSLV Mk III
Category	Medium to Heavy-lift Launch Vehicle
Height	43.5 meters
Diameter	4.0 m (Fairing: 5.0 m)
Lift-off Mass	640 tonnes
Payload to GTO	4,000 kg
Payload to LEO	8,000 kg
Stages	3 (Solid + Liquid + Cryogenic)
Indigenous	Fully Indian technology

Stages of LVM3:

Stage	Propellant	Description
Booster Stage	Solid (HTPB)	Twin S200 solid rocket boosters
Core Stage	Liquid (UH25 + N ₂ O ₄)	Two Vikas engines
Cryogenic Stage	Liquid (LOX + LH ₂ – CE-25)	High-thrust indigenous cryogenic engine

Space for Notes:

Major Missions of LVM3:

Mission Name	Launch Date	Payload	Notes
LVM3/CARE	Dec 18, 2014	CARE Module	Suborbital; tested re-entry capsule
LVM3-D1 / GSAT-19	June 5, 2017	GSAT-19	First full orbital flight
LVM3-D2 / GSAT-29	Nov 14, 2018	GSAT-29	Communication satellite
LVM3 M1 / Chandrayaan-2	July 22, 2019	Chandrayaan-2	India's second Moon mission
LVM3 M2 / OneWeb-1	Oct 23, 2022	OneWeb Gen-1 Satellites	First commercial launch
LVM3 M3 / OneWeb-2	Mar 26, 2023	OneWeb Gen-1 Satellites	Second batch commercial
LVM3 M4 / Chandrayaan-3	July 14, 2023	Chandrayaan-3	Successful soft-landing on Moon

Space for Notes:
Bluebird Satellite – Key Facts:

Parameter	Details
Developer	AST SpaceMobile (Texas, USA)
Satellite Mass	~6,000 kg (Heavy-class satellite)
Antenna Area	~64 square meters (Half a football field)
Orbit	Low Earth Orbit (LEO)
Launcher	GSLV (likely Mk III / LVM3)
Unique Capability	Direct 5G voice + broadband to regular smartphones
Purpose	Space-based telecom services in rural/remote areas

Strategic & International Significance:
For India:

- **Commercial Boost:** Entry into heavy satellite launch market.
- **ISRO Branding:** Competes with SpaceX and Ariane.
- **Atmanirbhar Bharat:** Shows India's capability in cryogenic tech and heavy payloads.
- **Revenue:** Brings commercial income through global satellite services.

For India-US Relations:

- **First time a US heavy satellite is launched by India.**
- Shows strategic trust in ISRO's reliability.
- Diversifies US satellite launch options beyond SpaceX.

INS Himgiri vs INS Udaygiri – Project 17A Frigates
Why in News?

The Indian Navy will commission two Project 17A stealth frigates, INS Udaygiri and INS Himgiri, at Visakhapatnam, marking the first-ever simultaneous induction of frontline warships with advanced weaponry, sensors, and 75% indigenous content, showcasing India's shipbuilding expertise and naval strength.

Description:

Feature	INS Himgiri	INS Udaygiri
Shipyard	Built at Garden Reach Shipbuilders & Engineers (GRSE), Kolkata	Built at Mazagon Dock Shipbuilders Limited (MDSL), Mumbai
Project	3rd ship of Nilgiri-class (Project 17A)	2nd ship of Nilgiri-class (Project 17A)
Delivery (Latest News)	Delivered to Indian Navy at GRSE, 2025	Delivered to Indian Navy at MDSL, 2025

Space for Notes:

Legacy	Reincarnation of erstwhile INS Himgiri (Leander-class frigate, decommissioned in 2005)	Modern avatar of erstwhile INS Udaygiri (Steam ship, decommissioned in 2007)
Design	Designed by Warship Design Bureau (WDB) and overseen by Warship Overseeing Team (Kolkata)	Same P-17A design, follow-on of Shivalik-class (Project 17)
Propulsion	Combined Diesel or Gas (CODOG) – diesel engine + gas turbine → drives Controllable Pitch Propeller (CPP) on each shaft	Same CODOG propulsion system with CPP & Integrated Platform Management System (IPMS)
Weapon Suite	- Supersonic Surface-to-Surface missiles - Medium-Range Surface-to-Air missiles - Close-in Weapon Systems (CIWS)	- Supersonic Surface-to-Surface missiles - Medium-Range Surface-to-Air missiles - 76 mm Gun - 30 mm & 12.7 mm CIWS
Stealth & Sensors	P-17A has advanced stealth, survivability & combat capability vs Shivalik class	P-17A ships have enhanced stealth + state-of-the-art weapons & sensors (indigenous sourcing)
Indigenisation	75% indigenous content , involving 200+ MSMEs at GRSE	Major weapons & sensors sourced from indigenous OEMs
Significance	Showcases India's Atmanirbharta in warship design & construction	Supports self-reliance, economic growth, MSME ecosystem & employment generation

- Both are Nilgiri-class (Project 17A) frigates, follow-on of Shivalik-class (Project 17).
- Equipped with CODOG propulsion + CPP + IPMS.
- Stealth features & advanced indigenous sensors/weapons.
- Reflecting India's push for Atmanirbhar Bharat in naval defence manufacturing.

DRDO's Integrated Air Defence Weapon System (IADWS)

Why in News?

The Defence Research & Development Organisation (DRDO) successfully conducted the maiden flight test of the indigenous Integrated Air Defence Weapon System (IADWS) off the Odisha coast. Marks a major step towards multi-layered, indigenous air defence capability for India.

Description:

- **IADWS = Multi-layered Air Defence System** developed by DRDO.
- **Key Components:**
 - **Quick Reaction Surface-to-Air Missiles (QRSAMs)** → for medium-range aerial threats.
 - **VSHORADS (Very Short-Range Air Defence Systems)** → man-portable defence against low-flying aircraft, drones, helicopters.
 - **High-power Laser-based Directed Energy Weapon (DEW)** → futuristic technology to destroy drones and UAVs.
- **Support Systems:** Integrated radars, drone detection & destruction units, command & control systems, communication networks.

Test Details:

- Conducted from **Integrated Test Range (ITR)**, Chandipur, Odisha.
- Targets:
 - **2 high-speed UAVs**
 - **1 multi-copter drone**
- All three were destroyed **simultaneously at different ranges and altitudes** by QRSAM, VSHORADS & DEW.
- All subsystems performed flawlessly → confirmed by ITR tracking instruments.

Significance:

- Provides **layered protection against aerial threats** (drones, UAVs, aircraft, cruise missiles).
- First Indian system to **integrate missiles with a Directed Energy Weapon**.
- Reduces dependency on imports like **NASAMS-II (US)** or other foreign systems.
- Strengthens India's **air defence architecture** → critical for protecting metros, strategic assets, and military bases.

Agni-V Missile
Why in News?

India successfully test-fired the nuclear-capable **Agni-5 missile** from Chandipur, Odisha (August 20, 2025). The test, conducted under the **Strategic Forces Command**, validated operational parameters. Earlier in March 2024, Agni-5 was tested with **MIRV technology**, enhancing India's strategic deterrence capability.

Description:

- **Type:** Intermediate-Range Ballistic Missile (IRBM), but with potential **Intercontinental Ballistic Missile (ICBM)** capability.
- **Developed by:** Defence Research and Development Organisation (DRDO).
- **Manufactured by:** Bharat Dynamics Limited (BDL).
- **User:** Strategic Forces Command (SFC).
- **Status:** Active in service.

Technical Specifications:

- **Range:**
 - Base range: **5,400 km**.
 - Extended capability: **7,000–8,000 km**, giving it near-ICBM capability.
- **Weight:** 50,000–56,000 kg.
- **Length:** 17.5 m.
- **Diameter:** 2 m.
- **Warhead Capacity:**
 - 3–6 tested warheads.
 - Can carry **10–12 nuclear MIRVs** (Multiple Independently targetable Re-entry Vehicles).
- **Warhead weight:** 3,000–4,000 kg.
- **Speed:** Up to **Mach 24** (29,400 km/h).

Mobility & Launch Platform:

- **Road Mobile:** Mounted on **8×8 Tatra Transporter-Erector-Launcher (TEL)**.
- **Rail Mobile:** Canisterised Missile Package.
- **Transport:** Road + Rail (canisterised for survivability).

Propulsion & Fuel:

- **Stages:** Three-stage missile.
- **Propellant:** Solid fuel (improves readiness & storage life).

Space for Notes:

Guidance & Navigation:

- RLG-INS (Ring Laser Gyroscope – Inertial Navigation System).
- Multi-GNSS support (GPS, GLONASS, IRNSS, etc.).
- Redundant micro-inertial navigation for precision.

Agni Missile Series:

Missile	Type / Stage	Range	Warhead Capacity	Propulsion	Status / Notes
Agni-I	Short Range Ballistic Missile (SRBM), Single-stage	700 – 1,200 km	~1,000 kg	Solid	Inducted in 2004; Can target Pakistan completely
Agni-II	Medium Range Ballistic Missile (MRBM), Two-stage	2,000 – 3,500 km	~1,000 kg	Solid	Road & Rail mobile; Covers China's southern provinces
Agni-III	Intermediate Range Ballistic Missile (IRBM), Two-stage	3,000 – 5,000 km	~1,500 kg	Solid	High accuracy; Can cover almost all of China
Agni-IV	Intermediate Range Ballistic Missile (IRBM), Two-stage	3,500 – 4,000 km	~1,000 kg	Solid	Advanced navigation; lighter composite materials
Agni-V	Intercontinental Ballistic Missile (ICBM), Three-stage	5,000 – 5,500+ km	~1,500 kg	Solid	Canister-launched; MIRV capable (in future); Covers entire China & beyond
Agni-VI (under development)	Intercontinental Ballistic Missile (ICBM), Three-stage	8,000 – 10,000 + km (speculated)	MIRV capable (Multiple warheads)	Solid	To be submarine & land-based; Next-gen deterrent

Project 17A – Stealth Frigate 'Himgiri' Delivered
Why in News?

The Indian Navy received Himgiri, an advanced guided-missile frigate built by GRSE under Project 17A. It marks a major step toward self-reliance in warship construction and is the third ship of the Nilgiri-class, featuring modular, multi-mission capabilities.

Description:

Delivered on: 31st July 2025

Location: GRSE, Kolkata

About Project 17A (P-17A):

- Follows the **P-17 (Shivalik-class)** stealth frigates.
- Aimed at constructing **advanced stealth multi-mission frigates**.
- **Seven frigates** planned under P-17A:
 - Four by Mazagon Dock Shipbuilders Ltd (MDL), Mumbai.
 - Three by Garden Reach Shipbuilders & Engineers (GRSE), Kolkata.

Space for Notes:

Himgiri (Yard 3022):
Key Highlights:

- 3rd ship of Nilgiri Class (P-17A).
- 1st P-17A frigate built by GRSE.
- Named after the erstwhile INS Himgiri (Leander-class), decommissioned in 2005.
- Reflects quantum leap in:
 - Stealth
 - Survivability
 - Combat capability
 - Automation
 - Modular construction
- Designed by: Warship Design Bureau (WDB).
- Construction overseen by: Warship Overseeing Team (Kolkata).

Design & Technology Features:

- Construction Philosophy: Integrated Modular Construction
- Propulsion:
 - CODOG (Combined Diesel or Gas)
 - Diesel engines + Gas turbines
 - Drives Controllable Pitch Propeller (CPP)
- Weapon & Sensor Suite:
 - Supersonic Surface-to-Surface Missiles (SSM)
 - Medium-Range Surface-to-Air Missiles (MRSAM)
 - 76 mm Naval Gun
 - 30 mm + 12.7 mm Close-in Weapon Systems (CIWS)
- Platform Control: Integrated Platform Management System (IPMS)

Indigenisation & Employment Impact:

- Indigenous content: ~75%
- MSME involvement: Over 200 MSMEs
- Employment generation:
 - ~4,000 direct
 - ~10,000 indirect

Significance:

- Boosts Aatmanirbharta in defence shipbuilding.
- Enhances India's blue-water navy capability.
- Demonstrates India's growing prowess in indigenous warship design & manufacturing.

Quasi-Moon Vs Mini-Moon vs Trojan vs Horseshoe Orbits
Why in News?

Astronomers discovered asteroid 2025 PN7, a tiny quasi-moon trailing Earth in a Sun-centered orbit since 1957. Unlike short-lived mini-moons, quasi-moons remain for decades. Likely the smallest of its kind, it will stay in Earth's vicinity for about 126 years.

Description:
Earth's Co-Orbital Companions:

Feature	Quasi-Moon (Quasi-Satellite)	Mini-Moon (Temporary Satellite)	Trojan Orbit	Horseshoe Orbit
Orbit type	Sun-centered (heliocentric), similar to Earth's	Captured temporarily by Earth's gravity	Sun-centered, located at L4/L5 Lagrange points (60° ahead/behind Earth)	Sun-centered, alternates between leading and trailing Earth

Space for Notes:

Bound to Earth?	Not gravitationally bound	Gravitationally bound (for months–years)	Not bound	Not bound
Appearance from Earth	Appears to orbit Earth, but is actually orbiting Sun	True (temporary) moon of Earth	Appears as if it's always ahead or behind Earth	Appears as if it “swings” in a horseshoe path relative to Earth
Stability	Decades (e.g., 2025 PN7 ~1955–2085)	Short-term (months to few years)	Stable over long timescales (millions of years for Jupiter's Trojans)	Intermediate stability
Examples	2025 PN7 (smallest & least stable known), 469219 Kamo'oalewa	2024 PT5 (detected in 2024), 2020 CD3	Jupiter Trojans (thousands), Earth Trojan 2010 TK7	Earth horseshoe: 3753 Cruithne
Significance	Allows long-term study of small asteroids	Useful for studying temporary Earth captures	Show gravitational stability near Lagrange points	Show dynamic orbital evolution around Earth's path

Rabies

Why in News?

The Delhi government, in collaboration with United Nations Development Programme(UNDP), will implant microchips in around 10 lakh stray dogs to strengthen rabies control, digitise vaccination records, and manage stray populations. The initiative comes amid rising dog-bite and rabies cases in the city.

Description:

- **Rabies:** A deadly zoonotic viral disease caused by the *Rabies Virus (RABV)*.
- **Family:** *Rhabdoviridae*; **RNA virus**.
- **Target:** Nervous system → causes acute encephalitis (inflammation of brain).
- **Neglected Tropical Disease (NTD)** affecting poor & rural populations, esp. in Asia and Africa.

Transmission:

- Spread mainly through **saliva of infected animals**.
- **Dogs:** Responsible for up to **99% of human rabies cases**.
- Entry routes:
 - **Bites** by infected animals.
 - Rarely: saliva entering **open wounds** or **mucous membranes** (eyes, mouth).
- Found on all continents except **Antarctica**.

Pathogenesis:

- Virus either:
 1. Directly enters the **Peripheral Nervous System (PNS)** → migrates to the brain.
 2. Replicates in **muscle tissue** → enters nerves via **neuromuscular junctions**.
- Leads to **fatal encephalitis** once CNS is infected.

Space for Notes:

Symptoms:

- **Incubation:** Usually 2–3 months (can range 1 week–1 year).
- **Early signs:** fever, pain, tingling/burning at wound site.
- **Advanced stage:**
 - **Furious rabies** → hyperactivity, hallucinations, hydrophobia.
 - **Paralytic rabies** → gradual paralysis, coma.
- **Once symptoms appear** → 100% fatal.

Prevention:

- **Vaccine-preventable disease.**
- **Dog vaccination** (including puppies) → most cost-effective method (stops transmission at source).
- **WHO goal:** Zero human deaths from dog-mediated rabies by 2030.

Treatment:

- **Post-Exposure Prophylaxis (PEP):**
 - Immediate wound washing with soap & water.
 - **Human Rabies Immune Globulin (HRIG).**
 - **4–5 doses of rabies vaccine** (administered ASAP).
- Nearly 100% effective if given promptly before symptoms appear.

AstroSat
Why in News?

AstroSat, India's first multi-wavelength space observatory launched in 2015, has completed 10 years of operations, surpassing its designed 5-year mission life and continuing to deliver valuable astronomical data.

Description:

- India's first dedicated multi-wavelength space observatory
- Launched on **28 September 2015** by PSLV-C30 (XL) from Satish Dhawan Space Centre, Sriharikota
- Designed mission life: **5 years** → Still operational in 2025 (10 years completed)
- Managed by: ISRO Telemetry, Tracking and Command Network (ISTRAC), Bengaluru

Objectives:

- Study **celestial sources** in X-ray, optical, UV simultaneously.
- Understand **high-energy processes** in binary star systems (black holes, neutron stars).
- Study **star formation** within and beyond our galaxy.
- Detect **new X-ray sources.**
- Conduct **UV deep-field survey** of the Universe.

Major Achievements:

- Observed sources ranging from **Proxima Centauri (nearest star)** to **galaxies 9.3 billion light years away.**
- First-time detection of **FUV (Far Ultraviolet) photons** from distant galaxies.
- Provided insights into **black holes, neutron stars, and star birth regions.**

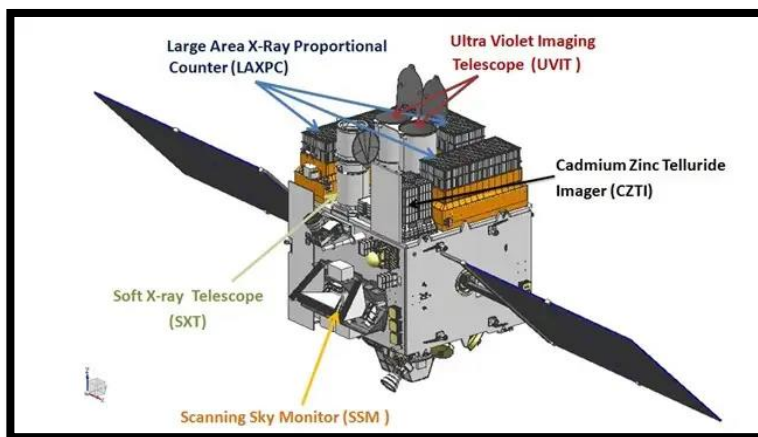
Scientific Payloads (5):

1. **UVIT** – Ultraviolet Imaging Telescope (UV region).
2. **LAXPC** – Large Area X-ray Proportional Counter (high-energy X-rays).
3. **CZTI** – Cadmium-Zinc-Telluride Imager (hard X-rays).
4. **SXT** – Soft X-ray Telescope.
5. **SSM** – Scanning Sky Monitor.

Space for Notes:

Institutional Collaboration:

- Developed by ISRO with participation of:
 - IUCAA (Pune)
 - TIFR (Mumbai)
 - IIA (Bengaluru)
 - RRI (Bengaluru)
- International partners: Canada & U.K.


Space for Notes:
New Farming Technology to Stop Desertification
Why in News?

Researchers at the Central University of Rajasthan successfully grew wheat on arid desert land using **desert soilification technology** with an indigenous bioformulation, demonstrating reduced irrigation needs, higher yields, and potential to combat **desertification in western Rajasthan**.

Description:

- Desertification in India:** Accelerating in western Rajasthan due to:
 - Degradation of **Aravalli ranges**
 - Spread of **sand dunes**
 - Rainfall variability** & climate change
 - Unscientific plantation** and land misuse
- Threat:** Expansion of **Thar desert** towards the **National Capital Region (NCR)**.

Soilification Technology:

- Process:** Modification of desert sand into soil using **polymers + bioformulation**.
- Functions:**
 - Enhances **water retention**
 - Cross-links sand particles → improves soil structure
 - Stimulates **microbial activity** → improves stress resistance of crops

Wheat Experiment (Ajmer, 2024–25):

- Crop:** Wheat-4079 (indigenous variety)
- Area:** 1,000 sq. m in Banseli village, Ajmer
- Sown:** 13 kg seeds → **Harvest:** 260 kg wheat
- Yield ratio:** 1:20 (double compared to arid zone without technology)
- Irrigation:** Only **3–4 cycles** (vs 5–6 normally)

Other Crops Tested:

- Bajra
- Guar gum
- Chickpea
- Results:** **54% higher yield** in bioformulation-amended sand (vs normal desert soil).

Institutional Support:

- **Lead:** CUoR Dept. of Microbiology (Prof. Akhil Agrawal & team)
- **Partners:**
 - Krishi Vigyan Kendra (KVK)
 - Rajasthan Horticulture Department

Significance:

- Helps combat desertification (UNCCD relevance).
- Promotes climate-resilient agriculture in arid zones.
- Reduces water use in farming.
- Increases food security in barren desert regions.
- Example of applied science → societal impact.

India's First Bamboo-based Bioethanol Biorefinery (Numaligarh, Assam)
Why in News?

Prime Minister Narendra Modi inaugurated India's first bamboo-based bioethanol plant in Golaghat, Assam, alongside laying the foundation for a ₹7,230-crore polypropylene project at Numaligarh Refinery. The facility aims to boost clean energy, reduce fossil fuel dependence, and benefit local farmers and tribal communities.

Description:

- **Name:** Bamboo-based 2G Bioethanol Biorefinery
- **Location:** Numaligarh, Assam
- **Developer:** Assam Bio-Refinery Pvt. Ltd. (joint venture of NRL, Fortum & Chempolis)
- **Launch:** September 2025
- **Capacity:**
 - Feedstock → 5 lakh tonnes bamboo / year
 - Output → 49,000 TPA bioethanol + green chemicals (furfural, acetic acid)
 - 25 MW power from lignin/bio-coal

Technology & Process:

- **Type:** 2G (second-generation) ethanol (uses non-food biomass)
- **Technology provider:** Chempolis Oy (Finland) – "Formicobio" fractionation
- **Process:**
 - Bamboo cellulose → fermented to ethanol
 - Hemicellulose → furfural, acetic acid
 - Lignin → bio-coal & electricity
- **Zero-waste:** residues → biochar & power

Significance:

- **Energy security:** Substitutes petrol; aids E20 blending target (2025)
- **Climate benefit:** Carbon-negative; aligns with Net Zero 2070
- **Rural economy:** Income & jobs for NE bamboo growers → promotes Atmanirbhar Bharat
- **Circular economy:** Utilises agri/forest residue efficiently

Related Schemes & Policies:

- **National Policy on Biofuels (2018)** – promotes 2G ethanol
- **E20 Roadmap** – 20% ethanol blending with petrol by 2025
- **North East Bamboo Mission** – encourages bamboo cultivation

Cheyava Falls Rock – Possible Biosignature on Mars
Why in News?

NASA announced that its **Perseverance rover** has detected "potential biosignatures" in a Martian rock named **Cheyava Falls**, containing clay, silt, organic carbon, sulphur, oxidised iron, and phosphorus – the strongest evidence yet suggesting ancient microbial life on Mars, pending further detailed analysis.

Space for Notes:

Description:

- The **Perseverance Rover** discovered “**Cheyava Falls**”, an arrowhead-shaped rock, on the northern edge of **Neretva Vallis**, an ancient river valley feeding **Jezero Crater**.
- Rock shows **chemical signatures & textures** that may indicate past **microbial life** (billions of years ago).
- The area once had **running water** → favourable for life.

Instruments & Findings:

- **SHERLOC** (Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals) detected **organic compounds** in the rock.
- Organics = carbon-based molecules, building blocks of life (but may also arise abiotically).
- Rock also contains **clay, silt, oxidised iron, sulphur, phosphorus** → good preservers of biosignatures.

About Perseverance Rover:

Item	Details
Mission	Part of NASA's Mars 2020 Mission
Nickname	Percy
Launch	30 July 2020 – Cape Canaveral, Florida
Landing	18 Feb 2021 – Jezero Crater
Dimensions	3 m (L) × 2.7 m (W) × 2.2 m (H)
Weight	~1,025 kg
Power	MMRTG – converts plutonium decay heat to electricity
Mobility	6 wheels, robotic arm, drill
Main Objective	Search for signs of ancient life , collect & cache rock/regolith samples for Earth return

Scientific Goals & Sample Strategy:

- Examine ancient lakebed sediments for **biosignatures**.
- Drill rock cores, seal in **metal tubes**, deposit on surface for **future sample-return mission** (joint NASA-ESA).

Significance:

- Strongest hint yet of **past life on Mars**, but **not conclusive**.
- Supports theory that **Neretva Vallis–Jezero region** once had habitable conditions.
- Data will refine our understanding of **astrobiology** & Mars' geologic history.

Caveats / Next Steps:

- Organic molecules may also form through **non-biological reactions**.
- Need for **Earth-based lab analysis** of cached samples.
- Sample-return mission delayed (budget/logistics).

Semicon 2025 – Vikram 32-bit Processor
Why in News?

India launched its first fully indigenous **Vikram 32-bit processor** at **Semicon 2025** in New Delhi, presented to PM Modi. The processor, built for harsh environments, marks a milestone in India's semiconductor self-reliance and future tech-driven economic growth.

Description:

- **Launch:** India's first fully indigenous **Vikram 32-bit processor** presented to PM Modi at **Semicon 2025** (New Delhi).
- **Developer:** Designed and fabricated in India under **Atmanirbhar Bharat** push.
- **Features:**
 - Qualified for **harsh environmental conditions** (use in defense, space, automotive, etc.).
 - Symbol of India's **indigenous semiconductor capability**.
- **Expansion:** Two more semiconductor plants expected to release chips in the next **2–3 months**.

Space for Notes:

Investment Push in Semiconductor Ecosystem:

- **Stable Policy:** India projected as a **lighthouse of stability** amid global policy turmoil.
- **Demand & Growth:**
 - Electronics production & exports are rising.
 - Quarterly increase in semiconductor demand.
- **Startup Ecosystem:**
 - Growing investor confidence in semiconductor design startups.
 - Vibrant innovation environment.

Global Industry Perspective:

- **ASML CEO Christophe Fouquet's View:**
 - **Economic Growth:** Semiconductor industry to generate jobs & boost GDP.
 - **National Resilience:** Enhances supply chain security & innovation.
 - **Partnerships:** ASML ready to collaborate with India.

Ethanol Blending in India
Why in News?

The Supreme Court dismissed a petition challenging the nationwide roll-out of 20% ethanol-blended petrol (E20), upholding the government's policy aimed at supporting farmers, conserving foreign exchange, and reducing emissions despite concerns over vehicle compatibility and consumer choice.

Description:

- **Ethanol:** alcohol-based biofuel, derived from sugarcane, maize, biomass.
- Blending petrol with ethanol → reduces carbon emissions, oil imports, & boosts energy self-reliance.
- **Ethanol Blended Petrol (EBP) Programme:** Launched 2003;
 - E10 achieved in 2022
 - E20 achieved in 2025

Benefits of E20 Programme:

Environmental: Cuts CO₂ emissions significantly.

Economic: Saves ₹50,000+ crore annually in crude oil imports.

Farmers' income: Increases demand for sugarcane & other feedstock crops.

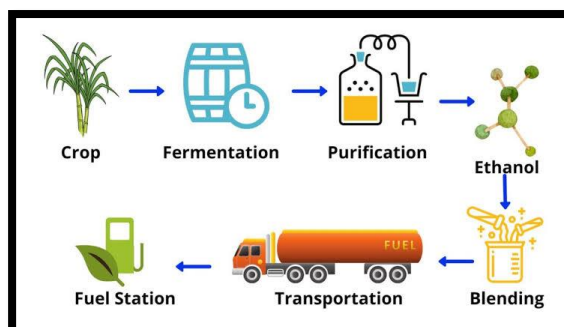
Energy Security: Reduces dependency on imported fossil fuels.

Challenges & Concerns:

1. **Fuel Efficiency**
 - Ethanol has **30% less energy** than petrol → mileage drops.
 - Govt view: only **1–2% loss** for newer vehicles, **3–6% for older ones** (with tuning).
 - Experts: **6–7% real-world loss** possible.
2. **Vehicle Compatibility Issues:**
 - Ethanol is **hygroscopic** (absorbs moisture) → leads to:
 - Corrosion of metal components (fuel tank, injectors).
 - Degradation of rubber/plastic (gaskets, seals).
 - Altered **air-fuel ratio**, affecting performance.
 - **Older vehicles (pre-2023)** face higher risks.
3. **Maintenance Costs:**
 - More wear & tear → higher repair bills.
 - Hero MotoCorp & TVS acknowledge need for **re-engineered components**.

Industry & Govt Response:

- Auto makers producing **E20-compatible models**.
- Service advisories issued for older vehicles.
- Govt pushing for **calibrated ECUs** to minimise damage.


Space for Notes:

Future Outlook:

- Higher blends (E30, E40) under discussion.
- Will require:
 - Dual fuel dispensing infrastructure.
 - Retrofitting/phase-out of older vehicles.
 - Regulatory clarity & consumer awareness.

Chandrayaan-3
Why in News?

ISRO has invited proposals from India's scientific community for analysis and utilisation of Chandrayaan-3 lander and rover data. The Announcement of Opportunity, open till October 21, 2025, aims to enhance scientific outcomes from India's historic 2023 lunar south pole landing mission.

Description:

- Follow-on mission to Chandrayaan-2.
- Aim: To demonstrate **safe soft landing, rover mobility, and in-situ experiments** on the lunar surface.
- **Launch Vehicle:** LVM3-M4 (from SDSC, Sriharikota).
- **Configuration:**
 - Propulsion Module (PM)
 - Lander Module (LM) with Rover

Objectives:

1. Demonstrate **safe and soft landing** on the Moon.
2. Demonstrate **rover roving** on the lunar surface.
3. Conduct **in-situ scientific experiments**.
4. Test and validate **advanced landing technologies** (hazard detection, altimetry, velocimetry, throttleable engines).

Key Payloads:
Lander (Vikram):

- **ChaSTE** – Chandra's Surface Thermophysical Experiment → thermal conductivity & temperature.
- **ILSA** – Instrument for Lunar Seismic Activity → seismicity around landing site.
- **RAMBHA-LP** – Langmuir Probe → near-surface plasma density & variations.
- **LRA (NASA)** – Laser Retroreflector Array → lunar laser ranging studies.

Rover (Pragyan):

- **APXS** – Alpha Particle X-ray Spectrometer → elemental composition (Mg, Al, Si, K, Ca, Ti, Fe).
- **LIBS** – Laser Induced Breakdown Spectroscopy → qualitative & quantitative elemental analysis.

Propulsion Module:

- **SHAPE** – Spectro-polarimetry of Habitable Planet Earth → studying Earth's spectral & polarimetric signatures for exoplanet habitability studies.

Significance:

- Strengthens India's **lunar exploration capability**.
- Prepares for **future interplanetary missions**.
- Enhances global standing in **space technology and planetary science**.
- Contributes to **South Pole exploration** (crucial for water ice studies).

Space for Notes:



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