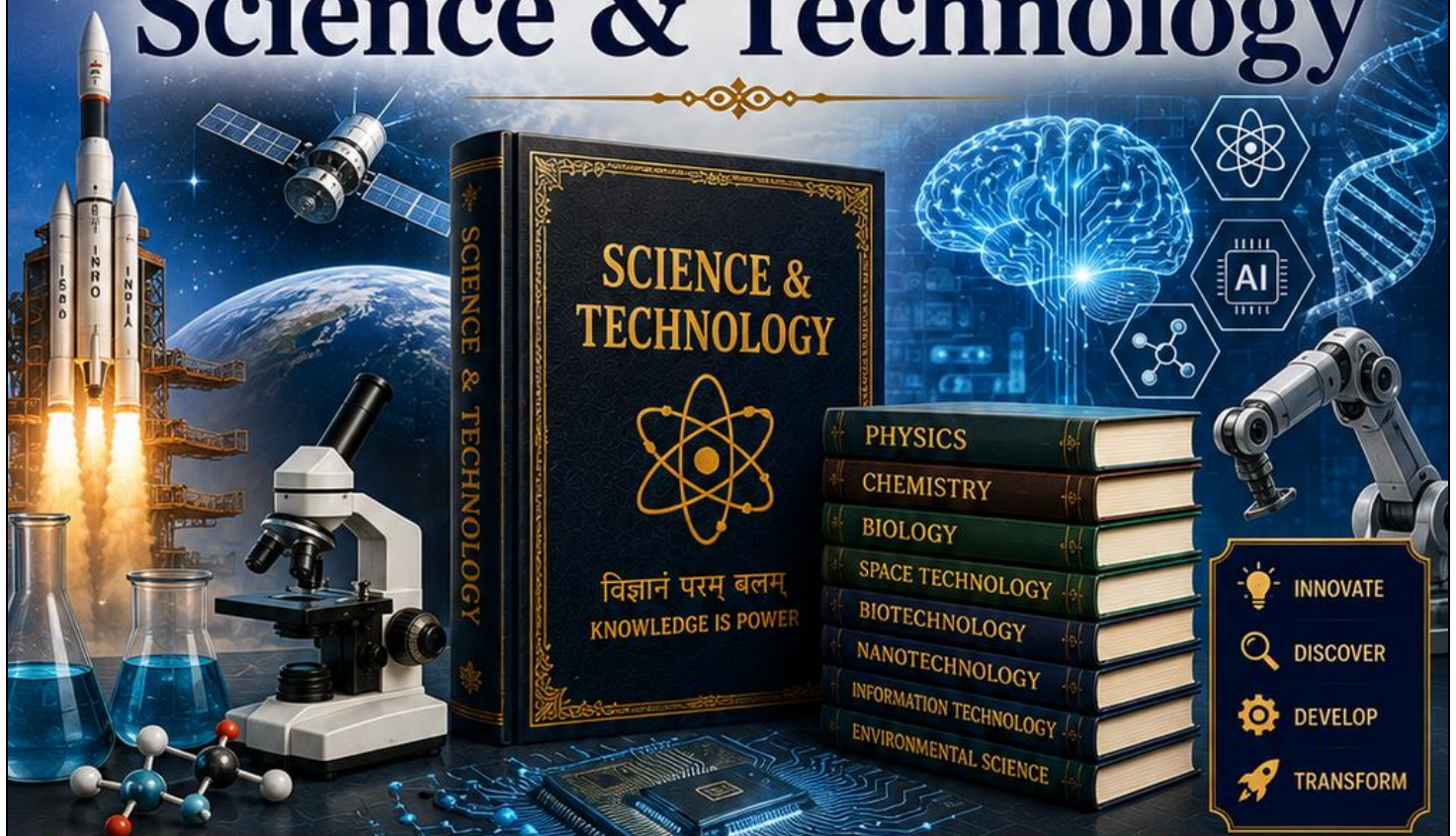




P.L. RAJ IAS & IPS ACADEMY

Civil Services Study Material

Science & Technology



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In-depth Study of All Important Topics



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Chapter-wise PYQs & Model MCQs



STRATEGIC PREPARATION

Concept Clarity + Answer Writing

UPSC Prelims Current Affairs (July 2026) MONTHLY COMPILATION



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1. Pins Instrument Approach: A Milestone in India's Helicopter Navigation

Prelims:

Science & Technology, Infrastructure

Mains:

GS Paper III–Science & Technology, GS Paper II–Governance

Current relevance:

The **Ministry of Civil Aviation** has approved **India's first Private Point-in-Space (PinS) Instrument Approach Procedure** for helicopter operations **at Undavalli Heliport, Andhra Pradesh**.



Highlights:

1. India has approved its **first Private Point-in-Space (PinS) Instrument Approach Procedure** for helicopter operations at **Undavalli Heliport**.
2. **Point-in-Space (PinS):** It is a **satellite-based instrument** approach procedure that **enables helicopters to safely approach heliports** without conventional instrument landing infrastructure.
3. The procedure was developed by the **Airports Authority of India (AAI)** and approved by the **Directorate General of Civil Aviation (DGCA)** in accordance with ICAO Standards and Recommended Practices (SARPs).
4. **Technology Integration:**
Supports the wider adoption of **indigenous satellite-based navigation technologies**, including **GAGAN**, for precision aviation operations.
5. **Other features:**
 - i. Enables **safe and precise** instrument approaches to heliports.
 - ii. Facilitates reliable **all-weather helicopter operations**.
 - iii. **Enhances connectivity to remote** and strategically important locations.
6. **Applications**

- i. Emergency Medical Services (EMS).
- ii. Disaster relief operations.
- iii. Tourism and pilgrimage services.
- iv. Offshore operations.
- v. Corporate aviation.
- vi. Regional connectivity.
- vii. Instrument Flight Rules (IFR) operations in remote areas.

Source: PIB-

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2280128®=48&lang=1>

2. Multi-Lane Free Flow (MLFF) Tolling System

Prelims:

Science & Technology, Infrastructure

Mains:

GS Paper III-Infrastructure, GS Paper II-Governance

Current relevance:

The **National Highways Authority of India (NHAI)** has successfully launched the **Multi-Lane Free Flow (MLFF) Tolling System** at Manoharpura Toll Plaza on the **Delhi-Jaipur** section of **NH-48**.



Highlights:

1. The **Multi-Lane Free Flow (MLFF)** system is a **barrier-less electronic toll collection mechanism** that enables vehicles to pass through toll plazas without stopping.
2. **Objective:** To create a **seamless, barrier-free, and technology-driven toll collection system** that improves traffic flow and enhances commuter convenience.
3. **Technology:** The system integrates **Automatic Number Plate Recognition (ANPR)** technology with **FASTag-based Electronic Toll Collection (ETC)** for automated toll collection.
4. **E-Notice Mechanism:**
 - i. Vehicles with **insufficient FASTag balance**, invalid or non-functional FASTags receive **an Electronic Notice (E-Notice)**.
 - ii. Users must pay the applicable toll within **72 hours**, failing which **double the normal user fee** is charged.

Key features:

1. Provides barrier-free toll collection with **zero waiting time** at toll plazas.
2. Ensures **uninterrupted movement of vehicles** without stopping.
3. Automates toll collection through **minimal human intervention**.

- Integrates **FASTag** and **Automatic Number Plate Recognition (ANPR)** technology for seamless digital toll payments.

Source: PIB-

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2279896®=48&lang=1>

3. Digital India BHASHINI Division (DIBD)

Prelims:

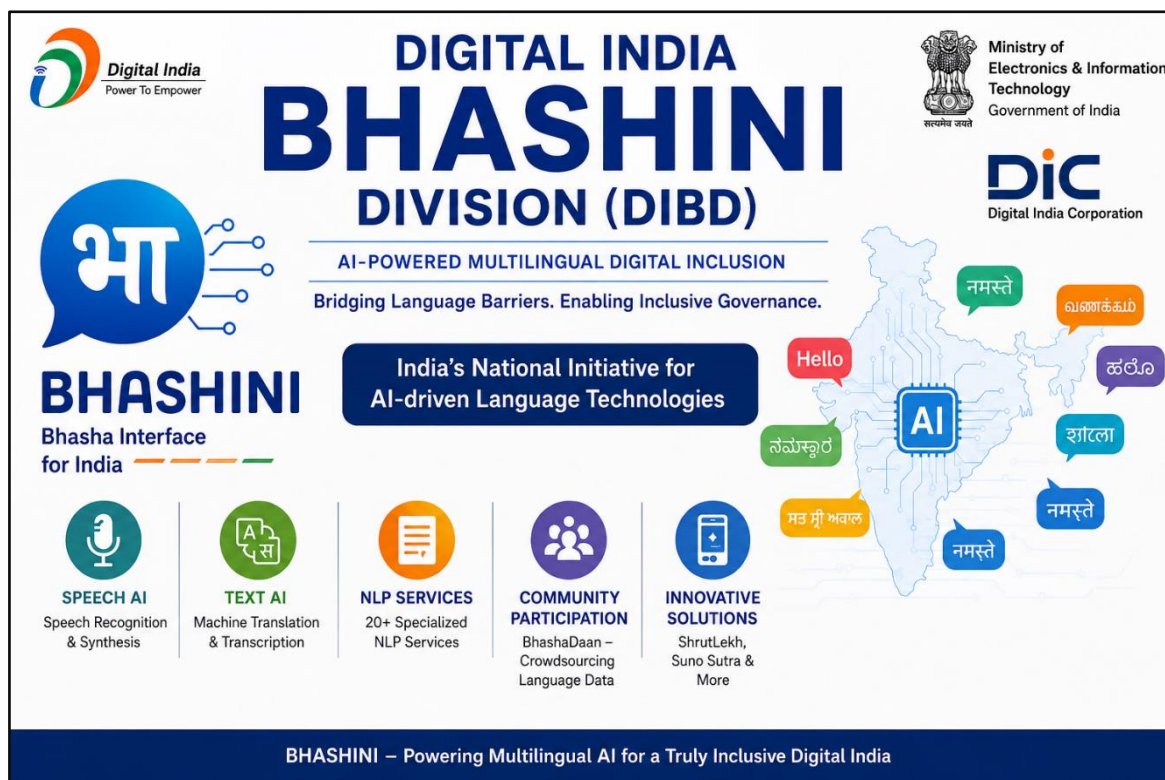
Science & Technology, Governance

Mains:

GS Paper II-Governance, GS Paper III-Science & Technology

Current relevance:

The **Digital India BHASHINI Division (DIBD)** showcased its multilingual AI innovations at the **National Conference on e-Governance (NCeG) 2026**.



Highlights:

BHASHINI is India's national initiative for AI-driven multilingual digital inclusion, implemented by the **Digital India BHASHINI Division (DIBD)** under the Digital India Corporation (DIC), **Ministry of Electronics and Information Technology (MeitY)**.

Objective:

To enable **citizens to access digital services in their preferred language** through AI-powered speech and text technologies.

AI-Driven Applications:

1. ShrutLekh

An **AI-powered real-time speech-to-text and translation solution** used for live transcription during conference sessions.

2. BhashaDaan

A **national crowdsourcing initiative** that enables citizens to contribute and validate language datasets for AI development.

3. Suno Sutra

India's **first handheld multilingual edge AI device**, enabling multilingual communication and AI-assisted interactions.

BHASHINI supports **multilingual public service** delivery through platforms such as:

CPGRAMS, Nyaya Setu, Arogya Vani, SabhaSaar, Yuva Saarthi

Significance:

1. Promotes inclusive and **citizen-centric digital governance**.
2. **Reduces language barriers** in accessing government services.
3. Strengthens India's **Digital Public Infrastructure (DPI)**.
4. Advances the vision of **Digital India** by making governance accessible in multiple languages.

Source: PIB-

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2280234®=48&lang=1>

4. Submarine Cable System

Prelims:

Science & Technology, Infrastructure

Mains:

GS Paper II-International Relations, GS Paper III-Science & Technology, Infrastructure

Current relevance:

A consortium comprising **Microsoft, Singtel, Tata Communications, and Lightstorm** has unveiled the **India–International Subsea Express Alliance (I-2SEA)**.



Highlights:

1. **I-2SEA (India–International Subsea Express Alliance)** is a submarine optical fibre cable system connecting **India, Malaysia, and Singapore** to enhance regional digital connectivity.
2. **Objective:**

To provide **high-speed, low-latency digital connectivity** for AI workloads, cloud services, hyperscalers, enterprises, and data centres across the India–Southeast Asia corridor.

3. **Implementation Partners:**

- i. **NEC Corporation** has been appointed as the system supplier.
 - ii. **ASEAN Cables Ship (ACPL)** will serve as the marine installation partner.
4. Provides **direct and low-latency subsea connectivity to Hyderabad**, a major AI and hyperscaler data centre hub.

Source: THE HINDU–

<https://www.thehindu.com/news/national/telangana/submarine-cable-system-project-linking-india-malaysia-singapore-unveiled/article71173557.ece>

5. India Enters a New Era in Semiconductor Manufacturing

Prelims:

Science & Technology, Economy

Mains:

GS Paper III–Science & Technology, Economy, Internal Security

Current relevance:

India marked a major milestone in its semiconductor journey as the **CG SEMI OSAT (Outsourced Semiconductor Assembly and Test)** facility at **Sanand, Gujarat**, commenced **commercial production**.



Highlights

1. Major Milestone

- i. **CG SEMI'S OSAT** facility has become India's third semiconductor plant to enter commercial production in 2026.
- ii. The project was completed in 27 months, from groundbreaking to commercial operations.

2. Global Collaboration

The Sanand facility has been established in **partnership with Renesas Electronics (Japan)** enabling India to gain access to:

- i. Advanced semiconductor technologies
- ii. Global manufacturing standards
- iii. International quality systems

The chips produced will cater to Automobile industry, two-wheelers, Industrial equipment.

3. Social Impact

The project is also emerging as a **model of inclusive development**. Young women from Jharkhand, Chhattisgarh, Madhya Pradesh, Bihar, Jammu & Kashmir, Kerala,

Gujarat have been employed as **plant operators** after receiving specialized semiconductor training in Malaysia.

Source: PIB-

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2281174®=48&lang=1>

6. SOLVE Platform for Gaganyaan Mission

Prelims:

Science & Technology, Space Technology

Mains:

GS Paper III-Science & Technology

Current relevance:

ISRO successfully conducted the first ground test of the **Sub-Orbital Launch Vehicle for Experiments (SOLVE)**.



Highlights:

SOLVE: An Overview

1. **Sub-Orbital Launch Vehicle for Experiments (SOLVE)** is a **solid motor based test platform** developed by **ISRO**.
2. It is designed to conduct **Integrated Parachute Tests** for validating the crew **module's deceleration system** under different mission conditions.
3. The platform provides flexibility for testing critical systems before the actual **Gaganyaan mission**.
4. **Technology:**
 - i. The **SOLVE solid motor** is derived from the **PSLV Strap-on Motor** with modifications.
 - ii. Features **slow burn-rate propellant** and a **straight nozzle with Secondary Injection Thrust Vector Control (SITVC)** to meet Gaganyaan mission requirements.

Gaganyaan Mission:

1. It is **India's first indigenous human spaceflight mission**, developed by the **Indian Space Research Organisation (ISRO)**.
2. **Aim:** To send **Indian astronauts (Gaganyatris)** into **Low Earth Orbit (LEO)** for a short-duration mission and safely return them to Earth.
3. Demonstrates India's capability to **independently develop** and execute **human spaceflight technology**, including crew launch, orbital operations, and the safe recovery of astronauts.
4. **Gaganyaan Mission Readiness Tests:**
 - i. **First Ground Test of SOLVE.**
 - ii. **Integrated Air Drop Test (IADT-02)**- Tests the parachute system of the Gaganyaan crew module for a safe landing.
 - iii. **Mission MITRA (Mapping of Interoperable Traits and Response Assessment)** conducted in Leh to assess astronaut performance under challenging conditions.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/how-will-tests-solve-gaganyaan-astronauts-safe-landing-explained/article71187964.ece>

7. Vepdegestrant – Cancer therapy drug

Prelims:

Science & Technology, Biotechnology, Health

Mains:

GS Paper II-Health, GS Paper III-Science & Technology

Current relevance:

Recently, **U.S. Food and Drug Administration (FDA)** approved the drug vepdegestrant for patients with **ESR1-mutated, ER-positive, and HER2-negative advanced breast cancer**. It is the world's first therapy that the FDA has approved that is based on PROTAC technology.

FDA APPROVAL FOR VEPDEGESTRANT
A NEW TARGETED THERAPY FOR BREAST CANCER

FDA U.S. FOOD & DRUG ADMINISTRATION APPROVED

- Vepdegestrant is a first-in-class oral selective estrogen receptor degrader (SERD).
- Approved for the treatment of adults with advanced or metastatic **ER-positive, HER2-negative** breast cancer with **ESR1 mutations**, who have progressed on endocrine therapy.
- Offers a new treatment option for patients with limited alternatives and represents a major step forward in precision oncology.

How Vepdegestrant Works

Estrogen binds to the Estrogen Receptor (ER). Vepdegestrant binds to ER, leading to ER degradation, which blocks cancer cell growth.

Highlights:

- Vepdegestrant** is the world's first therapy that the U.S. Food and Drug Administration (FDA) has approved that is based on **PROTAC technology**.
- PROTAC (proteolysis-targeting chimaera):**

- i. It is a molecule-like substance which are designed to **remove specific protien** from a cell.
- ii. This is achieved with the help of bodily enzyme named "**E3 Ligase**", which is naturally involved in **protein degradation** process.
- iii. PROTAC has two Ends, one side attaches to the target protein and other binds to E3 Ligase, by artificially bringing these together the **PROTAC** causes the **target protein to be degraded** by the cell. This is called **targeted protein degradation**.

3. Advantages over conventional Drugs:

- i. Conventional drugs work by binding to a protein and blocking its function, often requiring repeated doses. In contrast, **PROTACs** degrade the **target protein** and are then released to destroy other proteins, allowing them to act repeatedly like a **catalyst**.
- ii. **PROTACs** degrade the **entire target protein**, thereby blocking all of its functions, unlike **conventional drugs** that inhibit only a **specific activity of the protein**.

4. Key Features:

- i. **Convenient Oral Dosing:** Intaken as **oral tablet**, replacing the need for monthly intramuscular injections required with therapies like fulvestrant.
- ii. **Manageable Safety Profile:** Most side effects were mild, including fatigue, nausea, muscle pain, and temporary changes in liver enzymes or ECG findings.

Source: THE HINDU - <https://www.thehindu.com/sci-tech/science/why-fda-approval-for-vepdegestrant-is-a-major-shift-in-cancer-therapy/article71188088.ece>

8. Nanophotonic devices

Prelims:

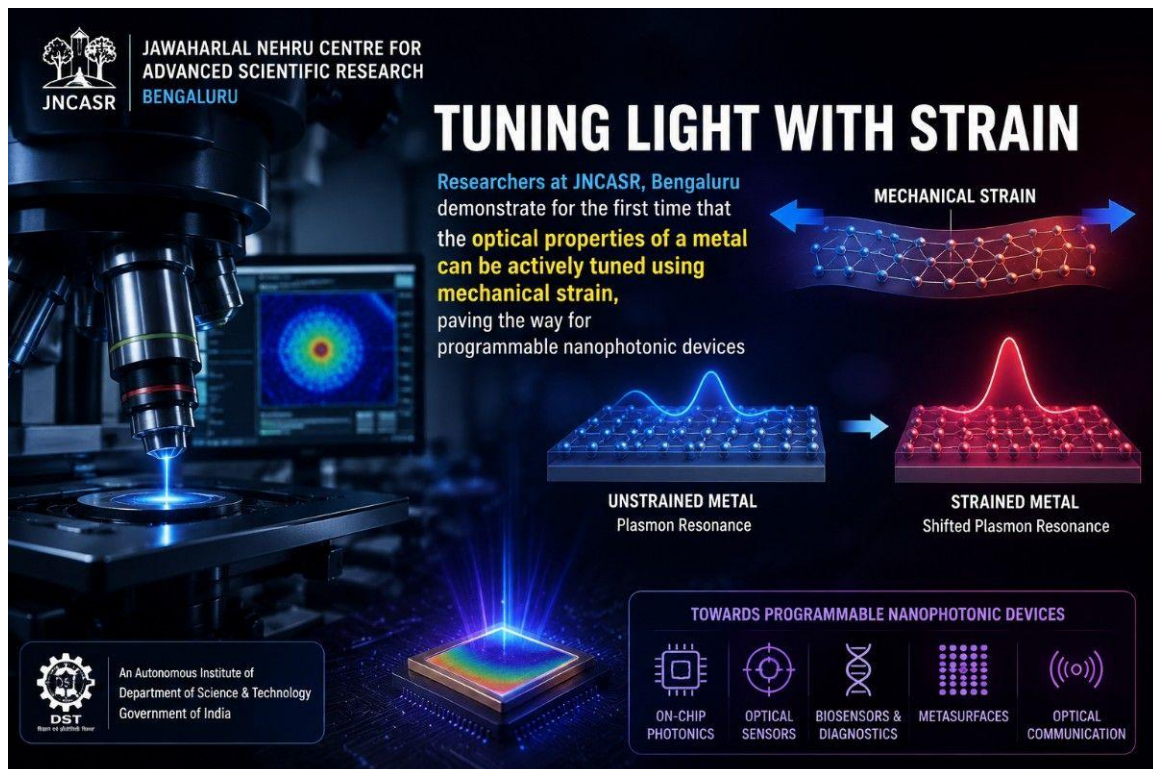
Science & Technology, Nanotechnology

Mains:

GS Paper III-Science & Technology

Current relevance:

Researchers at the **Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru**, have demonstrated for the first time that the optical properties of a metal can be actively tuned using mechanical strain, paving the way for **programmable nanophotonic devices**.



Highlights:

1. The discovery could enable **programmable optical devices**, advanced sensors, and faster photonic chips that are compatible with existing semiconductor manufacturing technologies.
2. **Plasmon Resonance:**

- i. Plasmon resonance is the ability of certain **metals to trap and concentrate light into tiny spaces** by making their free electrons vibrate together. This allows the development of much smaller and more **efficient light-based devices**.
- ii. **Applications include:**
 - Ultra-sensitive chemical and biological sensors
 - Cancer diagnostics
 - High-speed optical communication
 - Photonic circuits that use light instead of electricity
 - Meta surfaces for controlling light in advanced optical devices.

3. **Material Used:**

The study used ultrathin films of **Titanium Nitride (TiN)**, a material that behaves similarly to gold in its interaction with light but is much more heat-resistant, chemically stable, and **compatible with modern computer chip manufacturing (CMOS technology)**.

Source: PIB

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2282020®=3&lang=1>

9. Himalayan yak

Prelims:

Science & Technology, **Environment & Ecology**, Agriculture, Geography

Mains:

GS Paper III–Science & Technology, Agriculture, Environment, Internal Security

Current relevance:

Scientists from the **Indian Council of Agricultural Research's (ICAR) National Research Centre on Yak (NRC-Y), Dirang (Arunachal Pradesh)**, in collaboration with

Assam Don Bosco University, have developed an **Internet of Things (IoT)-based smart collar**.



Highlights:

Technological Innovation:

1. Internet of Things (IoT)-Based Smart Collar:

The system consists of a **wearable smart collar** fitted on the yak that uses **embedded sensors and wireless communication** to continuously collect and transmit physiological and location data in real time.

2. Geo-Fencing Capability:

The device employs **geo-fencing technology**, creating virtual boundaries using **GPS, Wi-Fi, and cellular networks**. It sends alerts whenever an animal crosses the predefined geographical limits.

3. Real-Time Health Monitoring

The smart system continuously monitors the yak's **health status, stress levels, and movement patterns**, enabling the early detection of illness and facilitating timely veterinary intervention.

About Himalayan yak:

1. It is also known as "**Ship of the Himalayas**"
2. The yak is native to the **Himalayan and Tibetan Plateau region of Asia**.

3. Major populations are found in Ladakh, Arunachal Pradesh, Sikkim, Himachal Pradesh, Uttarakhand.
4. Adapted to **extreme cold and low-oxygen environments**, the Himalayan yak primarily inhabits **alpine meadows**, high-altitude grasslands, mountain pastures, and **cold desert landscapes**.
5. **Both male and female** Himalayan yaks **possess curved horns**, although they vary in size and shape.
6. It serves **multiple economic purposes** by providing milk, meat, wool, hair, leather, and manure, while also acting as a reliable draught and transport animal in the Himalayas.

Source: THE HINDU – <https://www.thehindu.com/news/national/scientists-develop-health-tracker-for-high-altitude-yaks/article71190428.ece>

10. Leucine

Prelims:

Science & Technology, Biotechnology

Mains:

GS Paper II-Health, GS Paper III-Science & Technology

Current relevance:

Recent research has shown that the **essential amino acid leucine** not only supports muscle growth but also **protects mitochondria**, helping cells produce energy efficiently and potentially reducing the risk of metabolic and age-related diseases.



Highlights:

1. **Leucine:**

- i. It is an **essential amino acid** that the human body cannot produce and must obtain through the diet.
- ii. It belongs to the **Branched-Chain Amino Acid (BCAA)** family, along with **isoleucine** and **valine**.

2. **Role of Leucine:**

It supports **muscle growth, tissue repair, protein synthesis, and cellular energy production.**

3. **Mitochondria:**

The energy-producing organelles of cells that generate **Adenosine Triphosphate (ATP)**, the cell's primary energy source.

4. **Leucine's Contribution to Cellular Function:**

It helps maintain the **outer membrane of mitochondria**, ensuring efficient ATP production and normal cellular function.

5. **Significance:**

Healthy mitochondria improve energy production and may help reduce the risk of **metabolic disorders, muscle degeneration, and age-related diseases.**

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/how-the-amino-acid-leucine-helps-our-cells-produce-energy/article71188124.ece>

11. Samriddh Gram

Prelims:

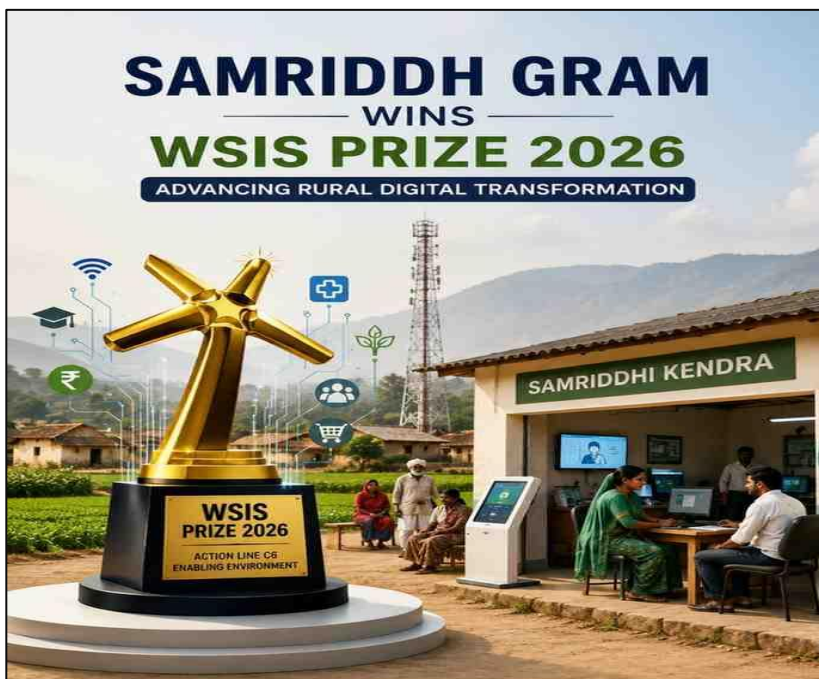
Science & Technology, Governance, Economy

Mains:

GS Paper II-Governance, GS Paper III-Science & Technology

Current relevance:

The **Department of Telecommunications (DoT)** won the **WSIS Prize 2026** under Action Line C6 – Enabling Environment for its flagship **Samriddh Gram: Integrated Phygital Service Delivery Model Enabled by BharatNet**, receiving global recognition for promoting inclusive rural digital development.



Highlights:

About Samriddh Gram:

1. It is a flagship rural digital transformation initiative of the **Department of Telecommunications (DoT), Ministry of Communications**.
2. It is built on the **BharatNet** broadband network to deliver integrated **phygital (physical + digital)** services in rural areas.
3. The initiative establishes **Samriddhi Kendras** as one-stop village service centres.
4. It provides services in **healthcare, education, agriculture**, financial inclusion, skilling, **e-governance, and e-commerce**.
5. It integrates **telecom connectivity, digital platforms, and assisted physical service delivery** for seamless access to public services.
6. Supports technologies such as **Health ATMs**, AR/VR-based skill development, **IoT-enabled agriculture**, drone-assisted farming, **PM-WANI**, FTTH connectivity, and digital governance services.
7. It aims to **bridge the digital divide** and promote **inclusive rural development** through Digital Public Infrastructure (DPI).

WSIS Prizes:

1. The WSIS Prizes are organised under the **World Summit on the Information Society (WSIS)** process led by the **International Telecommunication Union (ITU)**.
2. They recognise projects that effectively use **Information and Communication Technologies (ICTs)** to promote sustainable development.
3. Samriddh Gram won the **World Summit on the Information Society (WSIS) Prize 2026** under **Action Line C6 – Enabling Environment** during the **WSIS Forum 2026** held in **Geneva**.

Source: PIB –

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2282831®=48&lang=1>

12. Pinaka Long Range Guided Rocket (LRGR)

Prelims:

Science & Technology, Defence

Mains:

GS Paper III–Science & Technology, Defence & Security

Current relevance:

The Defence Research and Development Organisation (DRDO) successfully conducted the flight-test of the Pinaka Long Range Guided Rocket (LRGR) at the Integrated Test Range (ITR), Chandipur, Odisha.



Highlights:

1. DRDO successfully tested the **Pinaka Long Range Guided Rocket (LRGR)** from the Integrated Test Range (ITR), Chandipur.
2. **Developing Agencies:**
 - Designed by the **Armament Research and Development Establishment (ARDE)**.
 - Developed in collaboration with:
 - i. **High Energy Materials Research Laboratory (HEMRL)**
 - ii. **Defence Research and Development Laboratory (DRDL)**
 - iii. **Research Centre Imarat (RCI)**
3. **About Pinaka LRGR**

- An **indigenously developed** precision-guided rocket system developed by the **Defence Research and Development Organisation (DRDO)**.
- It is designed to provide **long-range, high-precision strike capability for the Indian Army**.
- The LRGR was successfully flight-tested from the Integrated Test Range (ITR), demonstrating a **minimum range of 60 km**.

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2282572®=48&lang=1>

13. Filariasis

Prelims:

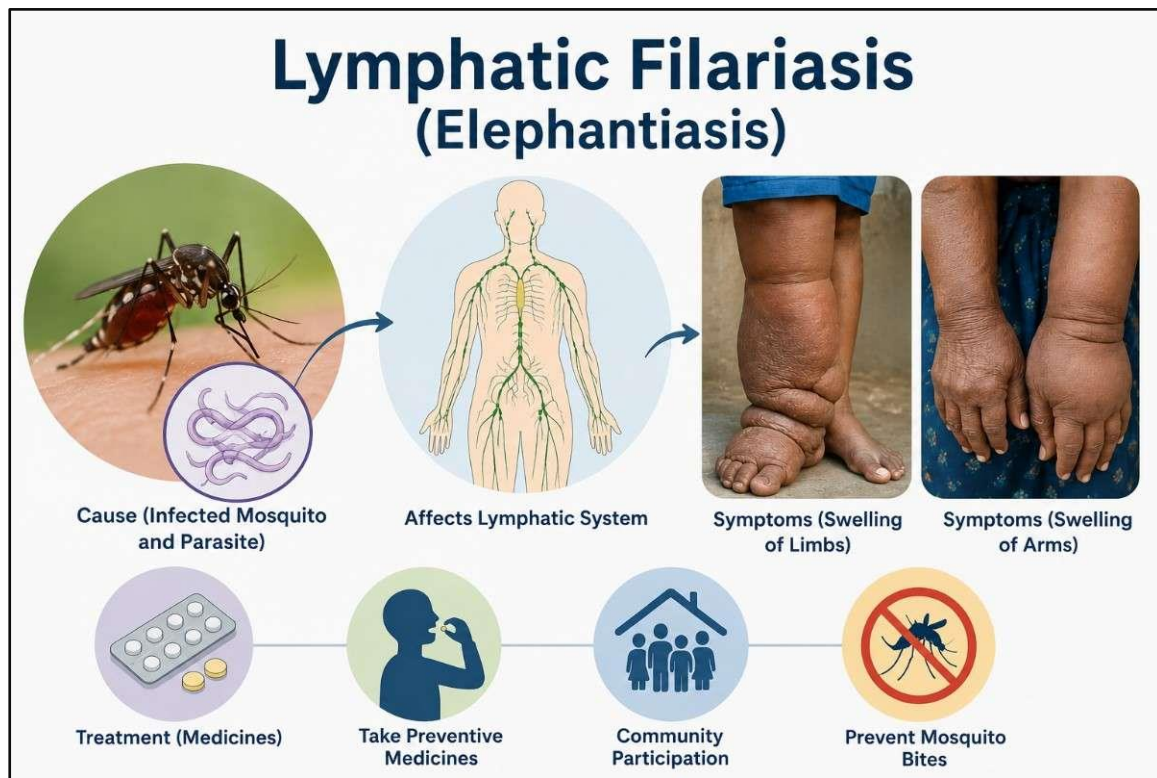
Science & Technology, Health

Mains:

GS Paper II-Health, GS Paper III-Science & Technology

Current relevance:

The **West Bengal Health Department** has launched a **Mass Drug Administration (MDA)** campaign against **Lymphatic Filariasis (Elephantiasis)** in **10 districts**, aiming to eliminate the disease in the State by **2030**.



At a glance:

Lymphatic Filariasis

1. It commonly known as **Elephantiasis**, is a **mosquito-borne Neglected Tropical Disease (NTD)**.
2. It is caused by **parasitic filarial worms** that infect the **human lymphatic system**, leading to abnormal swelling (lymphoedema) of body parts.
3. **Symptoms:**
 - **Early Stage** - asymptomatic, Fever, Swollen lymph nodes.
 - **Chronic Stage** - Severe swelling (Lymphoedema) of: Legs, Arms, Breasts, Genital organs.
4. **Diagnostic Methods:**

It is diagnosed through **blood smear examination** (preferably collected at night), **antigen detection tests**, ultrasound to detect adult worms, and **PCR-based molecular tests**.
5. **Prevention:**

Mass Drug Administration (MDA) in endemic areas, effective **mosquito control** measures, **increased community awareness** with early treatment.

6. Mass Drug Administration (MDA):

- A public health strategy where **anti-filarial medicines are given to all eligible people in endemic areas**, irrespective of infection status.
- **Objective:** Interrupt transmission and eliminate Lymphatic Filariasis.

7. National Programme:

National Programme for Elimination of Lymphatic Filariasis (NPELF) implemented by the Ministry of Health & Family Welfare.

8. WHO Initiative:

- **Global Programme to Eliminate Lymphatic Filariasis (GPELF)** launched by **WHO** in 2000.
- Lymphatic Filariasis is one of the **Neglected Tropical Diseases (NTDs)** targeted for global elimination.

Source: THE HINDU – <https://www.thehindu.com/news/national/west-bengal/west-bengal-conducts-filariasis-drug-drive-in-10-districts-targets-elimination-by-2030/article71210351.ece>

14. Cyanobacteria

Prelims:

Science & Technology, Environment & Ecology

Mains:

GS Paper III–Science & Technology, Environment

Current relevance:

A team of scientists from **the Indian Institute of Technology Guwahati (IIT Guwahati)** has developed a **biological material using cyanobacteria (blue-green algae)** that can effectively remove **lead (Pb)** from contaminated water.



Highlights:

About Cyanobacteria (Blue-Green Algae):

1. Cyanobacteria are **photosynthetic microorganisms** that can produce their own food through photosynthesis.
2. They are commonly found in **freshwater, marine, and moist terrestrial environments**.
3. Many cyanobacteria can **fix atmospheric nitrogen**, helping **improve soil fertility**.
4. They play an important role in maintaining ecosystems and **cleaning polluted environments** through **bioremediation**.

Bioremediation:

The process of using living organisms such as microorganisms, algae, fungi, or plants to remove, degrade, or neutralize pollutants from contaminated soil, water, or air, thereby restoring the environment naturally.

Significance:

1. Provides an **eco-friendly and low-cost method** for removing heavy metal contamination.

2. Can improve access to **safe drinking water**.
3. Offers a **sustainable alternative** to conventional chemical water treatment methods.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/iit-guwahati-team-finds-blue-green-algae-can-remove-lead-from-water/article71198226.ece>

15. Eärendil-1

Prelims:

Science & Technology, Space Technology

Mains:

GS Paper III–Science & Technology, Environment, Internal Security / Disaster Management

Current relevance:

The **U.S. Federal Communications Commission (FCC)** has authorised **Reflect Orbital** to launch **Eärendil-1**, a test satellite equipped with a **large deployable mirror** designed to reflect sunlight onto selected areas of the Earth during nighttime.



Highlights:

1. **Federal Communications Commission (FCC):**

- It is an **independent agency** of the United States Government.
- It regulates communications by **radio, television, satellite, cable, and other communication technologies**.

2. **Reflect Orbital:**

A U.S.-based space technology company developing **space-based reflective systems** to redirect sunlight for practical applications.

3. **About Eärendil-1:**

- It is a **test satellite** equipped with a **deployable, highly reflective thin-film mirror**.
- The mirror is **motorised** and can be oriented to reflect sunlight toward selected locations on Earth during nighttime.
- The satellite will operate in a **Non-Geostationary Orbit (NGSO)**.

4. **Non-Geostationary Orbit (NGSO):**

an orbit in which satellites **do not remain fixed over one point** on the Earth's surface and includes Low Earth Orbit (LEO), Medium Earth Orbit (MEO), as well as other inclined and polar orbits.

5. **Applications:**

- The technology can provide light during **disaster relief** and **emergency management operations**.
- It can support **humanitarian missions** by providing temporary illumination in affected areas.
- It can help **extend the operating hours of solar panels** by reflecting sunlight after sunset.
- Provide **temporary lighting** for **remote or inaccessible locations** where conventional lighting is unavailable.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/us-regulator-green-lights-mission-to-launch-giant-mirror-to-orbit/article71213314.ece>

16. National Innovation Challenge for Drone Application and Research (NIDAR 2.0)

Prelims:

Science & Technology

Mains:

GS Paper III–Science & Technology, Economy, Internal Security

Current relevance:

The **Ministry of Electronics and Information Technology (MeitY)**, in collaboration with the **Drone Federation India (DFI)**, has launched the **National Innovation Challenge for Drone Application and Research (NIDAR 2.0, 2026–27)** under the **SwaYaan initiative**.



Highlights:

About NIDAR (National Innovation Challenge for Drone Application and Research):

1. Background:

- i. The first phase of **NIDAR (2025–26)** was launched in **2025**.
- ii. **NIDAR 2.0**, was launched in **2026**, the **flagship innovation** platform under the **SwaYaan** initiative.
- iii. It is jointly organised by the **Ministry of Electronics and Information Technology (MeitY)** and the **Drone Federation India (DFI)**.

2. Objective:

To encourage students to develop **autonomous drones, indigenous drone components**, and **AI-enabled drone technologies** using Indian-made processors.

3. Key Focus:

The initiative promotes the development of smarter drones using the **indigenous VEGA processor** and strengthens **self-reliance** in **drone electronics** and **semiconductor technologies**.

About SwaYaan:

1. It is a **Capacity Building** initiative for Human Resource Development in **Unmanned Aircraft Systems (UAS)**, including **drones** and **allied technologies**.
2. It was approved by the **Ministry of Electronics and Information Technology (MeitY)** in **2022**.
3. **Aim:** To develop a **skilled workforce** for India's rapidly growing **drone ecosystem**.
4. It is implemented through a **Hub-and-Spoke model** involving **30 premier institutions**, including **IISc, IITs, IIITs, NITs, C-DAC, and NIELIT**.
5. It focuses on **five key themes**:
 - i. Aeromechanics
 - ii. Drone Electronics
 - iii. Guidance, Navigation & Control (GNC) Algorithms and Simulation
 - iv. Drone Applications

v. Allied Unmanned Aircraft System (UAS) Technologies

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2284236®=48&lang=1>

17. UMANG Portal

Prelims:

Science & Technology, Governance

Mains:

GS Paper II–Governance, GS Paper III–Science & Technology, Internal Security

Current relevance:

Security researchers reported **multiple vulnerabilities** in the **UMANG (Unified Mobile Application for New-age Governance) portal**, exposing sensitive user information such as **EPFO UANs, LPG booking details, and Aadhaar numbers**.



At a glance:

Security Flaws:

1. Researchers identified **multiple security flaws** in the **UMANG portal**, potentially exposing the personal data of millions of users.
2. The reported vulnerabilities exposed information such as: EPFO **Universal Account Numbers (UANs)**, LPG cylinder booking details, Aadhaar numbers stored across several services.
3. **Government Response:**
MeitY acknowledged the security vulnerabilities and stated that **corrective and preventive measures**, including the **encryption of sensitive information** in the affected APIs, are being implemented.
4. **Role of CERT-In:**
The vulnerabilities were reported to the **Indian Computer Emergency Response Team (CERT-In)**, the national nodal agency that assists organisations in **identifying and mitigating cybersecurity threats**.

About UMANG Portal:

1. Unified Mobile Application for New-age Governance (UMANG), developed by the **Ministry of Electronics and Information Technology (MeitY)** and the **National e-Governance Division (NeGD)**.
2. It provides a **single platform** to access **Central, State, and local government services** through a mobile application and web portal.
3. The platform offers services such as **EPFO, PAN, Aadhaar-linked services, DigiLocker, Passport, gas booking, utility bill payments, healthcare, education, and taxation**.
4. It is available in **multiple Indian languages**, making government services more accessible.
5. Supports the vision of **Digital India** by promoting **paperless, faceless, and cashless governance**.

6. It enables **single sign-on (SSO)**, allowing users to access multiple government services with one login.
7. The platform is accessible through **Android, iOS, KaiOS, and the UMANG web portal**.

Source: THE HINDU - <https://www.thehindu.com/sci-tech/technology/umang-portal-flaws-exposed-user-data-across-hundreds-of-services-researchers-find/article71217208.ece>

18. Gaganyaan

Prelims:

Science & Technology, Space Technology

Mains:

GS Paper III-Science & Technology, Technology and Innovation

Current relevance:

The **Indian Space Research Organisation (ISRO)** successfully completed **three major qualification tests** of critical **Gaganyaan crew module systems**.

TEST OF GAGANYAAN SYSTEM

ISRO successfully carries out tests of Gaganyaan systems

Crew Module Uprighting System
Ensures the crew module returns to an upright position after splashdown in the sea.

Umbilical Mechanism Separation Test
Ensures clean separation between crew module and service module before re-entry.

Apex Cover Separation Test
Validates the structural integrity of the crew module during apex cover separation before parachute deployment.

MeitY
Ministry of Electronics and Information Technology

NeGD
National e-Governance Division

These tests strengthen the safety, reliability, and readiness of **India's Gaganyaan Human Spaceflight Programme.**

At a glance:

Three Major System Tests:

1. Crew Module Uprighting System (CMUS) Test:

It uses **stored cold-gas inflation technology** to restore the crew module to an upright position after splashdown, ensuring astronaut safety after landing.

2. Umbilical Mechanism Separation Test:

The umbilical mechanism connects the **crew module** and **service module**, demonstrated its clean separation and structural stability before atmospheric re-entry.

3. Apex Cover Separation Test:

The **apex cover protects the parachute system** during the mission and separates just before **parachute deployment** to enable the crew module to decelerate safely during descent.

About Gaganyaan:

1. It is **India's first indigenous human spaceflight mission**, developed by the **Indian Space Research Organisation (ISRO)**.
2. **Aim:** To demonstrate India's capability to send humans into space and safely return them to Earth.
3. It is designed to place **three Gaganyatris (astronauts)** in **Low Earth Orbit (LEO)**, around **400 km** above Earth, for a duration of up to **three days**.
4. The astronauts will return safely through **atmospheric re-entry** followed by splashdown in the sea.
5. The mission uses **Launch Vehicle Mark-3 (LVM3)**, India's heavy-lift launch vehicle.
6. **Vyommitra:** A **female humanoid robot**, will fly on uncrewed test missions before the crewed mission to validate spacecraft systems.
7. Programme comprises both **uncrewed test missions** and a **crewed mission**.
8. India will become the **fourth country**, after the **United States, Russia, and China**, to independently develop and launch a human spaceflight mission.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/isro-successfully-carries-out-tests-of-gaganyaan-crew-module-systems/article71214549.ece>

19. Global Helium Supply Concerns

Prelims:

Science & Technology, Economic Geography

Mains:

GS Paper III–Science & Technology, Economy, International Relations

Current relevance:

China has temporarily imposed an immediate **ban on helium exports**, raising concerns over global helium supply.



Highlights:

1. **China** has imposed a **temporary ban on helium exports**, adding to existing global supply uncertainties.
2. Although China produces only about **1.6%** of the world's helium, it imports over **80%** of its domestic requirement.
3. The major helium producers are **United States, Qatar, Russia, Canada, Algeria**.

About Helium:

1. Helium is a **non-renewable natural resource** formed by the radioactive decay of **uranium and thorium** within the Earth's crust.
2. It is the **second lightest element** after hydrogen and is **colourless, odourless, non-toxic**, and chemically inert.
3. It has an extremely **low boiling point** of about **-269°C**, making it ideal for **cryogenic applications**.
4. **Strategic Resource:**
 - i. It is essential for **semiconductor manufacturing and MRI scanners**.
 - ii. It supports advanced technologies such **as quantum computing, aerospace, and rocket systems**.
 - iii. It is also critical for **fibre-optic** manufacturing and **leak detection applications**.

Source: THE HINDU –

<https://www.pressreader.com/foryou?popupArticleId=281801405717526>

20. Jumping Gene

Prelims:

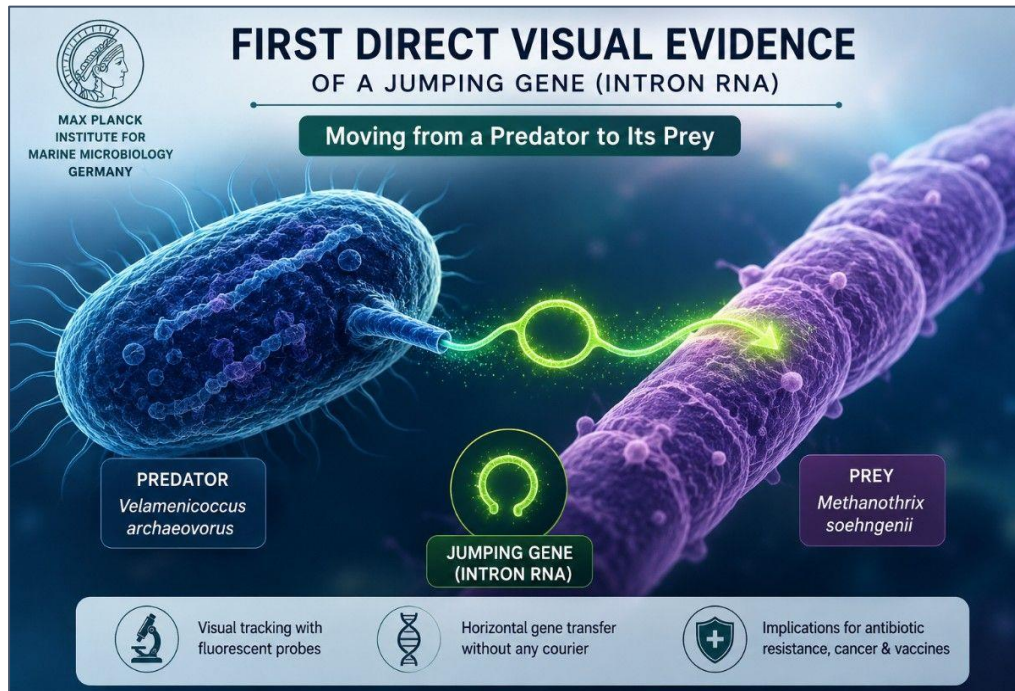
Science & Technology

Mains:

GS Paper III–Science & Technology

Current relevance:

Researchers at the **Max Planck Institute for Marine Microbiology, Germany**, have provided the **first direct visual evidence** of a **jumping gene (intron RNA)**.



Highlights:

1. Scientists visually tracked an **RNA intron** moving from a **predatory bacterium** to its **archaeal prey**, marking the **first direct observation** of horizontal gene transfer without a biological courier.
2. The study focused on the interaction between **Methanothrix soehngensis** (a methane-producing archaeon) and **Velamenicoccus archaeovorus**, an ultramicrobacterium that preys on the archaeon.
3. Scientists used **fluorescent RNA probes** and **confocal fluorescence microscopy** to visually track the movement of the intron RNA.
4. The study demonstrates **horizontal gene transfer (HGT)**, where genetic material is transferred between unrelated organisms rather than inherited from parents, with the transfer occurring **without the involvement of viruses**.
5. **Significance:**

i. **Medical Applications:**

Jumping genes are associated with the development of several **cancers** and play a role in the **spread of antibiotic resistance** among microorganisms.

ii. **Biotechnological Applications:**

Circular RNA molecules derived from mobile introns are being explored as promising **next-generation vaccine platforms** due to their stability and potential for efficient gene delivery.

About Jumping Genes:

1. Jumping genes, also known as **Transposable Elements (TEs)**, are DNA sequences that can move from one location to another within a genome.
2. In some cases, they can also move between **different organisms**, contributing to genetic diversity and evolution.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/why-scientists-watched-a-gene-hop-from-a-predator-into-its-prey/article71220657.ece>

21. Hydrogen-Powered Train**Prelims:**

Science & Technology, Environment & Ecology

Mains:

GS Paper III – Science & Technology, Environment, Infrastructure, Energy

Current relevance:

India's **first indigenously developed** hydrogen fuel cell-powered train was inaugurated on 17 July 2026 and is set to commence operations on the **Jind–Sonipat section** of Northern Railway.



Ministry of Railways
Government of India

INDIA'S FIRST HYDROGEN-POWERED TRAIN

ADVANCING GREEN RAIL MOBILITY



G20
भारत 2023 INDIA





10-COACH
Hydrogen fuel cell trainset



1200 kW
Hydrogen fuel cell propulsion system



75 kmph
Operational Speed
(Design Speed: 110 kmph)



~2,600
Passenger Capacity



CONNECTS
Jind Junction, Gohana Junction & Sonipat



BY-PRODUCT
Only water vapour and heat



WILL OPERATE ON THE JIND–SONIPAT SECTION
of Northern Railway



ZERO EMISSION
Only water vapour and heat as by-product

Highlights:

About Hydrogen-Powered Train:

1. It is a railway train that **uses hydrogen fuel cells** to generate electricity onboard, which powers its electric traction motors instead of diesel.
2. The train is powered by a **1200 kW** hydrogen fuel cell propulsion system, enabling clean and efficient operation.
3. It has an approved maximum operating speed of **75 kmph** and a design speed of **110 kmph**.
4. **Working Principle:**
 - i. Hydrogen stored onboard reacts with oxygen from the atmosphere inside a **Proton Exchange Membrane Fuel Cell (PEMFC)** to generate electricity.
 - ii. The electricity produced by the **fuel cell powers** the train's electric traction motors, enabling smooth and efficient operation.
 - iii. The process emits **only water vapour and heat** as by-products, producing **zero carbon dioxide emissions** at the point of use.
5. **Operational Readiness:**

40

- i. Indian Railways has established **comprehensive standard operating procedures (SOPs)**, regular safety audits, and operational protocols for safe hydrogen train operations.
- ii. The **hydrogen refuelling system** will be monitored round the **clock (24×7)** to ensure safe, reliable, and uninterrupted operations.
- iii. Critical operations will be managed by **trained and certified personnel**.

6. **Safety Features:**

- i. **Hydrogen leak and flame detection systems** have been installed at hydrogen production, storage, and refuelling facilities for continuous monitoring.
- ii. **Safety sensors** are inspected and maintained regularly to ensure reliable performance and **early detection** of any hazards.
- iii. The train is equipped with an **automatic safety mechanism** that immediately shuts off the hydrogen supply if heat, flame, smoke, or any abnormal condition is detected.

7. **Paving the Way for Green Railways:**

It supports the **National Green Hydrogen Mission**, advances India's **net-zero goals**, and lays the foundation for a cleaner, more resilient, and **sustainable railway system**.

Source: PIB –

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2285268®=48&lang=1>

22. **Semicon 2.0**

Prelims:

Government Schemes and Initiatives, Science & Technology, Economy

Mains:

GS Paper III–Science and Technology, Economy

Current relevance:

The Union Cabinet has approved ₹1.27 lakh crore for **Semicon India Programme 2.0 (India Semiconductor Mission – ISM 2.0)** to strengthen India's semiconductor ecosystem.



Highlights:

Background:

The **India Semiconductor Mission (ISM)** is a flagship initiative of the Government of India **launched in 2021** under the **Ministry of Electronics and Information Technology (MeitY)** to develop a complete semiconductor and display manufacturing ecosystem in India.

Semicon India Programme 2.0:

1. Semicon 2.0 is the **next phase** of the India Semiconductor Mission that focuses on **scaling semiconductor manufacturing**, strengthening supply chains, encouraging research, and making India a **globally competitive semiconductor hub**.
2. **Nodal Ministry:** Ministry of Electronics and Information Technology (MeitY)
3. **Implementing Agency:** India Semiconductor Mission (ISM)

Key Objectives:

1. Promote indigenous **design, development, and manufacturing** of semiconductor chips.
2. Expand support to suppliers of **raw materials, minerals, specialty gases**, and other semiconductor ecosystem components.
3. **Reduce India's dependence** on imported semiconductors and strengthen supply chain resilience.

Six-Pillar Approach of Semicon 2.0:

1. **Indigenous Chip Design:** Promote the design of semiconductor chips in India.
2. **Research and Development (R&D):** Strengthen innovation, technology development, and intellectual property (IP) creation.
3. **Manufacturing Ecosystem:** Establish globally competitive **semiconductor fabrication (fabs)**, and packaging (ATMP/OSAT) facilities.
4. **Raw Material Support:** Encourage domestic production of critical minerals.
5. **Supply Chain Development:** Build a resilient end-to-end semiconductor supply chain.
6. **Technology Advancement:** Facilitate the adoption of next-generation semiconductor technologies for emerging sectors such as **Artificial Intelligence (AI), electric vehicles (EVs), 5G/6G, Internet of Things (IoT), and high-performance computing.**

Source: THE HINDU -

<https://www.pressreader.com/foryou?popupArticleId=281977499383437>

23. Cyclosporiasis

Prelims:

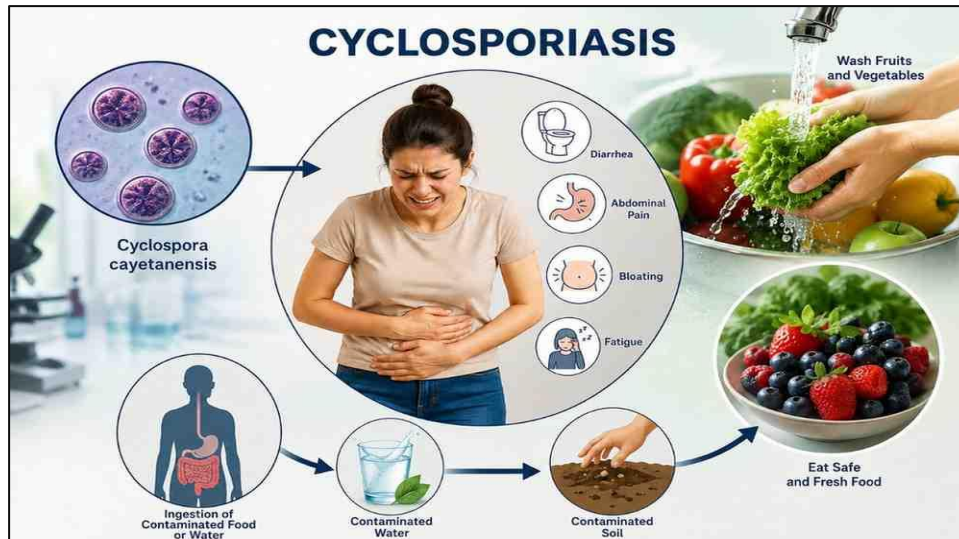
Science & Technology, Health

Mains:

GS Paper II-Health, **GS Paper III**-Science & Technology

Current relevance:

The **United States** has reported a major outbreak of **cyclosporiasis**, with over 1,600 confirmed cases across 34 States, prompting public health advisories by the **U.S. Centers for Disease Control and Prevention (CDC)**.



Highlights:

Cyclosporiasis:

1. It is a **foodborne gastrointestinal illness** caused by the microscopic parasite **Cyclospora cayetanensis**.
2. It spreads through the **faeco-oral route** by consuming food or water contaminated with **human faeces** containing the parasite.
3. It is **not transmitted from person to person** and spreads only through the consumption of contaminated food or water.

Adverse Health Effects:

1. Severe dehydration.
2. **Malabsorption** of nutrients.
3. **Cholecystitis** (inflammation of the gallbladder).
4. **Reactive arthritis**
5. Symptoms may persist for several weeks or recur if left untreated.

Treatment:

1. The recommended treatment for cyclosporiasis is a **7–10-day course of Trimethoprim–Sulfamethoxazole (TMP–SMX)**, along with **adequate oral rehydration** to prevent dehydration.
2. Individuals with weakened immune systems may require a longer duration of treatment depending on the severity of the infection.

preventive measures:

1. **Strengthen food safety surveillance and disease monitoring systems** to enable the early detection and effective control of foodborne disease outbreaks.
2. **Promote good hygiene and safe food handling practices** throughout the food supply chain, from production and processing to distribution and consumption.
3. **Enhance public awareness** and demonstrates how foodborne parasitic diseases can spread rapidly through contaminated fresh produce.

Source: THE HINDU– https://www.pressreader.com/india/the-hinduinternational9bn2/20260717/281904484941648?srsIid=AfmBOopx_klOzQybpcI2tdrKsTPLZ3aYSWdwAjnleqDHn7mvuO7oINf2

24. Kudankulam Nuclear Power Plant Data Leak

Prelims:

Science & Technology, Infrastructure

Mains:

GS Paper III– Science & Technology, Cyber Security, Internal Security

Current relevance:

A **cybersecurity breach** involving **Kudankulam Nuclear Power Plant (KKNPP)** data came to light after cybercriminals leaked files on the **Dark Web** following an attempted **ransomware attack** on Reliance Infrastructure's third-party cloud server.



Highlights:

Background:

1. The Kudankulam Nuclear Power Plant (KKNPP) is located in Tirunelveli district, Tamil Nadu, and is operated by the **Nuclear Power Corporation of India Limited (NPCIL)**.
2. A **ransomware attack** on a third-party cloud server used by Reliance Infrastructure led to the leakage of operational documents related to the Kudankulam Nuclear Power Plant (KKNPP).
3. Approximately 14.3 GB of KKNPP-related data, part of a larger 1.2 TB dataset, was published on the **Dark Web** after the ransom demand was reportedly not paid.
4. The leaked data included engineering blueprints, supplier details, equipment review documents, **meeting and inspection records**, and insurance policy documents related to the Kudankulam Nuclear Power Plant's **operational infrastructure**.

Ransomware Attack:

It is a type of **malicious software (malware)** that blocks access to systems or steals data and **demands payment (ransom)** to restore access or prevent public disclosure.

Dark web:

- I. It is a **hidden part of the internet** that is not indexed by standard search engines and can only be accessed using **specialized software** such as the Tor browser.
- II. It is **used for both legitimate purposes**, such as protecting privacy and anonymous communication, and **illegal activities**, including cybercrime, data trading, and ransomware operations.

Source: THE HINDU– https://www.pressreader.com/india/the-hindu-mumbai9wwd/20260717/281728391282532?srsId=AfmBOorAAp6Zn2IrepvRWncuEid5Cn_P9mtsohKYZHahHg_jyxRVATSH

25. Magnetic Tree Hypothesis

Prelims:

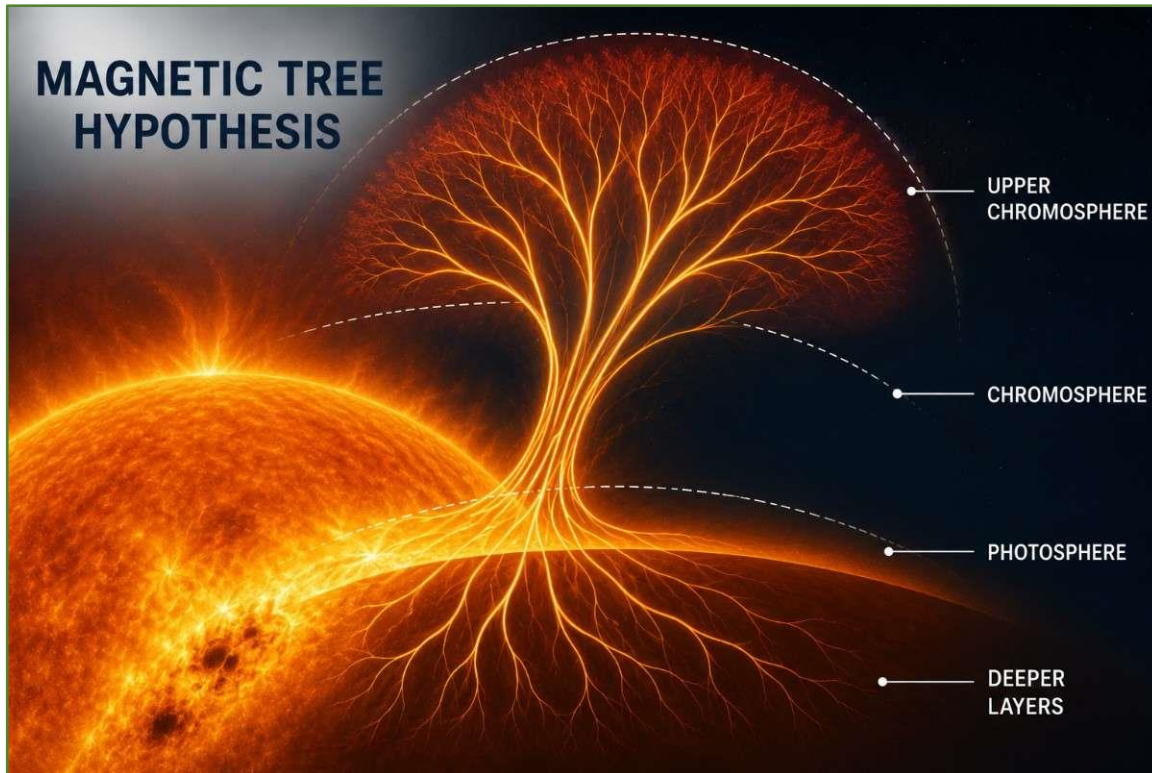
Science & Technology,

Mains:

GS Paper III–Science & Technology

Current relevance:

Scientists from **ARIES**, in collaboration with Indian research institutions and **NASA**, have provided **the first observational evidence supporting the Magnetic Tree Hypothesis**, revealing that the Sun's poleward plasma flow extends into the upper chromosphere.



Highlights:

Background:

1. Scientists have long known that the Sun exhibits a **slow poleward movement of hot plasma**, called the meridional flow, which transports magnetic fields across the solar surface.
2. Earlier, the Sun's meridional plasma flow had been detected only in its **lower atmospheric layers**. The latest study reveals that this flow extends nearly **3,000 km above the visible surface into the upper chromosphere**.

Key findings:

1. The study provides the **first direct evidence** that the Sun's poleward plasma flow extends into the **upper chromosphere**.
2. Bright radio features move poleward in close alignment with the **Sun's magnetic fields**, indicating a strong connection between the Sun's surface and upper atmosphere.
3. Plasma flows toward the poles at speeds of about 5–15 metres per second, with variations over the **11-year solar cycle**.

4. The **northern and southern hemispheres** exhibit **different plasma flow patterns** depending on their magnetic activity.

Magnetic Tree Hypothesis:

1. It proposes that **magnetic structures extending high above the Sun's surface** remain connected to deeper layers, similar to the way the branches of a tree remain connected to its trunk and roots.
2. It suggests that the Sun's upper atmosphere remains closely connected to the deeper layers, reflecting the movements occurring within the Sun.

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2285705®=48&lang=1>

26. Vikram-1

Prelims:

Science and Technology, Government Policies and Initiatives

Mains:

GS Paper III–Science and Technology

Current relevance:

Skyroot Aerospace is preparing to launch **Vikram-1** under **Mission Aagaman**, making it **India's first privately developed orbital launch vehicle**.



Highlights:

About Vikram-1:

1. Vikram-1 is **India's first privately developed orbital launch vehicle**, developed by **Skyroot Aerospace**.
2. It is capable of placing **payloads** of up to **350 kg** into **Low Earth Orbit (LEO)**.
3. The launch vehicle features an **all-carbon composite** structure, **solid-fuel** boosters, and a **3D-printed liquid engine**.
4. It is designed for **commercial satellite launches**, strengthening India's indigenous launch capabilities and **expanding private sector participation** in the space industry.
5. It will be launched under **Mission Aagaman**, carrying multiple customer payloads into Low Earth Orbit (LEO).
6. **Aim:** To validate India's **indigenous commercial orbital launch** capability and showcase the success of India's space sector reforms.

Space Sector Reforms Supporting Private Participation:

1. Indian Space Policy, 2023

Opened the entire space value chain to **private players**, promoting innovation, investment, and international collaboration.

2. IN-SPACE

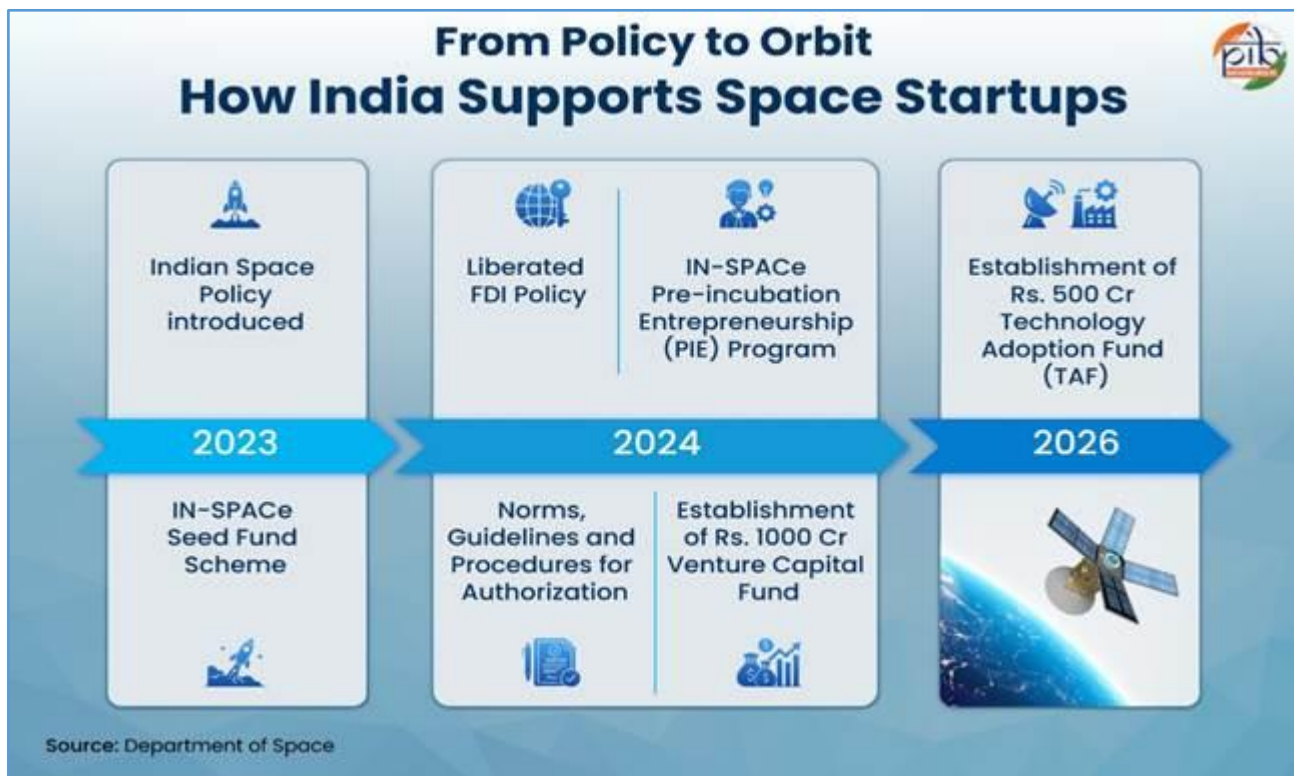
Acts as a **single-window regulator**, enabling private participation and facilitating access to ISRO's facilities and technologies.

3. NewSpace India Limited (NSIL)

ISRO's **commercial arm**, responsible for commercial launch services, satellite solutions, and technology transfer.

4. Liberalised FDI Policy

Permits **higher automatic FDI** in the space sector to attract investments, advanced technology, and boost private participation.



Source: PIB –

<https://www.pib.gov.in/PressNoteDetails.aspx?NotelId=159250&ModuleId=3®=48&lang=1>

27. QDenga (TAK-003)

Prelims:

Science and Technology, Health

Mains:

GS Paper II – Health, Government Policies and Interventions, GS Paper III – Science and Technology

Current relevance:

The **Drug Controller General of India (DCGI)** has granted market authorisation to **Takeda Biopharmaceuticals India's QDENG (TAK-003)**, making it the **first dengue vaccine** approved in India.



Highlights:

1. **QDENG (TAK-003)** is India's **first approved dengue vaccine**, developed by **Takeda Biopharmaceuticals** for the prevention of dengue disease.
2. **Key Features:**
 - i. It is a **live-attenuated tetravalent dengue vaccine**.
 - ii. Designed to provide protection against **all four dengue virus serotypes (DENV-1, DENV-2, DENV-3, and DENV-4)**.
 - iii. It is approved for **individuals aged 4 to 60 years** and is administered as a **two-dose vaccine**, with the second dose given **three months** after the first.
 - iv. **Special Feature:** Can be administered **without prior dengue screening** and irrespective of **previous dengue infection**.
3. **About Dengue:**

- i. Dengue is a **mosquito-borne viral disease** caused by the dengue virus (DENV).
- ii. It is transmitted primarily through the bite of an infected **female Aedes aegypti mosquito**.
- iii. Common symptoms include **high fever, severe headache, pain behind the eyes, muscle and joint pain, skin rash, nausea, and vomiting**.
- iv. Severe dengue may lead to **plasma leakage, bleeding, shock** (Dengue Shock Syndrome), and organ impairment.
- v. The management of dengue is primarily supportive, with **adequate fluid replacement** being the cornerstone of treatment, as no specific antiviral therapy is available.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/health/india-approves-first-dengue-vaccine-for-individuals-aged-4-to-60-years/article71244651.ece>

28. Ultrafast Organic Anodes for Next-Generation Rechargeable Batteries

Prelims:

Science and Technology

Mains:

GS Paper III–Science and Technology, Energy

Current relevance:

In Collaboration with **Indian Association for the Cultivation of Science (IACS)** and **S. N. Bose National Centre for Basic Sciences (SNBNCBS)**, scientists have developed a porous organic anode material based on a **Covalent Organic Framework (COF)** that enables ultrafast charging and high durability in rechargeable batteries in the near future.



Highlights:

1. Developed a porous organic anode using **Covalent Organic Framework (COF)** technology.
2. Allows rapid movement of **lithium ions**, reducing charging time significantly.
3. The battery **achieved 80% charge** in just over one minute.
4. Maintained excellent **cycling stability** over repeated charge-discharge cycles.
5. Also demonstrated the **ability to store sodium ions**, indicating potential for sodium-ion batteries.
6. Successfully tested in a practical battery device, showing **real-world applicability**.
7. **Covalent Organic Framework (COF):**
 - i. COFs are **highly porous**, crystalline organic materials made by linking light elements (C, H, O, N, B, etc.) through strong covalent bonds.
 - ii. Their ordered **nanoporous structure** provides:
 - a) Large surface area.
 - b) Fast ion transport pathways.
 - c) High structural stability.
 - d) Tunable chemical properties.
8. **Significance:**
 - i. Supports the growing demand for **Electric Vehicles (EVs)**.

- ii. Enables **faster charging** for smartphones, laptops, and portable electronics.
- iii. Improves storage solutions for **renewable energy** such as solar and wind.
- iv. Reduces charging downtime while improving battery **safety and durability**.
- v. Strengthens India's **research capabilities** in advanced battery technologies.

9. Challenges:

- i. Scaling up laboratory synthesis for mass production.
- ii. Cost-effective manufacturing of **Covalent Organic Framework (COF)** materials.
- iii. **Long-term commercial validation** under varied operating conditions.
- iv. **Integration** with existing battery manufacturing processes.

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2285704®=48&lang=1>

29. Borophene

Prelims:

Science & Technology, Environment & Ecology

Mains:

GS Paper III – Science & Technology, Environment

Current relevance:

Scientists from the **Institute of Advanced Study in Science and Technology (IASST)**, Guwahati, an autonomous institute under the Department of Science and Technology (DST), have demonstrated for the **first time that borophene**.



Highlights:

1. Researchers successfully demonstrated, for the first time, the **use of borophene as a high-performance lubricant additive** in **castor oil**, marking its first reported **application in lubrication technology**.
2. Borophene is a **two-dimensional (2D) nanomaterial** consisting of a **single layer of boron atoms**, known for its exceptional mechanical strength, electrical conductivity, chemical stability, and tribological (friction-reducing) properties.
3. **Working Mechanism:**
 - i. During operation, borophene **disperses uniformly** in castor oil without chemical modification and forms a durable **protective tribofilm** composed of **iron oxides, carbonaceous species, and boron-based compounds**.
 - ii. This **tribofilm** reduces shear stress, enhances load-bearing capacity, and minimizes friction, wear, and tear, thereby **improving lubrication performance** and machine efficiency.
4. **Potential Applications:**
 - i. Renewable Energy Systems
 - ii. Marine Applications

- iii. Green Lubrication Technologies
- iv. Sustainable Manufacturing
- v. Industrial Machinery

1. The **integration of borophene** with **renewable castor oil** marks a major advancement in sustainable lubrication technology by combining **nanotechnology, renewable resources, and enhanced energy efficiency.**

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2287664®=48&lang=2>

30. Nuclear Energy Mission & Three-Stage Nuclear Programme

Prelims:

Science & Technology, Environment

Mains:

GS Paper III–Science and Technology, Energy

Current relevance:

India has taken a significant step towards strengthening its long-term energy security by simultaneously advancing the **Nuclear Energy Mission (NEM)** and the **Three-Stage Nuclear Power Programme.**

NUCLEAR ENERGY MISSION (NEM)

ACHIEVE **100 GWe**
NUCLEAR POWER GENERATION
CAPACITY BY **2047**

TO SUPPORT



VIKSIT
BHARAT



INDIA'S
NET ZERO TARGET
BY **2070**

THREE-STAGE NUCLEAR PROGRAMME

STAGE 1

PHWR PROGRAMME



- Use of Indigenous Uranium Resources
- Pressurised Heavy Water Reactors (PHWRs)

Energy Generation

STAGE 2

FAST BREEDER REACTOR PROGRAMME



- Use of Plutonium produced in Stage 1
- Fast Breeder Reactors (FBRs)

Breeding of More Fuel

STAGE 3

THORIUM UTILISATION PROGRAMME



- Use of Thorium (Abundant in India) with Uranium
- Advanced Heavy Water Reactors (AHWRs)

Sustainable Energy for Future



CLEAN & RELIABLE
ENERGY



LOW CARBON
EMISSIONS



ENERGY SECURITY
FOR INDIA



SAFE, SECURE &
SUSTAINABLE

Highlights:

Nuclear Energy Mission (NEM):

1. The **Nuclear Energy Mission (NEM)** was announced in the **Union Budget 2025–26** with the objective of achieving **100 GWe** nuclear power generation capacity by **2047** to support **Viksit Bharat** and India's **Net Zero target by 2070**.
2. The mission also aims to develop and operationalise at least **five indigenous Small Modular Reactors (SMRs)** by **2033**.

Three-Stage Nuclear Power Programmed:

1. India follows a **closed fuel cycle**, where spent fuel from one stage becomes fuel for the next.
2. The success of this strategy depends on the sequential development of all three stages. While the **first stage** has already been **mastered**, the country has recently crossed a historic milestone by entering the second stage.
3. **Stage I – Pressurised Heavy Water Reactors (PHWRs)**

Natural uranium is used as fuel in PHWRs to generate power. The spent fuel from these reactors produces **plutonium**, which becomes the primary input for the next stage.

4. Stage II – Fast Breeder Reactors (FBRs)

- i. The **Prototype Fast Breeder Reactor (PFBR)** at **Kalpakkam, TN** marks India's entry into this stage. These reactors will be used to breed **Uranium-233** from **thorium**, laying the groundwork for Stage 3.
- ii. The PFBR uses **Uranium-Plutonium Mixed Oxide (MOX) fuel**.
- iii. The reactor is designed to eventually use **Thorium-232** in the blanket. Through transmutation, Thorium-232 will be **converted into Uranium-233**, the fuel that will power India's third stage of nuclear energy based on thorium.
- iv. **Closed Fuel Cycle:** The spent fuel generated by the PFBR will be reprocessed and recycled back into the reactor. This closes the second-stage fuel cycle and paves the way for large-scale use of India's abundant thorium reserves in Stage 3.

5. Stage III – Thorium-Based Nuclear Power:

- i. This stage will **harness India's vast thorium reserves** at scale, using the Uranium-233 bred in Stage 2 as fuel. Thorium is considered a practically vast energy source and this stage holds the key to India's long-term energy security.
- ii. For large-scale commercial deployment of thorium, conventional reactor technologies alone may not be sufficient. Therefore, the **Department of Atomic Energy** is simultaneously **developing advanced reactor systems** capable of efficiently utilizing thorium.

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2288294®=48&lang=1>

31. Blue Straggler Star

Prelims:

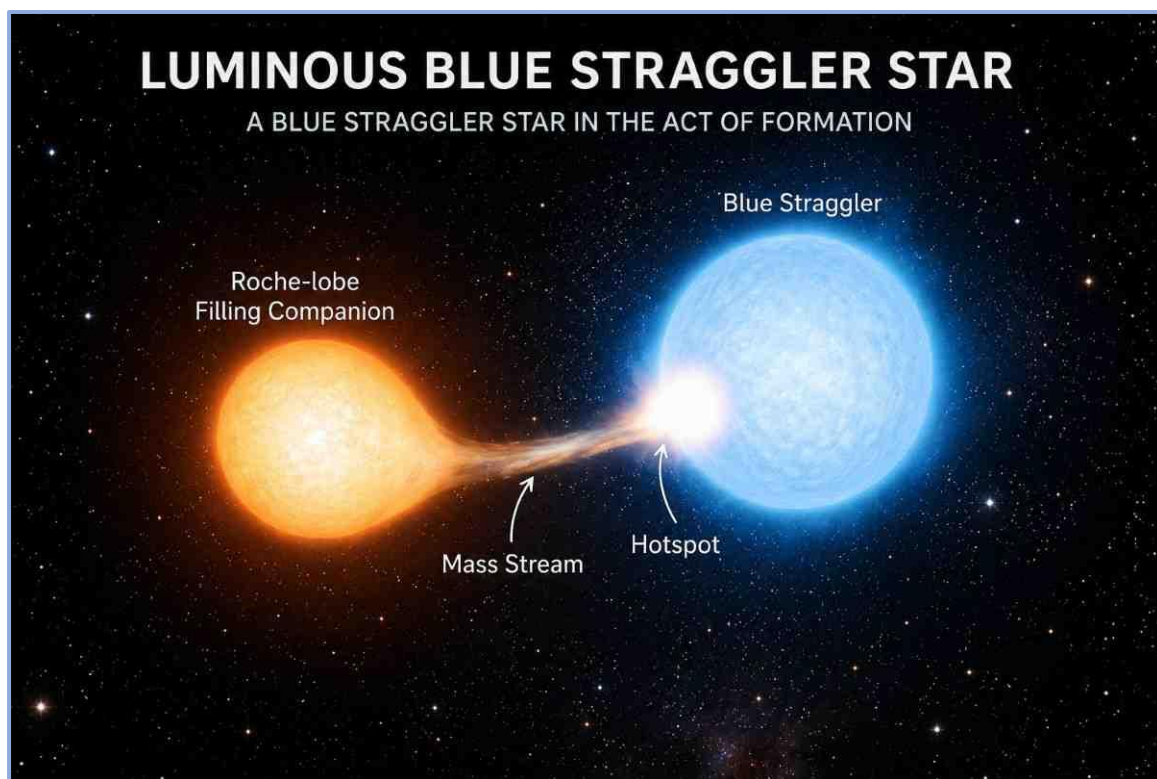
Science and Technology

Mains:

GS Paper III – Science and Technology

Current relevance:

Indian astronomers, along with international collaborators, have reported the rare discovery of a **Blue Straggler Star (BSS) caught in the process of formation.**



Highlights:

About Blue Straggler Stars:

- i. Blue Straggler Stars are an unusual class of stars found in star clusters. Compared with other stars in the same cluster, they appear **hotter, brighter, more massive, younger than expected.**
- ii. They are believed to form either by **gaining matter from a companion star or through the merger of two stars**, which increases their mass and makes them

appear rejuvenated. However, direct observational evidence of these formation processes has remained **extremely rare**.

Significance of the Discovery:

- i. The discovery offers **strong direct evidence** that Blue Stragglers can form through **mass transfer between stars** in a binary system.
- ii. It explains **stellar rejuvenation** by showing how an older star can gain matter and become hotter, brighter and apparently younger.
- iii. The system serves as a **valuable natural laboratory** for studying the evolution of interacting binary stars.
- iv. Understanding Blue Straggler formation helps astronomers assess the **age and evolutionary history of star clusters** more accurately.
- v. The continuing transfer of matter shows that interactions between **binary stars can persist for billions of years**.

Source: PIB –

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2290027®=48&lang=1>

32. India's Fight to Combat Hepatitis

Prelims:

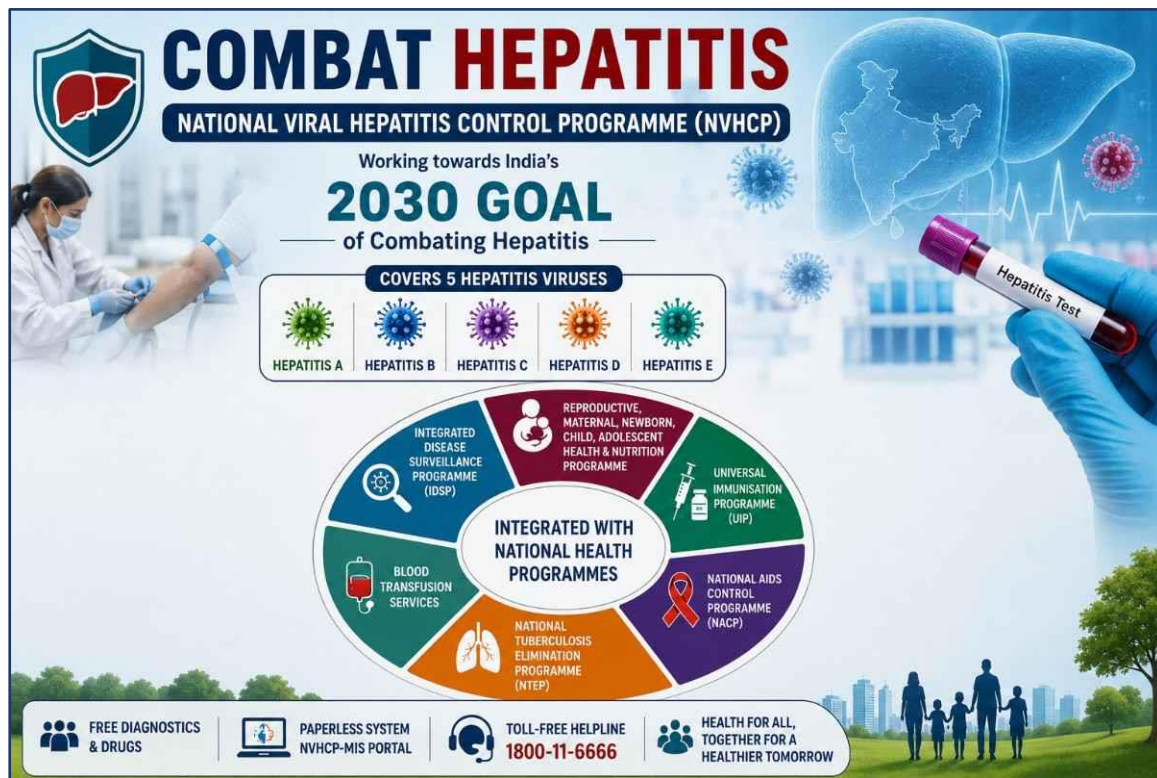
Science & Technology, Health, Government Schemes

Mains:

GS Paper II– Public Health, GS Paper III– Science and Technology

Current relevance:

India is strengthening its efforts to achieve the **2030 goal of combating hepatitis** through the **National Viral Hepatitis Control Programme (NVHCP)** by integrating prevention, screening, diagnosis, and free treatment services with various national health programmers.



Highlights:

1. Hepatitis:

- i. It is an inflammation of the liver caused by hepatitis viruses, other infections, toxic substances such as alcohol and drugs, and autoimmune diseases.
- ii. The five main hepatitis viruses are **Hepatitis A, B, C, D, and E**, of which **Hepatitis B and C** are the **most common** and can lead to **chronic liver disease, cirrhosis, and liver cancer**.

2. National Viral Hepatitis Control Programme (NVHCP):

- i. Launched in **2018**, aims to **combat hepatitis** by providing **screening, diagnosis, treatment, free drugs, and diagnostic services** through an **integrated health systems approach** in convergence with various national health programmes.
- ii. Its key focus areas include **awareness generation, improved access to healthcare, diagnosis, and treatment for all eligible individuals**.

3. Prevention and Disease Management

- i. **Hepatitis A and E** are primarily prevented through **safe drinking water, sanitation, and hygiene** measures.

- ii. **Hepatitis B** is a vaccine-preventable disease covered under the **Universal Immunisation Programme (UIP)**.
 - iii. **Hepatitis C** prevention focuses on **safe injection practices and harm reduction** measures, while treatment is provided using **Direct-Acting Antiviral (DAA) drugs**.
 - iv. **Hepatitis D** is prevented by preventing **Hepatitis B infection** through Hepatitis B vaccination.
4. The NVHCP is integrated with **multiple national programmes** to strengthen prevention and management:
- i. **Integrated Disease Surveillance Programme (IDSP)** for monitoring Hepatitis A and E.
 - ii. **Reproductive, Maternal, Newborn, Child, Adolescent Health and Nutrition Programme** for universal screening of pregnant women for Hepatitis B.
 - iii. **Universal Immunisation Programme (UIP)** to ensure Hepatitis B birth-dose vaccination and Hepatitis B Immunoglobulin (HBIG) for eligible newborns.
 - iv. **National AIDS Control Programme (NACP)** for screening high-risk groups and Hepatitis B vaccination of healthcare workers.
 - v. **National Tuberculosis Elimination Programme (NTEP)** for molecular testing using existing diagnostic infrastructure.
 - vi. **Blood Transfusion Services** for linking Hepatitis B and C positive blood donors to appropriate care.

Source: PIB –

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2289761®=48&lang=1>

33. PRAXIS Mission

Prelims:

Science & Technology

Mains:

GS Paper III–Science and Technology

Current relevance:

NASA has selected **PRAXIS (Planetary Rings Autonomous EXploration with In-situ Sampling)** as a **NIAC (NASA Innovative Advanced Concepts) 2026 Phase I** mission.



At a glance:

1. Objective:

- i. The mission seeks to answer key scientific questions on **how planetary rings form, evolve, and what ring particles are made** of through direct in-situ sampling.
2. PRAXIS will use a **bio-inspired robotic explorer** powered by an **Artificial Intelligence (AI) model** to autonomously identify and sample ring particles.
3. Instead of flying through planetary rings, the spacecraft will **graze the ring plane** and perform a **touch-and-go sampling** using a **long deployable boom**, allowing safe collection of surface samples from selected ring particles.
4. The spacecraft will collect free-floating particles and use onboard instruments, assisted by AI, to measure particle **size, porosity, composition**.

5. Selection under **NIAC Phase I** enables PRAXIS to undertake simulations and system design studies, with progression to **Phase II** paving the way for the development of a **physical prototype**.

Source: THE HINDU - <https://www.thehindu.com/sci-tech/science/praxis-a-nasa-mission-to-graze-planet-rings/article71269143.ece>

34. Andromeda Galaxy

Prelims:

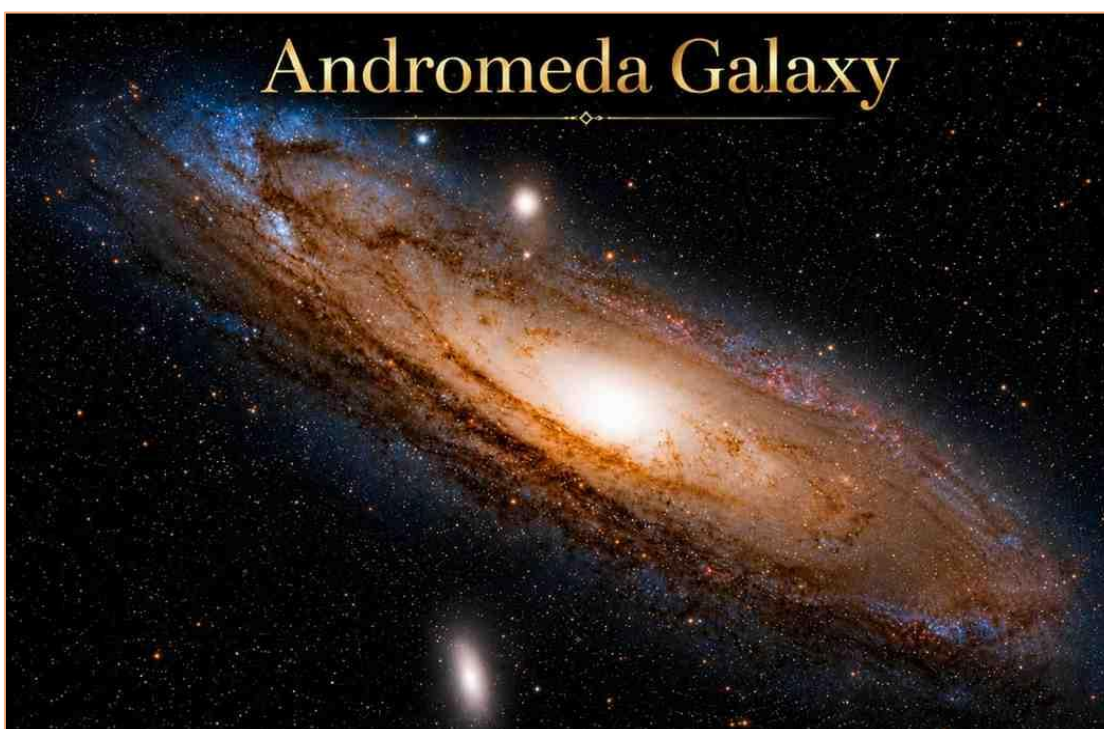
Science & Technology

Mains:

GS Paper III-Science and Technology

Current relevance:

Astronomers have used data from the **Hubble Space Telescope** to create the clearest map yet of **star formation across most of the Andromeda Galaxy over the last 500 million years**, revealing a steady decline in star-forming activity.



At a glance:

1. The study found that **Andromeda's star formation rate** has been **steadily declining**, with the sharpest decline occurring during the last 40 million years.
2. Recent star formation is mainly concentrated within the galaxy's **ring structures**, where the decline is also most evident.
3. Researchers identified a '**dead zone**' near **M32**, a satellite galaxy of Andromeda, where new star formation has nearly ceased, indicating that **the satellite galaxy likely interacted with or passed through Andromeda's stellar disc**, disrupting the gas clouds needed to form new stars.
4. The findings suggest that **Andromeda is transitioning from an active, star-forming galaxy to a quieter 'middle-age' phase**, gradually moving toward a more **quiescent state**.
5. **Significance:**
Studying Andromeda's evolution can help **improve our understanding of the life cycle of massive galaxies** and develop better methods to measure changes in distant galaxies.
6. **About Andromeda Galaxy:**
 - i. It is **largest galaxy in the Local Group** and the nearest major spiral galaxy to the Milky Way.
 - ii. Located about **2.5 million light-years** from Earth and is approximately **2–2.5 times wider** than the Milky Way.
 - iii. Classified as a **spiral galaxy** with a bright central bulge, spiral arms, and ring structures.

Source: THE HINDU – <https://www.thehindu.com/sci-tech/science/andromeda-galaxy-entering-middle-age/article71276485.ece>

35. IndiaAI Mission

Prelims:

Government Policies & Initiatives, Science & Technology

Mains:

GS Paper II-Government Policies & Interventions, GS Paper III-Science & Technology

Current relevance:

The Government highlighted the progress of the **IndiaAI Mission**, including the identification of **762 AI use cases across 62 Ministries**, approval of **58 AI Centres of Excellence**, establishment of **543 Data & AI Labs**, and initiatives to promote responsible AI for governance and public service delivery.



At a glance:

1. IndiaAI Mission aims to **democratise technology**, create employment opportunities, and promote the safe, inclusive and responsible adoption of Artificial Intelligence in India.

Seven Pillars of the IndiaAI Mission:

1. **IndiaAI Compute:**

Develops a high-end, scalable AI computing ecosystem to support **startups and research**.

2. **Foundation Models:**

Supports **indigenous Large Language Models (LLMs)**, Multimodal Models and Small Language Models for India-specific applications.

3. **IndiaAI Application Development Initiative (IADI):**

To develop, scale, and deploy AI solutions that drive large-scale **socio-economic transformation** across key sectors.

4. **IndiaAI Future Skills:**

Builds AI talent pipeline through **Data & AI Labs**, fellowships and industry-oriented AI education.

5. **AIKosh:**

Provides a **unified platform** for **high-quality datasets**, AI models and tools.

6. **Safe & Trusted AI:**

To promote responsible AI through indigenous governance frameworks and evaluation tools suited to India's **socio-economic and cultural needs**.

7. **IndiaAI Startup Financing:**

To provide financial support to AI startups throughout their lifecycle, from prototype development to commercialization.

11 National-Level Hackathons & Innovation Challenges:

1. **IndiaAI Innovation Challenge** – AI solutions for healthcare, agriculture, governance, learning disabilities, and climate change.
2. **IndiaAI I4C CyberGuard AI Hackathon** – AI for classification of cybercrime complaints and identification of emerging crime patterns.
3. **IndiaAI–GSI Mineral Targeting with AI Hackathon** – AI/ML for advanced mineral prognostication using geoscientific datasets.
4. **Cancer AI & Technology Challenge (CATCH)** – AI to strengthen cancer screening, diagnostics, treatment support, and healthcare operations.

5. **IndiaAI Face Authentication Challenge** – AI-enabled de-duplication and one-to-many photo verification to improve the integrity of public examinations.
6. **IndiaAI Intelligent Document Processing (IDP) Challenge** – AI for automated extraction, classification, validation, and structuring of multilingual documents.
7. **IndiaAI Innovation Challenge 2026** – AI solutions for AYUSH healthcare and MSMEs.
8. **IndiaAI Challenge for Transforming Governance** – AI solutions for governance use cases across key government departments.
9. **IndiaAI Financial Compliance Reporting Challenge** – AI-enabled compliance monitoring and risk assessment.
10. **CDSCO–IndiaAI Health Innovation Acceleration Hackathon** – AI-driven automation of regulatory workflows, including document summarisation, anonymisation, and inspection reporting.
11. **PMJAY Auto Adjudication Hackathon** – AI-based adjudication frameworks for PMJAY claims.

IndiaAI Impact Summit:

India hosted the India-AI Impact Summit **2026** in New Delhi, to actively engage with the India AI Impact Expo and identify AI applications relevant to their respective domains to accelerate AI adoption across the Government.

1. The **Digital Personal Data Protection Act, 2023** provides the framework for lawful processing and protection of personal data.
2. **Responsible AI Projects:** Projects focus on AI bias mitigation, explainable AI, algorithm auditing, privacy-preserving AI and deepfake detection.
3. **AI Governance Framework:**

India has established institutional mechanisms including AI Governance and Economic Group (AIGEG), Technology and Policy Expert Committee (TPEC), AI Safety Institute (AISi).

4. **Cyber Security:**

Indian Computer Emergency Response Team (CERT-In) has issued AI security advisories and launched AI security capacity-building initiatives.

Source: PIB-

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2291062®=1&lang=1>

36. Telecom Manufacturing Zone (TMZ)

Prelims:

Government Policies & Initiatives

Mains:

GS Paper II-Government Policies & Interventions, GS Paper III-Science & Technology

Current relevance:

The **Department of Telecommunications (DoT)** and the Government of Madhya Pradesh are set to sign a **Memorandum of Understanding (MoU)** for the establishment of **India's first Telecom Manufacturing Zone (TMZ), Phase-I**, at Gwalior, Madhya Pradesh.



Highlights:

Objectives:**1. Strengthen Domestic Telecom Manufacturing**

Build a **world-class manufacturing ecosystem** for telecom equipment and allied technologies.

2. Promote Indigenous Innovation

Encourage **indigenous design, manufacturing, and development** of next-generation telecom products and solutions.

3. Support National Vision

Advance the vision of **Aatmanirbhar Bharat** by strengthening India's domestic telecommunications manufacturing ecosystem.

Projected Outcomes:**1. Telecom Value Chain:**

To serve as a catalyst for the growth of **telecom equipment manufacturers, technology companies, MSMEs, start-ups**, and other stakeholders.

2. Investment & Industrial Growth: Attract investments and foster innovation across the telecom sector.**3. Employment Generation:** Create substantial employment opportunities and promote regional industrial development.**4. Supply Chain Resilience:** Strengthen the telecom manufacturing supply chain.**5. Global Manufacturing Hub:** Position India as a **global hub for telecom manufacturing and innovation**.

Source: PIB –

<https://www.pib.gov.in/PressReleaseDetail.aspx?PRID=2291322®=48&lang=1>

37. Himalayan Chandra Telescope (HCT)

Prelims:

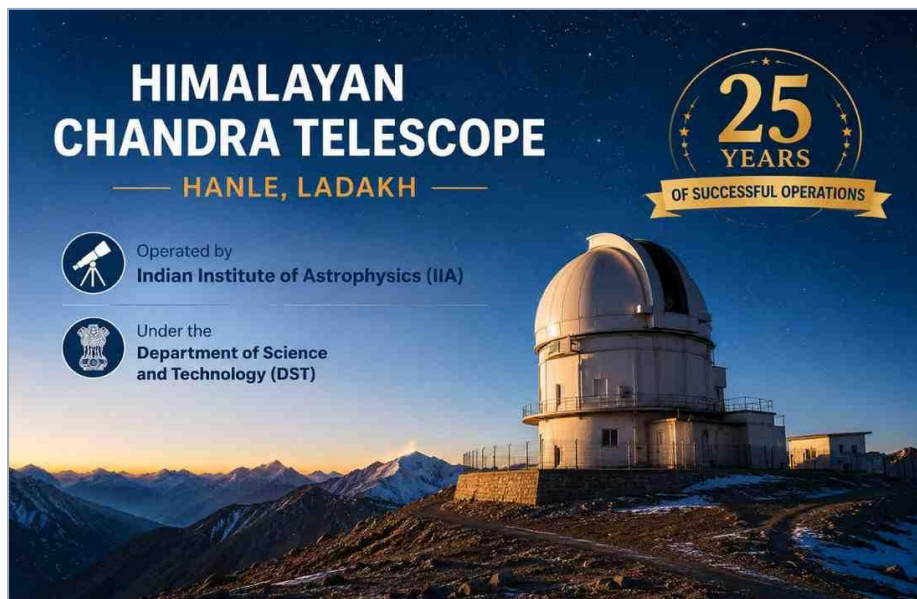
Science & Technology

Mains:

GS Paper III–Science & Technology

Current relevance:

The **2-m Himalayan Chandra Telescope (HCT)** at Hanle, Ladakh completed **25 years of successful operations**, marked by a conference showcasing its history, scientific achievements, engineering milestones, and future expansion plans.



Highlights:

Historical background:

1. The idea of establishing an optical telescope in the trans-Himalayan region had been a long-standing aspiration of the Indian astronomical community.
2. The **2-m Himalayan Chandra Telescope** achieved its **First Light** on **2000**, located at **Hanle, Ladakh**.
3. Operated by the **Indian Institute of Astrophysics (IIA)**, an autonomous institution under the **Department of Science and Technology (DST)**.
4. The telescope was named **Himalayan Chandra Telescope (HCT)** in honour of **Nobel Laureate Subramanyan Chandrasekhar**.

Unique Features:

1. Operated remotely in real time from the **IIA campus at Hosakote, Bengaluru**, through a dedicated **INSAT-3B satellite** link since June 2001.
2. It is equipped with three scientific instruments, the **HFOSC** for optical imaging and spectroscopy, **uTIRSPEC** for near-infrared spectroscopy and imaging, and **HESP**, a high-resolution Echelle spectrograph for detailed spectroscopic observations.

Major Research Contributions:

1. **Planetary Science:** HCT has been used for spectroscopy of comets, studies of exoplanet atmospheres, and participated in the discovery of the TRAPPIST-1b exoplanet.
2. **Stellar Astrophysics:** It has supported research on nebulae, star-forming regions, young stellar objects, variable stars, binary systems, and chemically peculiar stars.
3. **Transient Astronomy:** HCT has contributed to the study of novae, supernovae, and their expanding shells.
4. **Extragalactic Astronomy:** It has enabled research on galaxies, lensed quasars, interacting galaxies, and active galactic nuclei.

Source: PIB –

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2291141®=48&lang=2>

38. Virtual Magnets in EV Motors

Prelims:

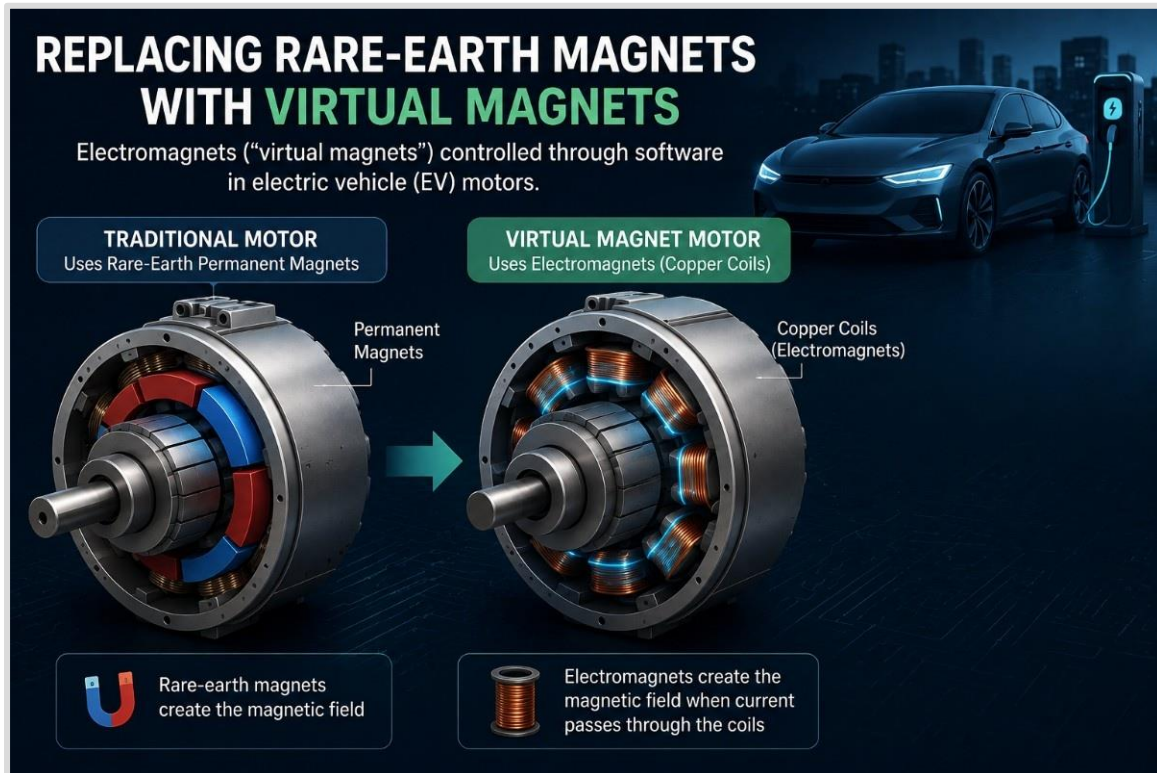
Science & Technology

Mains:

GS Paper III–Science & Technology

Current relevance:

A Bengaluru-based startup, **Vimag Labs**, has claimed to replace **rare-earth permanent magnets** in electric vehicle (EV) motors with **electromagnets ("virtual magnets")** controlled through software.



Highlights:

Virtual Magnets:

1. The motor replaces **permanent magnets** with **copper coils wound** around a **ferromagnetic core**, which become **electromagnets** when supplied with electric current.
2. The software does not generate magnetism but regulates the current supplied to the coils, thereby controlling the **strength and direction of the electromagnetic field**.

Established Use of Electromagnets:

1. Use in Power Generation:

Large generators in **hydroelectric, thermal and nuclear power plants** have long used **electromagnets instead of permanent magnets**.

2. Brushless Excitation System:

As the rotor rotates continuously, a rectifier mounted on it **converts AC into DC to energise the rotor coils**, eliminating the need to supply DC through sliding contacts.

Electromagnets in EVs

1. **Electrically Excited Motors:** BMW and Renault have been working on motors that use **electromagnets** instead of permanent magnets.
2. Even a **0.1%** improvement in **motor efficiency can significantly increase an EV's driving range**, or enable a smaller battery, thereby reducing the vehicle's weight and cost.
3. **Permanent Magnet Synchronous Motors (PMSMs)** currently dominate the EV market because they offer the **highest efficiency**, while the battery pack remains the **costliest and heaviest** component of an EV.

Source: THE HINDU- <https://www.pressreader.com/india/the-hindu-international-9bn2/20260730/281934549743681?srsId=AfmBOopekzUc7JZDP83gsRFBraVR6igrGplg7VENH7MuLOm9P8RaBpb0>

39. DAANVEER

Prelims:

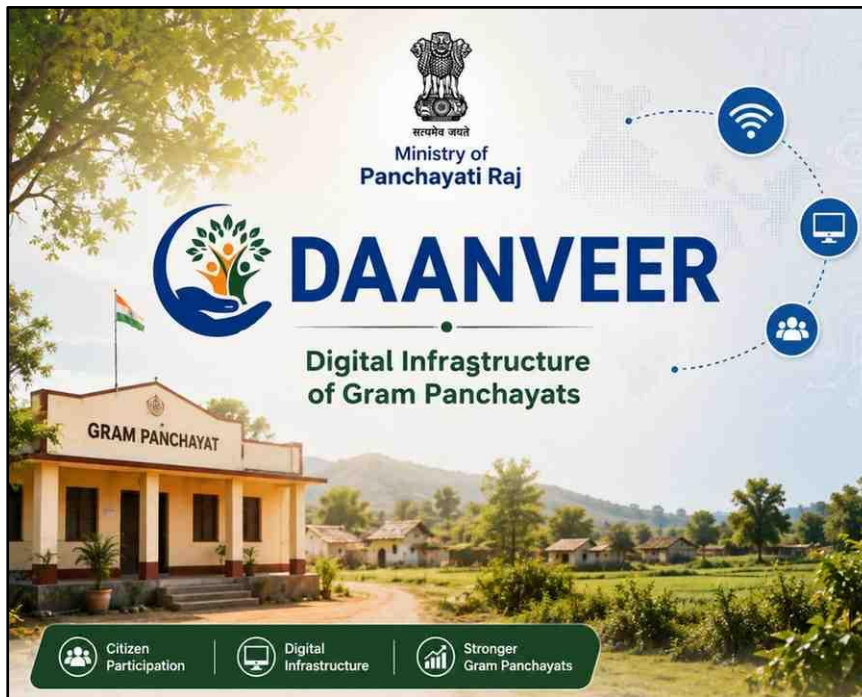
E-Governance

Mains:

GS Paper II-e-Governance, GS Paper III-Science & Technology

Current relevance:

The **Ministry of Panchayati Raj** launched **DAANVEER**, a citizen participation initiative to strengthen the **digital infrastructure of Gram Panchayats** by enabling voluntary contributions of computers through the **Meri Panchayat App**.



Highlights:

1. **DAANVEER** is a **technology-enabled, transparent and verifiable platform** that enables citizens and organisations to contribute towards the digital infrastructure needs of **Gram Panchayats**.
2. It is an initiative of the **Ministry of Panchayati Raj (MoPR)**, developed in collaboration with the **National Informatics Centre (NIC)** and **DigiHaat**.
3. **Objective:**
 - i. Aims to bridge the computer and digital infrastructure gap in **Gram Panchayats** across the country.
 - ii. It establishes a **long-term, citizen-driven mechanism** to strengthen local institutions through voluntary public contributions.
 - iii. To enhance service delivery, transparency, and **grassroots governance** by strengthening digital infrastructure at the Panchayat level.
4. **Key features:**
 - i. Citizens and organizations can donate standardized, quality-verified computer bundles to eligible Gram Panchayats through the **Meri Panchayat mobile** application, which is integrated with the **Digital marketplace**.
 - ii. Donors can select pre-approved computer bundles based on **State-specific technical specifications**, with delivery details generated automatically.

- iii. The platform ensures complete transparency through **end-to-end digital tracking** from dispatch to installation and provides a digital certificate of appreciation to every donor.
- iv. Carrying the tagline **“Give Back to Your Village,”** DAANVEER promotes **voluntary public participation** in strengthening digital infrastructure at the grassroots.
- v. It provides a credible platform for citizens, including the **Indian diaspora**, to reconnect with and **contribute to the development of their native villages**.

5. Integration with Digital Governance Ecosystem:

DAANVEER builds upon the Ministry's digital governance ecosystem, including **e-GramSwaraj, Meri Panchayat, Sabha Saar, Audit Online, Gram Manchitra**, Other digital governance platforms.

Source: PIB-

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2291370®=48&lang=1>

40. Alanine Aminotransferase (ALT)

Prelims:

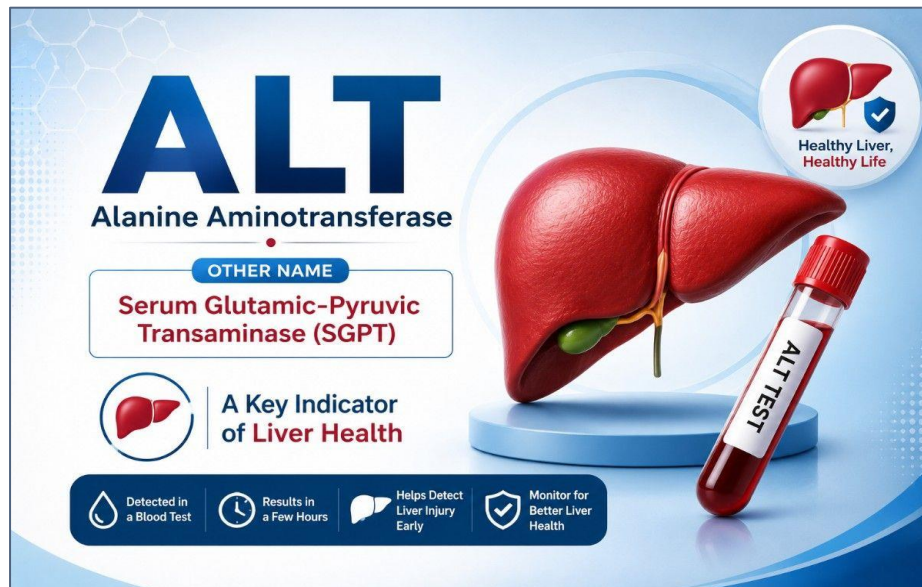
Health

Mains:

GS Paper II-Issues Relating to Public Health, GS Paper III-Science & Technology

Current relevance:

The **Union Health Ministry** has urged people to monitor **Alanine Aminotransferase (ALT)** levels as an early indicator of liver injury, highlighting the growing burden of liver diseases.



Highlights:

Global Burden of Liver Diseases:

1. According to the **WHO**, liver diseases cause around **2 million deaths annually** worldwide.
2. **Viral hepatitis** caused an estimated **1.3 million deaths** in 2022.
3. Around **254 million people** live with **chronic Hepatitis B**, while **50 million** live with **chronic Hepatitis C**.
4. The burden of **Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD)** is increasing due to rising obesity and diabetes.

Alanine Aminotransferase (ALT):

1. It is an enzyme found predominantly inside liver cells, **also known as Serum Glutamic–Pyruvic Transaminase (SGPT)**.
2. Damage or inflammation of liver cells causes **ALT to leak into the bloodstream**, making it one of the earliest laboratory markers of liver injury.
3. ALT is also present in smaller amounts in **muscles and the heart**; therefore, elevated ALT does not always indicate liver disease.

Role of ALT Testing:

1. ALT is a component of the **Liver Function Test (LFT)**, performed using a **blood sample** to **assess liver enzymes** and function, with results typically available within a few hours.

2. Although many laboratories consider **ALT levels below 40 units/L** as normal, interpretation depends on the patient's clinical condition.

Individuals Recommended for ALT Testing:

1. ALT testing is already included in most **comprehensive health check-ups**.
2. Individuals with the following conditions should undergo **regular evaluation**, they are obesity, diabetes, thyroid disorders, high cholesterol, viral hepatitis, long-term medication use, alcohol consumption, family history of liver disease, sedentary lifestyle.

Elevated ALT may occur in:

1. Acute viral hepatitis
2. Alcohol-related liver disease
3. Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD)
4. Autoimmune hepatitis
5. Chronic liver diseases

Measures:

1. Maintaining a healthy weight, **reducing alcohol intake**, limiting **saturated fats**, refined **carbohydrates and sugary foods**, and engaging in regular physical activity are essential for liver health, while **viral hepatitis and autoimmune hepatitis** require **specific medical treatment**.

Source: THE HINDU – [What Alanine aminotransferase level can reveal about liver health](#)