

MESSAGE FROM DR. KHAN

Every issue of Current Connect is a dialogue between the present that questions and the future that must answer. As we step into the final quarter of 2025, India stands at a remarkable intersection of change: festivals have returned to our streets, debates have returned to our institutions, and faith in reform has returned to governance. The rhythm of this nation, sometimes noisy and often noble, continues to remind us that democracy breathes best when citizens think deeply and act ethically.

This October edition reflects that rhythm. From constitutional morality and fiscal federalism to cloud-seeding experiments and global scientific milestones, every page of this issue attempts to convert news into understanding and information into insight. You will find the same India seen from many windows the policymaker's precision, the economist's concern, the sociologist's empathy, and the geographer's wonder.

Our team has tried to weave together events and ideas that matter the tightening air above Delhi, the quiet resilience of our forests, the growing power of clean energy, the shifting alliances in the Indo-Pacific, and the endless experiments of human courage in science and space. Each article is not merely a note for your preparation but a reminder that every fact in governance carries a face, and every number hides a human story.

In this issue, the Essay of the Month "Trains of Faith: Festivals and the Great Indian Return" celebrates the emotion that still moves the world's largest democracy. The Case Study of the Month "When the Sky Refused to Rain" challenges us to see ethics not as theory but as an everyday test of honesty under uncertainty. And our Philosophy of the Month section asks the timeless question of how artificial intelligence can remain human at heart.

Preparation, after all, is not just about mastering subjects; it is about mastering perspective. To read Current Connect is to learn how to listen to the pulse of the people, the whisper of the Constitution, and the echo of the future calling through the present.

As you read this magazine, remember that every paragraph you understand is a paragraph you can transform. Keep learning, keep questioning, and keep believing, for the best answers are born out of moral curiosity.

– Dr. A. R. Khan
Director, KSG IAS

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INDIAN POLITY

Contempt of Court in India

Why in News

Recent actions by Indian courts have revived the spotlight on the offence of contempt of court. A press release from the Contempt of Courts Act, 1971 outlines the law and procedure for contempt. Further, a recent case in the Telangana High Court issued a notice under contempt rules to a government agency head for alleged disregard of court's direction.

Background / Concept

"Contempt of court" refers to conduct that either disobeys a judicial order (civil contempt) or which scandalises, interferes with, or lowers the authority of a court (criminal contempt) under the Contempt of Courts Act, 1971. The Constitution of India under Articles 129 and 215 recognises the power of the Supreme Court and High Courts as courts of record and bestows them with the power to punish for contempt.

Key Features

- **Types:** Civil contempt (wilful disobedience of court orders) and criminal contempt (scandalising court, obstructing justice).
- **Punishment:** Up to six months' simple imprisonment or fine or both for criminal contempt under Section 12 of the Act.
- **Procedure:** Courts of record have the inherent power; the Act sets out safeguards (e.g., hearing, notice).
- **Recent Developments:** The Telangana HC case invokes Form I under Contempt Rules—requiring personal appearance to explain non-compliance.

Prelims Connect

- Act Name & Year: Contempt of Courts Act, 1971.
- Constitutional Provisions: Articles 129 (SC), 215 (High Courts).
- Two types of contempt: civil and criminal.
- Key procedural part: Section 12 (Punishment) and Sections 3-5 (defences) of the Act.

Mains Connect

"Examine the scope and significance of the law of contempt of court in India. How does it balance the independence of judiciary and freedom of speech?"

Prelims Practice Question

- Q. With reference to 'Contempt of Court' in India, consider the following statements:
1. It is defined under the Contempt of Courts Act, 1971.
 2. Civil contempt includes wilful refusal to comply with a court order.
 3. Criminal contempt includes publication that scandalises the judge only, irrespective of whether the due course of judicial proceedings is affected.

4. The Supreme Court and the High Courts have the inherent power to punish for contempt.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only
- (b) 1 and 3 only
- (c) 2 and 4 only
- (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Statement 3 is incorrect because criminal contempt requires that the publication or act "prejudices, or interferes or tends to interfere with, the due course of judicial proceedings" (Section 2 (c) of the Act) — simply scandalising without effect is not sufficient.

Supreme Court Judgment on Summoning of Advocates by Investigating Agencies

Why in News

The Supreme Court of India delivered a significant ruling in *Bar Council of India vs Union of India & Others*, holding that law-enforcement agencies must exercise restraint while summoning practising advocates during criminal or economic investigations.

The Ministry of Law and Justice, the Court laid down guidelines to protect legal professionals from harassment, while affirming that no one is above the law.

Background

The petition was filed by the Bar Council of India (BCI) citing increasing instances where the Enforcement Directorate (ED) and CBI issued summons to advocates representing clients under investigation. The BCI argued that such actions erode attorney-client privilege and violate Article 19(1)(g) (freedom of profession) and Article 21 (personal liberty).

The Union Government countered that summons were issued only where advocates acted as intermediaries in money-laundering or benami transactions.

Key Highlights of the Judgment

1. **No Blanket Immunity:** Advocates cannot claim absolute exemption from criminal law; however, investigative summons must show "specific and direct nexus" to the alleged offence.
 2. **Prior Approval:** Any summons to a practising advocate must receive written approval from a supervising officer not below Joint Director (ED/CBI).
 3. **Protection of Client Confidentiality:**
 - Agencies cannot demand privileged communications or case files.
 - Section 126 of the Indian Evidence Act (1872) protects attorney-client privilege.
 4. **Professional Misconduct vs Criminal Liability:** The Court distinguished between disciplinary proceedings under the Advocates Act (1961) and criminal prosecution under IPC or PMLA.
 5. **Role of Bar Councils:** Directed the BCI and State Bar Councils to establish "Emergency Legal Protection Cells" to assist advocates subjected to arbitrary action.
- Bench:** Chief Justice D. Y. Chandrachud, Justices J. B. Pardiwala, and Sanjiv Khanna.

Significance

- Reinforces rule-of-law balance between professional independence and accountability.
- Clarifies interface of legal privilege, due process, and criminal investigation.
- Expected to influence agency protocols under the PMLA 2002 and CrPC Sections 160–91.
- Recognised advocates' offices as "zones of confidentiality", comparable to medical or journalistic privilege.

Prelims Connect

- **Key Articles:** 19(1)(g), 21.
- **Statutes Cited:** Advocates Act 1961; Indian Evidence Act 1872 (Section 126); PMLA 2002; CrPC Sections 160 & 91.
- **Regulatory Body:** Bar Council of India – statutory under Section 4 of the Advocates Act.
- **Similar Precedent:** Rajendra Sail v. Madhya Pradesh High Court (2005) – upheld limits of privilege where crime is involved.

Mains Connect

"Analyse the Supreme Court's 2025 guidelines on summoning of advocates by investigative agencies. How do they reconcile professional privilege with accountability under criminal law?"

Prelims Practice Question

Q. With reference to the Supreme Court's 2025 judgment on summoning of advocates by investigating agencies, consider the following statements:

1. The Court granted complete immunity to practising advocates from any investigative summons.
2. Agencies must obtain prior written approval from a senior officer before summoning an advocate.
3. Section 126 of the Indian Evidence Act protects attorney–client communications from disclosure.
4. The judgment was delivered by a Bench headed by the Chief Justice of India.

Which of the statements given above are correct?

- (a) 2, 3 and 4 only (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 4 only

Answer: (a)

Explanation: Statement 1 is incorrect – no complete immunity; only procedural safeguards were issued.

Koyla Shakti Dashboard and CLAMP Portal – Digitising India's Coal Governance

Why in News

The Ministry of Coal launched two major digital platforms — the Koyla Shakti Dashboard and the Coal Logistics & Monitoring Portal (CLAMP) — to enhance transparency, efficiency, and data-driven decision-making across the coal ecosystem.

These tools integrate production, dispatch, quality, logistics, and environmental parameters for real-time monitoring by the government and industry.

Background

India is the second-largest coal producer (after China) and coal still fuels $\approx 45\%$ of the country's installed power capacity.

To achieve "Smart Coal Governance" under Digital India 2.0, the Ministry initiated an end-to-end digital architecture linking Coal India Ltd (CIL), Singrauli and Talcher clusters, and State Mining Companies through GIS-based data analytics.

Key Features

Koyla Shakti Dashboard

- Developed by Ministry of Coal + National Informatics Centre (NIC).
- Real-time tracking of:
 - Production & dispatch data from all subsidiaries of CIL.
 - Captive & commercial mine operations.
 - Environmental clearances, safety audits, and land acquisition progress.
- Public-facing dashboard to promote transparency for investors and citizens.
- Integrated with PM-GatiShakti National Master Plan for seamless logistics mapping.

CLAMP ("Coal Logistics and Monitoring Portal")

- Provides end-to-end visibility of coal movement from pit-head to consumer.
- Enables coordination between Railways, Ports, and Power Utilities.
- Incorporates satellite-based mine surveillance using ISRO's Bhuvan Platform.
- Allows predictive analytics to forecast demand and manage coal stocks at thermal power plants.

Strategic Significance

- **Efficiency Gain:** Reduces mismatch between production and consumption; estimated 5 % logistics cost saving.
- **Transparency:** Public data release reduces scope for pilferage and unaccounted dispatch.
- **Environmental Compliance:** Geo-tagging of overburden dumps and afforestation sites ensures monitoring under the Mine Closure Guidelines 2023.
- **Investor Confidence:** Aligns Indian coal sector governance with global ESG norms ahead of COP-30 targets.

Institutional and Policy Context

- Aligned with National Coal Logistics Plan 2023–33 and Coal Sector Digitalisation Roadmap 2025.
- Links with CIL Sustainability Report 2025, promoting "Responsible Coal Mining."

- Developed under the guidance of NICSI and Central Mine Planning & Design Institute (CMPDI).

Prelims Connect

- Ministry:** Ministry of Coal.
- Technical Partner:** NIC & CMPDI.
- Purpose:** Real-time data integration for production, logistics, environment, and governance.
- Associated Initiatives:** PM-Gati Shakti, Digital India 2.0, National Coal Logistics Plan 2023–33.
- Monitoring Tool:** CLAMP – Coal Logistics and Monitoring Portal.

Mains Connect

“Discuss how initiatives like the Koyla Shakti Dashboard and CLAMP Portal contribute to efficiency, transparency, and sustainability in India’s coal sector governance.”

Prelims Practice Question

Q. With reference to India’s new coal governance initiatives, consider the following statements:

- The Koyla Shakti Dashboard is a real-time data platform of the Ministry of Coal integrating production and environmental compliance.
- The CLAMP Portal monitors coal logistics through coordination between railways and ports.
- Both platforms are part of the PM Gati Shakti National Master Plan.
- They are jointly implemented by the Ministry of Power and the Ministry of Environment.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Implemented by the Ministry of Coal, not by Power or Environment; the rest are correct.

Rehabilitation Council of India (RCI) – Strengthening Inclusive Education and Disability Standards 2025

Why in News

The Ministry of Social Justice and Empowerment (MSJE) announced that the Rehabilitation Council of India (RCI) would launch a National Accreditation Framework for Special Education Institutes, aimed at improving the quality of rehabilitation professionals and aligning training with the Rights of Persons with Disabilities (RPwD) Act 2016.

The Council will also roll out the RCI e-Gyan Kendra for digital up-skilling of special educators and therapists.

Background

The Rehabilitation Council of India Act, 1992 established the RCI as a statutory body to regulate and standardise the training of professionals involved in rehabilitation and special education.

The Council maintains a Central Rehabilitation Register (CRR) and ensures that only qualified personnel deliver services to persons with disabilities (PwDs).

RCI functions under the Department of Empowerment of Persons with Disabilities (DEPwD), MSJE.

Key Functions of RCI

- Regulation & Standardisation:** Lays down norms for syllabi, minimum standards, and recognition of institutions.
- Registration:** Maintains CRR for qualified rehabilitation professionals.
- Continuing Education:** Organises in-service training and refresher courses through the RCI e-Gyan Kendra.
- Research Promotion:** Supports innovations in assistive technology and inclusive-classroom pedagogy.
- Monitoring & Compliance:** Periodic audits of special education institutions for adherence to RPwD Act standards.

Recent Developments (2024–25)

- Accreditation Framework 2025:** Multi-tier rating (A–C) based on infrastructure, inclusion outcomes, and faculty qualifications.
- RCI e-Gyan Kendra:** Online learning platform integrated with DIKSHA and SWAYAM.
- National Curriculum Revision:** Updated syllabi for occupational therapy, special B.Ed., speech pathology, and mental-health rehabilitation.
- Collaboration:** Tie-up with NCERT for early-childhood inclusion modules.
- Workforce Data:** Over 3.5 lakh professionals registered on CRR as of 2025 (↑ 15 % since 2022).

Institutional and Legal Context

- Parent Act:** Rehabilitation Council of India Act 1992 (amended 2000).
- Linked Legislation:** Rights of Persons with Disabilities Act 2016.
- Associated Schemes:**
 - Deendayal Disabled Rehabilitation Scheme (DDRS) – funding NGOs.
 - Accessible India Campaign (Sugamya Bharat Abhiyan).
 - PM-DAKSH Scheme – skill development for PwDs.

Prelims Connect

- Year of Establishment: 1992.
- Headquarters: New Delhi.
- Nodal Ministry: MSJE (Department of Empowerment of Persons with Disabilities).
- Core Functions: Standardisation, registration, monitoring, continuing education.
- Key Initiatives (2025): Accreditation Framework & e-Gyan Kendra.

Mains Connect

"Discuss the role of the Rehabilitation Council of India in promoting professional standards and inclusive education under the RPwD Act 2016."

Prelims Practice Question

Q. With reference to the Rehabilitation Council of India (RCI), consider the following statements:

1. It is a statutory body constituted under the Rehabilitation Council of India Act, 1992.
2. It functions under the Ministry of Education.
3. The Council maintains a Central Rehabilitation Register of qualified professionals.
4. It recently launched the e-Gyan Kendra for digital training of special educators.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: It works under the Ministry of Social Justice and Empowerment, not the Ministry of Education.

National Song (Vande Mataram): Constitutional and Cultural Context 2025

Why in News

The Union Ministry of Culture directed all Central educational and cultural institutions to hold collective recitations of "Vande Mataram" on national occasions, emphasising its historic role in India's freedom movement. This move coincided with the 125th anniversary of Bankim Chandra Chattopadhyay's poem first published in Anandamath (1899).

Background

"Vande Mataram" (meaning 'I bow to thee, Mother') was composed in Sanskrit & Bengali by Bankim Chandra Chattopadhyay in 1870s.

It became the anthem of national awakening, symbolising Mother India as divine and benevolent.

The song gained prominence after Rabindranath Tagore's rendition at the 1896 Indian National Congress Session in Calcutta.

The Constituent Assembly debates of 1948 settled the status of "Vande Mataram" as the National Song, while "Jana Gana Mana" was adopted as the National Anthem (Resolution of 24 January 1950).

Constitutional Status & Legal Context

- **Article 51A(a):** Every citizen has a duty "to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem." (National Song not explicitly mentioned.)

- **Supreme Court View:** In *Bijoe Emmanuel v. State of Kerala* (1986), the Court held that no person can be compelled to sing either the Anthem or the Song if it violates freedom of conscience under Article 19(1)(a) and Article 25.
- **Official Directives:** The Ministry of Home Affairs (MHA), through its Flag Code and cultural protocols, recognises "Vande Mataram" as having equal honour and symbolic sanctity though not the same constitutional enforceability as the Anthem.
- **Parliamentary Reference (2024):** Private Member's Bill sought to accord statutory recognition to the National Song under the Emblems and Names (Prevention of Improper Use) Act 1950.

Cultural and Historical Significance

- **Freedom Movement:** Served as a rallying cry during Swadeshi Movement (1905–11) and Quit India Movement (1942).
- **Artistic Legacy:** Inspired songs by Aurobindo Ghosh, Dwijendralal Roy, and Tagore; featured in early nationalist cinema.
- **Literary Interpretation:** Blends Bhakti (devotion) and Desh Bhakti (patriotism)—portraying the nation as Durga-like protector.
- **Global Cultural Link:** Adopted in Indian diaspora events as a symbol of civilisational unity.

Contemporary Relevance (2025)

- **Commemorative Events:** 125 years of Anandamath; digital archives launched under Azadi Ka Amrit Mahotsav 2.0.
- **Academic Integration:** NCERT (2025) introduced contextual modules on national symbols in civic education.
- **Debates:** Renewed discussions on balancing plural identity with cultural nationalism in educational spaces.
- **Cultural Diplomacy:** Indian missions abroad use Vande Mataram performances in Republic Day events.

Prelims Connect

- Composer: Bankim Chandra Chattopadhyay.
- First Public Singing: Rabindranath Tagore (1896 INC Session).
- Status: National Song (not constitutional article).
- Language: Sanskrit & Bengali.
- Appears in: Novel Anandamath (1882, published 1899).
- Linked Acts: Flag Code of India 2022; Emblems and Names Act 1950.

Mains Connect

"Examine the historical and constitutional position of 'Vande Mataram' as India's National Song. How does it embody the synthesis of spirituality and patriotism?"

Prelims Practice Question

Q. With reference to "Vande Mataram", consider the following statements:

1. It was first sung at the Indian National Congress Session of 1896.
2. The Constitution explicitly mentions "Vande Mataram" as the National Song of India.
3. It forms part of the novel Anandamath written by Bankim Chandra Chattopadhyay.
4. Every citizen is constitutionally bound to sing it under Article 51A.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 1, 2 and 3 only
(c) 2 and 4 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: The Constitution does not explicitly mention the National Song, and there is no constitutional obligation to sing it.

National Biodiversity Authority (NBA) – Guarding India's Genetic Wealth 2025

Why in News

The Ministry of Environment, Forest and Climate Change (MoEFCC) unveiled the "Biodiversity Digital Repository (BDR)" under the National Biodiversity Authority (NBA) to document India's biological resources and associated traditional knowledge.

The repository supports enforcement of the Biological Diversity (Amendment) Act 2023, which streamlines access-benefit sharing (ABS) and strengthens protection against bio-piracy.

Background

Established in 2003 under the Biological Diversity Act 2002, the NBA (headquartered in Chennai) is a statutory, autonomous body for implementing the Convention on Biological Diversity (CBD 1992).

It works through a three-tier federal structure:

1. NBA (Central level) – policy, international liaison, approval of foreign access;
2. State Biodiversity Boards (SBBs) – manage in-state resources;
3. Biodiversity Management Committees (BMCs) – prepare People's Biodiversity Registers (PBRs) at local level.

Core Functions of NBA

- **Access Regulation:** Approves access by foreign entities to Indian biological resources (Sections 3–6).
- **Benefit Sharing:** Ensures equitable sharing with local communities.
- **Conservation Oversight:** Monitors threatened species and advises MoEFCC.

- **Traditional Knowledge Protection:** Maintains Indian Biodiversity Information System (IBIS) and links with Traditional Knowledge Digital Library (TKDL).
- **Capacity Building:** Trains state boards & panchayats on ABS mechanisms.

Recent Developments (2024-25)

- **BDR 2025:** A digital one-stop portal mapping 1.8 million species records from PBRs across states.
- **ABS Simplification:** Under 2023 amendment, domestic Indian users no longer require prior NBA approval—delegated to SBBs.
- **De-criminalisation:** Civil penalties replaced criminal offences for easier compliance.
- **Community Royalties:** ₹127 crore distributed (FY 2024-25) to local BMCs from ABS agreements.
- **International Collaboration:** MoU with African Union on gene-pool protection and Nagoya Protocol implementation.

Institutional and Legal Context

- Parent Law: Biological Diversity Act 2002 (amended 2023).
- Associated Schemes: Access-Benefit Sharing Fund (ABS Fund); Mission LiFE; National Mission on Biodiversity & Human Well-being (2025).
- Key Convention: UN Convention on Biological Diversity (CBD 1992); Nagoya Protocol (2010).
- Linked Institutions: National Biodiversity Authority (Chennai), National Botanical Research Institute (Lucknow), Zoological Survey of India (Kolkata).

Prelims Connect

- Year of Establishment: 2003.
- Headquarters: Chennai.
- Parent Act: Biological Diversity Act 2002 (amended 2023).
- Three-tier Structure: NBA – SBB – BMC.
- Portal Launched: Biodiversity Digital Repository (BDR) 2025.
- International Protocol: Nagoya Protocol on Access & Benefit Sharing.

Mains Connect

"Discuss the role of the National Biodiversity Authority in implementing the Biological Diversity (Amendment) Act 2023. How does it balance conservation, commercial use and community rights?"

Prelims Practice Question

Q. With reference to the National Biodiversity Authority (NBA), consider the following statements:

1. It was established under the Biological Diversity Act 2002.
2. It approves foreign access to India's biological resources.

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3. It functions under the Ministry of Environment, Forest and Climate Change.

4. Its headquarters is in New Delhi.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 1 and 4 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The headquarters is in Chennai, not New Delhi.

Appointment of District Judges – Judicial Federalism in Practice 2025

Why in News

The Supreme Court delivered its judgment in All India Judges Association vs Union of India (2025), clarifying the process of appointment and transfer of District Judges under Article 233 of the Constitution.

The Court reaffirmed that the Governor must act in consultation with the High Court, not merely the State Public Service Commission, while appointing judicial officers.

Background

Under Article 233, District Judges are appointed by the Governor of the State in consultation with the High Court exercising jurisdiction in that State.

They form the backbone of India's subordinate judiciary, handling over 87 per cent of all pending cases nationwide.

Conflicts between State governments and High Courts over control and transfer of judges have repeatedly tested India's federal balance in the judicial domain.

Key Constitutional Provisions

- **Article 233(1):** Governor shall appoint persons to be District Judges in consultation with the High Court.
- **Article 234:** Recruitment of persons other than District Judges to the judicial service shall be made by the Governor in accordance with rules made in consultation with the State PSC and High Court.
- **Article 235:** Control over district courts and subordinate judiciary vests in the High Court.

Highlights of the 2025 Judgment

1. **Consultative Primacy:** Consultation under Article 233 implies concurrence of the High Court; its view is binding unless palpably irrational.
2. **Eligibility Clarified:** Only advocates with not less than seven years' practice can be directly recruited as District Judges (per 2019 Rules & All India Judicial Service Framework).
3. **Transfer Protocol:** High Court's administrative committee to recommend transfers; Governor acts formally.
4. **Transparency Mandate:** Directed all States to digitise judicial service rosters and maintain online vacancy portals linked to the Department of Justice (DoJ).

5. **Diversity and Reservation:** States permitted to apply vertical & horizontal reservation as per local laws, provided judicial independence is not compromised.

Bench: Chief Justice D. Y. Chandrachud, Justices Sanjiv Khanna and B. V. Nagarathna.

Significance

- Reinforces judicial federalism — a cooperative mechanism where constitutional power is shared between the executive (Governor) and judiciary (High Court).
- Reduces scope for executive interference in lower-judiciary appointments.
- Encourages uniformity across States and paves the way for an eventual All India Judicial Service (AIJS).
- Strengthens judicial accountability through digitisation and merit-based recruitment.

Institutional Context

- **Supervising Bodies:** Department of Justice (DoJ); High Courts; State Judicial Academies.
- **Linked Reforms:** e-Courts Phase III (2023-27); National Judicial Data Grid (NJDG) integration.
- **Judicial Cadre Statistics (2025):** Sanctioned Posts – 24 112; Vacant – 5 089 (≈ 21 %).

Prelims Connect

- **Articles:** 233 – Appointment; 234 – Recruitment; 235 – Control.
- **Authority:** Governor in consultation with High Court.
- **Eligibility:** 7 years' practice as advocate.
- **Linked Scheme:** All India Judicial Service Proposal (Constitution Art. 312 enabling).
- **Recent Judgment:** All India Judges Association (2025) — consultative primacy of High Court.

Mains Connect

"Examine the constitutional procedure for the appointment of District Judges under Articles 233–235. How does the 2025 Supreme Court ruling reinforce judicial federalism and independence?"

Prelims Practice Question

- Q. With reference to the appointment of District Judges in India, consider the following statements:
1. They are appointed by the Governor in consultation with the High Court concerned.
 2. The consultation of the Public Service Commission is mandatory for such appointments.
 3. Only advocates with at least seven years of practice are eligible for direct recruitment.
 4. The control over subordinate courts vests in the Supreme Court.
- Which of the statements given above are correct?
- (a) 1 and 3 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: PSC consultation applies under Article 234, not 233; control lies with the High Court (Article 235).

Operation HAECHI-VI – Interpol Crackdown on Cyber Fraud Networks (2025)

Why in News

The Central Bureau of Investigation (CBI), India's Interpol National Central Bureau (NCB), participated in Interpol's global Operation HAECHI-VI, which dismantled hundreds of cyber-enabled financial-fraud networks across 70 countries. The operation resulted in the arrest of 3 950 suspects worldwide, seizure of USD 257 million, and identification of 400 new scam patterns—including investment, romance, and crypto-related frauds.

Background

"HAECHI" (Korean for 'guardian against fraud') is an Interpol-led multi-phase initiative launched in 2020 by South Korea to counter cyber-enabled financial crimes.

It targets crimes such as:

- Business Email Compromise (BEC)
- Online investment and loan scams
- E-commerce fraud
- Voice-phishing and crypto-laundering networks

India joined HAECHI-III (2022) and has since expanded coordination through Interpol's Global Financial Crime Task Force (GFCTF).

Key Highlights of Operation HAECHI-VI (2025)

- Duration: January – September 2025
- Participating Nations: 70, including India, France, Singapore, UAE, Nigeria, and South Korea
- Recovered Assets: USD 257 million frozen or returned to victims
- Suspects Arrested: 3 950 globally (58 from India)
- Indian Component:
 - CBI Cyber Crime Unit and FIU-India traced ₹190 crore in cross-border crypto laundering.
 - Partnership with Indian Computer Emergency Response Team (CERT-In) to track phishing clusters in Noida and Hyderabad.
- New Fraud Trends Identified:
 - Deep-fake video investment ads using public figures' likenesses.
 - Gaming-platform wallet laundering loops.
 - Romance scams using AI-generated profiles.

Mechanism and Coordination

- **Financial Crime Monitoring System (FCMS):** Interpol's secure platform enabling real-time transaction freezes across banks.
- **HAECHI Gateway:** Online reporting interface for member countries to flag fraudulent domains.

- **Indian Linkages:** Joint CBI-FBI investigation desk at Lyon Interpol HQ; integration of HAECHI data with India's I4C portal (Indian Cyber Crime Coordination Centre).

Strategic Significance

- **Financial Security:** Prevents cross-border laundering through shell companies and crypto exchanges.
- **Cyber Sovereignty:** Enhances India's reputation as an active Interpol partner in digital crime control.
- **Capacity Building:** Interpol training modules now adopted by NCRB and I4C for state cyber cells.
- **Public Awareness:** Data used to update CERT-In's "Cyber Surakshit Bharat" campaign.

Prelims Connect

- **Lead Agency (Global):** Interpol (Lyon, France).
- **Lead Country:** South Korea (KNPA – Korean National Police Agency).
- **Indian Nodal Agencies:** CBI, FIU-India, CERT-In, I4C (MHA).
- **Focus:** Cyber-enabled financial fraud and crypto laundering.
- **Key Tool:** Interpol FCMS – global real-time transaction freeze mechanism.

Mains Connect

"Explain the significance of India's participation in Interpol's Operation HAECHI-VI. How does such global cooperation strengthen cyber-crime prevention and financial-fraud investigation?"

Prelims Practice Question

Q. With reference to Interpol's Operation HAECHI-VI (2025), consider the following statements:

1. It targets cyber-enabled financial frauds such as investment and romance scams.
2. The operation is jointly led by Interpol and the World Bank.
3. India's CBI and FIU-India participated in the 2025 phase of the operation.
4. It uses Interpol's Financial Crime Monitoring System to freeze transactions in real time.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only
- (b) 1 and 2 only
- (c) 2 and 4 only
- (d) 1, 2, 3 and 4

Answer: (a)

Explanation: It is Interpol-led, not jointly by the World Bank; India participated through CBI and FIU-India.

Securities Transaction Tax (STT) – Revenue Trends and Market Impact 2025

Why in News

The Ministry of Finance in its Monthly Economic Review (October 2025) reported that Securities Transaction Tax (STT) collections touched a record ₹48,750 crore in H1 FY 2025–26, reflecting a 21 % year-on-year increase.

The surge is attributed to robust participation in derivatives and equity delivery trades, and a growing retail investor base supported by digital broking platforms.

Background

Introduced in 2004 (Finance Act 2004), the STT is a direct tax levied on the value of taxable securities transactions executed on recognized stock exchanges in India.

It replaced the earlier system of long-term capital gains tracking to simplify taxation and discourage speculative short-term trading.

Scope of the Tax

- **Applicable Instruments:**
 - Equity shares
 - Equity-oriented mutual funds (ETFs)
 - Derivatives (futures & options)
 - Units of business trusts
- **Tax Incidence:**
 - Buyer, seller, or both depending on the transaction type.
- **Collection Mechanism:**
 - Collected by stock exchanges (NSE, BSE) and deposited to the Consolidated Fund of India.

Recent Developments (2023 – 2025)

- **STT Rate Revision (Budget 2023):**
 - Futures → 0.0125 % (from 0.01 %)
 - Options → 0.0625 % (from 0.05 %)
- **Derivative Boom:** Post-2023 changes in lot size and margin rules increased daily derivatives turnover to ₹420 lakh crore (Sept 2025).
- **Retail Expansion:** 12 crore active demat accounts (↑ 27 % YoY).
- **Revenue Impact:** STT now forms nearly 11 % of total direct tax receipts from non-corporate taxpayers.
- **CBDT Monitoring:** Advanced analytics introduced to detect wash-trade and algorithmic fraud under STT reporting framework.

Economic and Policy Significance

- **Revenue Stability:** Acts as a predictable source of non-corporate direct tax revenue.
- **Market Discipline:** Curbs excessive short-term speculation.
- **Transparency:** Easy audit trail reduces tax evasion compared to capital-gains reporting.
- **Criticisms:**

- May deter liquidity in derivatives and arbitrage markets.
- Adds cascading cost when combined with GST on brokerage and stamp duty.

Institutional and Legal Context

- **Administered by:** Central Board of Direct Taxes (CBDT).
- **Statutory Basis:** Chapter VII of the Finance (No. 2) Act 2004.
- **Linked Regulations:** Income-tax Act 1961 (Sections 111A and 10 (38) for capital gains benefits).
- **Associated Frameworks:** Market Infrastructure Institutions (SEBI-regulated).

Prelims Connect

- Introduced In: 2004.
- Collected By: Stock exchanges, credited to Consolidated Fund of India.
- Recent Rate Change: Budget 2023.
- Administering Body: CBDT under Dept. of Revenue.
- Objective: Curb speculative trading and ensure traceable tax collection.

Mains Connect

"Analyse the revenue and market implications of the Securities Transaction Tax in India. Do recent hikes balance fiscal needs with market depth?"

Prelims Practice Question

- Q. With reference to the Securities Transaction Tax (STT) in India, consider the following statements:
1. It is a direct tax levied on the value of securities traded on recognized stock exchanges.
 2. The revenue from STT is shared between the Centre and States.
 3. It applies to equity, mutual funds and derivative transactions.
 4. It was introduced by the Finance Act 2004.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: STT is a central direct tax; its proceeds are not shared with States.

Schedule M Norms – Strengthening Pharmaceutical Manufacturing Standards 2025

Why in News

The Union Ministry of Health and Family Welfare notified the revised Schedule M to the Drugs and Cosmetics Rules 1945, mandating Good Manufacturing Practices (GMP 2.0) for all pharmaceutical units from 1 April 2026.

These upgraded norms aim to align Indian drug-manufacturing standards with WHO GMP benchmarks after a series of export-linked quality lapses in 2023-24.

Background

Schedule M lays down minimum requirements of premises, equipment, personnel, hygiene, and documentation for manufacturing drugs.

It was last comprehensively updated in 2001.

The 2025 revision followed the Joint Inspection Drive 2023—a nationwide audit of 8 500 units—which revealed gaps in documentation, contamination control, and validation practices, particularly among small and medium firms.

Key Provisions of the Revised Schedule M (2025)

1. Risk-Based Classification:

- Category A: Large export units → mandatory WHO-GMP certification.
- Category B: MSME units → 18-month transition period with subsidy under Pharma Upgradation Fund (PUF).

2. Quality-Management System (QMS Mandate):

- Internal audits, CAPA (Corrective and Preventive Action), and product-recall protocols made compulsory.
- Data integrity and electronic batch records introduced under 21 CFR-like compliance.

3. Facility Standards:

- Air-handling units (HEPA filters), microbial monitoring, segregated zones for β -lactam and cytotoxic drugs.
- Dedicated areas for penicillin and steroid production to prevent cross-contamination.

4. Regulatory Digitalisation:

- Integration with SUGAM Portal for online licensing and inspection reports.
- Barcode-linked batch traceability for export compliance.

5. Enforcement and Timelines:

- Implementation deadline – April 2026 (for large units), October 2026 (for MSMEs).
- Joint oversight by CDSCO and State Drug Controllers.

Significance

- **Public Health:** Aims to reduce sub-standard or spurious drug incidents domestically and abroad.
- **Export Competitiveness:** Improves credibility in regulated markets (US, EU, Africa).
- **Ease of Business:** Single-window compliance via SUGAM Portal replaces manual paperwork.
- **MSME Support:** ₹ 1000 crore Pharma Upgradation Fund notified for technology modernisation.
- **Employment:** Boost for pharma engineering and quality-control professions.

Institutional and Legal Context

- **Parent Law:** Drugs and Cosmetics Act 1940 & Rules 1945.
- **Regulator:** Central Drugs Standard Control Organisation (CDSCO) under MoHFW.
- **Linked Initiatives:** Pharma Vision 2047, PM-PRANAM (Pharma Resilience & New Age Manufacturing) Scheme.
- **International Alignment:** WHO-GMP (2023 revision); ICH-Q10 Pharmaceutical Quality System.

Prelims Connect

- Schedule M: Prescribes GMP for drug manufacture under Drugs and Cosmetics Rules 1945.
- Revised Year: 2025 (after 24 years).
- Effective From: 1 April 2026.
- Regulator: CDSCO (MoHFW).
- Objective: Harmonise with WHO standards, ensure data integrity and traceability.

Mains Connect

"Discuss the significance of the revised Schedule M (2025) for India's pharmaceutical sector. How does it balance global quality compliance with MSME viability?"

Prelims Practice Question

- Q. With reference to the revised Schedule M (2025), consider the following statements:
1. It prescribes Good Manufacturing Practices (GMP) for drug manufacture under the Drugs and Cosmetics Rules 1945.
 2. Its latest update mandates digital batch record systems and risk-based classification of manufacturers.
 3. The Central Drugs Standard Control Organisation (CDSCO) is responsible for its implementation.
 4. The revised Schedule M is part of the National Medical Devices Policy 2023.
- Which of the statements given above are correct?
- (a) 1, 2 and 3 only (b) 1 and 2 only
(c) 3 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Schedule M applies to drugs, not medical devices; devices are covered under separate rules (Schedule M(III) proposed).

Safeguarding Political Accountability in India

Why in News

A recent Constitution (Amendment) Bill introduced in Parliament seeks to tighten the disqualification clauses under the anti-defection law and bring greater accountability in political parties' financing and inner functioning.

These amendments revive the core question of how India's constitutional democracy can institutionally safeguard political accountability without stifling representation.

Background

The founders of the Constitution envisioned a responsible government answerable to Parliament and the people (Articles 74–75, 163–164). Over time, however, defections, opaque funding and personality-centric politics have eroded the link between representation and responsibility.

While the Tenth Schedule (1985) curbed defections and the 91st Amendment (2003) restricted ministerial size, loopholes such as mass defections through "mergers," delays in Speaker's decisions, and unregulated political financing continue to undermine accountability.

Key Features of the 2025 Proposed Amendment

- Time-Bound Defection Decisions:** Speakers must decide disqualification petitions within 90 days; failure triggers automatic reference to the Election Commission of India (ECI).
- De-linking from Speaker's Office:** Independent tribunals or ECI panels to adjudicate defection cases to avoid conflict of interest.
- Party Finance Disclosure:** Mandatory public audit of party donations above ₹20 000 through digital portals linked with the Election Commission's Political Finance Monitoring System (PFMS).
- Internal Democracy Clauses:** Political parties must conduct periodic intra-party elections and file compliance reports under Section 29A of the RPA 1951.
- Recall Experiment:** Pilot provision for electoral recall mechanism for urban local bodies subject to legislative framework.

Broader Significance

Dimension	Accountability Impact
Constitutional	Strengthens Articles 102 and 191 by ensuring timely disqualification and upholding collective responsibility.
Institutional	Empowers ECI and auditing agencies to monitor political parties.
Fiscal	Reduces black-money in political funding through digital traceability.
Democratic Culture	Revives intra-party pluralism and grass-roots leadership development.

Concerns Raised

- Separation of Powers:** Judicialising Speaker's functions may blur legislative autonomy.
- Data Privacy:** Disclosure of donor identities could chill legitimate political contributions.
- Recall Risks:** Populist recall campaigns may destabilise governance in polarised constituencies.

- Enforcement Capacity:** ECI and CAG need enhanced manpower and tech infrastructure to monitor compliance.

Recent Developments (2024–25)

- SC Judgment (2024):** Directed Speakers to decide defection cases within reasonable periods (Ashok Lahiri v. West Bengal Assembly).
- ECI Initiative:** Pilot Political Funding Disclosure Portal launched (Aug 2025).
- Parliamentary Committee (2025):** Recommended state funding of elections with strict expenditure ceilings.

Prelims Connect

- Articles:** 75, 164 (Collective Responsibility); 102, 191 (Disqualification); 326 (Adult Suffrage).
- Acts:** Representation of the People Act 1951 (Section 29A – Registration of Political Parties).
- Tenth Schedule:** Inserted by 52nd Amendment (1985) – Anti-Defection Law.
- 91st Amendment (2003):** Limits Council of Ministers size to 15 % of Assembly.
- Institutions:** Election Commission of India, CAG, Lok Pal.

Mains Connect

"Discuss the constitutional and institutional mechanisms available to ensure political accountability in India. How can reforms in anti-defection and party-finance laws strengthen democratic ethics?"

Prelims Practice Question

Q. With reference to political accountability in India, consider the following statements:

- The Tenth Schedule was inserted into the Constitution by the 91st Amendment Act.
- Under the 2025 proposed amendment, the Speaker's decision on defection cases is final and cannot be reviewed.
- Political parties must file audited accounts under Section 29C of the RPA 1951.
- The concept of collective responsibility is enshrined in Articles 75 and 164.

Which of the statements given above are correct?

- 3 and 4 only
- 1 and 2 only
- 2 and 3 only
- 1, 2 and 3 only

Answer: (a)

Explanation: Tenth Schedule was added by the 52nd Amendment; Speakers' decisions are subject to judicial review (Kihoto Hollohan 1992).

Restoring Fiscal Power for the States

Why in News

The debate on India's fiscal federalism has resurfaced after States demanded greater flexibility in taxation and compensation under the Goods and Services Tax (GST) regime. The discussion follows recent proposals to extend the GST Compensation Cess beyond 2026 and to revisit the Finance Commission's devolution formula.

Background

The GST framework (Article 279A) aimed to create a harmonised indirect tax structure, but it also centralized fiscal powers that were earlier shared between the Union and States.

While GST has streamlined tax administration, it has constrained States' fiscal autonomy — especially after the end of the compensation period in June 2022.

States argue that the federal compact under the Constitution, particularly Articles 246, 268–275, was designed to ensure fiscal balance through both vertical (Union–State) and horizontal (State–State) equity.

Key Issues in India's Fiscal Federalism

1. **Erosion of State Tax Base:** With GST subsuming major revenue sources like VAT, octroi, and entry tax, States now depend heavily on the GST Council for rate decisions.
2. **Delayed Compensation:** Compensation cess transfers during the pandemic were delayed, affecting States' borrowing and welfare outlays.
3. **Centralisation of Cess and Surcharge:** Over one-sixth of gross tax revenue is now collected through cesses and surcharges that are not shareable under Article 270 — effectively reducing devolution.
4. **Borrowing Constraints:** FRBM ceilings and NITI Aayog's performance-linked grants limit fiscal manoeuvrability, particularly for development-heavy States.
5. **Institutional Imbalance:** The GST Council operates by consensus but tends to privilege national uniformity over regional diversity.

Recent Developments (2024–25)

- **Proposal for GST 2.0:** Discussions underway to include petroleum, natural gas and electricity within GST with calibrated revenue protection for States.
- **Finance Commission Review:** The 16th Finance Commission (2025–30) is examining a higher States' share of 43 % in divisible tax pool.
- **Reform of Compensation Cess:** MoF considering a permanent disaster and climate-related revenue buffer fund.
- **State Innovations:** Kerala, Tamil Nadu, and Karnataka are exploring "green cess" and "sin tax" within constitutional limits.

Constitutional and Fiscal Context

Provision	Purpose
Art. 269A	Levy & collection of GST in inter-State trade.
Art. 270	Distribution of taxes between Union and States.
Art. 275	Grants-in-aid to States in need of assistance.
Art. 280	Constitution of Finance Commission.
Art. 279A	Establishes GST Council.

Way Forward

- **Revisit GST Architecture:** Greater flexibility for States to vary rates within narrow bands.
- **Predictable Transfers:** Time-bound formula for GST compensation and Finance Commission grants.
- **Limit Cess Proliferation:** Merge cesses into shareable taxes to uphold cooperative federalism.
- **Strengthen Fiscal Responsibility Framework:** Balance prudence with developmental freedom.
- **Empower State Finance Commissions:** Revive devolution to local bodies to enhance third-tier fiscal strength.

Prelims Connect

- **Articles:** 268–275 (Distribution of Revenues), 279A (GST Council).
- **Institutions:** GST Council, Finance Commission, CAG.
- **Schemes/Acts:** GST (Compensation to States) Act 2017.
- **Key Term:** Vertical devolution – Centre to States share; Horizontal devolution – among States.

Mains Connect

"Discuss the challenges faced by States in maintaining fiscal autonomy under the GST regime. Suggest reforms to restore cooperative and competitive federalism."

Prelims Practice Question

- Q. With reference to India's fiscal federalism, consider the following statements:
1. The proceeds of cesses and surcharges are shareable with the States under Article 270.
 2. The GST Council is a statutory body under the Finance Act 2017.
 3. The Finance Commission recommends the vertical and horizontal devolution of taxes.
 4. The GST Compensation Cess is levied under a law passed by Parliament.
- Which of the statements given above are correct?
- (a) 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 4 only

Answer: (a)

Explanation: Cesses/surcharges are not shareable; the GST Council is constitutional (Art. 279A).

Towards a Fast, Fair, and Transparent Judiciary

Why in News

The debate around judicial accountability and efficiency has been reignited after the Supreme Court's response to criticisms of judicial delay and opacity in appointments.

A recent editorial titled "Calling out the Criticism of the Indian Judiciary" underscored that ensuring justice delivery is not only a legal obligation but also a democratic necessity — one that must balance speed, fairness, and transparency.

Background

The Indian judiciary is the guardian of the Constitution, tasked with upholding the rule of law and protecting rights under Articles 32 and 226.

However, structural inefficiencies — pendency, vacancies, opaque appointments, and inadequate digital infrastructure — continue to erode citizens' faith in timely justice.

As of 2025, over 4.5 crore cases remain pending across all courts (National Judicial Data Grid, September 2025), with nearly 70% of them in district courts.

Core Challenges

1. **Case Backlog and Delay:** Procedural adjournments, poor documentation, and shortage of judges contribute to chronic pendency.
2. **Vacancies and Infrastructure:** Nearly 30% of High Court judgeships and 25% of district court posts remain vacant.
3. **Opaque Collegium System:** Lack of transparency in judicial appointments and transfers raises concerns of accountability and representation.
4. **Technology Gaps:** e-Courts and e-Filing initiatives are uneven across States; many trial courts still rely on manual records.
5. **Access and Affordability:** Legal aid mechanisms under NALSA remain underfunded; marginalized groups face systemic barriers to justice.

Recent Reforms and Developments (2024–25)

- **Third Phase of e-Courts Mission:** ₹7,200 crore project launched to digitise all court records, enable virtual hearings, and use AI-based case listing.
- **National Judicial Infrastructure Authority (NJIA):** Proposal under consideration to create a permanent body to oversee court buildings, technology, and manpower.
- **Fast-Track Mechanisms:** Expansion of fast-track courts for crimes against women, environment, and cybercrime.
- **Judicial Vacancies Dashboard (NJDG+):** A new public dashboard monitors appointments and retirement schedules.
- **AI Integration:** Pilot use of SUPACE (Supreme Court Portal for Assistance in Court Efficiency) for legal research and data tagging.

Judicial Accountability and Transparency Measures

Reform Area	Key Initiative	Expected Outcome
Appointments	Collegium resolutions made public with reasons (since 2023)	Enhances institutional transparency
Pendency Management	AI-driven case classification and prioritisation	Faster hearings
Disciplinary Oversight	Internal redressal complaints within judiciary	Reduces arbitrariness
Public Access	Live-streaming of constitutional bench hearings	Improves transparency and citizen engagement

Balancing Speed and Fairness

While speedy justice is a constitutional right under Article 21, it must not come at the cost of due process or judicial independence.

Judicial reforms must, therefore, integrate efficiency with empathy — ensuring that courts remain both swift and just.

Way Forward

- Institutionalise Judicial Infrastructure Authority for long-term planning.
- Implement National Judicial Appointments Commission (NJAC) 2.0 with safeguards for independence and transparency.
- Ensure time-bound case management with penal consequences for non-compliance.
- Expand Gram Nyayalayas and Lok Adalats for local justice.
- Integrate AI and data analytics for real-time performance audits.

Prelims Connect

- **Articles:** 21 (Right to Speedy Justice), 32 & 226 (Writ Jurisdiction), 50 (Separation of Judiciary from Executive).
- **Institutions:** NJDG, e-Courts Mission Project, NALSA, Collegium System.
- **Reports:** India Justice Report 2024 – India ranked low on judge-population ratio (21 per million).
- **Judgments:** Hussainara Khatoon (1979) – Recognised speedy trial as fundamental right.

Mains Connect

"Speed and transparency are twin pillars of a just judiciary. Examine the need for institutional reforms to ensure timely and accountable justice delivery in India."

Prelims Practice Question

- Q. With reference to India's judiciary, consider the following statements:
1. The right to a speedy trial is explicitly mentioned in Article 21 of the Constitution.

2. The Collegium system for appointments was created through constitutional amendment.
3. The National Judicial Data Grid (NJDG) is maintained by the e-Committee of the Supreme Court.
4. Live streaming of court proceedings has been approved for all subordinate courts in India.

Which of the statements given above are correct?

- (a) 1 and 2 only
- (b) 3 only
- (c) 1 and 3 only
- (d) 2 and 4 only

Answer: (c)

Explanation: Speedy trial is derived from Article 21, not explicitly stated; Collegium evolved via judgments, not amendment; NJDG is under SC e-Committee.

Reimagining the Role of the National Commission for Minorities

Why in News

Public discourse around the National Commission for Minorities (NCM) has intensified following renewed demands to enhance its statutory powers and ensure better representation of marginalized religious communities.

The NCM, though well-intentioned, has “barely served those for whom it was set up,” underscoring the need for structural reform in its mandate and functioning.

Background

The National Commission for Minorities (NCM) was established in 1992 under the National Commission for Minorities Act, to safeguard the rights and interests of minorities as guaranteed by Articles 15, 16, 25–30 of the Constitution.

Six communities — Muslims, Christians, Sikhs, Buddhists, Parsis, and Jains — are currently notified as minorities under Section 2(c) of the Act.

While envisioned as a watchdog institution, the NCM's recommendations remain advisory and non-binding, which has limited its real influence in preventing discrimination or ensuring equitable access to welfare schemes.

Institutional Role and Mandate

- **Advisory Function:** Recommends policy measures to the Union and State governments for minority welfare.
- **Monitoring Function:** Reviews implementation of safeguards under Constitution and laws.
- **Grievance Redressal:** Inquires into complaints of deprivation or rights violations.
- **Coordination:** Acts as liaison between minority communities and government agencies.

Current Challenges

1. **Limited Statutory Powers:** Lacks investigative authority comparable to the National Commission for SCs or NHRC.
2. **Vacancies and Delays:** Long gaps in chairperson and member appointments reduce continuity.
3. **Overlapping Jurisdiction:** Ministry of Minority Affairs (MoMA) implements schemes, leaving NCM as a recommendatory body without control over outcomes.
4. **Inadequate Representation:** Often, smaller minorities like Parsis and Buddhists lack consistent representation.
5. **Weak Enforcement:** NCM's annual reports are rarely tabled or discussed in Parliament, limiting accountability.

Recent Developments (2024–25)

- **Proposal for “NCM 2.0”:** Draft amendment under review to grant quasi-judicial powers for inquiry and summon.
- **Digital Dashboard:** “Minority Welfare Monitoring System” integrated with MoMA schemes such as Nai Udaan and Seekho aur Kamao.
- **New Charter of Responsibilities:** Encourages interfaith dialogue initiatives and State Minority Commissions' standardization.
- **Case Reference:** SC in T. M. A. Pai Foundation (2002) reaffirmed minority institutions' right to establish and administer educational institutions, highlighting the continuing relevance of NCM oversight.

Comparative Perspective

Institution	Legal Basis	Powers
National Commission for SCs	Article 338	Constitutional, quasi-judicial
National Commission for STs	Article 338A	Constitutional
NCM	NCM Act 1992	Statutory, advisory only
NHRC	Protection of Human Rights Act 1993	Quasi-judicial, recommendatory with binding weight

Reform Proposals

- **Constitutional Status:** Upgrade NCM under a new Article 338B (analogous to NCBC) to ensure independence.
- **Time-bound Grievance Disposal:** Mandate case resolution within 60 days.
- **Parliamentary Oversight:** Annual reports to be compulsorily tabled and discussed.
- **Representation Norm:** Rotational inclusion of smaller minorities.

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- **Performance Audit:** Third-party evaluation of scheme delivery to minority groups.

Prelims Connect

- **Established:** 1992 under NCM Act.
- **Nodal Ministry:** Ministry of Minority Affairs.
- **Minorities Notified:** Muslims, Christians, Sikhs, Buddhists, Parsis, Jains.
- **Articles Linked:** 15, 16, 25–30.
- **Key Scheme Interface:** Nai Roshni, USTAAD, Seekho aur Kamao.

Mains Connect

"Critically examine the role and limitations of the National Commission for Minorities in safeguarding minority rights in India. Suggest measures for strengthening its institutional effectiveness."

Prelims Practice Question

Q. With reference to the National Commission for Minorities (NCM), consider the following statements:

1. It is a constitutional body established under Article 338B of the Constitution.
2. It can issue binding orders similar to a civil court.
3. Jains are among the communities notified as minorities under the NCM Act.
4. The Commission functions under the Ministry of Minority Affairs.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 3 and 4 only
(c) 1, 3 and 4 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: NCM is a statutory, not constitutional, body; its orders are recommendatory.

20 Years of the Right to Information Act, 2005**Why in News**

Two decades after its enactment, the Right to Information (RTI) Act, 2005 remains one of India's most transformative governance reforms.

As the Act completes 20 years, civil society and constitutional experts have called for renewed commitment to transparency, amid concerns over rising pendency, institutional dilution, and legislative overlap with newer laws such as the Bharatiya Sakshya Adhinyam (2023) and the proposed Digital Personal Data Protection (DPDP) Act (2023).

Background

The RTI Act replaced the culture of secrecy inherited from the Official Secrets Act, 1923, by granting citizens the statutory right to access government information.

It operationalised Article 19(1)(a) — freedom of speech and expression — which inherently includes the right to know.

The law came into force on 12 October 2005, marking a watershed moment in citizen-centric governance.

Objectives of the Act

- Promote transparency and accountability in public authorities.
- Contain corruption and misuse of discretion.
- Empower citizens to participate in decision-making.
- Harmonise confidentiality with public interest.

Achievements Over Two Decades

1. **Democratisation of Governance:** Over 3 crore RTI applications filed since 2005, spanning issues from ration delivery to defence procurements.
2. **Empowerment of the Marginalised:** Rural and urban poor have used RTI to demand social welfare entitlements.
3. **Institutional Innovation:** Central and State Information Commissions established as independent appellate bodies.
4. **Judicial Reinforcement:**
 - Union of India v. ADR (2002) – affirmed citizens' right to know candidates' backgrounds.
 - Reserve Bank of India v. Jayantilal N. Mistry (2015) – upheld transparency of financial regulators.
5. **Public Finance Impact:** Audit transparency improved in flagship schemes like MGNREGS, PMAY, and NFSA.

Challenges and Emerging Concerns

- **Pendency and Vacancy:** Over 3.2 lakh appeals pending before information commissions (CIC Annual Report 2024).
- **Dilution of Autonomy:** 2019 amendment allowed Central Government to fix tenure and salaries of Information Commissioners, undermining independence.
- **Data Privacy vs Transparency:** Overlap with DPDP Act 2023 may curtail information disclosure in the name of privacy.
- **Digital Divide:** RTI digitisation uneven across states; rural applicants still rely on manual filing.
- **Retaliation and Threats:** More than 90 RTI activists reportedly attacked or killed over the years, underscoring weak whistleblower protection.

Recent Developments (2024–25)

- **CIC e-RTI Portal 2.0:** Integrated filing and real-time tracking for 2,000+ central public authorities.
- **Lokpal-RTI Convergence:** Anti-corruption complaints via RTI linked to Lokpal dashboard for synergy.
- **State Innovations:** Maharashtra and Odisha adopted RTI analytics dashboards for departmental performance.
- **Judicial Reminder:** Supreme Court (2024) reaffirmed that "confidentiality cannot override public accountability" (N. Ramesh v. State of Tamil Nadu).

Way Forward

- Fill vacancies and ensure fixed, independent tenures for Commissioners.
- Establish a National RTI Audit Cell to monitor compliance and delay.
- Harmonise RTI with DPDP Act to balance privacy with transparency.
- Strengthen Whistle Blowers Protection Act 2014 for safety of information seekers.
- Promote proactive disclosure (Section 4) through open data platforms to reduce RTI burden.

Prelims Connect

- Enacted: 2005; came into force on 12 Oct 2005.
- Repealed Act: Partially supersedes Official Secrets Act, 1923.
- Constitutional Link: Article 19(1)(a) – Freedom of Speech.
- Institutions: Central & State Information Commissions.
- Recent Amendments: RTI (Amendment) Act 2019.
- Associated Laws: Whistle Blowers Protection Act 2014, DPDP Act 2023.

Mains Connect

"Twenty years of the RTI Act have deepened democracy but exposed its fragilities. Critically examine its achievements and emerging challenges in ensuring accountable governance."

Prelims Practice Question

Q. With reference to the Right to Information Act, 2005, consider the following statements:

1. It gives constitutional status to the right to information under Article 19(1)(a).
2. The Central Information Commission is a constitutional body.
3. The 2019 amendment empowers the Central Government to determine the tenure of Information Commissioners.
4. Proactive disclosure under Section 4 reduces the need for individual RTI requests.

Which of the statements given above are correct?

- (a) 2 and 3 only
- (b) 1, 3 and 4 only
- (c) 3 and 4 only
- (d) 1, 2, 3 and 4

Answer: (c)

Explanation: RTI is a statutory, not constitutional, right; CIC is statutory; tenure control introduced by 2019 amendment.

ECONOMY

India's First National Policy on Geothermal Energy

Why in News

The Government of India has approved the National Policy on Geothermal Energy (2025) the country's first comprehensive framework to harness the Earth's internal heat as a source of clean, reliable, and renewable power. the policy aims to develop 1,000 MW of geothermal power capacity by 2030, beginning with pilot projects in Ladakh, Gujarat, and Chhattisgarh.

This move aligns with India's broader commitment to achieve 500 GW of non-fossil fuel capacity by 2030 and its Net Zero 2070 target.

Background

Geothermal energy is the thermal energy generated and stored beneath the Earth's surface, extracted through natural hot springs, steam reservoirs, and subsurface magma systems.

Globally, it is a mature clean energy source used extensively in Iceland, the U.S., the Philippines, and Indonesia.

India, despite being located in a geologically active region, has underutilized this resource due to technical, financial, and infrastructural challenges.

According to the Geological Survey of India (GSI), India has over 340 geothermal springs across seven geothermal provinces, with a potential exceeding 10,000 MW.

Major Geothermal Provinces in India

Region	Location / State	Type / Features
Puga-Chumathang	Ladakh	High enthalpy source; pilot site for India's first geothermal plant.
Tattapani	Chhattisgarh	Medium enthalpy; suitable for hybrid heating systems.
Cambay Graben	Gujarat	Sedimentary basin with industrial-scale potential.
Manikaran	Himachal Pradesh	Hot water and steam springs.
Bakreshwar	West Bengal	Hydrothermal system near volcanic lineaments.
Ratnagiri-Rajapur	Maharashtra	Coastal geothermal reservoir.
Surajkund	Jharkhand	Shallow thermal gradient field.

Key Provisions of the National Policy (2025)

1. **Institutional Framework:** Establishes a National Geothermal Energy Mission (NGEM) under the Ministry of New and Renewable Energy (MNRE).

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2. **Public-Private Partnership (PPP):** Enables private investment in exploration, drilling, and operation through viability gap funding (VGF).
3. **Pilot Projects:**
 - 5 MW plant at Puga, Ladakh (NTPC-ONGC JV).
 - 20 MW demonstration project at Tattapani, Chhattisgarh.
 - 10 MW binary-cycle system at Cambay Basin, Gujarat.
4. **Research and Development:** Collaboration between GSI, IITs, and international partners for high-enthalpy reservoir mapping.
5. **Direct Use Applications:** Encourages geothermal heating for greenhouses, space heating, aquaculture, and industrial drying.

Advantages of Geothermal Energy

- **Base-load Power:** Unlike solar/wind, provides round-the-clock, weather-independent supply.
- **Low Carbon Footprint:** Emits less than 5% of coal-based power's CO₂ levels.
- **Land Efficiency:** Requires less surface area than equivalent solar or wind capacity.
- **Grid Stability:** Complements intermittent renewable sources.
- **Local Development:** Provides livelihood opportunities in remote regions like Ladakh.

Challenges

- **High Upfront Cost:** Drilling and exploration constitute 50–60% of project cost.
- **Technical Complexity:** Deep drilling and reservoir maintenance require advanced expertise.
- **Data Deficiency:** Limited geophysical mapping and seismic risk assessment.
- **Policy Coordination:** Need for convergence with mining and environment clearances.
- **Limited Domestic Supply Chain:** Dependence on imported turbines and drilling technology.

Way Forward

- Establish National Centre for Geothermal Technology & Innovation (NCGTI) under MNRE.
- Introduce Feed-in Tariffs and Renewable Purchase Obligations (RPOs) for geothermal energy.
- Incentivise geothermal-solar hybrid systems in cold and high-altitude regions.
- Integrate geothermal energy into the National Grid through Green Energy Corridor.
- Promote geo-tourism and local heating cooperatives in Ladakh and Himachal Pradesh.

Prelims Connect

- **Geothermal Energy:** Heat from Earth's interior used for electricity and heating.

- **High Enthalpy Source:** Suitable for power generation (>150°C).
- **Binary Cycle Plant:** Uses secondary fluid with lower boiling point for efficient power generation.
- **Puga Valley:** India's first geothermal pilot site in Ladakh.
- **Ministry:** MNRE (nodal ministry for geothermal policy).

Mains Connect

"India's geothermal policy marks a diversification of its renewable energy basket. Analyse the potential, challenges, and strategic relevance of geothermal energy in achieving India's clean energy goals."

Prelims Practice Question

- Q. With reference to geothermal energy in India, consider the following statements:
1. The Puga Valley in Ladakh is India's first geothermal pilot site.
 2. The National Geothermal Energy Mission is implemented under the Ministry of Power.
 3. Geothermal energy is intermittent and depends heavily on seasonal variations.
 4. India's major geothermal provinces include Cambay, Tattapani, and Manikaran.
- Which of the statements given above are correct?
- (a) 1 and 4 only (b) 2 and 3 only
(c) 1, 2 and 4 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: The mission is under MNRE; geothermal power is continuous, not intermittent.

Transit-Oriented Development for Urban Sustainability**Why in News**

India's Ministry of Housing and Urban Affairs (MoHUA) has recently emphasized Transit-Oriented Development (TOD) as a cornerstone of the new National Urban Transport Policy (2025), focusing on compact, walkable cities centered around mass transit systems.

Cities such as Ahmedabad, Pune, and Delhi NCR are integrating TOD corridors under the Urban Infrastructure Development Fund (UIDF) to promote low-carbon mobility and sustainable urbanization.

The TOD framework will also be aligned with India's Nationally Determined Contributions (NDCs) and SDG 11: Sustainable Cities and Communities.

Background

Urban India contributes nearly 63% of GDP but also accounts for rising energy use and vehicular emissions.

Rapid motorization has led to congestion, sprawl, and air pollution. Traditional city planning prioritized road expansion, not accessibility.

Transit-Oriented Development (TOD) reverses this logic — it focuses on creating high-density, mixed-use urban spaces around mass transit hubs (metro, bus, or suburban rail), where people can live, work, and commute efficiently without private vehicles.

Introduced through the National TOD Policy (2017), the concept is now being implemented through metro rail projects and Smart City Plans across India.

Core Principles of TOD

1. **Compact Urban Form:** Concentrating development within walking distance (typically 500–800 m) of transit stations.
2. **Mixed Land Use:** Combining residential, commercial, and recreational spaces to reduce travel demand.
3. **Walkability & Cycling Infrastructure:** Prioritizing pedestrian safety and non-motorized transport (NMT).
4. **Public Transport Integration:** Seamless connectivity between metro, bus, and rail systems.
5. **Inclusive Development:** Affordable housing near transport hubs for lower-income groups.

Recent Developments (2024–25)

Initiative	Key Highlights
National TOD Framework 2.0 (2025)	Revised guidelines integrating TOD with Smart City and AMRUT 2.0 missions.
UIDF Financing	₹10,000 crore fund operationalized for state TOD projects through HUDCO.
Delhi TOD Policy (Phase II)	TOD zones notified around Pink and Magenta Metro lines for 200 hectares of redevelopment.
Ahmedabad–GIFT Corridor	First fully integrated Multi-Modal Transport Hub (MMTH) under TOD principles.
Indore & Kochi	Pilot TOD mapping using AI-based zoning and pedestrian heat analysis.

Economic and Environmental Significance

- **Reduced Emissions:** Cuts vehicular pollution by 15–30% in TOD-integrated cities.
- **Land Value Capture:** Increases property tax and real estate value near transit corridors.
- **Job Creation:** Infrastructure and service sector growth along transit hubs.
- **Climate Resilience:** Compact, vertical development conserves peri-urban ecosystems.
- **Equity:** Ensures proximity-based mobility for all socio-economic groups.

Challenges

- **Institutional Coordination:** Multiple agencies (urban development, metro, housing) often lack convergence.

- **Financing Gaps:** Long gestation periods and uncertain real estate returns.
- **Zoning Conflicts:** Rigid land-use regulations hinder mixed-use planning.
- **Affordability Concerns:** Risk of gentrification and displacement near transit hubs.
- **Data Deficiency:** Inadequate city-level GIS and transport demand models.

Way Forward

- Strengthen Urban Transport Integration Cells under MoHUA for coordinated planning.
- Implement Land Value Capture (LVC) and Transit Impact Fee (TIF) mechanisms.
- Mandate TOD zoning bylaws across all 100 Smart Cities.
- Introduce Public–Private Partnership (PPP) models for multi-modal hubs.
- Encourage Green TOD through rooftop solar, rainwater harvesting, and energy-efficient design.

Prelims Connect

- National TOD Policy: 2017, MoHUA.
- UIDF: Urban Infrastructure Development Fund (2023–24 Budget); supports Tier-2 and Tier-3 cities.
- MMTH: Multi-Modal Transport Hub; integrates various transit systems.
- NDC Link: Emission reduction through sustainable mobility.
- Related Missions: AMRUT 2.0, Smart Cities Mission, Gati Shakti Masterplan.

Mains Connect

“Transit-Oriented Development (TOD) offers a blueprint for sustainable, inclusive, and low-carbon urbanization in India.” Examine the opportunities and challenges of implementing TOD in Indian cities.

Prelims Practice Question

- Q. With reference to Transit-Oriented Development (TOD), consider the following statements:
1. It promotes compact, high-density urban growth around mass transit nodes.
 2. The UIDF was launched to finance TOD projects exclusively in metro cities.
 3. TOD seeks to integrate land use and transport planning for sustainable mobility.
 4. India's National TOD Policy was first notified in 2017.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: UIDF covers Tier-2 and Tier-3 cities, not only metro regions.

Global Financial Stability Report 2025: India's Resilience Amid Global Economic Headwinds

Why in News

The International Monetary Fund (IMF) released its Global Financial Stability Report (GFSR) – October 2025, highlighting India as a “bright spot of macro-financial stability” in a volatile global environment marked by inflation, tightening liquidity, and geopolitical uncertainties. India's banking sector resilience, digital financial ecosystem, and robust capital inflows were cited as major factors insulating it from global financial turbulence.

Background

The IMF's GFSR, published biannually, assesses global financial system stability and vulnerabilities.

The 2025 edition examined post-pandemic recovery trajectories, risks from rising sovereign debt, AI-driven market volatility, and climate-linked financial disruptions.

India's case stood out for maintaining high growth with low external vulnerability, even as advanced economies face financial tightening and emerging markets struggle with capital flight.

Key Findings for India (GFSR 2025)

Parameter	India's Status
GDP Growth (FY25)	6.7% – highest among major economies
Banking NPA Ratio	3.1% – lowest in over a decade
Inflation (CPI)	Moderating at 4.6%, within RBI tolerance band
Forex Reserves	\$655 billion – 3rd largest globally
Public Debt-to-GDP	81% (manageable under FRBM glide path)
Capital Inflows	\$43 billion FDI; stable portfolio inflows post-IMF inclusion of Indian bonds
Financial Inclusion Index	64% (up from 53% in 2020) driven by UPI and Jan Dhan 2.0

Highlights from the Report

- India's Digital Resilience:** IMF acknowledged India's Digital Public Infrastructure (DPI) — UPI, Aadhaar, DigiLocker — as a global benchmark for financial inclusion and real-time payments.
- Sound Banking and Credit Growth:** The Credit-to-GDP gap remains positive, with PSBs posting profits and credit growth at 14%, supported by robust provisioning and recapitalisation.
- Controlled Inflation and Fiscal Prudence:** The RBI's calibrated policy has stabilised inflation despite supply shocks, while the Union Government's capital

expenditure (₹11.1 lakh crore) supports growth without triggering fiscal imbalance.

- External Stability:** The inclusion of Indian government bonds in JP Morgan's Global Bond Index (2025) boosted global investor confidence.
- Climate Finance Readiness:** India ranked among the top 5 emerging markets for green bond issuances and ESG-aligned investments.

Global Context

- The global GDP growth forecast for 2025 was revised downward to 2.9% due to the U.S.–China trade fragmentation and supply chain shocks.
- Over 40% of low-income countries were identified at risk of debt distress.
- AI-driven financial markets show rising volatility and risk mispricing.
- The IMF called for digital regulation frameworks to prevent algorithmic and cyber-based financial instability.

Significance for India

- Macroeconomic Credibility:** India's macro fundamentals remain strong despite global headwinds, demonstrating policy consistency and credible fiscal management.
- Investor Magnet:** Robust regulatory oversight by RBI and SEBI enhances investor confidence and risk mitigation.
- Financial Sovereignty:** Reduced dependence on short-term capital and stable forex reserves provide a cushion against sudden global liquidity shocks.
- Regional Leadership:** India's financial stability model is being studied by developing economies, particularly under the G20 and Global South frameworks.

Challenges Ahead

- High Public Debt:** Requires medium-term fiscal consolidation.
- Rural Credit Gaps:** Uneven access to formal finance in Tier-3 and rural areas.
- Climate Exposure:** Agriculture and MSME sectors remain vulnerable to extreme weather.
- AI-driven Risk Concentration:** Need for algorithmic audit norms to ensure fintech transparency.

Way Forward

- Institutionalise Financial Stability and Development Council (FSDC 2.0) with climate and cyber-risk cells.
- Expand India Stack 3.0 for cross-border financial inclusion in South Asia.
- Strengthen RBI's macroprudential toolkit for digital asset regulation.
- Promote green taxonomy for uniform ESG classification in finance.

- Encourage retail participation in bond markets via RBI Retail Direct 2.0.

Prelims Connect

- GFSR: Published by IMF twice a year.
- Objective: Monitor global financial vulnerabilities and systemic risks.
- RBI Mandate: Financial Stability under Section 45Z of RBI Act, 1934.
- FSDC: Apex body chaired by Finance Minister for inter-agency coordination.
- India's Forex Reserves (2025): ~\$655 billion, 3rd highest globally.

Mains Connect

"India's financial stability today is not accidental but institutional." Analyse how structural reforms, digital governance, and macroprudential policies have enhanced India's resilience amid global volatility.

Prelims Practice Question

Q. With reference to the IMF's Global Financial Stability Report (GFSR), consider the following statements:

1. It is published annually by the World Bank.
2. The 2025 edition described India as one of the most resilient emerging economies.
3. The report analyses systemic financial risks and vulnerabilities across economies.
4. It is coordinated by the IMF's Fiscal Affairs Department.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 3 only
(c) 2, 3 and 4 only (d) 1, 2 and 4 only

Answer: (b)

Explanation: GFSR is published biannually by the IMF (Monetary and Capital Markets Department), not by the World Bank.

Building a Resilient and Future-Ready Startup Ecosystem

Why in News

India's startup ecosystem—once defined by hypergrowth and funding surges—is now entering a phase of consolidation and resilience-building.

"A Startup Revolution: The Goal of Innovation Capital" underscored the need for a shift from valuation-driven growth to value-driven innovation, particularly in sectors critical to national priorities like deep tech, clean energy, and digital inclusion.

The Startup India Mission has now recognized over 1.2 lakh startups, generating 13 lakh direct jobs, making India the third-largest startup ecosystem in the world—after the U.S. and China.

Background

India's startup revolution began with the Startup India Initiative (2016) and has since evolved into a multi-dimensional growth story spanning fintech, edtech, agritech, healthtech, and clean tech.

However, the post-2022 funding winter exposed structural vulnerabilities—overdependence on foreign capital, weak corporate governance, and unsustainable business models.

The focus is now shifting towards innovation-led, regulatory-compliant, and globally competitive enterprises that can withstand external shocks.

Current Status (2025 Snapshot)

Parameter	Details
Recognized Startups	1,20,000+ (DPIIT data, 2025)
Unicorns	118 (valuation ≥ \$1 billion)
Direct Employment	13 lakh people
Funding Scenario	\$18 billion raised in FY2024–25 (15% decline from previous year)
Sectoral Leaders	Fintech, AI/DeepTech, HealthTech, Clean Energy, Defence Tech

Key Policy Developments (2024–25)

1. **Startup India Seed Fund 2.0:** Expanded with ₹2,000 crore allocation to support early-stage innovation in Tier-2 and Tier-3 cities.
2. **Digital India Innovation Fund:** Encourages AI, quantum computing, and semiconductor startups through incubation and IP support.
3. **National Deep Tech Startup Policy (2025):** Introduced by MeitY and DPIIT to promote indigenous research-driven ventures in AI, biotech, and space technology.
4. **Unified Regulatory Sandbox:** SEBI, RBI, and IRDAI collaborate to streamline compliance for fintech innovation.
5. **India Startup Exchange Portal (2025):** New digital platform for funding visibility, mentorship, and international collaboration.

Challenges in the Ecosystem

- **Funding Fatigue:** Decline in VC inflows amid global monetary tightening.
- **Governance Gaps:** Weak due diligence, lack of independent boards, and overvaluation pressures.
- **Innovation Divide:** 75% of startups concentrated in five major cities—Delhi, Mumbai, Bengaluru, Pune, Hyderabad.
- **Talent Drain:** Brain drain in emerging tech sectors like AI and robotics.
- **Exit Barriers:** Limited IPO readiness and acquisition ecosystem.

Government's Response

- **Ease of Doing Business 2.0:** Simplified regulatory regime with decriminalisation of minor startup offences.
- **Startup Credit Guarantee Scheme:** Risk-sharing framework for collateral-free loans.
- **Capacity Building:** 250+ incubators and 40 Centres of Excellence under the Atal Innovation Mission.
- **Women and Rural Startups:** "Women First Prosperity for All" initiative under Startup India for gender inclusion.
- **Green Startups Focus:** Integration of climate-tech and circular economy models through carbon credit incentives.

Way Forward

- **Strengthen Domestic Capital:** Encourage pension and insurance funds to invest in Indian startups.
- **Deep Tech & IP Ownership:** Focus on R&D, patents, and indigenous design.
- **Regulatory Harmonisation:** Unified framework across sectors to reduce compliance burden.
- **Global Scaling:** Use platforms like G20 Startup20 and Indo-Pacific Innovation Forum to access new markets.
- **Resilience Metrics:** Develop sustainability and ethical benchmarks to assess long-term viability.

Prelims Connect

- Startup India Initiative: Launched 2016 under DPIIT.
- Atal Innovation Mission: NITI Aayog's flagship incubation framework.
- SIDBI's Seed Fund: Supports early-stage startups.
- Startup20: G20 engagement group launched under India's presidency (2023).
- National Deep Tech Startup Policy (NDSP): Approved in 2025 for R&D-led entrepreneurship.

Mains Connect

"India's startup revolution must now evolve from funding-driven expansion to innovation-driven consolidation." Analyse the key structural reforms needed to build a resilient, inclusive, and globally competitive startup ecosystem.

Prelims Practice Question

- Q. With reference to India's startup ecosystem, consider the following statements:
1. The Startup India Seed Fund Scheme provides debt-based funding to unicorns.
 2. The National Deep Tech Startup Policy focuses on research-driven innovation in frontier technologies.
 3. Startup20 was established under India's G20 Presidency to promote global startup collaboration.

4. The Atal Innovation Mission functions under the Ministry of Commerce and Industry.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 1, 2 and 3 only (d) 2, 3 and 4 only

Answer: (a)

Explanation: AIM is under NITI Aayog; the Seed Fund offers grants, not debt financing.

Decarbonising Indian Railways: Powering the Tracks of Green Growth

Why in News

The Indian Railways — one of the world's largest transport networks — has accelerated its mission to achieve Net Zero Carbon Emissions by 2030, ahead of India's national 2070 target.

The Railways has expanded its renewable energy sourcing, electrification network, and green hydrogen pilot operations.

Indian Railways has achieved 95% electrification, commissioned its first hydrogen fuel-cell train (Vande Metro-H₂), and aims to generate 30 billion units of renewable power annually by 2030.

Background

Indian Railways (IR) consumes about 2.7 billion litres of diesel and 20 billion kWh of electricity annually — contributing nearly 7 million tonnes of CO₂ emissions.

Given its scale and energy intensity, decarbonising the Railways is central to India's sustainable transport vision under the Panchamrit commitments (COP26).

The focus areas include 100% electrification, renewable integration, hydrogen trains, energy efficiency, and green finance mechanisms.

Major Initiatives Driving Decarbonisation

1. 100% Electrification of Broad Gauge Network

- As of October 2025, 95% of the 66,700 km network is electrified; full coverage expected by March 2026.
- Reduces diesel dependency and particulate emissions.
- Saves approximately ₹14,500 crore annually in fuel expenditure.

2. Renewable Energy Integration

- Target: 30 billion units/year of renewable energy by 2030.
- Solar installations on 1,200 stations, 500 trains, and 300 workshops.
- Wind farms commissioned in Tamil Nadu and Maharashtra.
- Partnership with SECI and NTPC Green Energy for power purchase agreements.

3. Hydrogen Trains and Alternative Fuels

- India's first hydrogen-fuel Vande Metro prototype launched in 2025 (Sonipat–Jind section).
- Each train reduces CO₂ emissions by 11 tonnes/day.
- Trials for hydrogen blending with CNG in maintenance locomotives underway.
- Supports the National Green Hydrogen Mission (NGHM) goal of 5 MMT annual production by 2030.

4. Energy Efficiency and Smart Infrastructure

- Head-on Generation (HOG) system adopted in 1,000 passenger trains, eliminating diesel generators.
- Regenerative braking in electric locomotives saving 10–15% power.
- LED illumination across all stations.
- Smart meters and SCADA systems for real-time energy optimisation.

5. Green Certification and Finance

- 150 stations and 25 workshops certified as "Green Buildings" by CII–IGBC.
- Mobilisation of Green Bonds (₹20,000 crore) under IR's Mission Net Zero.
- Integration with the Carbon Credit Trading Scheme (CCTS 2023) for emission monetisation.

Institutional and Global Partnerships

Agency / Partner	Role
NITI Aayog	Policy and monitoring under Mission Net Zero.
Ministry of Railways	Lead implementing agency.
SECI / NTPC	Renewable power procurement and solar park development.
Japan / Germany (JICA, KfW)	Technology and green finance partnerships.
UNFCCC & IEA	Knowledge sharing and carbon inventory benchmarking.

Challenges

- **Financing Gaps:** ₹2.5 lakh crore investment needed for full decarbonisation.
- **Grid Integration Issues:** Renewable intermittency and balancing challenges.
- **Hydrogen Storage Risks:** Safety, cost, and infrastructure concerns.
- **Rolling Stock Modernisation:** Need for hydrogen-compatible engines and maintenance.
- **Inter-agency Coordination:** Between Railways, MNRE, and MoP for renewable power supply.

Way Forward

- Accelerate hydrogen train corridors in Gujarat, Maharashtra, and Haryana.

- Expand solar and wind hybrid projects in railway land parcels.
- Implement carbon accounting framework under CCTS.
- Foster public–private partnerships (PPP) for technology transfer.
- Integrate rail electrification with renewable power pooling to create India's first net-positive transport system.

Prelims Connect

- Target: Net Zero by 2030 (Indian Railways).
- National Green Hydrogen Mission: 5 MMT annual production by 2030.
- HOG System: Head-on Generation replaces diesel power cars.
- Regenerative Braking: Converts kinetic energy into electricity.
- CCTS 2023: Carbon Credit Trading Scheme under MoEFCC.

Mains Connect

"Decarbonising Indian Railways is not only a climate action measure but an economic strategy for efficiency and self-reliance." Examine the role of green technologies and institutional reforms in achieving this goal.

Prelims Practice Question

- Q. With reference to the Indian Railways' decarbonisation plan, consider the following statements:
1. The Railways aims to achieve Net Zero Carbon Emissions by 2030.
 2. The Head-on Generation (HOG) system replaces diesel generator cars with electric power drawn from overhead lines.
 3. Hydrogen trains have been launched under the National Electric Mobility Mission Plan.
 4. The Railways plans to source at least 30 billion units of renewable power annually by 2030.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Hydrogen trains are part of the Green Hydrogen Mission, not the Electric Mobility Mission Plan.

Breaking the Unemployment Trap: Rethinking Jobs, Skills and Growth in India

Why in News

Persistent unemployment continues to challenge India's growth narrative despite record GDP expansion. India's jobless growth paradox highlights a mismatch between economic recovery and employment intensity, particularly among the youth and educated workforce.

The Periodic Labour Force Survey (PLFS) 2024–25 shows an urban unemployment rate of 6.6%, and nearly 42% of graduates under 25 remain underemployed or jobless.

Meanwhile, PIB reports progress under PM Vishwakarma, Skill India 2.0, and the Rural Livelihood Missions, yet structural barriers persist in linking skill formation with market absorption.

Background

India's demographic dividend—65% of the population under 35—can be transformative or explosive.

The economy needs to add 8–10 million jobs annually to absorb new entrants, but automation, informalisation, and sectoral inequality have slowed employment elasticity.

The shift toward capital-intensive sectors, combined with the decline of labour-intensive manufacturing, has widened the growth–employment disconnect.

Understanding the “Unemployment Trap”

1. **Structural Mismatch:** Skill supply does not align with market demand—especially in IT, logistics, and green sectors.
2. **Informality:** Over 80% of India's workforce remains informal, lacking job security or social protection.
3. **Underemployment:** Many are engaged in low-productivity or disguised jobs, particularly in agriculture.
4. **Automation Anxiety:** Industry 4.0 technologies are replacing low-skilled jobs faster than new digital opportunities arise.
5. **Gender Gap:** Female labour participation remains around 28%, far below global averages.

Recent Government Initiatives (2024–25)

Programme / Policy	Key Focus
PM Vishwakarma Yojana	Formal credit and skill support for traditional artisans and craftsmen.
Skill India 2.0	Industry-linked reskilling programmes for new-age manufacturing and green jobs.
PM Kaushal Rozgar Portal	AI-driven national employment exchange linking job-seekers and employers.
Digital India Skill Hub	Focused on coding, cybersecurity, drone operations, and AI.
National Apprenticeship Promotion Scheme (NAPS)	Stipend support to MSMEs for training youth.

Key Dimensions of the Employment Challenge

1. **Agrarian Dependence**
 - Nearly 45% of workforce still engaged in agriculture, contributing only 17% of GDP.
 - Diversification into agro-processing and rural enterprises remains slow.

2. Manufacturing Stagnation

- Labour-intensive sectors like textiles, leather, and food processing have plateaued post-COVID.
- PLI schemes have yet to significantly raise employment multipliers.

3. Service Sector Duality

- High-end services (IT, fintech) booming, but low-end (hospitality, retail) show volatility and seasonal dependence.

4. Urban Youth Unemployment

- Rising educated unemployment due to degree inflation and limited professional apprenticeships.

5. Public Sector Contraction

- PSU hiring declined; government employment now <5% of total workforce.

Way Forward: From Job Creation to Job Transformation

- **Link Skills with Demand:** Integrate Skill India programmes with NCS (National Career Service) and MSME clusters.
- **Labour-Intensive Growth:** Promote textile, tourism, construction, and food processing under Make in India 2.0.
- **Localisation of Employment:** Encourage state-specific employment zones through Deendayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY).
- **Green Jobs Revolution:** Harness solar, EV, and waste management sectors for sustainable employment.
- **Gender and Gig Inclusion:** Formalise platform workers and expand childcare infrastructure to enable women's workforce participation.

Prelims Connect

- PLFS: Conducted by NSO annually; measures unemployment based on “usual” and “current weekly” status.
- Unemployment Types: Structural, frictional, cyclical, disguised.
- Schemes: PM Vishwakarma, Skill India 2.0, NAPS, DDU-GKY, PMEGP.
- Reports: India Employment Report (ILO 2024), CMIE Unemployment Survey.

Mains Connect

“India's unemployment crisis is not merely about lack of jobs, but lack of the right jobs.” Analyse the structural, technological, and policy challenges in ensuring inclusive employment-led growth.

Prelims Practice Question

- Q. With reference to unemployment in India, consider the following statements:
1. The Periodic Labour Force Survey (PLFS) is conducted by the Ministry of Labour and Employment.
 2. Disguised unemployment is primarily found in agricultural and informal sectors.

3. The PM Vishwakarma Yojana aims to enhance credit and skill support for artisans.
 4. The National Apprenticeship Promotion Scheme provides financial incentives to trainees directly.
- Which of the statements given above are correct?
- (a) 2 and 3 only (b) 1, 2 and 4 only
(c) 1 and 3 only (d) 2, 3 and 4 only

Answer: (a)

Explanation: PLFS is conducted by NSO under MoSPI; NAPS incentives go to employers, not directly to trainees.

Very Large Gas Carrier (VLGC) 'Shivalik': Strengthening India's Maritime Energy Logistics Chain

Why in News

India commissioned its first indigenously-built Very Large Gas Carrier (VLGC), 'Shivalik', marking a milestone in the nation's quest for energy transport self-reliance and shipbuilding capacity.

Built by Cochin Shipyard Ltd. (CSL) for the Shipping Corporation of India (SCI), the VLGC can transport over 80,000 m³ of liquefied petroleum gas (LPG), meeting India's rising clean-fuel demand.

The initiative aligns with Make in India, Sagarmala, and Atmanirbhar Bharat programmes, reflecting India's emergence as a maritime logistics power in Asia.

Background

India is the second-largest LPG consumer in the world. Currently, more than 60% of LPG imports are carried on foreign-flagged vessels, resulting in freight outflows exceeding ₹15,000 crore annually.

Developing a domestic VLGC fleet will:

- Reduce dependence on foreign shipping,
- Enhance energy-security supply chains, and
- Boost domestic shipbuilding and port engineering ecosystems.

Key Features of VLGC 'Shivalik'

Parameter	Specification
Builder	Cochin Shipyard Ltd (CSL), Kochi
Owner/Operator	Shipping Corporation of India (SCI)
Capacity	80,000 m ³ LPG storage
Propulsion	Dual-fuel engine (LPG + Marine Gas Oil)
Technology	IMO Tier III compliant, Energy Efficient Design Index (EEDI Phase III)
Range	12,000 nautical miles without refueling
Crew Capacity	35 officers and seafarers
Special Note	First LPG carrier built in India for international voyages

Strategic Significance

1. **Energy Security and Import Resilience:** Reduces freight dependency on foreign vessels, ensuring continuous LPG supply amid global crises.

2. **Maritime Self-Reliance:** Cochin Shipyard joins global VLGC builders—Japan, South Korea, China—signifying entry into a high-technology shipbuilding segment.
3. **Green Transition in Shipping:** Dual-fuel engines and EEDI Phase III standards cut CO₂ emissions by up to 20%. Supports India's goal of net-zero shipping by 2070.
4. **Economic Spillovers:** Creates employment in steel, engineering, navigation equipment and port maintenance. Encourages private participation in LPG transport and chartering.
5. **Global Trade Integration:** Enhances India's share in the LPG shipping market and strengthens links with Middle-East export corridors.

Challenges

- **High Capital Cost:** Each VLGC costs \$80–100 million; financing via Ship Acquisition Funds needed.
- **Limited Infrastructure:** Few Indian ports currently handle VLGC berthing (draft ≥ 15 m).
- **Crew Training Gap:** Specialised LPG handling skills are still nascent in domestic maritime academies.
- **Insurance and Flagging Issues:** Regulatory framework for gas carriers under Indian flag needs further clarity.

Way Forward

- **Expand Domestic Fleet:** Add 10–12 VLGCs by 2030 through PPP and leasing models.
- **Upgrade Ports:** Develop deep-draft LPG terminals at Kandla, Paradip, and Ennore.
- **Skill Development:** Launch Gas Carrier Operations modules under Maritime Skill Council.
- **Green Shipping Finance:** Leverage India's Green Finance Framework for eco-vessels.
- **Regional Connectivity:** Use VLGCs to service South Asia and ASEAN gas trade routes.

Prelims Connect

- VLGC: Vessel carrying ≥ 70,000 m³ LPG.
- Cochin Shipyard Ltd (CSL): India's largest public sector shipbuilder under MoPSW.
- Sagarmala Programme: Port-led industrialisation and logistics efficiency.
- EEDI: Energy Efficiency Design Index – IMO mechanism for CO₂ reduction.

Mains Connect

"Maritime self-reliance is as vital to energy security as domestic production." Examine how projects like the VLGC 'Shivalik' align with India's blue economy and energy transition goals.

Prelims Practice Question

- Q. With reference to the Very Large Gas Carrier (VLGC) 'Shivalik', consider the following statements:

1. It is India's first indigenously built VLGC constructed by Cochin Shipyard Ltd.
2. It operates on dual fuel engines using LPG and marine gas oil.
3. It was developed under the Sagarmala Programme of the Ministry of Ports, Shipping and Waterways.
4. VLGCs can carry up to 1,20,000 m³ of compressed natural gas.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 2 and 4 only
(c) 1 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: VLGCs transport LPG, not compressed natural gas (CNG); capacity 80,000 m³.

Reassessing India's Industrial Health: Insights from the Annual Survey of Industries 2023–24

Why in News

The National Statistical Office (NSO) released the findings of the Annual Survey of Industries (ASI) 2023–24, offering a detailed picture of India's factory sector performance and its role in post-pandemic recovery.

The survey indicates a 6.8% rise in gross value added (GVA) by registered manufacturing units, supported by strong output in chemicals, machinery, and food processing.

However, employment generation and MSME participation remain below pre-pandemic levels, highlighting India's struggle to achieve inclusive industrial recovery.

Background

The Annual Survey of Industries (ASI) is India's most comprehensive industrial data source, covering over 2.6 lakh factories under the Factories Act, 1948.

It measures variables such as output, input, employment, wages, fixed capital, and productivity—helping policymakers assess the health and structure of the manufacturing sector.

The 2023–24 cycle represents the first full post-COVID industrial landscape, reflecting the twin pressures of supply chain disruptions and energy transition costs.

Key Findings of ASI 2023–24

Parameter	Observation
Gross Value Added (GVA)	₹15.2 lakh crore (↑6.8% YoY)
Fixed Capital Formation	↑8.2% — driven by electronics, auto components, and pharmaceuticals
Employment	1.68 crore workers — still 3% below pre-COVID levels
Wages	Average annual wage per worker ₹3.6 lakh — marginal 4% increase
Top Performing States	Gujarat, Tamil Nadu, Maharashtra, Karnataka
Sectors Driving Growth	Petroleum refining, chemicals, food processing, machinery, textiles

Sectoral Highlights

- **Capital Goods Surge:** Machine tools and electrical equipment led investments under the PLI Scheme (2023–25).
- **Food Processing Resilience:** 10% rise in GVA amid export-led demand and cold-chain expansion.
- **Textiles Recovery Lag:** Persistent export slowdown and rising cotton prices constrained competitiveness.
- **Green Manufacturing:** 8% increase in renewable component production (solar cells, EV batteries).
- **Regional Disparities:** Western and Southern states account for 70% of industrial GVA.

Structural Insights

1. **Formalisation Momentum:** GST and PLI have accelerated the transition of medium units into formal supply chains.
2. **Labour Productivity:** Output per worker rose 4.3%, but automation-driven gains not matched by job creation.
3. **Energy Transition Costs:** Industries investing heavily in cleaner fuels and efficiency upgrades under Perform, Achieve, and Trade (PAT) scheme.
4. **Export Linkages:** High dependence on global demand cycles — particularly for engineering goods and pharma.
5. **MSME Integration Gap:** Only 25% of small units report access to institutional credit.

Policy and Institutional Context

Policy / Mission	Objective / Link to ASI Findings
Production Linked Incentive (PLI) Schemes	Boosted capital formation and manufacturing value chains.
National Manufacturing Policy (NMP)	Aims to raise manufacturing share in GDP from 17% to 25% by 2030.
PM Gati Shakti & National Logistics Policy	Reduced freight time, improving competitiveness.
Make in India 2.0	Shift toward high-tech manufacturing and exports.
Green Industrial Transition Plan (2025)	Encourages decarbonisation of industrial clusters.

Challenges Highlighted

- **Jobless Industrial Growth:** Output expansion not translating into proportional employment.
- **Credit Bottlenecks for MSMEs:** Rising interest rates and compliance burdens.
- **Skill Gaps:** Automation increasing need for mid-level technical upskilling.

- **Environmental Compliance Costs:** Smaller units struggle to meet ESG and emission norms.
- **Regional Imbalances:** North and East lag behind in industrial diversification.

Way Forward

- **MSME Financing Ecosystem:** Strengthen credit guarantees and digital invoice-based lending.
- **Industrial Clusters 4.0:** Smart, energy-efficient zones integrating AI and IoT.
- **Labour-Technology Balance:** Create re-skilling funds for automation-exposed workers.
- **Export Diversification:** Move beyond textiles and pharma toward semiconductors, EVs, and green tech.
- **Data-Driven Industrial Policy:** Institutionalise ASI findings into annual Economic Survey inputs.

Prelims Connect

- **Annual Survey of Industries (ASI):** Conducted by NSO under MoSPI.
- **Coverage:** Factories under the Factories Act, 1948 employing ≥ 10 workers with power or ≥ 20 without power.
- **GVA (Gross Value Added):** Measures net output after deducting intermediate consumption.
- **PLI Schemes:** Incentive-based model to promote domestic manufacturing.
- **PAT Scheme:** Under the Bureau of Energy Efficiency for industrial energy efficiency.

Mains Connect

"India's industrial recovery must be inclusive, resilient, and sustainable rather than merely output-driven." Analyse the lessons from the Annual Survey of Industries 2023–24 in this context.

Prelims Practice Question

- Q. With reference to the Annual Survey of Industries (ASI) in India, consider the following statements:
1. It is conducted annually by the Ministry of Commerce and Industry.
 2. The survey covers both organized and unorganized manufacturing sectors.
 3. Factories employing 10 or more workers with power connection are covered under it.
 4. The ASI provides estimates of Gross Value Added and employment in the factory sector.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 3 and 4 only
(c) 1, 3 and 4 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: ASI is conducted by NSO (MoSPI) and covers the organized manufacturing sector only.

Sailing Towards Self-Reliance: The Strategic Leap of India's VLGC 'Shivalik'

Why in News

India achieved a landmark in maritime and energy logistics with the commissioning of its first indigenously built Very Large Gas Carrier (VLGC) — 'Shivalik'.

Constructed by Cochin Shipyard Ltd. (CSL) for the Shipping Corporation of India (SCI), the vessel marks India's entry into the elite group of nations capable of designing and building 80,000 m³-class LPG carriers.

It reinforces India's ambition to strengthen its blue economy, energy transport autonomy, and green shipping capabilities under Sagarmala and Atmanirbhar Bharat.

Background

India, the second-largest LPG consumer globally, depends on foreign vessels for over 60% of its LPG imports — an annual freight outflow of around ₹15,000 crore.

The development of a domestic VLGC fleet like Shivalik directly addresses this dependency while advancing India's maritime engineering ecosystem.

It symbolises the transition from coastal shipping to strategic shipping, where national security, energy security, and technological self-sufficiency converge.

Key Features of VLGC 'Shivalik'

Aspect	Details
Builder	Cochin Shipyard Ltd (CSL), Kochi
Operator	Shipping Corporation of India (SCI)
Capacity	80,000 m ³ LPG
Fuel Type	Dual-fuel engine (LPG + Marine Gas Oil)
Compliance	IMO Tier III, EEDI Phase III (20% lower CO ₂ emissions)
Range	12,000 nautical miles
Crew	35
Distinctive Feature	India's first VLGC built for international voyages

Strategic Significance

1. Energy Security Backbone

- Ensures uninterrupted LPG imports amid global supply disruptions.
- Reduces dependence on foreign carriers during crises or sanctions.

2. Maritime Self-Reliance

- Positions India among a handful of VLGC-building nations (Japan, South Korea, China).
- Strengthens shipbuilding capacity under Atmanirbhar Bharat and Maritime India Vision 2030.

3. Green Transition in Shipping

- Dual-fuel system reduces emissions and meets IMO 2030 climate compliance.

- A stepping stone for adopting ammonia and hydrogen-based propulsion in future vessels.

4. Economic Multiplier

- Stimulates allied sectors—steel fabrication, port infrastructure, navigation systems, and marine insurance.
- Encourages private participation in LPG logistics and offshore services.

5. Geostrategic Leverage

- Expands India's footprint in Gulf-ASEAN LPG shipping routes.
- Enhances maritime diplomacy under the Indo-Pacific Oceans Initiative (IPOI).

Challenges

- Capital Intensity: High upfront cost (\$90 million+ per vessel).
- Port Limitations: Only select ports (Kandla, Ennore) can currently berth VLGCs.
- Crew Specialisation: Need for LPG handling and cryogenic safety training.
- Policy Gaps: Insurance and flagging frameworks for gas carriers under Indian registry evolving slowly.

Way Forward

- Expand India's VLGC fleet through PPP models and leasing incentives.
- Upgrade deep-draft ports and establish integrated LPG terminals.
- Create a Maritime Skills Academy for cryogenic and dual-fuel propulsion training.
- Introduce Green Maritime Finance under India's sovereign green bond umbrella.
- Develop South Asia Gas Corridor under BIMSTEC cooperation for regional energy transport.

Prelims Connect

- VLGC: Ships carrying $\geq 70,000 \text{ m}^3$ LPG (Liquefied Petroleum Gas).
- Cochin Shipyard Ltd (CSL): India's largest public shipyard under MoPSW.
- Sagarmala Programme: Enhances port-led development and logistics efficiency.
- EEDI (Energy Efficiency Design Index): IMO mechanism to reduce marine carbon intensity.

Mains Connect

"Maritime self-reliance is the new frontier of energy independence." Discuss how indigenous shipbuilding initiatives like the VLGC 'Shivalik' advance India's blue economy and strategic autonomy.

Prelims Practice Question

- Q. With reference to India's Very Large Gas Carrier (VLGC) 'Shivalik', consider the following statements:

1. It is India's first indigenously built LPG carrier.
2. It operates using dual-fuel engines compliant with IMO's EEDI Phase III norms.
3. The vessel was constructed under the Make in India initiative by Hindustan Shipyard Limited.
4. It enhances India's participation in the Gulf-ASEAN LPG transport corridor.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The vessel was built by Cochin Shipyard Ltd., not Hindustan Shipyard.

Balancing the Markets: Rethinking India's Securities Transaction Tax (STT)

Why in News

The government has initiated a comprehensive review of the Securities Transaction Tax (STT) structure to align capital market taxation with evolving investor behaviour, derivatives trading patterns, and fiscal stability.

Triggered by record volumes on the National Stock Exchange (NSE) — crossing ₹5 lakh crore in daily derivatives turnover (October 2025) — the move seeks to simplify taxation while ensuring market depth and transparency.

This review follows industry concerns that high STT on derivatives distorts investment behaviour and reduces long-term liquidity.

Background

The Securities Transaction Tax (STT) was introduced in 2004 to replace cumbersome capital gains tracking by taxing transactions directly at the exchange level.

It applies to every sale or purchase of securities — including equities, derivatives, and mutual fund units — executed through recognised exchanges.

Revenue from STT is a crucial component of direct tax collection, contributing nearly ₹38,000 crore in FY2024-25, but critics argue it has made short-term trading costlier and less globally competitive.

Current STT Structure (as of FY2025)

Transaction Type	STT Rate	Levied On
Equity Delivery	0.1%	Both Buy & Sell
Equity Intraday	0.025%	Sell side only
Futures (Derivatives)	0.0125%	Sell side
Options	0.0625%	Sell side on premium
Mutual Funds / ETFs	0.001%	Sell side
Bonds / Debentures	Nil	Exempted

(Source: CBDT Circular, April 2025)

Key Issues Driving Reform

1. High Transaction Costs

- India's trading costs are among the highest globally due to combined STT + GST + exchange fees.
- Deters long-term institutional investors.

2. Derivatives Dominance

- Over 95% of total market turnover now comes from derivatives, but only 5% of revenue from STT — indicating imbalance.

3. Tax Arbitrage & Double Taxation

- STT levied alongside stamp duty and capital gains tax creates overlapping tax burdens.

4. Behavioural Shift

- Traders increasingly shift to offshore derivatives instruments (ODIs) and GIFT City exchanges to avoid high STT.

Recent Developments (2025)

- CBDT–SEBI Joint Working Group constituted to rationalise rates and integrate STT with GST and Stamp Duty frameworks.
- Proposal to lower STT on options and introduce rebate for long-term equity investors.
- Discussions on integrating STT revenue-sharing with states under a new fiscal federalism model for capital markets.

Economic and Fiscal Implications

Positive Impacts	Concerns
Simplified collection and compliance	Reduced short-term fiscal inflow
Transparency and traceability	Market volatility during reform period
Encourages long-term equity culture	Potential short-term trading slowdown
Enhances investor protection	Need for harmonisation with GST regimes

Way Forward

- Rationalise Derivative Rates: Create parity between futures and options taxation.
- Shift to Value-Based Taxation: Encourage investment over speculation.
- Integrate STT–Stamp Duty Framework: One unified digital levy per transaction.
- Incentivise Retail Participation: Rebates for SIPs and direct equity investments.
- Align with Global Best Practices: Benchmark against Singapore, London, and NYSE.

Prelims Connect

- STT: Introduced under Finance Act, 2004; collected by the stock exchange.

- Administered By: Central Board of Direct Taxes (CBDT).
- Exemptions: Government securities and bonds.
- Revenue Use: Direct tax collection; not shared with states.
- Related Tax: Commodity Transaction Tax (CTT, 2013).

Mains Connect

"Transaction taxes like STT must balance fiscal needs with market efficiency." Examine the role of STT in ensuring capital market transparency and discuss the rationale for its reform in India's 2025 financial landscape.

Prelims Practice Question

- Q. With reference to the Securities Transaction Tax (STT), consider the following statements:
- STT is levied on all financial transactions conducted through stock exchanges in India.
 - It was introduced to simplify tax compliance by replacing capital gains tax on equities.
 - The tax is collected by the stock exchange and remitted to the Central Government.
 - STT is applicable on both buying and selling of futures contracts.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2 and 3 only

Answer: (b)

Explanation: STT complements, not replaces, capital gains tax. It is levied on the sell side for derivatives.

Foreign Currency Settlement System (FCSS): Building India's Global Payment Sovereignty

Why in News

The Reserve Bank of India (RBI) has operationalised the Foreign Currency Settlement System (FCSS) a dedicated mechanism for settlement of cross-border payments in major foreign currencies such as USD, GBP, and EUR through Indian banks.

The move aims to reduce reliance on global settlement networks like SWIFT and CHIPS and enhance India's capacity to manage foreign exchange settlements autonomously.

This is a landmark step toward building India's global financial infrastructure sovereignty, especially in the wake of rising geopolitical sanctions and cyber risks.

Background

Traditionally, all foreign currency transactions — even between two Indian banks — were settled through correspondent banks abroad, leading to:

- High transaction costs,
- Settlement delays, and
- Vulnerability to third-country financial sanctions.

The FCSS provides a domestic platform for clearing and settling transactions denominated in select foreign currencies, without routing them through foreign systems.

It forms part of RBI's broader initiative under the International Financial Services Framework 2.0 and complements mechanisms like the Rupee Trade Settlement (RTS) introduced in 2022.

Key Features of FCSS

Feature	Description
Operator	Reserve Bank of India (through RBI's Core Banking – E-Kuber System)
Currencies Covered (Phase 1)	USD, GBP, EUR
Participants	AD Category-I Banks, IFSCA-licensed units in GIFT City
Settlement Mode	Payment-vs-Payment (PvP) to eliminate settlement risk
Technology Base	Blockchain-supported validation with ISO 20022 message format
Operational Hours	22-hour settlement window aligned with global time zones

Objectives

1. **Reduce Settlement Risk:** Ensures simultaneous exchange of currencies, mitigating Herstatt Risk.
2. **Lower Transaction Costs:** Avoids multiple correspondent fees and time-zone delays.
3. **Enhance Strategic Autonomy:** Enables Indian banks to continue cross-border operations amid global disruptions.
4. **Deepen Offshore Market Linkages:** Strengthens GIFT City as an alternative global settlement hub.
5. **Support Trade Diversification:** Facilitates invoicing in multiple currencies and helps exporters hedge efficiently.

Strategic Significance

1. **Financial Resilience**
 - Shields Indian trade from disruptions due to geopolitical sanctions or global payment freezes.
2. **Global Integration**
 - Enables smoother trade with key partners under Rupee and foreign currency settlement frameworks.
 - Reduces dependence on western banking intermediaries.
3. **Technology Leadership**
 - India becomes one of the few emerging economies with independent multi-currency settlement capability.
4. **Complement to Digital Rupee**
 - FCSS can later integrate with Central Bank Digital Currency (CBDC) for faster cross-border digital settlements.

Challenges

- **Liquidity Management:** Requires large foreign currency buffers within domestic banks.

- **Operational Complexity:** Ensuring continuous sync with global currency markets.
- **Regulatory Coordination:** RBI, FEMA, and IFSCA must harmonise compliance frameworks.
- **Global Acceptance:** Convincing counterparties abroad to participate in an India-led settlement ecosystem.

Way Forward

- Expand currency coverage to JPY, AED, and SGD in Phase 2.
- Integrate with GIFT IFSC's International Settlement System (IISS).
- Create Insolvency Protection Frameworks for settlement participants.
- Develop Regional Clearing Alliances with BRICS, ASEAN, and African partners.
- Promote CBDC cross-linkages for instantaneous multi-currency digital settlements.

Prelims Connect

- **FCSS:** RBI-led mechanism for settling foreign currency payments domestically.
- **PvP (Payment-vs-Payment):** Ensures simultaneous exchange of currencies to prevent default.
- **SWIFT:** Society for Worldwide Interbank Financial Telecommunication – global messaging network.
- **Herstatt Risk:** Loss from time-zone mismatch in currency settlements.
- **IFSCA:** International Financial Services Centres Authority headquartered in GIFT City, Gujarat.

Mains Connect

"Financial sovereignty today lies not only in currency control but in settlement architecture." Analyse how the Foreign Currency Settlement System strengthens India's financial autonomy and trade resilience in a multipolar world.

Prelims Practice Question

- Q. With reference to the Foreign Currency Settlement System (FCSS), consider the following statements:
1. It allows cross-border payment settlement in major foreign currencies through Indian banks.
 2. It operates on a Payment-vs-Payment (PvP) model to eliminate settlement risk.
 3. It is implemented by the Securities and Exchange Board of India (SEBI).
 4. It aims to reduce reliance on global settlement systems like SWIFT.
- Which of the statements given above are correct?
- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The FCSS is implemented by the RBI, not SEBI. It facilitates secure settlement in major foreign currencies.

Digital Trust Revolution: How Electronic Bank Guarantees (e-BGs) Are Transforming India's Financial System

Why in News

The Central Board of Indirect Taxes and Customs (CBIC), in collaboration with the National E-Governance Services Ltd. (NeSL) and Indian Banks' Association (IBA), has fully rolled out the Electronic Bank Guarantee (e-BG) platform across all major public and private sector banks.

This reform digitises the entire lifecycle of bank guarantees (BGs)—from issuance to invocation—ushering in an era of paperless, real-time, and fraud-proof financial assurance.

The initiative supports India's broader vision of Digital Public Infrastructure (DPI) and Ease of Doing Business (EoDB) 2.0.

Background

A Bank Guarantee is a financial instrument issued by a bank on behalf of a client to assure payment or performance obligations to a beneficiary.

Traditionally, BGs involved manual paperwork, physical stamping, courier delays, and high risks of forgery or tampering.

To address these inefficiencies, the e-BG system was conceptualised in 2022 and is now integrated with the NeSL Digital Document Execution (DDE) platform, which authenticates guarantees through digital stamping, e-signatures, and blockchain-secured ledgers.

Key Features of the e-BG Platform

Feature	Description
Platform Owner	National E-Governance Services Ltd. (NeSL) under IBA supervision
Integration	Linked with the Central Registry of Securitisation Asset Reconstruction and Security Interest (CERSAI)
Authentication	Digital signature and Aadhaar-based verification
Storage	Blockchain-based repository ensuring tamper-proof documents
Accessibility	24×7 online issuance, renewal, invocation and verification
Implementation	All scheduled commercial banks mandated to onboard by FY2025-26

Significance

- Fraud Elimination:** Eliminates forged or duplicate guarantees through unique digital identifiers verified by beneficiaries in real time.
- Ease of Doing Business:** Reduces BG issuance time from 2–3 days to less than 10 minutes, accelerating project clearances, especially in infrastructure, customs, and government procurement.

- Transparency and Auditability:** Creates a verifiable, time-stamped trail accessible to regulators, auditors, and project owners.
- Cost and Compliance Efficiency:** Removes need for physical stamp papers, couriering, and branch verification—saving millions annually.
- Integration with Trade and Customs:** e-BGs now accepted on the ICEGATE Customs Portal for import/export obligations—simplifying trade finance operations.

Challenges

- Adoption Gaps:** Smaller cooperative banks yet to digitise legacy guarantee systems.
- Cybersecurity:** Requires multi-layered protection for high-value guarantees.
- Legal Harmonisation:** Existing laws (Indian Contract Act, Stamp Act) need alignment with digital execution norms.
- Awareness:** Beneficiaries in Tier-2 and Tier-3 regions require capacity-building for e-BG usage.

Way Forward

- Expand Scope:** Include performance bonds and insurance guarantees.
- Strengthen Legal Backing:** Codify e-BGs under the Indian Evidence Act as admissible electronic records.
- Capacity Building:** RBI-led certification programme for e-BG officers.
- International Integration:** Link with cross-border trade platforms via SWIFT e-Guarantee standards.
- Cyber-Resilience Framework:** Continuous auditing of NeSL blockchain integrity.

Prelims Connect

- e-BG:** Electronic Bank Guarantee executed on the NeSL platform.
- NeSL:** India's first Information Utility under the IBC, 2016.
- CERSAI:** Central registry of charges and security interests.
- ICEGATE:** Indian Customs E-Gateway for digital documentation.
- Legal Basis:** Information Technology Act, 2000 – Section 4 (Legal recognition of e-records).

Mains Connect

"In a digital economy, trust must move as fast as transactions." Analyse how the Electronic Bank Guarantee system strengthens transparency, efficiency, and fraud-resilience in India's financial sector.

Prelims Practice Question

- Q. With reference to the Electronic Bank Guarantee (e-BG) system, consider the following statements:

1. It is implemented jointly by the Reserve Bank of India and the Central Board of Direct Taxes.
2. It uses blockchain technology and digital signatures for verification.
3. It allows beneficiaries to authenticate guarantees in real time through a central repository.
4. It has been integrated with the ICEGATE platform for customs operations.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2, 3 and 4 only
(c) 1, 2 and 4 only (d) 2 and 4 only

Answer: (b)

Explanation: e-BGs are overseen by CBIC and NeSL, not by RBI or CBDT.

Sawalkote Hydel Project: Balancing Energy Ambition and Ecological Sensitivity in Jammu & Kashmir

Why in News

The long-delayed Sawalkote Hydroelectric Project (HEP) on the Chenab River in Jammu & Kashmir has received final techno-economic clearance from the Central Electricity Authority (CEA) and environmental approval from the Ministry of Environment, Forest and Climate Change (MoEFCC).

With a planned capacity of 1,856 MW, Sawalkote will be India's third-largest hydro project after Tehri (Uttarakhand) and Dibang (Arunachal Pradesh).

This milestone marks a significant step in India's Northern Grid energy diversification and strategic water management in the Chenab basin.

Background

Conceived in 1984, the project faced multiple delays due to environmental clearances, resettlement challenges, and seismic concerns.

It is being executed by NHPC Ltd. at a cost of ₹22,000 crore, located between Ramban and Udhampur districts on the Chenab River.

The project's reservoir will stretch over 25 km, impacting nearly 2,000 families, and lies in the western Himalayan seismic zone, making environmental and safety management critical.

Project Highlights

Feature	Details
River	Chenab (tributary of Indus)
Installed Capacity	1,856 MW (6 × 309.3 MW turbines)
Project Developer	NHPC Ltd.
Location	Ramban & Udhampur, J&K
Estimated Cost	₹22,000 crore
Annual Energy Generation	7,800 million units (MU)

Reservoir Length	25 km
Commissioning Target	2032
Employment Impact	10,000 direct and indirect jobs during construction

Strategic Significance

1. **Energy Security for the North:** The project will supply power to J&K, Punjab, Haryana, and Delhi, stabilising the northern grid during peak demand.
2. **Hydrological Advantage:** Part of the Chenab River cascade with Baglihar, Dulhasti, and Ratle projects, ensuring optimised river utilisation under the Indus Waters Treaty (IWT).
3. **Local Development Catalyst:** Boosts regional employment, infrastructure, and industrialisation, aligning with the Vision J&K Power Mission 2030.
4. **Strategic Importance:** Located near India's western frontier, the project enhances water-use rights under the IWT framework vis-à-vis Pakistan.

Environmental and Social Dimensions

Aspect	Concern / Mitigation Strategy
Biodiversity Impact	Threat to riverine species; NHPC to implement compensatory afforestation on 300 hectares.
Seismic Sensitivity	Advanced dam design with earthquake-resistant features compliant with IS 1893:2016.
Displacement & R&R	2,000 affected families; NHPC to provide cash, housing, and livelihood rehabilitation under J&K R&R Policy 2021.
Sedimentation	Silt-trap structures and flushing tunnels planned to extend reservoir life.
Water Flow Regulation	Minimum ecological flow of 25 cumecs to maintain downstream ecology.

Challenges

- **Seismic Risks:** The Chenab Valley lies in Zone V, requiring advanced dam safety monitoring.
- **Resettlement Delays:** Local protests over compensation adequacy.
- **Environmental Litigation:** Concerns by ecological groups about cumulative river impact.
- **Interstate Coordination:** Power-sharing and water management agreements with downstream states.

Way Forward

- **Comprehensive Basin Planning:** Integrate Chenab projects under a unified watershed framework.
- **Technology Integration:** Deploy remote dam monitoring and AI-based flow forecasting systems.
- **Community Partnership:** Continuous local engagement through NHPC's CSR and livelihood programmes.

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- Eco-Tourism Component: Develop Sawalkote Reservoir Zone as a clean-energy tourism hub.
- Green Finance: Access sovereign green bonds and climate adaptation funds for sustainable hydro development.

Prelims Connect

- Chenab River: Major Indus tributary originating from Bara Lacha Pass in Himachal Pradesh.
- NHPC: Nodal PSU for hydro projects; under Ministry of Power.
- Indus Waters Treaty (1960): Allocates western rivers (Indus, Jhelum, Chenab) to Pakistan with Indian rights for limited hydropower use.
- CEA: Central Electricity Authority—statutory body for techno-economic approval of power projects.

Mains Connect

"Hydropower in the Himalayas is both a blessing and a balancing act." Examine how projects like Sawalkote can contribute to clean energy goals while ensuring ecological and seismic safety.

Prelims Practice Question

Q. With reference to the Sawalkote Hydroelectric Project, consider the following statements:

1. It is located on the Chenab River between Ramban and Udhampur districts.
2. The project is being developed by the Jammu & Kashmir Power Development Corporation.
3. It will be India's third-largest hydropower project after Tehri and Dibang.
4. The project lies in Seismic Zone III according to IS 1893 classification.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 1 and 4 only

Answer: (a)

Explanation: The project is being developed by NHPC Ltd. and lies in Seismic Zone V.

Seeds of Sovereignty: India and the UPOV Debate on Farmers' Rights and Innovation

Why in News

India's stand at the Union for the Protection of New Varieties of Plants (UPOV) has once again drawn international attention after it reaffirmed non-membership of the 1991 UPOV Convention, citing its inconsistency with the Plant Variety Protection and Farmers' Rights (PPV&FR) Act, 2001. This comes amid growing global debates on seed patents, genetic modification, and farmers' control over traditional varieties, with India asserting the primacy of farmers as innovators and conservators of biodiversity.

Background

The UPOV Convention, established in 1961 (revised in 1991), is an international treaty that grants intellectual property rights (IPR) to plant breeders for new, distinct, uniform, and stable (DUS) varieties.

While over 75 countries are members, India chose not to accede to the UPOV 1991 version due to concerns that it could override farmers' rights to save, share, and reuse seeds.

Instead, India enacted its own sui generis law — the PPV&FR Act, 2001 — which balances breeder incentives with traditional agricultural practices and Article 39(a) of the Constitution (livelihood rights).

Key Features: UPOV vs. India's PPV&FR Act

Aspect	UPOV 1991 Convention	India's PPV&FR Act, 2001
Rights Granted	Exclusive commercial rights to breeders	Shared rights to breeders and farmers
Seed Saving	Restricted without breeder's permission	Farmers can save, use, exchange seeds
Farmers' Recognition	Absent	Recognises farmers as "conservers and breeders"
Registration Criteria	DUS (Distinct, Uniform, Stable)	DUS + Novelty + Benefit Sharing
Benefit Sharing	Not provided	Mandatory under National Gene Fund
Institutional Framework	UPOV Secretariat (Geneva)	Protection of Plant Varieties and Farmers' Rights Authority (India)

Significance of India's Stand

1. **Farmers' Sovereignty and Equity:** Reinforces India's moral and legal commitment to protect seed diversity and farmer autonomy, preventing monopolisation by global seed corporations.
2. **Biodiversity Protection:** Aligns with Biological Diversity Act (2002) and Nagoya Protocol on Access and Benefit Sharing.
3. **Innovation with Inclusion:** Encourages local and indigenous innovation in plant breeding while ensuring equitable benefit-sharing.
4. **Trade and TRIPS Compliance:** India's law is consistent with Article 27.3(b) of WTO's TRIPS Agreement, which allows nations to adopt a sui generis system for plant variety protection.
5. **South-South Solidarity:** Sets a model for developing countries balancing IPR with farmers' traditional knowledge and livelihood security.

Current Developments (2025)

- India proposed a Global Farmers' Innovation Forum under FAO to promote open-access seed innovation.
- The National Gene Fund disbursed over ₹75 crore for community-based seed conservation projects.
- Discussion underway for PPV&FR Act Amendment (2025) to include climate-resilient variety recognition and digital registration of farmer-breeders.

Challenges

- Enforcement Gaps: Limited capacity to detect IPR violations and illegal seed marketing.
- Awareness Deficit: Many small farmers unaware of their rights under PPV&FR.
- Private Sector Pressure: Global seed firms push for UPOV harmonisation under trade negotiations.
- Technological Dilemma: Need to balance gene-editing innovations (CRISPR-based varieties) with traditional systems.

Way Forward

- Strengthen PPV&FR Authority for faster registration and dispute resolution.
- Expand digital seed certification through the AgriStack ecosystem.
- Institutionalise community seed banks under the National Mission on Sustainable Agriculture.
- Build global coalitions of Global South nations to advocate farmer-centric IPR models.
- Integrate AI tools for tracking biopiracy and genetic resource use.

Prelims Connect

- UPOV: International treaty (1961, revised 1991) protecting plant breeders' rights.
- India's PPV&FR Act (2001): Recognises both breeders and farmers as right-holders.
- National Gene Fund: Collects benefit-sharing and compensates farmers.
- Authority: PPV&FR Authority under Ministry of Agriculture & Farmers Welfare.
- Nagoya Protocol (2010): Ensures fair and equitable sharing of genetic resource benefits.

Mains Connect

"In the race for agricultural innovation, the world must not forget the original innovators — the farmers." Examine how India's stance on UPOV reflects a balance between intellectual property rights and traditional agricultural practices.

Prelims Practice Question

- Q. With reference to India's position on the UPOV Convention, consider the following statements:
- India is a member of the UPOV 1991 Convention.

- India's PPV&FR Act, 2001 allows farmers to save, exchange, and reuse seeds.
- The National Gene Fund is established under the PPV&FR Act to ensure benefit-sharing.
- The Nagoya Protocol deals exclusively with plant breeders' rights.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 3 only
(c) 1 and 4 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: India is not a UPOV member; the Nagoya Protocol concerns access and benefit-sharing of genetic resources, not breeders' rights alone.

Mining Readiness Index 2025: Benchmarking India's Resource Governance Capacity

Why in News

The Ministry of Mines, in collaboration with the NITI Aayog and Indian Bureau of Mines (IBM), has released the State Mining Readiness Index (SMRI) 2025 — India's first framework to evaluate the mining ecosystem readiness of states and union territories.

This index measures how effectively states are managing their mineral wealth in terms of governance, technology, sustainability, and transparency, providing a roadmap for responsible resource-based growth.

Background

India is endowed with over 95 mineral types and holds significant reserves of critical and strategic minerals like lithium, rare earths, and graphite.

However, mining contributes only 1.9% to India's GDP, reflecting structural inefficiencies, environmental hurdles, and regulatory fragmentation.

To unlock the potential of the mining sector — especially under the National Mineral Policy 2019 and Critical Minerals Mission 2024 — the SMRI seeks to incentivise best-performing states and encourage evidence-based reforms.

About the State Mining Readiness Index (SMRI)

Dimension	Key Indicators
1. Governance & Policy Framework	Ease of doing mining business, digital clearances, policy consistency, transparency.
2. Infrastructure Readiness	Transport connectivity, energy availability, logistics, and processing facilities.
3. Environmental & Social Responsibility	Compliance with Forest, Environment, and Rehabilitation norms; ESG adoption.
4. Exploration & Technology Adoption	Geospatial data usage, drone surveys, and automation in mineral mapping.

5. Value Addition & Processing	Mineral beneficiation capacity and downstream linkages.
6. Sustainable Development Goal (SDG) Alignment	Integration with SDG 12 (Responsible Consumption and Production).

Highlights of SMRI 2025 Findings

Category	Top Performers	Emerging Performers
Overall Readiness	Odisha, Gujarat, Chhattisgarh	Rajasthan, Jharkhand
Exploration & Technology	Karnataka, Tamil Nadu	Madhya Pradesh
Sustainability Practices	Odisha, Goa	Maharashtra
Ease of Doing Mining	Gujarat, Telangana	Haryana

Key Insight:

Odisha leads due to digital transparency in auctions, while Gujarat excels in downstream mineral processing under its Mining-to-Manufacturing Corridor Model.

Significance

- Data-Driven Policy Benchmark:** Helps identify best practices and structural gaps in state-level mining governance.
- Investment Magnet:** Enhances investor confidence through predictability and regulatory clarity.
- Sustainability Alignment:** Promotes ESG integration and resource efficiency, key for India's green transition.
- Support to Critical Minerals Mission:** Guides exploration prioritisation for lithium, nickel, cobalt, and REEs.
- Centre-State Coordination:** Provides a comparative tool for rationalising royalty sharing and district mineral fund utilisation.

Challenges

- Regulatory Overlap:** Delays due to multi-agency jurisdiction (MoEFCC, MoM, State departments).
- Environmental Trade-offs:** Balancing mining growth with biodiversity protection.
- Technology Gap:** Limited adoption of automation and real-time monitoring in smaller states.
- Human Resource Deficit:** Lack of trained mining engineers and geologists in public sector cadres.

Government's Forward Steps

- Launch of National Mining Data Repository (NMDR 2.0) with 3D geological mapping.
- Integration with PARIVESH 3.0 portal for single-window environmental clearance.

- Capacity-building workshops with Coal Controller's Organisation (CCO) and GSI for state departments.
- Alignment of SMRI with District Mineral Foundation (DMF) dashboards for social welfare impact.

Way Forward

- Encourage public-private partnerships (PPP) in mineral exploration.
- Introduce Green Mining Certification to reward low-carbon practices.
- Establish Centre for Sustainable Mining Practices (CSMP) under NITI Aayog.
- Integrate AI-based monitoring for illegal mining detection.
- Expand the index to include marine and deep-sea mining readiness.

Prelims Connect

- SMRI: Framework by Ministry of Mines and NITI Aayog.
- National Mineral Policy 2019: Advocates sustainable, technology-driven mining.
- Critical Minerals Mission 2024: Targets self-reliance in 30 key minerals including lithium and REEs.
- DMF (District Mineral Foundation): Funds welfare in mining-affected regions.
- GSI: Geological Survey of India—exploration and resource mapping agency.

Mains Connect

"Resource-rich India must also become resource-responsible." Examine how the State Mining Readiness Index can transform India's mineral governance towards sustainability and competitiveness.

Prelims Practice Question

Q. With reference to the State Mining Readiness Index (SMRI) 2025, consider the following statements:

- It has been developed by the Ministry of Mines in collaboration with NITI Aayog and the Indian Bureau of Mines.
- It ranks states on the basis of ease of doing business only.
- Odisha and Gujarat were ranked among the top performers in the 2025 edition.
- It also evaluates environmental and social parameters linked to Sustainable Development Goals.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: SMRI is a multi-dimensional framework beyond ease of doing business, including sustainability and technology readiness.

Raising the Bar: How the New Schedule M Norms Aim to Rebuild India's Pharma Credibility

Why in News

The Ministry of Health and Family Welfare (MoHFW) notified revised Schedule M Norms under the Drugs and Cosmetics Rules, 1945, strengthening Good Manufacturing Practices (GMP) across India's pharmaceutical and cosmetic manufacturing units.

These norms, updated after nearly two decades, mandate enhanced quality-management systems, self-inspection protocols, data integrity, and environmental safeguards, aiming to restore confidence in "Made-in-India Medicines" following repeated global quality concerns.

Background

India is the world's third-largest producer of medicines by volume and supplies nearly 60 per cent of global vaccine demand.

However, incidents of substandard exports and WHO alerts in 2022–24 dented India's image as the 'pharmacy of the world'.

The revised Schedule M aligns Indian GMP standards with those of the World Health Organization (WHO) and the US FDA, ensuring uniform quality across 10,500+ licensed units, especially MSME-dominated clusters.

Key Provisions of the Revised Schedule M

Focus Area	New Mandate (2025)
Quality Management System (QMS)	Mandatory QMS covering all production stages; appointment of a Qualified Person (QP) for batch release.
Data Integrity & Documentation	Electronic records, real-time batch monitoring, tamper-proof audit trails.
Self-Inspection & Change Control	Annual internal audits with corrective action plans ("CAPA").
Facilities & Equipment	Clean rooms, HVAC systems, and contamination-control protocols compulsory.
Training & Personnel Hygiene	Regular competency assessments and GMP certification for technical staff.
Environmental Control	Mandatory effluent treatment and waste-disposal standards linked to CPCB guidelines.

Significance

- Global Market Access:** Aligns India's pharma exports with WHO GMP, US FDA, and EU standards—key for sustaining its \$27-billion export market.
- Consumer Safety and Trust:** Minimises risks of contaminated or ineffective drugs through traceability and validation systems.

- MSME Upgradation Drive:** Government has announced financial support and technical hand-holding to small units for upgrading facilities within the 24-month transition period.
- Ease of Compliance through Digitalisation:** Introduction of e-BMR (Batch Manufacturing Records) and online GMP audits to cut inspection delays.
- Environmental Accountability:** Integrates "green chemistry" and energy-efficient production targets within pharma industrial clusters.

Challenges

- Cost Burden:** MSMEs may face cost escalation of ₹3–5 crore per unit for upgradation.
- Inspection Capacity:** Only 2,000 drug inspectors for 10,000 units nationwide.
- Fragmented Implementation:** Quality compliance differs across states.
- Supply Disruptions:** Temporary shutdowns for retrofitting facilities may affect generic availability.

Way Forward

- Pharma Quality Upgradation Fund for MSMEs under SIDBI.
- Central Digital Portal for self-certification and audit tracking.
- Global Mutual Recognition Agreements (MRA) to avoid duplicate inspections.
- Public Transparency: Make inspection reports public to strengthen accountability.
- Skill Development: Launch a national GMP academy under Pharma Skill Council.

Prelims Connect

- Schedule M:** Prescribes GMP requirements under the Drugs and Cosmetics Rules, 1945.
- Authority:** Central Drugs Standard Control Organisation (CDSCO).
- Transition Period:** 24 months for existing units.
- WHO GMP vs Indian GMP:** The 2025 revision aligns Indian standards with WHO's Annex 2 guidelines.

Mains Connect

"India's pharmaceutical strength lies not only in quantity but in credibility." Critically evaluate the impact of the 2025 Schedule M Norms on India's drug export competitiveness and public health standards.

Prelims Practice Question

- Q. With reference to the revised Schedule M Norms (2025), consider the following statements:
- They apply only to new pharmaceutical manufacturing units established after 2025.
 - They mandate the appointment of a Qualified Person responsible for batch release.

3. They introduce electronic documentation and data integrity systems for manufacturing records.
4. They are issued under the National Medical Devices Policy 2023.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 2 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: They apply to all licensed units (new and existing) under the Drugs and Cosmetics Rules, 1945.

Shram Shakti Niti 2025: Crafting a Fair and Future-Ready Labour Landscape for India

Why in News

The Ministry of Labour and Employment has released the Draft National Labour and Employment Policy (NLEP) — titled Shram Shakti Niti 2025 — aimed at modernising India's workforce governance, social protection, and employment generation frameworks in line with changing work patterns.

This is the first comprehensive labour policy since independence, integrating the Code-based reforms (2020–24), the gig and platform economy, and gender-inclusive workforce participation.

Background

India's labour market is undergoing a historic transformation.

While the economy grows at over 6.5%, the employment elasticity has declined, and nearly 80% of workers remain in the informal sector.

Past policies focused primarily on industrial labour; Shram Shakti Niti 2025 broadens the lens to cover formal, informal, gig, and migrant workers within one unified policy framework.

It also operationalises Article 39 (Directive Principles) and aligns India's labour standards with ILO Conventions and Sustainable Development Goal 8 (Decent Work and Economic Growth).

Key Pillars of Shram Shakti Niti 2025

Pillar	Focus Area	Major Initiatives Proposed
1. Employment Generation	Labour-intensive sectors, MSMEs, green jobs	National Employment Strategy Framework (NESF) and Urban Employment Guarantee Scheme
2. Workforce Formalisation	Integration of informal and gig workers	Expansion of e-SHRAM to include platform workers and freelancers

3. Social Security	Universal protection and portability	Unified Social Security Account (USSA) linked to Aadhaar and UAN
4. Gender and Inclusivity	Female participation and workplace safety	Flexible work policies, maternity support, crèche incentives
5. Skills and Productivity	Demand-driven skilling ecosystem	Skill India 2.0 aligned with Industry 4.0 standards
6. Industrial Relations	Simplification and digitisation	Single-window grievance and collective bargaining dashboard
7. Labour Governance Digitisation	Paperless inspections and compliance	National Labour Compliance Grid (NLCG)

Significance

1. **Towards Universal Labour Inclusion:** Extends protection to gig, home-based, and self-employed workers, previously excluded from state welfare systems.
2. **Gender and Youth Empowerment:** Incentivises employers for gender-balanced workplaces; expands Maternity Benefit (Amendment) Act implementation.
3. **Alignment with Economic Strategy:** Supports Make in India 2.0, Green Employment Mission, and Digital India through integrated manpower planning.
4. **Technology-Driven Labour Administration:** Uses AI-enabled inspection tools and data from e-SHRAM and EPFO to improve compliance transparency.
5. **Labour Policy as Economic Policy:** Recognises labour reforms as drivers of productivity and equitable growth, not merely welfare mechanisms.

Challenges

- Implementation Coordination: Labour being on the Concurrent List requires centre–state alignment.
- Informality Depth: Transitioning 380 million informal workers into the formal system will be complex.
- Financial Sustainability: Ensuring contributory social security for gig workers without burdening MSMEs.
- Data Accuracy: e-SHRAM registration quality and duplication issues.
- Worker Awareness: Low literacy and lack of digital access among unorganised workers.

Way Forward

- Tripartite Consensus: Continuous dialogue between government, employers, and unions.
- Incentivised Formalisation: Tax and credit benefits for MSMEs employing registered informal workers.
- State-Specific Labour Missions: Regional variations in employment and wages to be addressed locally.

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- Portable Benefits: Seamless social protection through One Nation, One Labour Card.
- Digital Literacy Campaign: For workers to access entitlements via mobile platforms.

Prelims Connect

- Article 39: Directive Principles on equal pay and worker welfare.
- e-SHRAM: National database for unorganised workers, launched 2021.
- UAN: Universal Account Number under EPFO.
- ILO Convention 102: Minimum Standards of Social Security.
- Labour Codes: Wage Code, Social Security Code, Occupational Safety Code, Industrial Relations Code.

Mains Connect

"Shram Shakti Niti 2025 marks a shift from protectionism to empowerment." Discuss how the policy aims to balance flexibility with fairness in India's evolving labour ecosystem.

Prelims Practice Question

Q. With reference to the Draft National Labour and Employment Policy (Shram Shakti Niti 2025), consider the following statements:

1. It aims to extend social security benefits to gig and platform workers.
2. It mandates a fixed national minimum wage across all sectors.
3. It proposes integration of informal workers into the e-SHRAM database.
4. It seeks to establish a National Employment Strategy Framework.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The policy promotes flexible wage-setting with sectoral norms; no fixed universal minimum wage is proposed.

Powering Rural Prosperity: How PM-KUSUM is Driving India's Solar Revolution from the Ground Up

Why in News

The Ministry of New and Renewable Energy (MNRE) announced that over 60 lakh farmers have benefited under the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), marking a major milestone in India's rural energy transformation.

With solar capacity installations under the scheme crossing 15 GW in 2025, the programme is being hailed as the world's largest decentralised renewable energy initiative for the agricultural sector.

Background

Launched in 2019, PM-KUSUM aims to de-dieselise Indian agriculture and ensure energy security for farmers through solar-powered irrigation systems and decentralised generation units.

The scheme aligns with India's Panchamrit commitments at COP26 and contributes to the target of 500 GW of non-fossil fuel capacity by 2030.

It operates through three components that collectively link energy access, income generation, and environmental sustainability.

Structure of PM-KUSUM

Component	Objective	Targets / Mechanisms
Component A	Installation of grid-connected solar and other renewable power plants (up to 2 MW) on barren/fallow lands.	Target: 10 GW
Component B	Standalone solar-powered irrigation pumps (off-grid).	Target: 20 lakh pumps
Component C	Solarisation of existing grid-connected pumps.	Target: 15 lakh pumps

Achievements (as of 2025)

- 15 GW installed capacity across 27 states.
- Over 35 lakh solar pumps deployed (off-grid + on-grid).
- Savings: 6 billion litres of diesel annually.
- Emission Reduction: ~15 million tonnes of CO₂ avoided each year.
- DISCOM Benefits: Reduced subsidy burden on agricultural power supply.

Significance

1. **Energy Independence for Farmers:** Farmers no longer depend on erratic grid supply or costly diesel—solarisation ensures 24×7 reliable power.
2. **Doubling Farm Income:** Through Component-A and C, farmers sell surplus solar energy to DISCOMs at ₹3–₹3.50/unit, adding a new "income crop" to their fields.
3. **Rural Energy Transition:** Decentralised solar generation reduces transmission losses and strengthens rural grid resilience.
4. **Water-Energy-Food Nexus:** Encourages efficient irrigation, reducing over-extraction of groundwater through smart metering.
5. **Women Empowerment:** In several states (e.g., Rajasthan, Maharashtra), women's self-help groups (SHGs) manage community solar pumps, integrating gender inclusion with clean energy.

Challenges

- DISCOM Delays: Payment backlogs discourage farmer participation.
- Land Leasing Constraints: Bureaucratic hurdles in using barren land for solar installations.
- Capital Cost: Upfront expenses (~₹3 lakh/pump) deter small farmers despite subsidy.

- Maintenance & Technical Support: Limited local capacity for post-installation service.
- Financing Bottlenecks: Bank hesitancy in lending for distributed renewable systems.

Government's New Measures (2024–25)

- Viability Gap Funding (VGF) extended for Component A (up to 35%).
- PM-KUSUM 2.0 introduced with target extension to 2030 and 50 GW capacity.
- Integration with AgriStack: Solarisation data linked with land records for credit access.
- Unified Payment Platform: DISCOM payment monitoring through National Open Access Registry (NOAR).

Way Forward

- Streamline farmer–DISCOM contracts through a single national portal.
- Promote community-owned solar cooperatives for collective generation.
- Integrate PM-KUSUM with PM Matsya Sampada and PM Krishi Sinchai Yojanas.
- Establish Solar Kendra Clusters for maintenance and training.
- Introduce Green Bonds for Agriculture Energy to mobilise private investment.

Prelims Connect

- Launched: 2019 by MNRE.
- Aim: Solarisation of irrigation pumps and decentralised generation.
- Target (PM-KUSUM 2.0): 50 GW by 2030.
- Agencies: MNRE, State Nodal Agencies, DISCOMs.
- Funding Ratio: 60:30:10 (Centre: State: Farmer).

Mains Connect

"PM-KUSUM symbolises the convergence of climate action, farmer welfare, and energy security." Discuss how decentralised solarisation can redefine rural resilience in India.

Prelims Practice Question

- Q. With reference to the PM-KUSUM Scheme, consider the following statements:
1. It aims to replace diesel irrigation pumps with solar-powered systems.
 2. Farmers can sell surplus solar power generated on their land to distribution companies.
 3. The scheme is implemented by the Ministry of Power.
 4. The Centre provides 100% subsidy for installation of off-grid solar pumps.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 1, 2 and 4 only
(c) 1 and 3 only (d) 2, 3 and 4 only

Answer: (a)

Explanation: The scheme is implemented by MNRE, not the Ministry of Power; subsidies are shared (60:30:10 ratio).

SOCIETY

Reimagining Cities: A Roadmap for Sustainable Urbanisation in India

Why in News

India's urban population is projected to reach 600 million by 2036, adding nearly 40 crore new city dwellers within two decades.

Yet, the Comptroller and Auditor General (CAG) and the NITI Aayog's India Urban Governance Index 2025 warn that India's urban planning remains largely confined to land-use and infrastructure planning, neglecting sustainability, inclusivity, and resilience.

This has renewed the call for a "National Urbanisation Policy Framework 2.0", grounded in sustainability and participatory governance.

Background

Urbanisation in India has historically followed a reactive rather than proactive model—cities expand faster than their governance systems.

Out of India's 4,000+ statutory towns, fewer than 60 have active master plans updated after 2015.

This mismatch between growth and governance has led to sprawl, congestion, informal housing, and ecological degradation.

Global frameworks like the UN Habitat's New Urban Agenda (2016) and SDG 11 (Sustainable Cities and Communities) now guide India's shift towards integrated urban ecosystems that balance growth with liveability.

Key Dimensions of Sustainable Urbanisation

1. **Beyond Land-Use: The 4P Urban Paradigm:** India must move from "Plan–Permit–Populate–Pollute" to "People–Planet–Participation–Productivity". Urban planning must integrate mobility, energy, waste, housing, and ecology into one spatial framework.
2. **Resilient Infrastructure:** Urban flooding in Delhi, Mumbai, and Chennai highlights the need for blue–green infrastructure—reviving lakes, wetlands, and drainage corridors alongside built assets.
3. **Affordable Urban Housing:** Schemes like PM Awas Yojana (Urban) and SWAMIH Fund must be complemented by rental housing frameworks, micro-housing, and in-situ rehabilitation models for migrant populations.
4. **Decentralised Urban Governance:** The 74th Constitutional Amendment remains underutilised—ULBs (Urban Local Bodies) manage barely 30% of city budgets. Fiscal devolution and city-level data-driven governance are essential.
5. **Smart & Climate-Ready Cities:** Under National Mission on Sustainable Habitat (NMSH) and Smart Cities 2.0, India must integrate AI, IoT, and GIS-based tools for energy efficiency and emission tracking.

- 6. Social and Cultural Sustainability:** Urban growth should not erase cultural identity. Initiatives like HRIDAY (Heritage City Development) and Amrit Sarovar Mission exemplify culture–ecology balance.

Recent Developments (2025)

- National Urban Innovation Stack (NUIS): A digital backbone linking city datasets, property records, and service dashboards.
- Urban Green Transition Fund: Announced under Budget 2025–26 for renewable waste-to-energy projects.
- Model Urban Livability Index: NITI Aayog working with UN-Habitat to benchmark city liveability across 80 indicators.
- Climate-Resilient Urban Mission: Pilot projects launched in Bhubaneswar, Surat, and Indore.

Challenges

- Fragmented Governance: 12+ departments overlap on urban functions.
- Informal Settlements: Nearly 35% of urban dwellers lack secure housing.
- Data Deficit: Inconsistent urban mapping and poor spatial data integration.
- Fiscal Dependence: Cities rely heavily on state transfers; own revenue < 1% of GDP.
- Environmental Stress: Urban India generates 55 million tonnes of waste annually.

Way Forward

- Formulate National Urbanisation Policy 2.0 integrating climate resilience and digital governance.
- Strengthen metropolitan planning committees for regional-scale coordination.
- Mainstream urban commons (water bodies, green cover) into master planning.
- Enable city bonds and municipal green financing.
- Encourage citizen co-creation models through ward sabhas and digital participation tools.

Prelims Connect

- SDG 11: Sustainable Cities and Communities.
- 74th Amendment (1992): Empowered ULBs with 18 functions under the 12th Schedule.
- NMSH: Focus on climate-resilient urban planning.
- HRIDAY: Heritage City Development and Augmentation Yojana.
- CAG Report (2025): Highlighted weak fiscal decentralisation in ULBs.

Mains Connect

"India's urbanisation is inevitable; sustainable urbanisation is optional." Discuss how India can move beyond land-use planning to build resilient, inclusive, and climate-smart cities.

Prelims Practice Question

- Q. With reference to urban planning in India, consider the following statements:

1. The 74th Constitutional Amendment mandates the constitution of Metropolitan Planning Committees in every metropolitan area.
2. The National Mission on Sustainable Habitat focuses exclusively on rural housing.
3. The HRIDAY scheme aims to promote heritage-based urban development.
4. Urban Local Bodies in India generate more than 5% of the national GDP.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: NMSH focuses on urban habitat sustainability; ULB contribution to GDP remains below 1%.

The Six-Pocket Syndrome: The New Face of Consumerism and Childhood in Urban India

Why in News

The National Commission for Protection of Child Rights (NCPCR) recently expressed concern over the growing influence of "Six-Pocket Syndrome" among urban youth—where a single child becomes the focal point of spending for six earning adults (parents and grandparents).

This trend, while economically flattering, poses deep social and psychological implications linked to overconsumption, entitlement, and value dilution among children.

Background

Coined by child psychologists in Japan and now gaining currency in India, the "Six-Pocket Syndrome" describes a demographic pattern of shrinking families and rising disposable incomes.

With fewer children and dual-income households, expenditure on a single child's needs—education, gadgets, entertainment, and luxury—has grown exponentially.

In India, this has coincided with rapid urbanisation, digital exposure, and aspirational consumer culture, creating a generation of children more connected globally but sometimes detached emotionally and socially.

Understanding the Syndrome

Pocket Source	Relationship	Contribution to Spending
Pocket 1–2	Parents	Primary funding for lifestyle, gadgets, education
Pocket 3–4	Maternal Grandparents	Gifts, luxury, and emotional spending
Pocket 5–6	Paternal Grandparents	Ritual, cultural, and festival expenditure

The combined result — a surplus of care, cash, and convenience — often leads to material comfort without emotional balance.

Social and Psychological Implications

- 1. Rise of Material Identity:** Children equate love and success with possessions, fostering brand dependency and social comparison. Advertising and social media amplify this cycle through targeted marketing.
- 2. Decline of Emotional Resilience:** Excessive gratification reduces tolerance for failure and discomfort, creating what psychologists call a "comfort trap generation."
- 3. Erosion of Family Value Hierarchies:** Intergenerational financial support transforms into expectation-based relationships, weakening traditional Indian values of restraint and gratitude.
- 4. Child Rights Paradox:** While material rights (to play, study, travel) expand, emotional and developmental rights—to empathy, discipline, and community—often shrink.
- 5. Impact on Mental Health:** According to NIMHANS (2024), urban teens show a 25% rise in anxiety linked to peer lifestyle pressures—fuelled by digital consumerism and competitive schooling environments.

Constitutional and Legal Context

- Article 39(f) of the Constitution directs the State to ensure children grow in freedom and dignity.
- UN Convention on the Rights of the Child (UNCRC, 1989) emphasises balanced development—material, emotional, and moral.
- NCPCR (2005) now integrates media literacy modules under its Parvarish Project to sensitise families about consumerist influence.

Cultural Lens

In traditional Indian culture, restraint (sanyam) and balance (madhyam marg) were considered the essence of upbringing.

The syndrome thus reflects not only economic change but a cultural shift from contentment to consumption.

Challenges

- Digital Advertising:** Algorithmic targeting of children violates privacy and induces psychological dependence.
- Parenting Gaps:** Working parents compensate absence with excessive indulgence.
- Peer Pressure:** Social media normalises "status competition" through influencer culture.
- Lack of Media Literacy:** Schools rarely teach value discernment in consumption choices.

Way Forward

- Family Dialogue:** Encourage shared financial and emotional decision-making within households.

- Value Education:** Integrate ethics and empathy modules in NEP 2020 curriculum.
- Responsible Advertising:** Enforce ASCI and NCPCR guidelines on child-targeted marketing.
- Community Engagement:** Promote voluntary experiences and social service for holistic development.
- Digital Mindfulness Campaigns:** Teach conscious online behaviour under "Cyber Swachhta" initiatives.

Prelims Connect

- UNCRC (1989): International treaty protecting children's rights.
- NCPCR: Statutory body under the Commission for Protection of Child Rights Act, 2005.
- Article 39(f): Directive Principle ensuring protection of children's dignity.
- ASCI Code (2022): Advertising norms restricting direct marketing to minors.

Mains Connect

"India's consumer revolution must not create an emotionally bankrupt generation." Discuss the social and ethical dimensions of the Six-Pocket Syndrome in shaping childhood values in modern India.

Prelims Practice Question

- Q. With reference to the "Six-Pocket Syndrome," consider the following statements:
- It refers to the increasing influence of multiple income sources on a single child's lifestyle.
 - The National Commission for Protection of Child Rights (NCPCR) has launched awareness drives on this issue.
 - It is recognised under the United Nations Convention on the Rights of the Child (UNCRC) as a global child protection concern.
 - It primarily affects rural multi-sibling households.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 3 only (d) 1 and 4 only

Answer: (a)

Explanation: It primarily affects urban single-child households; while UNCRC covers balanced development, it doesn't specifically use the term "Six-Pocket Syndrome."

India's Vital Statistics Report 2023: Mapping the Demographic and Health Pulse of the Nation

Why in News

The Registrar General of India (RGI) released the "Vital Statistics of India Based on the Civil Registration System (CRS) Report 2023", offering comprehensive data on births, deaths, and infant mortality trends across the country.

The report highlights near-universal birth registration, improved death reporting, and the continued narrowing of India's gender gap at birth — key indicators for tracking India's progress toward SDG 3 (Health and Well-being) and SDG 5 (Gender Equality).

Background

The Civil Registration System (CRS) is India's legal and statistical framework for recording vital events under the Registration of Births and Deaths Act, 1969.

Administered by the Office of the Registrar General of India (RGI), it ensures uniform recording across states and serves as the basis for health, demographic, and policy planning.

Over the past decade, CRS coverage has expanded with the help of Aadhaar-based digital registration, integration with health management systems, and state-level innovations such as e-registries in Kerala, Gujarat, and Telangana.

Key Findings of the 2023 Report

Indicator	2022	2023	Trend Observation /
Birth Registration	92.7%	94.9%	Highest-ever coverage; Kerala, Maharashtra, Tamil Nadu top performers
Death Registration	87.8%	89.6%	Improved coverage, but rural underreporting persists
Infant Mortality Rate (IMR)	28 per 1,000 live births	26 per 1,000	Decline continues; better neonatal care and institutional delivery
Sex Ratio at Birth (SRB)	907	912	Marginal improvement; Haryana, Gujarat show significant gains
Stillbirth Registration	—	Introduced in 2023	Pilot inclusion in 9 states under amended CRS protocols
Top States (Overall Performance)	Kerala, Tamil Nadu, Maharashtra	Consistent leaders in digital registration and accuracy	

Highlights

- Digital Revolution in Registration:** Integration with CoWIN, eHospital, and e-SHRAM portals has digitised birth-death records, enabling real-time health monitoring and cross-verification.
- Health System Linkages:** CRS data now informs National Family Health Survey (NFHS-6) projections and Ayushman Bharat Health Account (ABHA) enrolments.

- Gender Sensitivity in Data:** Improved reporting under schemes like Beti Bachao Beti Padhao has helped address SRB disparities, particularly in north-western India.
- Mortality Mapping:** COVID-era improvements in death reporting systems have continued, with 14 states now achieving 100% medical certification of cause of death (MCCD) in urban areas.

Significance

- Policy Planning Backbone:** CRS data forms the empirical base for population projections, health resource allocation, and disaster preparedness.
- Evidence-Based Governance:** Facilitates targeted interventions for maternal and child health programmes such as Janani Suraksha Yojana and LaQshya.
- Gender Equity Tool:** Helps track the real-time effects of gender-based interventions and socio-cultural reforms.
- International Benchmark:** CRS aligns India's demographic monitoring with UN Statistical Division standards, reducing dependence on periodic sample surveys.

Challenges

- Rural-Urban Disparities:** Remote districts lag in death registration, particularly among women and the elderly.
- Institutional Gaps:** Coordination between health departments and registrar offices remains uneven.
- Capacity Constraints:** Shortage of registrars and inadequate data verification training.
- Privacy Concerns:** Linking health and demographic databases requires strong data protection protocols.

Way Forward

- Implement CRS Modernisation Mission 2.0 with AI-assisted verification and geotagging.
- Mandate online cause-of-death certification across all hospitals.
- Integrate CRS with the National Digital Health Mission (NDHM) for seamless policy linkage.
- Conduct annual data quality audits with support from NITI Aayog.
- Launch awareness drives to improve rural registration and reduce gender gaps.

Prelims Connect

- Legal Basis:** Registration of Births and Deaths Act, 1969.
- Nodal Agency:** Registrar General of India (RGI), Ministry of Home Affairs.
- New Initiative:** Stillbirth inclusion (2023).
- Linked Missions:** Ayushman Bharat, NDHM, NFHS.
- SDG Targets:** SDG 3.2 (Reduce infant mortality), SDG 16.9 (Legal identity for all).

Mains Connect

"Reliable vital statistics are the heartbeat of governance." Evaluate how the Civil Registration System strengthens India's demographic planning, health policy, and gender equity efforts.

Prelims Practice Question

Q. With reference to the Civil Registration System (CRS) in India, consider the following statements:

1. It operates under the Ministry of Health and Family Welfare.
2. Birth and death registration are legally mandatory under the Registration of Births and Deaths Act, 1969.
3. Stillbirth registration has been introduced in select states under the 2023 CRS update.
4. The CRS data forms part of the National Family Health Survey.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 4 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: CRS is administered by the Registrar General under the Ministry of Home Affairs, not Health; NFHS uses CRS data as a reference but not as a component dataset.

The Roadmap for a Demographic Mission in India: From Population Control to Population Management

Why in News

Recent debates on India's demographic trajectory—including declining fertility rates, ageing concerns, and workforce transitions—have reignited discussions around a "National Demographic Mission".

Proposes a holistic demographic governance framework, moving beyond population control to sustainable population management and human capital development.

Background

India's demographic story is at an inflection point.

According to the Sample Registration System (SRS) 2023, India's Total Fertility Rate (TFR) has declined to 1.99, below the replacement level (2.1).

Yet, the population continues to rise due to population momentum — a legacy effect of past high fertility.

By 2047, India will face the dual challenge of managing a shrinking youth base and a rapidly expanding elderly population, with over 19% aged 60+.

Hence, the debate is no longer about controlling numbers but optimising demographic potential through education, health, and labour policies.

Key Dimensions of the Demographic Mission

1. **From Control to Capability:** The focus must shift from numerical targets (birth reduction) to human capability building—expanding access to education, nutrition, and healthcare. This aligns with Amartya Sen's capability approach, which views development as the expansion of freedoms, not just fertility decline.
2. **Regional Demographic Diversity**
India's demographic map is split:
 - Southern & Western States (Kerala, Tamil Nadu, Maharashtra) show ageing and workforce shortages.
 - Northern States (Bihar, UP, Madhya Pradesh) still experience high fertility and dependency ratios.
 - A federal demographic framework is needed to balance workforce supply and social spending across states.
3. **Women-Centric Development:** Gender empowerment remains the most effective demographic stabiliser. According to NFHS-5, fertility rates correlate inversely with female literacy and employment. Expanding reproductive rights, safe contraception, and workplace equality can ensure sustainable demographic equilibrium.
4. **Productivity Dividend:** India's demographic dividend will persist until 2040, but only if matched by job creation and skill alignment. Schemes like PM Vishwakarma Yojana and Skill India 2.0 must target youth in high-growth sectors — renewable energy, healthcare, and digital services.
5. **Healthy Ageing:** With longevity increasing, the demographic mission must include elderly care, pension reforms, and geriatric health under Ayushman Bharat Digital Mission (ABDM).

Recent Policy Developments (2024–25)

- Population Research and Policy Institute (PRPI) proposed under NITI Aayog for integrated demographic modelling.
- National Elderly Health and Nutrition Mission (NEHNM) launched to strengthen old-age healthcare.
- National Family Planning Programme 2.0 revised its focus from "limiting" to "spacing and empowerment."
- Digital Fertility Dashboard launched by MoHFW to monitor reproductive health trends across states.

Significance

1. **Holistic Demographic Governance:** Integrates population, health, education, labour, and gender policies into one coordinated framework.
2. **Economic Advantage:** A well-nurtured workforce contributes to higher productivity and sustainable growth.

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3. **Social Cohesion:** Manages generational imbalances between ageing states and youthful ones through inter-state workforce planning.
4. **Sustainable Future:** Links demographic planning with climate resilience, urbanisation, and resource management.

Challenges

- **Workforce Mismatch:** Educated youth remain unemployable due to skill–industry disconnect.
- **Health Inequality:** High maternal mortality and malnutrition persist in poorer states.
- **Elderly Vulnerability:** Pension and health coverage inadequate for the 150 million elderly by 2036.
- **Gender Disparities:** Labour force participation of women remains below 25%.

Way Forward

- Launch National Demographic Mission (NDM) under NITI Aayog to coordinate centre–state efforts.
- Create Demographic Transition Index (DTI) to measure readiness across states.
- Expand care economy infrastructure (elderly homes, health workers, digital caregivers).
- Promote population literacy through school curricula and community awareness.
- Strengthen inter-state labour mobility compacts for equitable workforce distribution.

Prelims Connect

- TFR: 1.99 (SRS 2023).
- NFHS-5: Nationwide health and demographic survey.
- Population Momentum: Continued growth despite fertility decline.
- Demographic Dividend Period: Approx. 2020–2040.
- National Family Planning Programme (1952): World's first government-led fertility control initiative.

Mains Connect

"India's demographic debate must move from numbers to nurture." Discuss the need for a National Demographic Mission to ensure balanced, equitable, and sustainable population management.

Prelims Practice Question

- Q. With reference to India's demographic trends, consider the following statements:
1. India's Total Fertility Rate has fallen below the replacement level.
 2. Population momentum refers to continued population growth despite replacement-level fertility.
 3. The demographic dividend period in India is projected to extend until 2050.

4. The National Family Planning Programme was launched after Independence in 1965.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 1, 2 and 3 only
(c) 2, 3 and 4 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: India's TFR is below replacement; dividend likely until 2040; Family Planning Programme launched in 1952, not 1965.

GEOGRAPHY

Baratang Island – A Fragile Gem of the Andamans**Why in News**

Baratang Island, located between Middle and South Andaman, has recently been in the news following a report by the National Centre for Sustainable Coastal Management (NCSCM) highlighting the ecological stress caused by unregulated tourism, mangrove clearance, and rising coastal erosion. The Andaman & Nicobar Administration is drafting stricter eco-tourism norms under the Island Coastal Regulation Zone (ICRZ) Notification, 2019.

Background

Part of the Great Andaman group, Baratang Island is geologically unique for hosting India's only active mud volcanoes, intricate limestone caves, and dense mangrove ecosystems.

Situated near the Indian–Burma plate boundary, it lies in a seismically sensitive zone of the Andaman–Nicobar archipelago. The island also borders the Jarawa Tribal Reserve, inhabited by one of the few remaining indigenous communities of the Andamans giving it ecological, geological, and anthropological significance.

Key Geographical Features

- **Mud Volcanoes:** Caused by the expulsion of gases and liquid mud from subsurface pressurised sediments; active since the 2004 tsunami.
- **Limestone Caves:** Karst formations created through carbonic acid weathering, representing ancient sedimentary deposition.
- **Mangroves:** Found along the Nilambur–Baratang creek; act as carbon sinks and natural barriers against storm surges.
- **Biodiversity:** Habitat of saltwater crocodiles, Andaman wild pigs, and endemic birds such as the Andaman woodpecker and kingfisher.

Ecological Concerns

Tourist footfall has tripled in the last decade, straining fragile mangroves and karst systems.

Expansion of the Andaman Trunk Road has also increased intrusion into Jarawa tribal areas. Rising sea levels and salinity intrusion further threaten mangrove health and soil fertility.

Policy and Conservation Measures

- **Island Coastal Regulation Zone (ICRZ) 2019:** Categorises Baratang as an Ecologically Sensitive Area (ESA) with restricted construction.
- **Integrated Island Management Plan (IIMP):** Promotes low-impact, community-led tourism.
- **Society for Andaman and Nicobar Ecology (SANE):** Advocates mangrove reforestation and awareness-based tourism.
- **Blue Economy Vision:** Encourages nature-compatible livelihoods such as sustainable fishing and heritage-based eco-tourism.

Prelims Connect

- **Location:** Between Middle and South Andaman; part of North & Middle Andaman district.
- **Unique Features:** Mud volcanoes (India's only active site), limestone caves, mangroves.
- **Protection:** ICRZ 2019; falls under CRZ-IV for island ecosystems.
- **Tribal Zone:** Jarawa Reserve under Andaman and Nicobar (Protection of Aboriginal Tribes) Regulation, 1956.

Mains Connect

Discuss how eco-tourism in fragile island ecosystems like the Andamans can be aligned with ecological conservation and community welfare.

Prelims Practice Question

Q. With reference to Baratang Island, consider the following statements:

1. It is part of the Great Andaman group and contains India's only active mud volcanoes.
2. The island is located on the boundary between the Indian and Eurasian plates.
3. The Jarawa Tribal Reserve lies adjacent to Baratang Island.
4. It falls under the provisions of the Island Coastal Regulation Zone (ICRZ), 2019.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Baratang lies near the Indian–Burma (not Eurasian) plate boundary; all other statements are correct.

Balasan River – North Bengal's Changing Waterscape

Why in News

Flash floods in the Balasan River caused heavy damage to infrastructure near Siliguri and Darjeeling, washing away roads and bridges. Experts from the Central Water Commission (CWC) attributed the event to unregulated sand mining, hill deforestation, and erratic rainfall triggered by shifting monsoon dynamics and localised cloudbursts.

Background

The Balasan River originates from the Jorebunglow Range in the Darjeeling Himalayas at an elevation of about 2,400 metres. Flowing southwards through Matigara and Naxalbari, it finally joins the Mahananda River, a tributary of the Ganga. The Balasan supports irrigation, tea gardens, and local fisheries in the foothill plains of North Bengal.

Key Geographical Features

- **Catchment Dynamics:** Fed by monsoonal rainfall and Himalayan springs, Balasan's discharge varies sharply between wet and dry seasons.
- **Geomorphology:** Exhibits braided channels, shifting courses, and heavy sediment transport — typical of youthful Himalayan foothill rivers.
- **Soil & Land Use:** The alluvial soil in the Balasan basin supports extensive tea plantations, paddy cultivation, and urban settlements near Siliguri.
- **Tributary Linkages:** Forms part of the Teesta–Mahananda sub-basin, influencing groundwater recharge and local aquifers.

Environmental & Human Concerns

1. **Sand and Boulder Mining:** Continuous extraction along the lower Balasan has deepened riverbeds, destabilised banks, and damaged the riparian vegetation crucial for flood control.
2. **Encroachment:** Rapid urbanisation around Siliguri, especially near Matigara Bridge, has narrowed the river's floodplain.
3. **Deforestation in Upper Catchment:** Landslides in tea estates and road-cutting increase siltation.
4. **Changing Rainfall Pattern:** IMD data show a 17% rise in intense rainfall events in Darjeeling over the last decade, amplifying flood and erosion hazards.

Policy Framework & Interventions

- **Jal Shakti Abhiyan (Catch the Rain):** Encourages check-dam construction and reforestation in upper catchments.
- **Teesta Flood Management Plan:** Incorporates Balasan and smaller tributaries under an integrated flood control strategy.
- **District Mining Plans:** Being revised to regulate mechanised extraction using satellite mapping.

Prelims Connect

- **Origin:** Jorebunglow Range, Darjeeling Himalayas.

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- Confluence: Joins the Mahananda River, which flows into the Ganga through Bangladesh's Padma system.
- State: Entire course lies in West Bengal.
- Nearby Rivers: Teesta, Jaldhaka, and Mahananda — all part of the Brahmaputra–Ganga interfluvial system.

Mains Connect

Examine how small Himalayan rivers like Balasun illustrate the link between land-use change and flood vulnerability in India's mountain regions.

Prelims Practice Question

Q. With reference to the Balasun River, consider the following statements:

1. It originates in the Jorebunglow Range of the Eastern Himalayas and drains into the Mahananda River.
2. It flows through both West Bengal and Sikkim.
3. The Balasun basin forms a part of the Teesta–Mahananda sub-basin of the Ganga system.
4. The river exhibits a typical braided channel pattern in its upper course.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The river lies entirely within West Bengal; all other statements are correct.

Cloud Seeding – Artificial Rain**Why in News**

The national capital region undertook its first cloud-seeding trials in late October 2025 in an attempt to induce rainfall and reduce the persistently high air-pollution levels.

Background & Concept

Cloud seeding is a weather-modification technique wherein substances (such as silver iodide, potassium iodide, or liquid CO₂) are dispersed into clouds to promote condensation and precipitation. India's Ministry of Earth Sciences (MoES) via Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) has studied this since 2018–19. Earlier, the Government clarified that large-scale artificial rain programmes are not yet adopted due to uncertainties.

Key Issues & Developments

- The Delhi trial in 2025 is part of a broader pollution-mitigation strategy, targeting rapidly rising PM_{2.5} levels typical of the winter months.
- According to a PIB release, effectiveness depends upon specific cloud structures and atmospheric humidity; in Delhi's cold dry winters those conditions may not always be available.

- Economically, the Delhi government approved 5 trials at an outlay of ₹3.2 crore.
- Scientific debate remains: some experts caution that cloud-seeding addresses symptoms (pollution) rather than root causes (emissions) and may provide only temporary relief.

Government Policy & Global Parallels

- India's National Policy on Cloud Seeding (2012) outlines guidelines for state-level trial programmes.
- Globally, cloud-seeding has been used in the UAE, USA (Western States), China and Australia. Its success rates vary widely and cost-effectiveness remains contested.
- In India, MoES collaborates with IITs and state meteorological departments for pilot studies and long-term monitoring.

Prelims Connect

- CAIPEEX: Model experiment by IITM/Pune to study cloud-aerosol interactions.
- Typical seeding agents: silver iodide, dry ice, salt crystals.
- Key atmospheric requirement: supersaturated clouds, low ambient wind, sufficient humidity.

Mains Connect

"Analyse the role of emerging technologies such as cloud-seeding in pollution and drought mitigation in India. Highlight benefits, limitations and policy safeguards."

Practice Question (Prelims Style)

Q. With reference to cloud seeding, consider the following statements:

1. It involves dispersal of substances into clouds to enhance precipitation.
2. It is explicitly prohibited under India's National Weather Modification Policy of 2014.
3. One of India's pilot cloud-seeding experiments is CAIPEEX.

Which of the above are correct?

- (a) 1 and 3 only (b) 2 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

Answer: (a)

Explanation:

Statement 2 is incorrect, as government has not banned cloud-seeding but stressed scientific assessment.

Sudan – A Nation in Perpetual Transition**Why in News**

Sudan has remained in global focus after the Jeddah peace talks (September 2025) between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF) ended without a breakthrough. India evacuated its remaining

technical personnel under Operation Kaveri II, highlighting continuing insecurity in the Horn of Africa.

Background

Sudan, Africa's third-largest country, lies strategically between the Arab World and Sub-Saharan Africa. It borders Egypt in the north, the Red Sea in the east, South Sudan in the south, and Chad and Libya to the west.

Since the secession of South Sudan (2011), Sudan has faced political instability, military coups, and economic collapse. The latest civil conflict broke out in April 2023 between the SAF led by Gen. Abdel Fattah al-Burhan and the RSF led by Gen. Mohamed Hamdan Dagalo ("Hemedti").

Key Facts and Timeline

- 2019: Long-time ruler Omar al-Bashir toppled after mass protests.
- 2021: Transitional government dissolved in a military coup.
- 2023–25: Civil war between SAF and RSF devastates Khartoum, Darfur and Kordofan.
- 2025: UN estimates > 15 million displaced, 25 million facing food insecurity.
- Peace efforts: Jeddah talks (Saudi Arabia & US mediated) with AU, IGAD, and UN support continue intermittently.

Economic and Geostrategic Dimensions

- Oil & Minerals: Sudan lost 75 % of oil reserves to South Sudan but retains refineries and gold mines.
- The Nile Factor: Upper Nile waters remain vital for agriculture and electricity generation; Sudan is a stakeholder in the Grand Ethiopian Renaissance Dam (GERD) dispute.
- Location: Sits on the Red Sea corridor linking the Suez Canal with the Gulf of Aden a route crucial for global energy flows.
- India–Sudan Relations:
 - Bilateral trade ≈ US \$1 billion (2024–25), primarily agricultural goods and pharmaceuticals.
 - India earlier operated the ONGC Videsh Block 5A in South Sudan before conflict disruption.
 - Sudan is part of India's outreach under the IORA Observer Dialogue and SAGAR vision.

Humanitarian Crisis and International Response

- UN OCHA and World Food Programme warn of "catastrophic famine" by winter 2025.
- WHO reports cholera outbreaks in displaced persons' camps.
- India, through Operation Kaveri II, has evacuated 3,800 citizens and supplied medicines via INS Sumitra. African Union's peacekeeping framework AMISOM+ exploring new mandate for Sudanese theatre.

Prelims Connect

- Capital: Khartoum (administration shifted temporarily to Port Sudan).
- Currency: Sudanese Pound.
- River System: The Blue and White Nile meet at Khartoum to form the Nile.
- Neighbourhood: Bordered by seven countries — Egypt, Libya, Chad, Central African Republic, South Sudan, Ethiopia, Eritrea.
- Regional Group: Member – African Union (AU), Arab League, COMESA, IGAD.

Mains Connect

Analyse the causes and consequences of Sudan's ongoing conflict. How does it impact India's humanitarian and strategic interests in the Horn of Africa?

Prelims Practice Question

Q. With reference to Sudan, consider the following statements:

1. The Blue and White Nile meet at Khartoum.
2. Sudan shares its longest border with Ethiopia.
3. It is a member of both the African Union and the Arab League.
4. The capital has been shifted temporarily to Port Sudan since 2023.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

Answer: (d)

Explanation: Statements 1, 3 and 4 are correct; the longest border is with South Sudan, not Ethiopia.

Indi and Puliyanakudi Limes – India's Emerging GI Fruits

Why in News

The Indi Lime of Karnataka and Puliyanakudi Lime of Tamil Nadu** were granted the Geographical Indication (GI) tag by the Government of India. Aims to promote region-specific citrus varieties, safeguard farmers' rights, and boost exports under India's One District One Product (ODOP) initiative.

Background

India is the world's largest producer of limes and lemons, accounting for about 3 million tonnes annually (FAO, 2024). The Indi Lime from Vijayapura district (North Karnataka) and the Puliyanakudi Lime from Tenkasi district (Tamil Nadu) have long been valued for their strong aroma, thin peel, and high juice content. GI registration was facilitated by the NABARD GI Support Fund and state horticulture departments.

Unique Features

Indi Lime (Karnataka)

- Grown in the black-cotton soils of the semi-arid Deccan plateau.

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- Distinct for its acid-rich flavour (citric acid > 8 %).
- Naturally resistant to leaf-miner pests due to local climatic adaptation.
- Cultivation area $\approx$ 4,000 hectares – supporting over 12,000 farmers.

Puliyankudi Lime (Tamil Nadu)

- Thrives in the loamy alluvial soils of the Western Ghats foothills.
- Known for thin rind, higher vitamin C content, and long shelf-life.
- Forms a key component of Puliyankudi Lemon Festival promoting agri-tourism.

Economic and Policy Significance

- **Export Potential:** Limes from these regions are in demand in the Middle East and Europe; GI status enhances traceability.
- **Processing Linkages:** Supports value-addition through juice, citric acid extraction, and essential oil distillation.
- **Sustainability:** Both regions use micro-irrigation and organic-nutrient management under the PM-KSY Per Drop More Crop scheme.
- **Institutional Support:**
 - Agricultural and Processed Food Products Export Development Authority (APEDA) – branding and export facilitation.
 - GI Registry, Chennai – certification under the Geographical Indications of Goods (Registration and Protection) Act, 1999.

Prelims Connect

- Act: GI of Goods (Registration and Protection) Act, 1999 – administered by DPIIT.
- First GI Tag of India: Darjeeling Tea.
- Other Citrus GIs: Assam Kaji Nemu Lemon and Marathwada Sweet Lime.
- NABARD GI Support: Provides legal aid and branding funds to FPOs and co-ops.

Mains Connect

How do Geographical Indications promote inclusive agricultural development and rural branding in India? Illustrate with examples of Indi and Puliyankudi Limes.

Prelims Practice Question

- Q. With reference to Indi and Puliyankudi Limes, consider the following statements:
1. Both varieties recently received GI status in 2025.
 2. Indi Lime is cultivated in the alluvial soils of Tamil Nadu.
 3. Puliyankudi Lime is known for its thin rind and high vitamin C content.
 4. NABARD played a role in facilitating their GI applications.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Indi Lime (Karnataka) grows on black-cotton soils, not alluvial. Puliyankudi Lime and NABARD support statements are correct.

Taal Volcano – The Pacific's Restless Caldera**Why in News**

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) raised the alert level of Taal Volcano from 1 to 2 following a sharp rise in volcanic tremors, sulphur-dioxide emissions, and ground deformation near Lake Taal. International agencies like the Smithsonian Global Volcanism Program reported visible steam-driven explosions and ash plumes, renewing fears of a repeat of the 2020 eruption that displaced over 3 lakh people.

Background

Located about 60 km south of Manila on the island of Luzon, Taal Volcano is one of the world's smallest but most active volcanoes. It sits within a large caldera filled by Lake Taal, with a smaller island Volcano Island inside the lake containing its main crater.

The site exemplifies the "island-in-a-lake-in-an-island" phenomenon, making it a classic example in physical geography textbooks.

Geological Significance

- **Tectonic Setting:** Part of the Pacific Ring of Fire, where the Philippine Sea Plate subducts beneath the Eurasian Plate.
- **Eruption Type:** Primarily phreatomagmatic steam-driven explosions when magma interacts with water.
- **Crater Lake Chemistry:** The lake's high sulphur content and acidity make it one of the most extreme aquatic environments on Earth.
- **Historic Activity:** Recorded > 30 eruptions since 1572; major ones in 1754, 1911, 1965, and 2020.

Recent Developments

- September 2025: PHIVOLCS recorded > 250 volcanic tremors per day; SO₂ emissions > 10,000 tonnes/day.
- Evacuations ordered for 10 villages within a 7-km radius of Volcano Island.
- The UNESCO Global Geoparks Council proposed inclusion of the Taal Volcanic Landscape for its unique caldera system and biodiversity.
- Philippine authorities integrated real-time satellite monitoring with Japan's JAXA ALOS-3 imagery for early warning.

Global and Indian Relevance

- Serves as a model for studying crater-lake volcanoes similar to Lonar Crater (Maharashtra) and Baratang's mud volcanoes (Andamans).

- India's National Centre for Seismology (NCS) has referenced Taal in comparative studies on volcano-seismic interactions in the Indian Ocean region.
- Highlights the necessity for Disaster Risk Reduction (DRR) cooperation under the BIMSTEC and ASEAN frameworks.

Prelims Connect

- Location: Luzon Island, Philippines (14° N, 121° E).
- Type: Complex volcano with nested caldera.
- Ring of Fire: A chain of > 450 volcanoes surrounding the Pacific Ocean.
- Major Volcanoes on Ring of Fire: Mount Fuji (Japan), Mount Mayon (Philippines), Krakatoa (Indonesia), Mount St. Helens (USA).
- Volcanic Hazards: Ash fall, acid rain, lahars (volcanic mud flows).

Mains Connect

Explain the tectonic and environmental significance of the Taal Volcano. What lessons does it offer for volcanic and seismic disaster preparedness in South and Southeast Asia?

Prelims Practice Question

- Q. With reference to Taal Volcano, consider the following statements:
- It is a part of the Pacific Ring of Fire.
 - It is a shield volcano characterised by gentle lava flows.
 - The recent eruptions are mainly phreatomagmatic in nature.
 - It is located on Luzon Island in the Philippines.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Taal is a complex (stratovolcanic) system, not a shield volcano; it lies on Luzon and its eruptions are phreatomagmatic.

Cyclone Montha – Understanding the Bay's New Climate Reality

Why in News

The India Meteorological Department (IMD) tracked the formation of Cyclone Montha over the central Bay of Bengal. The cyclone intensified rapidly into a Very Severe Cyclonic Storm (VSCS) before making landfall near Odisha's Balasore coast, causing widespread flooding across eastern India. Regional Specialized Meteorological Centre (RSMC), Montha was notable for rapid intensification and double landfall trajectory—both attributed to warming sea-surface temperatures.

Background

Tropical cyclones are intense low-pressure systems forming over warm ocean waters ($\geq 27^\circ\text{C}$) with organized convection and cyclonic wind circulation. The Bay of Bengal accounts for nearly 80 % of India's cyclones, but recent trends show fewer but stronger storms—a sign of climate-induced volatility.

Cyclone Montha formed from a low-pressure area near the Andaman Sea on 3 October 2025, intensified within 36 hours, and made landfall on 8 October near Balasore before crossing into Jharkhand as a deep depression.

Meteorological Highlights

- Category: Very Severe Cyclonic Storm (VSCS)
- Wind Speed: $\approx 130\text{--}145\text{ km/h}$
- Central Pressure: $\approx 965\text{ hPa}$
- Rainfall: IMD reported 280 mm in Odisha and 150 mm in West Bengal within 48 hours.
- Notable Feature: "Rapid Intensification" – temperature anomaly of $+1.5^\circ\text{C}$ in the Bay's upper layer enabled Montha to jump two categories within a day.

Impact and Response

- Massive flooding in Balasore, Bhadrak, and Mayurbhanj districts; over 2 lakh people evacuated.
- National Disaster Response Force (NDRF) deployed 58 teams; zero casualties reported due to timely warning systems.
- Odisha State Disaster Management Authority (OSDMA) credited its "Zero Casualty Protocol", first tested during Cyclone Phailin (2013).
- The Centre sanctioned ₹400 crore under the State Disaster Response Fund (SDRF) for rehabilitation.

Scientific Insights

- Warming of the Bay of Bengal and Arabian Sea is altering cyclogenesis patterns.
- Montha's path resembled Amphan (2020) but intensified faster due to Ocean Heat Content (OHC) above 80 kJ/cm^2 .
- IMD-ISRO collaboration used SCATSAT-2 and INSAT-3D/3DR for real-time wind and moisture mapping, improving forecast accuracy to 95 %.
- WMO identified Montha as a case study for South Asian rapid-intensification phenomena linked to climate change.

Prelims Connect

- Cyclone Naming: By RSMC New Delhi; "Montha" was suggested by Myanmar.
- IMD Classification: Depression $\rightarrow$ Deep Depression $\rightarrow$ Cyclonic Storm ($62\text{--}88\text{ km/h}$) $\rightarrow$ Severe CS ($89\text{--}117\text{ km/h}$) $\rightarrow$ Very Severe CS ($118\text{--}166\text{ km/h}$) $\rightarrow$ Extremely Severe $\rightarrow$ Super Cyclone.
- Odisha Coast: High-vulnerability zone due to shallow bathymetry and funnel-shaped topography.

- ODRAF & OSDMA: Model state-level disaster response systems.

Mains Connect

"Discuss how the increasing frequency of rapid-intensification events like Cyclone Montha reflects the climate vulnerability of India's eastern coast. Suggest long-term mitigation and adaptation strategies."

Prelims Practice Question

- Q. With reference to Tropical Cyclone Montha (2025), consider the following statements:
1. It was named by Myanmar as per WMO ESCAP panel nomenclature.
 2. It originated in the Arabian Sea and made landfall in Gujarat.
 3. The cyclone underwent rapid intensification due to abnormally high sea-surface temperatures in the Bay of Bengal.
 4. Odisha's zero-casualty protocol was activated during the event.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Montha formed in the Bay of Bengal (not the Arabian Sea); named by Myanmar; rapid intensification and zero-casualty protocol are correct.

Kunar River – Hydro-Political Significance in South-Central Asia

Why in News

Discussions resumed between Afghanistan's interim government and Pakistan's Water & Power Development Authority (WAPDA) over sharing the Kunar River waters for the proposed Munda (Mohmand) Dam project. India, through its earlier aid to the Kunar-Kabul basin study, continues to monitor regional hydro-politics due to implications for Indo-Afghan cooperation and Pakistan's downstream water security.

Background

The Kunar River (also known as the Chitral River in its upper reaches) originates from glaciers of the Hindu Kush Mountains near the Broghil Pass in northern Pakistan. It flows west into Afghanistan's Kunar Province, joins the Kabul River near Jalalabad, and ultimately drains into the Indus River in Pakistan.

Length 480 km. It is part of the Indus Basin system and one of the few trans-boundary rivers linking Afghanistan and Pakistan.

Key Geographical and Hydrological Features

- **Source:** Southern slopes of the Hindu Kush, north-western Pakistan.
- **Tributaries:** Pech, Bashgal, and Landai Sind Rivers.

- **Confluence:** Joins the Kabul River about 90 km east of Jalalabad.
- **Flow Characteristics:** Snowmelt-fed; peak discharge during May–August; contributes $\approx 12\text{--}15\%$ of the Kabul River's annual flow.
- **Catchment Importance:** Supports agriculture and hydropower in eastern Afghanistan and north-western Pakistan (Khyber Pakhtunkhwa).

Geopolitical and Economic Significance

- Afghanistan has long proposed a Kunar Multi-Purpose Hydropower Project (1,000 MW) in collaboration with Pakistan to manage shared resources and reduce seasonal flooding.
- Pakistan's construction of the Mohmand (Munda) Dam on the same basin has raised concerns of upstream-downstream imbalance.
- The Kunar-Kabul-Indus linkage gives the river strategic leverage similar to India-China water issues in the Brahmaputra basin.
- For India, past technical cooperation in Kabul River Basin studies (2016–2018) reinforces its interest in regional hydrological stability affecting Indus water inflows.

Environmental Context

- Increasing glacial melt due to climate change in the Hindu Kush-Karakoram-Himalaya (HKKH) region threatens unpredictable flow regimes.
- Unregulated sand mining and deforestation in the Kunar valley have worsened sediment load and flash floods.

Prelims Connect

- Origin: Hindu Kush (Pakistan).
- Countries: Afghanistan and Pakistan.
- Joins: Kabul River → Indus River.
- Major Towns: Chitral (Pakistan), Asadabad and Jalalabad (Afghanistan).
- Projects: Mohmand Dam (Pakistan), proposed Kunar Hydro Project (Afghanistan).

Mains Connect

Discuss the strategic and environmental significance of the Kunar River basin in Afghanistan-Pakistan relations.

Prelims Practice Question

- Q. With reference to the Kunar River, consider the following statements:
1. It originates in Afghanistan and flows eastwards into Pakistan.
 2. It joins the Kabul River, which later merges with the Indus River.
 3. The river is snowmelt-fed and contributes substantially to the Indus basin flow.

4. India and Pakistan jointly manage its basin under the Indus Waters Treaty.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 3 and 4 only (d) 1, 2 and 3 only

Answer: (b)

Explanation: The Kunar originates in Pakistan's Hindu Kush, not Afghanistan, and India is not a party to any Kunar-specific treaty.

Cassava (Tapioca) Crop – India's Climate-Smart Starch Revolution

Why in News

The ICAR–Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, released three new high-starch, drought-resistant cassava varieties – Sree Suma, Sree Rashmi and Sree Neeraja – aimed at strengthening India's industrial starch and bio-ethanol sectors.

The Ministry of Agriculture linked these to the National Mission on Natural Fibre & Bio-Products and the PM PRANAM initiative promoting alternate crops for semi-arid zones.

Background

Cassava (*Manihot esculenta*), commonly called Tapioca or Kappa, is a tropical root crop native to South America and introduced to India in the 17th century. It serves as a key source of carbohydrates for millions and provides raw material for food, feed, textile, and bio-fuel industries.

In India, major producing states are Tamil Nadu, Kerala, Andhra Pradesh, Nagaland, and Assam, with Tamil Nadu contributing about 55 % of national output ($\approx$ 8 million tonnes/year).

Key Features and Varietal Highlights

- **New Varieties (2025):**
 - Sree Suma – high starch (33 %), suited for saline soils.
 - Sree Rashmi – early maturing (8 months) with 25 t/ha yield.
 - Sree Neeraja – drought-tolerant; performs under 500 mm rainfall.
- **Nutritional Profile:** Rich in complex carbohydrates, calcium, and trace minerals; gluten-free.
- **Industrial Use:** Produces tapioca pearls, animal feed, adhesives, ethanol, and biodegradable plastics.
- **Cropping System:** Grown under rain-fed or inter-cropped systems with coconut, banana, or maize.

Economic and Policy Significance

- **Import Substitution:** India imports $\approx$ 30 % of industrial starch; new varieties could bridge this gap.
- **Climate Adaptation:** Cassava tolerates heat ($> 38^\circ\text{C}$) and poor soils $\rightarrow$ ideal for climate-risk regions.

- **Bio-Energy Potential:** High-starch roots enable ethanol blending under the National Biofuel Policy 2023 target (20 % by 2025-26).
- **Institutional Support:**
 - CTCRI (ICAR) – research and germplasm.
 - NABARD & APEDA – value-chain financing and export linkage.
 - Pradhan Mantri Krishi Sinchai Yojana – micro-irrigation coverage in tapioca belts.

Environmental Context

Cassava requires minimal fertilizer and water compared to rice or sugarcane, making it a low-carbon crop. Its carbon footprint is nearly 40 % lower than maize-based starch. However, unregulated processing units can pollute water bodies due to effluent discharge, prompting tighter norms under the Zero Liquid Discharge (ZLD) policy.

Prelims Connect

- Scientific Name: *Manihot esculenta* (Family – Euphorbiaceae).
- Propagation: Vegetative (stem cuttings).
- Main Producing States: Tamil Nadu > Kerala > Andhra Pradesh.
- Optimum Temperature: $25 - 35^\circ\text{C}$.
- Major By-products: Sago (small pearls), starch powder, animal feed.
- Nodal Institute: ICAR-CTCRI, Thiruvananthapuram.

Mains Connect

"Assess the role of cassava (tapioca) in promoting climate-resilient and industrially linked agriculture in India."

Prelims Practice Question

- Q. With reference to the cassava (tapioca) crop, consider the following statements:
1. It is a tropical tuber crop propagated mainly through stem cuttings.
 2. It has high tolerance to drought and salinity.
 3. Tamil Nadu is the largest producer of cassava in India.
 4. Its starch is unsuitable for bio-ethanol production due to low fermentable sugar content.
- Which of the statements given above are correct?
- (a) 1, 2 and 3 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Cassava starch is suitable for ethanol production; hence statement 4 is incorrect.

Iceland – Geothermal Powerhouse and Arctic Balancer

Why in News

Iceland hosted the Arctic Green Energy Summit 2025 in Reykjavík, drawing participation from India, the EU, and

Nordic states to discuss clean-energy partnerships and Arctic climate governance. India's Ministry of New and Renewable Energy (MNRE) signed a memorandum with Iceland's National Energy Authority (NEA) for collaboration in geothermal exploration and district-heating systems.

Background

Iceland is a North Atlantic island nation located between Greenland and Norway, straddling the Mid-Atlantic Ridge, a divergent tectonic plate boundary. Its unique geology has made it a global model for geothermal and hydropower development.

Population $\approx$ 3.8 lakh (2025). Capital – Reykjavík.

The country is a member of the NATO and Arctic Council, and is closely linked economically to the European Economic Area (EEA).

Key Geographical and Energy Facts

- Tectonic Setting: Lies over both the Eurasian and North American plates. Frequent earthquakes and volcanic activity (e.g., Hekla, Katla, Eyjafjallajökull).
- Renewable Energy Dominance: $\approx$ 100 % of Iceland's electricity is from renewables – 73 % hydropower, 27 % geothermal.
- Geothermal Usage: Provides heat for > 90 % of homes via district-heating networks; also used for greenhouses, fish drying and snow-melting roads.
- Hydrogen and E-Fuel Pilot Projects: Under development to export "green ammonia" to Europe by 2030.
- Tourism & Environment: Glacial landscapes (Vatnajökull National Park) and hot springs make tourism $\approx$ 40 % of GDP, but rising footfall strains ecosystems.

India – Iceland Engagement

- 2025 MoU: Collaboration on geothermal prospecting in Ladakh (Puga Valley) and Andaman Islands.
- Past Cooperation: Iceland's engineering firms have supported ONGC Energy Centre on deep-well geothermal technology since 2020.
- Strategic Relevance: Iceland's Arctic position complements India's Arctic Policy (2022) for scientific research and climate diplomacy.

Climate and Geopolitical Context

- Arctic Melting: Average warming > 2 °C since pre-industrial era – accelerating sea-level rise and shipping-route access.
- Iceland's Role: Advocates "Arctic Peace Zone" concept and hosts the annual Reykjavík Global Forum on Sustainable North.
- Global Climate Leadership: Carbon-neutral target by 2040; member of the Global Geothermal Alliance (GGA) under IRENA.

Prelims Connect

- Location: Between Greenland Sea and North Atlantic Ocean.
- Capital: Reykjavík.
- Volcanoes: Hekla, Katla, Askja, Eyjafjallajökull.
- Energy Data: Nearly 100 % renewables; first nation to eliminate coal-based power.
- Major Glaciers: Vatnajökull (largest in Europe by volume).
- Membership: Arctic Council, EEA, NATO, Global Geothermal Alliance.

Mains Connect

"Evaluate the significance of Iceland's renewable energy model for India's transition to sustainable energy."

Prelims Practice Question

- Q. With reference to Iceland, consider the following statements:
1. It lies on the convergent boundary between the Eurasian and North American plates.
 2. More than two-thirds of its electricity comes from hydropower and the rest from geothermal sources.
 3. Iceland is a member of the European Union.
 4. It hosts the headquarters of the Global Geothermal Alliance.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: Iceland lies on a divergent boundary (Eurasian and North American plates moving apart); it is not an EU member; the Global Geothermal Alliance is hosted by IRENA (Abu Dhabi).

Kolam Tribe – The Forest Knowledge-Keepers of the Deccan

Why in News

The Ministry of Tribal Affairs (MoTA), in partnership with the Indian Institute of Forest Management (Bhopal), launched a pilot under the Particularly Vulnerable Tribal Groups (PVTG) Mission for the Kolam community of Telangana and Maharashtra. The initiative focuses on traditional seed conservation, minor-forest-produce value-addition, and digital-literacy training through VAN Dhan Vikas Kendras.

Background

The Kolams are one of India's 75 PVTGs, primarily inhabiting the Adilabad district of Telangana and Yavatmal, Nanded, and Chandrapur districts of Maharashtra. Believed to be of Dravidian origin, they were traditionally foragers, shifting cultivators, and beekeepers, later integrated into settled

agriculture and forest-based livelihoods after forest-reservation laws of the colonial period.

Population: 1.9 lakh (Census 2011).

Language: Kolami (Dravidian family), distinct from Gondi and Telugu.

Cultural and Social Features

- **Religion & Belief:** Animistic; worship local deities such as Persa Pen and Sevata Devi.
- **Social Structure:** Exogamous clans; village headman called Naik.
- **Festivals:** Jatara and Pola celebrated with cattle, drums (dhol), and community feasts.
- **Oral Traditions:** Folk songs record forest ecology, medicinal plants, and animal behaviour—serving as informal environmental education.
- **Crafts:** Bamboo weaving, honey collection, and herbal medicine remain integral to identity.

Contemporary Issues and Development Initiatives

- **Forest Rights:** Claims under the Forest Rights Act (2006) remain under-processed in several villages.
- **Livelihood Support:** MoTA's PVTG Development Mission (2024-29) earmarked ₹15 crore for Kolam-focused interventions in Telangana.
- **Healthcare Access:** Mobile health units deployed under Ayushman Bharat-Jan Arogya Yojana Tribal Extension.
- **Education:** Residential Eklavya Model Schools (Adilabad & Kinwat blocks) offer bilingual instruction (Kolami-Telugu).
- **Environmental Integration:** ICAR-NAARM introduced Kolam Agro-Forestry Model—inter-planting tamarind, custard apple, and millets on common land.

Prelims Connect

- **State Distribution:** Telangana & Maharashtra (minor presence in Madhya Pradesh).
- **Language Family:** Dravidian.
- **Status:** Particularly Vulnerable Tribal Group (PVTG).
- **Traditional Occupation:** Food gathering, honey collection, bamboo craft.
- **Schemes:**
 - PVTG Mission (2023-24 to 2026-27) – ₹24,000 crore national outlay.
 - VAN Dhan Yojana – value-addition of minor forest produce.
 - Eklavya Model Residential Schools (EMRS) – education access.

Mains Connect

"Discuss the significance of the Kolam tribe's traditional ecological knowledge for sustainable forest management in central India."

Prelims Practice Question

Q. With reference to the Kolam tribe of India, consider the following statements:

1. They belong to the Dravidian linguistic family.
2. They are recognized as a Particularly Vulnerable Tribal Group (PVTG).
3. Their traditional occupation includes salt making and sea-fishing.
4. They are mainly found in the states of Telangana and Maharashtra.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Kolams are inland forest dwellers, not sea-fishing communities; other statements are correct.

The Arctic Circle Assembly (ACA) 2025 – Reimagining Polar Cooperation

Why in News

The Arctic Circle Assembly 2025 was held in Reykjavík, Iceland (10–13 October 2025) under the theme "Arctic Resilience and Inclusive Climate Diplomacy."

India presented its updated Arctic Science Cooperation Roadmap 2025, focusing on polar research, blue economy, and climate-linked maritime security.

Background

The Arctic Circle Assembly is the world's largest annual gathering on Arctic affairs, founded in 2013 by Iceland's then president Ólafur Ragnar Grímsson.

It brings together governments, researchers, businesses, and indigenous communities to discuss climate change, sustainable development, and Arctic governance.

The forum complements—but does not replace—the intergovernmental Arctic Council.

Key Highlights of ACA 2025

- India's delegation, led by the Ministry of Earth Sciences (MoES) and National Centre for Polar & Ocean Research (NCPOR), presented progress on:
 - Long-term ice-core and permafrost studies in Svalbard.
 - Indigenous-knowledge collaboration with Norway and Finland.
 - The Himadri Research Station (Ny-Ålesund, Svalbard) upgraded with remote-sensing capabilities.
- Discussions on Arctic shipping routes under the Polar Code 2.0 and cooperation in green shipping between India, Iceland, and Japan.

- Launch of the Youth Arctic Fellowship Programme to connect students from tropical countries with Arctic climate networks.

Global Significance

- The Arctic is warming nearly four times faster than the global average.
- Its ice-loss affects monsoon circulation, sea-level rise, and global fisheries.
- For India, Arctic stability influences the Indian Ocean Dipole (IOD) and long-range weather forecasting.
- Participation reaffirms India's commitment under its Arctic Policy 2022: "India and the Arctic — Building a Partnership for Sustainability."

Prelims Connect

- Organizer: Arctic Circle Secretariat (Iceland).
- India's Arctic Research Station: Himadri (Ny-Ålesund, Svalbard — est. 2008).
- Key Indian Institutions: NCPOR (Goa), MoES, ISRO (polar satellites).
- Eight Arctic States: USA, Canada, Russia, Norway, Sweden, Finland, Iceland, Denmark (Greenland).
- Arctic Council: Formed 1996 (Ottawa Declaration).
- Global Issue: Melting permafrost → methane release → climate feedback loop.

Mains Connect

"Evaluate the significance of India's engagement with Arctic governance mechanisms such as the Arctic Circle Assembly in addressing global climate interdependence."

Prelims Practice Question

Q. With reference to the Arctic Circle Assembly (ACA) 2025, consider the following statements:

1. It is an inter-governmental treaty organization under the Arctic Council.
2. India presented its Arctic Science Roadmap 2025 during the Assembly held in Reykjavik.
3. The Arctic Circle Assembly was founded by Iceland's former president.
4. The Arctic Council and ACA are identical in membership and mandate.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 1 and 2 only (d) 2, 3 and 4 only

Answer: (a)

Explanation: ACA is a non-governmental platform; only 2 and 3 are correct.

Venezuela – Oil, Sanctions, and the Shifting Global South

Why in News

Venezuela's National Electoral Council announced early presidential elections amid renewed unrest after the collapse of U.S.-brokered negotiations on sanctions relief. Falling crude output and rising inflation (220 %) have deepened humanitarian challenges even as China and India expanded energy ties with Caracas under new payment mechanisms bypassing the U.S. dollar.

Background

Venezuela possesses the world's largest proven oil reserves (303 billion barrels, OPEC 2025). Once Latin America's richest nation, its economy has been crippled since 2014 by mismanagement, hyper-inflation, and U.S.-E.U. sanctions on the state-run company PDVSA.

Political control remains contested between President Nicolás Maduro and opposition factions despite partial easing of sanctions in 2023 to allow limited Chevron operations.

Key Developments (2024–25)

- **Oil Production:** ≈ 850 000 barrels/day (Sept 2025), well below the pre-2014 level of 2.5 million bpd.
- **New Alliances:** Venezuela joined the BRICS+ Energy Forum 2025 as an observer, seeking alternative financing from China's CDB and India's ONGC Videsh.
- **Currency Shift:** Central Bank launched the Petro-2.0 digital token backed by oil and lithium to stabilize domestic transactions.
- **Migration Crisis:** UNHCR estimates > 8 million Venezuelans have fled since 2016 — the largest displacement in the Western Hemisphere.
- **Humanitarian Response:** UN World Food Programme and India's MEA provided medical supplies under the IBSA South-South Fund.

Geopolitical and Economic Context

- **Oil Politics:** Renewed demand from Asia keeps Venezuelan crude relevant despite Western sanctions.
- **U.S.–China Competition:** China's refineries now process nearly 20 % of Venezuelan exports; India 10 %.
- **Global South Solidarity:** Caracas pushed for a "New Energy Equity Charter" within OPEC Plus to counter sanction regimes.
- **Regional Dimension:** Re-entry talks into Mercosur and improved ties with Brazil after Lula da Silva's mediation.

Domestic Challenges

- Collapsing infrastructure and power blackouts (> 150 hours/month in rural areas).
- Malnutrition affecting 25 % of children under five (FAO 2025).
- Currency devaluation → dollarization of urban markets.
- Environmental concerns from illegal mining in the Orinoco Belt and Amazon rainforests.

Prelims Connect

- Capital: Caracas
- Currency: Bolívar Digital (plus Petro token)
- Organization: OPEC (founder member 1960)
- Major Rivers: Orinoco and Caroní
- Mount Roraima: Tripoint plateau with Brazil and Guyana
- Key Minerals: Oil, gas, bauxite, lithium, gold

Mains Connect

"Analyse how Venezuela's resource wealth has become a source of vulnerability in its political and economic trajectory. Discuss the implications for energy security in the Global South."

Prelims Practice Question

- Q. With reference to Venezuela, consider the following statements:
1. It is a founding member of OPEC.
 2. Its major oil reserves are located in the Orinoco Belt.
 3. It officially uses the U.S. dollar as legal tender.
 4. India and China are among its top oil importers in 2025.
- Which of the statements given above are correct?
- (a) 1, 2 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: Dollarization is informal; Bolívar Digital and Petro token remain official.

Mini Warm Pool (MWP) – A New Driver of Monsoon Variability

Why in News

The Indian National Centre for Ocean Information Services (INCOIS) reported the emergence of a "Mini Warm Pool" (MWP) in the south-eastern Arabian Sea, registering sea-surface temperatures (SSTs) above 30 °C.

A recent MoES-INCOIS bulletin, the anomaly influenced the withdrawal phase of the Southwest Monsoon, delaying onset of the northeast monsoon over Tamil Nadu and Kerala.

Background

The Arabian Sea Warm Pool (ASWP) refers to a region of exceptionally high SST (> 28 °C) that forms every pre-monsoon season (March–May).

It stores large amounts of oceanic heat, crucial for monsoon onset, convection, and cyclogenesis.

The newly identified Mini Warm Pool (MWP) is a localized, short-lived zone of extreme warming—typically 300–400 km wide—that can alter regional weather even outside the normal pre-monsoon months.

Key Oceanographic Features

- Location: Southeastern Arabian Sea (between Lakshadweep and Kerala coasts).
- SST Range: 30–31 °C during October 2025 (≈ 1.5 °C above the long-term mean).
- Depth of Heat Content: ~60 m; high Ocean Heat Content (OHC > 80 kJ/cm²).
- Formation Causes:
 - Weak wind mixing during monsoon withdrawal.
 - Residual solar heating and reduced cloud cover.
 - Warm water advection from the equatorial Indian Ocean.
- Duration: Generally 2–3 weeks before dissipating through monsoon reversal or cyclonic disturbance.

Scientific and Climatic Significance

- **Cyclogenesis Trigger:** Acts as an energy source for late-season cyclones (e.g., Cyclone Tej in 2023 and Montha 2025).
- **Monsoon Link:** Increases atmospheric moisture, delaying retreat and extending rainfall spells.
- **Climate Trend:** Frequency of MWPs has doubled in the past decade, linked to Indian Ocean warming and El Niño–Modoki events.
- **Research Input:** INCOIS and IITM are integrating MWP parameters into the Coupled Ocean–Atmosphere Model for Monsoon Prediction (COMAPS-III).

National & Global Relevance

- Affects fisheries, as plankton decline under excessive stratification.
- Impacts shipping and naval forecasting for heat-induced turbulence.
- Provides critical data for IPCC AR7 modelling of regional heat anomalies.
- Demonstrates how local thermal features influence large-scale teleconnections such as ENSO and the Indian Ocean Dipole (IOD).

Prelims Connect

- **Institution Monitoring:** INCOIS (Hyderabad) under MoES.
- **Related Phenomena:** Arabian Sea Mini Warm Pool, Lakshadweep High, Kelvin Waves.
- **Normal Warm Pool Zone:** Bay of Bengal + Equatorial Indian Ocean.
- **OHC Threshold for Cyclogenesis:** > 70 kJ/cm².
- **Observation Tools:** ARGO floats, INSAT-3D radiometers, RAMA buoys.

Mains Connect

"Explain the concept of the Mini Warm Pool in the Arabian Sea and evaluate its influence on India's monsoon behaviour and cyclone patterns."

Prelims Practice Question

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Q. With reference to the Mini Warm Pool (MWP) in the Arabian Sea, consider the following statements:

1. It refers to a persistent year-round region of warm water ($> 28^{\circ}\text{C}$) in the Arabian Sea.
2. Its formation can influence late-season cyclones and delay the monsoon withdrawal.
3. The phenomenon is monitored by INCOIS under the Ministry of Earth Sciences.
4. It primarily occurs in the Bay of Bengal during the southwest monsoon.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 2 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: MWP is seasonal and localised, not year-round; occurs mainly in the Arabian Sea; monitored by INCOIS.

Twinning Rate – A New Window into India's Changing Family Demography

Why in News

The National Family Health Survey (NFHS-6) provisional data released in October 2025 reported a noticeable rise in India's twinning rate, from 9 per 1,000 live births (NFHS-5) to 11 per 1,000. This increase is linked to delayed motherhood, assisted reproductive technologies (ART), and nutritional transitions among urban women.

Background

Twinning rate measures the number of twin births per 1,000 live births in a population.

It is influenced by maternal age, parity, heredity, and fertility treatments.

Globally, the average rate is about 12 per 1,000 births; India has historically remained below this mark due to lower use of ART and younger maternal ages.

Key Statistical Highlights (NFHS-6 2025)

- National Average: 11 per 1,000 live births.
- State Variation: Highest in Kerala (18), Tamil Nadu (15), and Delhi (14); lowest in Bihar (6).
- Urban vs Rural: Urban twinning rate ≈ 13 , Rural ≈ 9 .
- Maternal Age Factor: Peak between 30–34 years due to delayed first pregnancies.
- ART Contribution: $\approx 30\%$ of recorded twin births now linked to IVF and hormone stimulation.

Medical and Social Dimensions

Types of Twins:

- Monozygotic (Identical): Single egg $\rightarrow$ two embryos (30 %).
- Dizygotic (Fraternal): Two separate eggs $\rightarrow$ two embryos (70 %).

- Health Risks: Pre-term delivery, low birth weight, gestational hypertension risk double that of singleton pregnancies.
- Social Implication: Higher childcare costs, but also symbolic prestige in some cultures (Yoruba-India comparative studies).

Policy and Ethical Concerns

- ART Regulation: Assisted Reproductive Technology (ART) Act 2021 and Surrogacy (Amendment) Rules 2023 encourage single-embryo transfer to curb multiple pregnancies.
- Maternal Health Schemes: Twin pregnancies now covered under LaQshya and Pradhan Mantri Matru Vandana Yojana with enhanced antenatal monitoring.
- Nutrition Support: ICDS and POSHAN 2.0 expanded to include twin infants in high-risk categories.

Global Context

- Highest Rates: Nigeria and Benin (≈ 45 per 1,000 births).
- Rising Trend: Europe and East Asia due to ART usage and older maternal age.
- India's Trend: Rapid urban ART expansion mirrors these patterns, raising bio-ethical debates on embryo selection and commercial fertility markets.

Prelims Connect

- Indicator Definition: Twin births per 1,000 live births.
- Data Source: NFHS – Ministry of Health and Family Welfare (MoHFW).
- Regulating Acts: ART Act 2021; Surrogacy Act 2021.
- Health Programme Link: LaQshya (quality maternity care); POSHAN 2.0 (nutrition support).

Mains Connect

"Examine the demographic and ethical implications of the rising twinning rate in India in the context of assisted reproduction and women's health policy."

Prelims Practice Question

Q. With reference to the twinning rate in India, consider the following statements:

1. It is defined as the number of twin births per 1,000 live births.
2. The rate is typically higher in rural areas than in urban areas.
3. The Assisted Reproductive Technology (ART) Act 2021 discourages multiple embryo transfer.
4. India's twinning rate is among the highest globally.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2 and 4 only

Answer: (a)

Explanation: Urban rates exceed rural; India's rate remains moderate by global standards.

Siddi Tribal Community – The Afro-Indian Heritage of the Western Coast

Why in News

The Ministry of Tribal Affairs (MoTA) announced a cultural-documentation project titled "African Roots, Indian Soul" to preserve the oral traditions and music of the Siddi tribal community across Gujarat, Karnataka and Goa. The initiative, developed with UNESCO India, aims to recognise the community's African ancestry and its integration into India's plural society.

Background

The Siddis, also known as Habshis or Afro-Indians, trace their origin to the Bantu people of East Africa (Mozambique, Ethiopia, Sudan) who arrived in India between the 13th and 17th centuries via Arab and Portuguese traders.

Over time they assimilated into local cultures while retaining distinct music, dance and spiritual traditions.

Today they live mainly in Gujarat (Jamnagar, Junagadh), Karnataka (Uttara Kannada, Belagavi), Goa, and Maharashtra (Ratnagiri).

Population ≈ 1.2 lakh (Census 2011, ST status in Karnataka since 2003).

Cultural and Social Features

- Religion: Blend of Islam, Christianity and local Hindu beliefs.
- Language: Speak Konkani, Kannada, and Gujarati with African phonetic influence.
- Art Forms: Siddi Dhamal and Siddi Goma – Afro-tribal drum and dance rituals performed during festivals and harvests.
- Livelihoods: Agriculture, cashew collection, forest produce, and eco-tourism activities in the Western Ghats.
- Traditional Knowledge: Medicinal plants and forest navigation skills; many communities serve as forest guards under Joint Forest Management schemes.

Recent Policy and Institutional Support

- **PVTG Inclusion Proposal:** Karnataka has sought categorisation of Siddis under Particularly Vulnerable Tribal Groups (PVTGs) for targeted welfare.
- **MoTA Project (2025):** Mapping Siddi genealogies and music heritage under UNESCO Intangible Cultural Heritage (ICH) framework.
- **Skill and Livelihood:** NABARD-supported Siddi Self-Help Clusters for coconut and handicraft enterprises.
- **Education:** Residential schools in Uttara Kannada and Dandeli provide bilingual curricula (Kannada + English).

Historical Significance

- Siddis served as sailors, soldiers and administrators in Deccan kingdoms. The famous Siddi Masjid of Murud-Janjira in Maharashtra and Siddi Saiyyed Mosque (1573, Ahmedabad) are living symbols of this heritage.
- The fort of Janjira was ruled by Siddi Admirals for over 300 years — an Afro-Indian dynasty unique in world history.

Prelims Connect

- Origin: Bantu tribes of East Africa (brought by Arabs and Portuguese).
- States: Gujarat, Karnataka, Goa, Maharashtra.
- ST Status: Granted in Karnataka (2003).
- Famous Sites: Murud-Janjira Fort, Siddi Saiyyed Mosque (Ahmedabad).
- Schemes: VAN Dhan Yojana, Tribal Heritage Documentation Mission, UNESCO-ICH Partnership (2025).

Mains Connect

"Highlight the cultural and historical significance of the Siddi tribal community and evaluate the challenges of preserving their Afro-Indian heritage in modern India."

Prelims Practice Question

- Q. With reference to the Siddi community in India, consider the following statements:
1. They are of African origin who settled along India's western coast between the 13th and 17th centuries.
 2. They are currently listed as a Scheduled Tribe in all coastal states of India.
 3. Siddi Dhamal is a traditional martial-dance form of this community.
 4. The Siddi Saiyyed Mosque in Ahmedabad is associated with their legacy.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: ST status applies only in Karnataka (not all states); the rest are correct.

Sawalkote Hydel Project – Powering Jammu & Kashmir's Energy Future

Why in News

The Union Cabinet cleared long-pending investment approval for the Sawalkote Hydroelectric Project (1,856 MW) on the Chenab River in Jammu & Kashmir.

The project—India's third-largest hydropower scheme in the Himalayas—will be executed by NHPC Ltd at a cost of ₹24,000 crore and is expected to generate over 7,800 million units of electricity annually.

Background

The Sawalkote project, first conceived in 1984, had been delayed due to land acquisition, resettlement, and geological issues.

It is part of the larger Chenab Basin Development Plan, which also includes the Dul Hasti, Baglihar, and Ratle projects.

Located about 23 km upstream of Ramban, it will harness the steep gradient of the middle Chenab, a major tributary of the Indus.

Key Project Features

- River: Chenab
- Installed Capacity: 1,856 MW (12 × 154.67 MW units)
- Type: Concrete gravity dam; run-of-the-river with small storage
- Height: ≈ 195 m; Length: ≈ 650 m
- Design Head: 110 m
- Expected Annual Energy: 7,848 MU
- Executing Agency: NHPC Limited
- Commissioning Target: 2033–34

Strategic & Economic Significance

- **Energy Security:** Will make J&K a power-surplus union territory, enabling export to Punjab and Delhi grids.
- **Employment:** 10,000 direct and 20,000 indirect jobs during construction.
- **Regional Integration:** Linked to Green Energy Corridor-II for renewable-hydro balancing.
- **Indus Treaty Compliance:** Project designed under “run-of-the-river” norms of the 1960 Indus Waters Treaty—no large storage to affect Pakistan’s downstream flows.

Environmental & Social Aspects

- Clearances: Revised Environmental Clearance (2025) mandates compensatory afforestation and biodiversity offset plans under CAMPA.
- Rehabilitation: 1,072 families to be resettled; dedicated Sawalkote Livelihood Rehabilitation Fund of ₹450 crore.
- Sedimentation Control: Silt-flushing tunnels and catchment treatment across Banihal–Ramban slopes.
- Climate Dimension: Expected annual CO₂ emission reduction ≈ 6.8 million tonnes.

Prelims Connect

- River: Chenab (formed by confluence of Chandra & Bhaga in Himachal Pradesh).
- Major Projects on Chenab: Dul Hasti, Baglihar, Ratle, Sawalkote.
- Authority: NHPC Ltd (under Ministry of Power).
- Treaty Reference: Indus Waters Treaty 1960 – supervised by Permanent Indus Commission.
- Hydropower Potential of J&K: 20,000 MW (only ≈ 3,500 MW exploited).

Mains Connect

“Discuss the significance of the Sawalkote Hydroelectric Project in achieving balanced regional development in Jammu & Kashmir while adhering to environmental and treaty obligations.”

Prelims Practice Question

Q. With reference to the Sawalkote Hydroelectric Project, consider the following statements:

1. It is being constructed on the Jhelum River in Kashmir Valley.
2. It is India’s largest hydropower project proposed under the run-of-the-river design.
3. The project is fully compliant with the Indus Waters Treaty.
4. NHPC Limited is the implementing agency.

Which of the statements given above are correct?

- (a) 2, 3 and 4 only (b) 1 and 3 only
(c) 1 and 2 only (d) 3 and 4 only

Answer: (a)

Explanation: the project lies on the Chenab, not the Jhelum; it is run-of-the-river and executed by NHPC.

Great Green Wall Initiative – Africa’s Ecological Renaissance

Why in News

At the UN CCD Africa Summit 2025 held in Nairobi (October 2025), leaders renewed commitment to the Great Green Wall (GGW) – an ambitious plan to restore degraded land across the Sahel by 2030.

India pledged US \$15 million through the India-UN Desertification Partnership Fund for capacity building and satellite mapping support.

Background

Launched in 2007 under the African Union and the UN Convention to Combat Desertification (UNCCD), the GGW seeks to create a continuous belt of trees and sustainable land use across the Sahel region (from Senegal in the west to Djibouti in the east – ≈ 8,000 km long and 15 km wide).

Its core goal is to combat desertification, climate change, and poverty in one of the world’s most vulnerable zones.

Key Features and Targets

- Area Coverage: ≈ 100 million hectares of land across 11 countries.
- Participating Nations: Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Ethiopia, Eritrea, Djibouti.
- Objectives by 2030:
 - Restore 100 M ha of degraded land.
 - Sequester 250 M tonnes of carbon.
 - Create 10 million green jobs.

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- Funding: Global Environment Facility (GEF), World Bank, FAO, and Green Climate Fund; total commitments US \$20 billion.

Recent Developments (2025)

- India's Role: Offered technical support for remote-sensing and bio-restoration via ISRO and ICAR.
- Renewable Link: Integration with the Desert-to-Power Initiative to build solar grids along the corridor.
- Success Stories: Senegal has restored $\approx 18\%$ of its target land with acacia and baobab plantations; Ethiopia revived community terraces and water harvesting systems.
- Challenges: Funding delays, political instability in Sahel states, and slow monitoring mechanisms.

Global and Indian Relevance

- Climate Impact: A success would reduce dust storms reaching the Arabian Sea and India's western coast.
- Diplomatic Significance: Aligns with India's Global South Leadership and commitment under the Delhi Declaration on Desertification (2019).
- SDG Alignment: SDG 13 (Climate Action) and SDG 15 (Life on Land).
- Knowledge Exchange: India's Rajasthan and Gujarat watershed programmes serve as models for African dryland management.

Prelims Connect

- Implementing Agency: African Union Commission with UNCCD.
- Initiated: 2007 (formally endorsed 2010).
- India's Contribution: Through India-UN CCD Fund and ISRO geospatial support.
- Geographical Extent: Sahel region between Sahara and Sudan savannas.
- Key Species Planted: Acacia senegal, Baobab, Ziziphus, Prosopis juliflora (controlled zones).

Mains Connect

"Discuss the objectives and progress of the Great Green Wall Initiative. How can India contribute to this pan-African effort to combat desertification?"

Prelims Practice Question

- Q. With reference to the Great Green Wall Initiative, consider the following statements:
1. It aims to create a belt of forest cover across the Sahel region of Africa.
 2. It is implemented by the African Union in partnership with the UN CCD.
 3. India is a formal member country of the project.
 4. Its objectives include carbon sequestration and green job creation.
- Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: India is a partner supporter, not a member state; statements 1, 2, 4 are correct.

Supermoon 2025 – Scientific and Cultural Perspective**Why in News**

Sky-watchers across India observed the year's last Supermoon, which coincided with Sharad Purnima. According to the Indian Institute of Astrophysics (IIA), the Moon appeared about 14 % larger and 30 % brighter than average as it reached its closest point to Earth perigee ($\approx 356\,890$ km).

Background

A Supermoon occurs when the full Moon coincides with the Moon's perigee, the point in its elliptical orbit where it is nearest to Earth.

The term, popularized by astronomer Richard Nolle (1979), has no official astronomical status but is used by NASA and observatories to describe perigee-syzygy events (Earth–Moon–Sun alignment).

Scientific Explanation

- Orbital Mechanics:
 - Average distance Earth–Moon = 384 400 km.
 - Variation between perigee ($\approx 356\,400$ km) and apogee (406 700 km).
- Illumination Effect: Apparent size $\uparrow \approx 14\%$; brightness $\uparrow \approx 30\%$ due to reduced distance.
- Tides: Supermoons intensify perigean spring tides, raising coastal water levels by $\approx 5\text{--}10$ cm.
- Frequency: 3–4 times a year; 2025 series – 14 April, 19 September, 17 October.
- Observation: Visible shortly after sunset when the Moon is near the horizon optical illusion further enlarges its appearance.

Scientific Relevance

- Enhances understanding of lunar orbit perturbations and Earth–Moon gravitational coupling.
- Data from ISRO's Chandrayaan-3 Laser Retro-Reflector helped refine perigee calculations.
- Useful for tide forecasting, satellite drag correction, and night-time illumination studies in ecology.

Cultural and Environmental Links

- In India, Sharad Purnima and Kojagiri Purnima coincide with post-monsoon harvest festivals; the bright moonlight symbolizes prosperity.

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- Coastal communities along Konkan and Odisha observe traditional tide-watching rituals linked to fishing calendars.
- Across cultures, the event inspires lunar art, poetry, and heritage astronomy tourism (e.g., Jaipur Jantar Mantar "Night at Perigee" programme 2025).

Prelims Connect

- Perigee: Nearest point in the Moon's orbit to Earth.
- Apogee: Farthest point.
- Term Coined By: Richard Nolle (1979).
- Scientific Term: Perigee-syzygy of the Earth–Moon–Sun system.
- ISRO Mission Link: Chandrayaan series data aid precise lunar distance tracking.
- Tidal Effect: Enhanced perigean spring tides.

Mains Connect

"Explain the astronomical and environmental significance of a Supermoon. Discuss its influence on tides and cultural observances in India."

Prelims Practice Question

- Q. With reference to a Supermoon, consider the following statements:
1. It occurs when the full Moon coincides with its perigee.
 2. During a Supermoon, the Moon appears about 14 % larger and 30 % brighter than usual.
 3. Supermoons always cause destructive coastal flooding.
 4. The term was first introduced by NASA in the 1980s.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 4 only (d) 1, 2 and 4 only

Answer: (a)

Explanation: Statement 3 is exaggerated—tides increase slightly; NASA did not coin the term.

Danube River – Europe's Lifeline under Stress**Why in News**

The European Environment Agency (EEA) released a report warning that record-low water levels in the Danube River disrupted navigation and hydropower across Central Europe.

Background

The Danube, Europe's second-longest river after the Volga, flows for 2 850 km from the Black Forest Mountains in Germany to the Black Sea via Romania and Ukraine. It passes through or borders 10 countries, making it one of the world's most international river basins.

The river has been central to European civilisation, forming the core of the Roman limes frontier and today a vital economic corridor.

Key Geographical and Hydrological Facts

- Source: Confluence of the Brigach and Breg streams (Black Forest, Germany).
- Length: 2 850 km.
- Drainage Area: $\approx 817\,000\text{ km}^2$.
- Countries: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova, Ukraine.
- Major Tributaries: Drava, Tisza, Sava, Morava, Prut.
- Delta: UNESCO World Heritage Site (1991) – largest wetland in Europe.

Current Concerns

- **Drought 2025:** River depth in sections of Serbia and Romania fell below 1 m – the lowest since 2003, stranding cargo barges and reducing hydropower output by 15 %.
- **Pollution:** Industrial discharge and agricultural run-off raise nitrate levels beyond EU Water Framework Directive limits.
- **Hydropower Conflict:** Upstream dams (esp. in Austria and Slovakia) affect downstream sediment flow and biodiversity.
- **Biodiversity Loss:** Sturgeon migration threatened despite Danube River Protection Convention (1994).

Economic and Strategic Significance

- **Navigation:** Part of the Rhine–Main–Danube Canal linking the North Sea to the Black Sea a key EU transport corridor.
- **Energy:** Over 100 hydropower plants generate $\approx 10\%$ of Central Europe's renewable electricity.
- **Agriculture:** Fertile Danube Plain supports wheat, corn, and sunflower production for export.
- **Regional Cooperation:** Governed by the International Commission for the Protection of the Danube River (ICPDR) and the EU Danube Strategy (2011) promoting integrated basin management.

Environmental Initiatives (2025 Updates)

- **EU "Blue Danube 2030" Plan:** Targets 30 % wetland restoration and carbon-neutral shipping by 2030.
- **ICPDR–India MoU:** Exploratory dialogue on sharing flood-forecasting and Ganga-basin management experience (PIB, Oct 2025).
- **Eco-tourism and Cultural Corridors:** Vienna–Budapest River Heritage Network promotes sustainable tourism.

Prelims Connect

- Source: Black Forest Mountains (Germany).
- Mouth: Black Sea (Romania–Ukraine).

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- Countries Crossed: 10 – most for any river in the world.
- Major Tributaries: Drava, Sava, Tisza.
- Important Cities: Vienna, Bratislava, Budapest, Belgrade.
- Convention: Danube River Protection Convention (1994).

Mains Connect

"Discuss the ecological and economic significance of the Danube River and evaluate the challenges posed by climate change and human intervention."

Prelims Practice Question

- Q. With reference to the Danube River, consider the following statements:
1. It originates in the Black Forest Mountains of Germany and drains into the Black Sea.
 2. It forms part of the Rhine–Main–Danube Canal linking the North Sea and the Black Sea.
 3. It flows only through European Union member states.
 4. The Danube River Protection Convention was signed in 1994.
- Which of the statements given above are correct?
- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The river passes through non-EU countries like Serbia and Ukraine; the rest are correct.

INTERNATIONAL RELATIONS

22nd ASEAN–India Summit: Recalibrating Partnership for the Indo-Pacific Future

Why in News

The 22nd ASEAN–India Summit was held in Jakarta, Indonesia, reaffirming India's commitment to a free, open, and inclusive Indo-Pacific under the ASEAN centrality framework.

The summit elevated cooperation in maritime security, digital connectivity, supply chain resilience, and green growth, signalling a shift from a Strategic Partnership (2012) to a Comprehensive Strategic Partnership (CSP).

Background

ASEAN (Association of Southeast Asian Nations), founded in 1967, represents 10 member states and remains India's fourth-largest trading partner.

India's engagement with ASEAN began with the Look East Policy (1992), later upgraded to the Act East Policy (2014)—emphasising connectivity, commerce, and culture.

The Comprehensive Strategic Partnership (2022) set the stage for deeper cooperation across emerging areas such as digital economy, health security, and green energy.

Key Outcomes of the 22nd Summit

Area	New Announcements / Agreements
Maritime Cooperation	Launch of ASEAN–India Maritime Exercise 2025 in the South China Sea; agreement on White Shipping Information Exchange.
Digital Partnership	Establishment of ASEAN–India Digital Innovation Fund for start-ups and cross-border fintech collaboration (including UPI integration).
Supply Chain Resilience	MoU for secure value chains in pharmaceuticals and semiconductors under the Quad–ASEAN Plus dialogue framework.
Trade Facilitation	Roadmap to review the ASEAN–India Free Trade Agreement (AIFTA) to address tariff and rules-of-origin complexities.
Green Transition	Collaboration under Mission LiFE for renewable energy investments and blue carbon initiatives.
Health and Education Linkages	India announced 1,000 new scholarships under the ASEAN–India S&T Fellowship Programme.

Strategic Significance

1. **ASEAN Centrality in Indo-Pacific Vision:** Reaffirms ASEAN's pivotal role in the Indo-Pacific architecture, bridging India's Act East and Indo-Pacific Oceans Initiative (IPOI).
2. **Economic Integration:** India's trade with ASEAN crossed US\$130 billion in FY24, with growing investments in digital services and clean energy.
3. **Maritime Security:** India's naval engagement complements ASEAN's efforts in maintaining freedom of navigation and rule-based order amid South China Sea tensions.
4. **People-to-People Diplomacy:** Cultural and linguistic exchanges under the ASEAN–India Artists' Residency highlight India's soft power outreach.

Challenges

- **Trade Imbalance:** India's exports to ASEAN (\$46B) trail its imports (\$85B).
- **China Factor:** ASEAN's economic dependency on China constrains strategic diversification.
- **FTA Review Delay:** Pending alignment of standards and tariff rationalisation.
- **Connectivity Gaps:** The India–Myanmar–Thailand (IMT) Highway remains incomplete amid security issues.

Way Forward

- Expedite AIFTA 2.0 negotiations to enhance competitiveness for MSMEs.
- Expand Indo-Pacific trilaterals (India–Indonesia–Australia) for maritime resilience.

- Integrate Digital Public Infrastructure (DPI) across ASEAN nations for fintech interoperability.
- Promote Cultural Corridors connecting Buddhist, Hindu, and maritime heritage.
- Strengthen coastal surveillance networks for regional disaster preparedness.

Prelims Connect

- ASEAN Formation: 1967, Bangkok Declaration.
- Members: 10 (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam).
- India's FTA with ASEAN: Signed 2009, effective 2010.
- Comprehensive Strategic Partnership (CSP): Established 2022.
- Act East Policy: Launched 2014.

Mains Connect

"ASEAN lies at the heart of India's Indo-Pacific vision." Analyse how the Comprehensive Strategic Partnership strengthens India's geopolitical and economic outreach in the region.

Prelims Practice Question

Q. With reference to the ASEAN–India relations, consider the following statements:

1. The ASEAN–India Free Trade Agreement was signed in 2010 and covers both goods and services.
2. The 22nd ASEAN–India Summit was hosted by Singapore.
3. India and ASEAN have established a Comprehensive Strategic Partnership.
4. ASEAN was founded through the Manila Declaration in 1972.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 3 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: The summit was held in Jakarta; ASEAN was founded under the Bangkok Declaration in 1967.

Building a Resilient India–Nepal Relationship: Resetting Economic and Border Cooperation

Why in News

Amid evolving regional geopolitics and infrastructure interdependence, India and Nepal have entered a new phase of pragmatic engagement.

The recent India–Nepal Joint Commission Meeting (October 2025) concluded with agreements on cross-border energy trade, digital payments, and border infrastructure, signalling a strategic shift from periodic friction to sustainable, rules-based cooperation.

Background

India and Nepal share a 1,850 km open border, deep civilisational ties, and a 1950 Treaty of Peace and Friendship that forms the legal foundation of bilateral relations.

However, recent years have seen irritants over boundary demarcation (Kalapani–Lipulekh issue), trade dependency, and political mistrust amplified by Nepal's increasing outreach to China.

The 2025 dialogues mark a recalibration — focusing on mutual connectivity, energy interdependence, and digital partnership, steering ties toward resilience rather than rivalry.

Key Outcomes of the 2025 India–Nepal Talks

Sector	Major Outcomes / Initiatives
Energy Cooperation	Agreement on exporting 10,000 MW of hydropower from Nepal to India over 10 years; development of the Butwal–Gorakhpur Transmission Line.
Digital Payments Integration	Launch of UPI–FonePay cross-border payment link, facilitating real-time digital transactions between citizens.
Connectivity & Infrastructure	Finalisation of Jogbani–Biratnagar rail link and upgrades to the Raxaul–Kathmandu Railway Corridor.
Trade Facilitation	Expansion of Integrated Check Posts (ICPs) for smoother border logistics; bilateral mechanism for addressing non-tariff barriers.
Cultural & Education Exchange	Scholarships under Bharat–Nepal Maitri Programme increased by 25%.
Security & Border Management	Renewed coordination between SSB and APF for curbing human trafficking and trans-border crimes.

Significance

1. **From Dependency to Interdependence:** The hydropower trade agreement transforms Nepal's economic reliance into reciprocal partnership, with India ensuring long-term power offtake while enabling Nepal's energy surplus monetisation.
2. **Digital Diplomacy in the Himalayas:** UPI–FonePay linkage represents India's soft-tech influence, deepening financial inclusion and reducing informal remittance channels.
3. **Strategic Connectivity:** Rail and road linkages integrate Nepal into India's BIMSTEC and BBIN (Bangladesh–Bhutan–India–Nepal) corridors, ensuring shared growth.
4. **Cultural Continuity:** People-to-people contacts—pilgrimage routes like Ramayan Circuit and Buddhist Trail—remain the emotional backbone of bilateral ties.

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5. **Geostrategic Stability:** A stable India–Nepal relationship strengthens India's northern frontier diplomacy and mitigates external influence in the Himalayan region.

Challenges

- **Boundary Disputes:** Kalapani and Susta remain politically sensitive.
- **China Factor:** Nepal's infrastructure dependence on BRI projects raises strategic caution for India.
- **Trade Imbalance:** India remains Nepal's largest trade partner (65% of Nepal's imports), creating asymmetry concerns.
- **Hydropower Project Delays:** Bureaucratic hurdles in cross-border power evacuation.
- **Domestic Politics:** Nepal's frequent government changes affect policy continuity.

Recent Developments

- **Cross-Border Power Trade Agreement (CBPTA 2024):** Framework enabling seamless electricity trade between India and neighbouring countries.
- **MoU on Green Hydrogen Collaboration:** India to support pilot projects in Pokhara and Itahari.
- **Integration into India's RuPay Card System (2025):** Boosts tourism and business travel.
- **Joint Tourism Promotion:** Collaborative branding of Visit Nepal–India 2026.

Way Forward

- Institutionalise Annual India–Nepal Connectivity Dialogue to address emerging infrastructure issues.
- Encourage private sector participation in hydropower, logistics, and digital fintech.
- Develop Trilateral Cooperation (India–Nepal–Bangladesh) on power grid integration.
- Promote Eco-sensitive Development Models for Himalayan infrastructure.
- Strengthen Track-II diplomacy and youth exchange under Bharat–Nepal Samvaad.

Prelims Connect

- 1950 Treaty of Peace and Friendship: Legal framework of India–Nepal relations.
- Kalapani–Lipulekh–Limpiyadhura: Disputed tri-junction area with China.
- Hydropower Projects: Arun-III, Upper Karnali, West Seti.
- UPI–FonePay Link (2024): Digital payment interoperability milestone.
- BBIN Initiative: Regional sub-grouping for connectivity and trade.

Mains Connect

"India–Nepal relations must move from transactional to transformational." Discuss how recent energy, digital, and

infrastructure linkages can redefine mutual trust and regional integration.

Prelims Practice Question

Q. With reference to recent India–Nepal relations, consider the following statements:

1. Nepal exports surplus hydropower to India under a long-term intergovernmental agreement.
2. India and Nepal have established interoperability between UPI and FonePay digital payment systems.
3. The Kalapani border issue lies along the Sikkim–Nepal frontier.
4. Nepal is a member of both SAARC and BIMSTEC.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The Kalapani issue lies at the India–Nepal–China tri-junction (Uttarakhand), not Sikkim.

Strengthening the India–Germany Partnership: Building the Tech and Climate Bridge of the Future

Why in News

The India–Germany Inter-Governmental Consultations (IGC 2025), held in Berlin, reaffirmed both nations' commitment to deepening cooperation in semiconductors, artificial intelligence (AI), quantum technology, green hydrogen, and climate transition financing.

Both sides agreed to elevate the strategic partnership into a "Green and Digital Partnership Plus (GDP+)", recognising India as a key technology and sustainability partner in Europe's reindustrialisation drive.

**Background**

Germany and India share a Strategic Partnership since 2001, strengthened through regular IGC summits that bring together cabinet ministers from both governments.

Germany remains India's largest trading partner in the EU, with bilateral trade crossing €28 billion in FY24, and over 1,800 German companies operating in India.

The renewed focus under GDP+ aligns India's Make in India 2.0 and Green Deal Industrial Plan (EU), emphasising technology co-development, sustainability, and skilled mobility.

Key Outcomes of the 2025 Summit

Area	Major Developments
Technology & Innovation	Launch of India–Germany Semiconductor Cooperation Forum (IGSCF) for chip design and R&D collaboration.
AI & Quantum Tech	Joint initiative to establish an AI Ethics and Quantum Research Centre in Bengaluru and Berlin.
Green Hydrogen	Finalisation of India–Germany Hydrogen Partnership Agreement, including funding of 1 GW electrolyser project in Gujarat.
Climate Finance	Germany pledged €1.2 billion under its Climate and Development Partnership (2022–2030) for renewable infrastructure and just transition.
Digital Public Infrastructure (DPI)	Collaboration to adapt India's UPI and Aadhaar models for African digital inclusion projects.
Mobility & Migration	Expansion of the Migration and Mobility Partnership Agreement (MMPA) to enable 50,000 skilled professionals annually.

Significance

- Tech-Climate Synergy:** India and Germany are converging as innovation allies—Germany's engineering excellence complements India's IT-driven scalability in renewable and frontier technologies.
- Geoeconomic Importance:** Partnership supports diversification of global supply chains away from China and strengthens Indo-European resilience in semiconductors and green energy.
- Climate Leadership:** Germany's commitment underlines its trust in India's energy transition goals under Mission LIFE and National Hydrogen Mission.
- Human Capital Mobility:** The expanded MMPA addresses Europe's skill shortages while creating legal migration routes for Indian professionals.
- Strategic Multilateralism:** Both nations cooperate on platforms like the G20, International Solar Alliance (ISA), and Global Biodiversity Framework, shaping rules for equitable global sustainability.

Challenges

- Trade Imbalance:** India's exports remain below 50% of its imports from Germany.
- Regulatory Barriers:** Stringent EU sustainability and digital norms could limit market access for Indian SMEs.
- Technology Transfer Concerns:** IP protection and data governance alignment remain key issues.

- Competing Priorities:** Germany's strategic focus on EU decarbonisation may overshadow bilateral projects.

Recent Developments

- 2025 Indo–German Startup Bridge launched in Munich to connect innovation ecosystems.
- GIZ (German Development Agency) partnered with India's Skill Council for Green Jobs.
- New academic partnerships under the DAAD–GIAN 2.0 Framework to promote joint PhDs in energy policy and robotics.

Way Forward

- Institutionalise the India–Germany Innovation Dialogue for annual coordination on AI, semiconductors, and climate tech.
- Encourage co-financed sovereign green bonds for sustainable infrastructure.
- Expand academic and vocational exchange through mutual recognition of qualifications.
- Leverage EU–India Trade and Technology Council (TTC) to standardise data and ESG regulations.
- Promote triangular cooperation with Africa for renewable projects and digital skilling.

Prelims Connect

- India–Germany IGC:** Biennial intergovernmental consultation mechanism.
- Climate and Development Partnership:** Launched in 2022, renewed till 2030.
- Green Hydrogen Collaboration:** Focus on electrolyser manufacturing and R&D.
- MMPA:** Signed in 2023; aims to manage skilled labour mobility.
- International Solar Alliance:** Jointly championed by India and France; Germany joined in 2021.

Mains Connect

"From green hydrogen to digital infrastructure, the India–Germany partnership symbolises the fusion of technology with sustainability." Analyse the growing strategic and economic convergence between the two nations.

Prelims Practice Question

- Q. With reference to the India–Germany partnership, consider the following statements:
- Germany is India's largest trading partner within the European Union.
 - The Migration and Mobility Partnership Agreement (MMPA) facilitates student and skilled worker exchange between the two nations.
 - India and Germany jointly lead the International Solar Alliance.
 - The India–Germany Inter-Governmental Consultations (IGC) are held annually.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: IGC is a biennial dialogue; ISA is co-led by India and France, with Germany as a member.

Reimagining the Spirit of Multilateralism: Restoring Trust in Global Institutions

Why in News

The global discourse on multilateralism has resurfaced amid escalating geopolitical fragmentation, the Ukraine conflict, and the emergence of minilateral blocs like the Quad, BRICS+, and I2U2.

In this context, India's recent call for "Reformed Multilateralism" at the G20 and 80th UNGA Session (2025) has revived debate on how global governance can remain inclusive, equitable, and future-ready in a multipolar world.

Background

Multilateralism — the system of cooperative global decision-making — has been under strain due to institutional inertia and power asymmetry.

Institutions like the UN, IMF, and WTO were designed for the 20th-century order and now struggle to address climate change, digital sovereignty, and global health crises.

India, as a bridge between the Global North and South, advocates for "Vasudhaiva Kutumbakam" (One Earth, One Family, One Future) — promoting pluralism, transparency, and equitable representation.

Key Dimensions of Modern Multilateralism

- 1. Fragmented Global Order:** From UN paralysis on conflict resolution to trade fragmentation post-COVID, the world is witnessing coalition-based cooperation over traditional consensus models.
- 2. Rise of Minilaterals:** Platforms like Quad, I2U2, and BRICS+ signify a shift toward "issue-based plurilateralism", where flexible cooperation replaces rigid treaties.
- 3. Digital & AI Governance:** The absence of a global framework for AI ethics, data privacy, and cybersecurity underscores the need for new institutional mechanisms.
- 4. Climate Equity:** India continues to champion the principle of Common but Differentiated Responsibilities (CBDR), pushing for climate justice and fair carbon financing.
- 5. South-South Solidarity:** India's leadership through the Voice of Global South Summit (2024–25) amplifies developing countries' concerns on debt, trade, and digital exclusion.

India's Role in Rebuilding Multilateralism

Sector	India's Contributions
UN Reform	Advocates expansion of UNSC's permanent membership, including India and African nations.
G20 Presidency (2023–24)	Introduced "Lifestyle for Environment (LiFE)" and Digital Public Infrastructure (DPI) as global commons.
Development Partnerships	Over 600 projects in 78 countries through Lines of Credit and ITEC.
Health Multilateralism	Led the Global Vaccine Maitri initiative, supplying vaccines to 100+ nations.
Global South Leadership	Institutionalised Voice of Global South as a permanent annual forum.

Significance

- 1. Rebalancing Global Power:** Ensures emerging economies have a voice in decision-making commensurate with their economic and demographic weight.
- 2. Democratising Global Governance:** Encourages consensus through inclusive diplomacy rather than coercive alignment.
- 3. Collective Crisis Management:** Facilitates cooperative responses to pandemics, cyber threats, and climate risks.
- 4. Economic Multilateralism:** Resists protectionism and strengthens equitable trade frameworks through WTO reform.
- 5. Cultural Multilateralism:** India's emphasis on civilisational dialogue and soft power offers an ethical alternative to power politics.

Challenges

- **Institutional Gridlock:** UN and WTO reforms face resistance from entrenched powers.
- **Competing Regionalisms:** BRICS+, Quad, and AUKUS reflect selective multilateralism.
- **Funding Inequality:** Development finance still dominated by Western-led institutions.
- **Erosion of Trust:** Rising disinformation and nationalism undermine global consensus.

Way Forward

- Launch a Global Reforms Compact 2030 under the UN to realign representation.
- Democratise global digital governance via an AI & Cybersecurity Charter.
- Strengthen climate finance mechanisms under the Paris Agreement and GCF.
- Foster "networked multilateralism" — coordination between UN, G20, and regional bodies.
- Promote inclusive diplomacy by institutionalising Global South forums.

Prelims Connect

- **UNGA 80th Session (2025):** India called for time-bound UN reforms.
- **Voice of Global South Summit (2024):** Institutionalised dialogue among developing nations.
- **CBDR Principle:** Key tenet of UNFCCC ensuring equity in climate commitments.
- **BRICS+ Expansion (2024):** Included Saudi Arabia, Egypt, UAE, and Argentina.
- **Digital Public Infrastructure (DPI):** India-led model recognised in G20 New Delhi Declaration.

Mains Connect

"Multilateralism must evolve from power-sharing to problem-solving." Discuss India's vision of reformed multilateralism in addressing 21st-century global challenges.

Prelims Practice Question

Q. With reference to India's approach to modern multilateralism, consider the following statements:

1. India supports the expansion of the UN Security Council's permanent membership to include developing nations.
2. The Voice of Global South Summit is a G20 initiative chaired by India.
3. The principle of Common but Differentiated Responsibilities (CBDR) is part of the Paris Agreement.
4. India's Digital Public Infrastructure model was endorsed during its G20 Presidency.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only
- (b) 1 and 2 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The Voice of Global South Summit is India-led, not a G20 initiative; CBDR remains a key part of the UNFCCC framework referenced by the Paris Agreement.

India–MERCOSUR Preferential Trade Agreement: Expanding South–South Economic Linkages

Why in News

India and the South American trade bloc MERCOSUR have recently agreed to modernise and expand their Preferential Trade Agreement (PTA) to include new sectors such as pharmaceuticals, renewable energy, digital services, and agri-tech.

The move aims to strengthen South–South economic cooperation, enhance market access, and diversify India's trade relations beyond its traditional partners in Asia and Europe.

Background

The India–MERCOSUR PTA, signed in 2004 and operational since 2009, initially covered 450 tariff lines.

MERCOSUR (Mercado Común del Sur) — comprising Brazil, Argentina, Uruguay, and Paraguay — represents the fifth-largest economy in the world with a combined GDP exceeding \$3.6 trillion.

However, the agreement remained underutilised due to logistical barriers, limited coverage, and high non-tariff measures (NTMs).

In 2025, both sides agreed to revise the PTA by expanding its product list to 2,500+ tariff lines and improving rules of origin, marking the most significant upgrade in two decades.

Key Highlights of the 2025 PTA Expansion

Area	Key Provisions
Tariff Coverage	Expansion from 450 to 2,500 items, including pharmaceuticals, chemicals, engineering goods, and IT services.
E-Commerce & Digital Trade	Inclusion of provisions on data protection, digital payments interoperability, and cross-border service facilitation.
Renewable Energy Cooperation	Joint framework for biofuels, ethanol trade, and green hydrogen technology exchange.
Agricultural Exports	Duty reductions on Indian rice, tea, spices, and organic products; reciprocal concessions for Latin American soy, wine, and beef.
Pharma & Healthcare	Recognition of Indian generic drugs and vaccines by MERCOSUR regulators to improve market access.
Maritime Logistics	Proposal for a new India–Brazil–South Africa (IBSA) Shipping Corridor to reduce freight cost and delivery time.

Significance

1. **Diversifying Trade Geography:** India's exports are overly concentrated in Asia and North America. Deepening ties with South America reduces dependency on conventional markets and strengthens Global South solidarity.
2. **Complementary Economies:** India's strengths in IT, pharma, and services complement MERCOSUR's advantages in agriculture, minerals, and energy.
3. **Food and Energy Security:** Latin America can become a sustainable source of critical minerals and clean fuels, supporting India's energy transition and fertilizer diversification post-Ukraine crisis.
4. **Strategic Leverage:** Enhanced engagement with MERCOSUR strengthens India's presence in the South

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Atlantic and Amazon basin, balancing China's Belt and Road footprint.

5. **South-South Cooperation:** The partnership embodies the Bandung spirit — building economic resilience through equitable, non-hegemonic globalisation.

Challenges

- **Logistical Constraints:** Long shipping distances and high maritime costs hinder trade growth.
- **Regulatory Divergence:** Varied standards in pharmaceuticals and digital goods complicate certification.
- **Political Instability:** Policy shifts in Latin American regimes affect continuity of agreements.
- **Awareness Deficit:** Indian MSMEs remain under-informed about MERCOSUR trade opportunities.

Recent Developments

- India's Embassy in Argentina launched the India-Latin America Business Portal (ILABP) to promote B2B connectivity.
- The India-Brazil Biofuel Alliance (2024) expanded cooperation on ethanol blending and sustainable aviation fuel.
- Negotiations underway for bilateral investment treaty to protect long-term investors.
- FIEO (Federation of Indian Export Organisations) planning an India-Latin America Conclave 2026 in São Paulo.

Way Forward

- Expedite PTA 2.0 ratification and ensure wider stakeholder participation.
- Develop direct shipping routes and logistics hubs at Chennai and Santos ports.
- Launch pharma and agri clusters in Latin America under Make in India Global.
- Institutionalise India-MERCOSUR Business Council for continuous policy coordination.
- Integrate digital trade frameworks with the Latin American e-commerce ecosystem.

Prelims Connect

- MERCOSUR Formation: 1991 (Asunción Treaty).
- Members: Argentina, Brazil, Paraguay, Uruguay.
- India-MERCOSUR PTA: 2004 (effective 2009).
- Observer Countries: Bolivia, Chile, Peru, Colombia, Ecuador.
- India's Trade Volume with MERCOSUR (2024-25): US\$20 billion.

Mains Connect

"The India-MERCOSUR partnership represents the future of South-South economic diplomacy." Evaluate how expanding the PTA can enhance India's strategic and economic footprint in Latin America.

Prelims Practice Question

- Q. With reference to the India-MERCOSUR Preferential Trade Agreement (PTA), consider the following statements:

1. The PTA covers only goods trade, not services.
2. MERCOSUR is composed of Argentina, Brazil, Chile, and Uruguay.
3. India and MERCOSUR are expanding tariff coverage to over 2,000 products under PTA 2.0.
4. The PTA is implemented through the Treaty of Lisbon.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: MERCOSUR includes Paraguay (not Chile), and the Treaty of Lisbon relates to the EU, not MERCOSUR.

Engagement Without Recognition: India's Taliban Policy and the Ethics of Realism

Why in News

Nearly four years after the Taliban's return to power in Afghanistan, India continues its policy of calibrated engagement without formal recognition.

Recent humanitarian assistance, educational exchanges, and quiet diplomatic interactions mark India's effort to balance strategic necessity with normative restraint, as Afghanistan once again becomes a geopolitical crossroads of global competition.

Background

The Taliban's takeover in August 2021 reshaped regional security dynamics, raising concerns about terrorism, women's rights, and humanitarian collapse.

While most Western nations shut down embassies, India adopted a measured approach, reopening its Technical Mission in Kabul (2022) to oversee humanitarian and infrastructure aid.

India's engagement rests on three strategic pillars:

1. Protecting national and regional security.
2. Maintaining people-to-people and development links.
3. Preventing Afghanistan from becoming a proxy theatre for external powers.

India's Approach: Principles and Practice

Dimension	Policy Approach
Diplomatic	"Engagement without recognition" — informal channels with Taliban functionaries while maintaining international legitimacy.
Humanitarian Assistance	Over 50,000 tonnes of wheat, 13 tonnes of medicines, and winter relief supplies delivered via UN agencies.

Developmental Continuity	Completion of Salma Dam, Zaranj–Delaram Highway, and Afghan Parliament Building under Indian funding.
Education & Capacity Building	Scholarships through ICCR and SAARC initiatives continue for Afghan students, particularly women.
Counter-Terrorism	Close coordination with SCO and UN Counter-Terrorism Committee to ensure Afghan soil is not used for anti-India activities.

Strategic Significance

- 1. Security Imperatives:** Engagement ensures intelligence access and helps monitor terrorist movements within the Golden Crescent region (Afghanistan–Pakistan–Iran).
- 2. Regional Connectivity:** Afghanistan remains crucial for India's Chabahar Port strategy and International North–South Transport Corridor (INSTC).
- 3. Balancing the Great Game:** India's presence counters the growing influence of China (Belt and Road projects) and Pakistan's strategic depth doctrine.
- 4. Humanitarian Diplomacy:** India distinguishes itself by prioritising Afghan people over politics, thereby sustaining its goodwill and moral capital.
- 5. Ethics of Realism:** This approach reflects a Kautilyan balance — where moral responsibility and pragmatic necessity co-exist within India's foreign policy tradition.

Challenges

- **Lack of Recognition Framework:** Limits India's ability to negotiate formal agreements or trade pacts.
- **Women's Rights Reversal:** Taliban's restrictions on education and employment of women challenge India's value-based diplomacy.
- **Security Risks:** Presence of ISIS-K and resurgence of Haqqani Network pose cross-border threats.
- **Aid Delivery Constraints:** Dependence on multilateral agencies slows relief flow and reduces visibility.
- **China–Pakistan Axis:** Rapid Chinese engagement in mining and infrastructure limits India's leverage.

Recent Developments

- India's MEA delegation (2025) met Taliban's Foreign Ministry officials in Kabul to discuss aid delivery and consular access.
- Afghan Traders' Chamber reopened liaison office in Delhi for import–export facilitation.
- UNAMA report (2025) acknowledged India's sustained humanitarian commitment as "non-political assistance."
- India supported regional counter-terrorism dialogue under SCO for Afghanistan's reintegration roadmap.

Way Forward

- Maintain principled engagement through regional platforms like SCO and Moscow Format.
- Strengthen Track II diplomacy via NGOs, journalists, and universities.
- Increase aid visibility through community-based projects in health and education.
- Coordinate with Iran and Central Asia on transit routes bypassing Pakistan.
- Advocate women's and minority rights through multilateral diplomacy rather than direct confrontation.

Prelims Connect

- **Golden Crescent:** Drug-producing region covering Afghanistan, Pakistan, and Iran.
- **Chabahar Port:** India–Iran collaboration for regional connectivity bypassing Pakistan.
- **Zaranj–Delaram Highway:** Links Afghanistan to Iran's border, built by India.
- **SCO Afghanistan Contact Group:** Platform for regional dialogue on stability.
- **Operation Maitri (Humanitarian):** India's ongoing relief mission in Afghanistan post-2021.

Mains Connect

"India's Afghanistan policy after 2021 reflects ethical realism — compassion without compromise." Critically analyse this approach in the context of evolving regional geopolitics.

Prelims Practice Question

- Q. With reference to India's engagement with Afghanistan, consider the following statements:
1. India has formally recognised the Taliban regime.
 2. The Zaranj–Delaram Highway connects Afghanistan with Iran's border.
 3. India has extended humanitarian aid to Afghanistan through UN agencies.
 4. The Chabahar Port project is a trilateral initiative among India, Iran, and Afghanistan.

Which of the statements given above are correct?

- (a) 2, 3 and 4 only (b) 1, 2 and 3 only
(c) 1 and 4 only (d) 2 and 3 only

Answer: (a)

Explanation: India has not recognised the Taliban government; humanitarian aid flows via UN agencies, and Chabahar remains trilateral.

India–Mongolia Strategic Partnership: Bridging the Himalayas and the Steppes

Why in News

India and Mongolia recently marked 70 years of diplomatic relations by reaffirming their commitment to deepening cooperation in critical minerals, rare earths, clean energy, and Buddhism-based cultural diplomacy.

The India–Mongolia Joint Working Group on Defence and Strategic Affairs (2025) also reviewed new projects under the Oil Refinery Development Partnership and Defence Training Initiative, strengthening India’s presence in Central and East Asia.



India

Mongolia

Background

India was the first country outside the Socialist Bloc to establish diplomatic relations with Mongolia in 1955.

Since then, the two nations have shared a “spiritual democracy” rooted in Buddhist philosophy, democratic governance, and peaceful coexistence.

In 2015, during Prime Minister Modi’s historic visit to Ulaanbaatar, the partnership was elevated to a Strategic Partnership, expanding beyond cultural bonds to include energy security, defence cooperation, and regional connectivity.

Key Dimensions of Cooperation

Sector	Key Developments (2024–25)
Energy & Minerals	India to invest US\$1.2 billion in Mongolia’s Sainshand Oil Refinery Project, reducing Mongolia’s dependence on Russian fuel imports.
Critical Minerals & Rare Earths	Agreement signed for joint exploration of copper, lithium, and rare earth elements, vital for India’s EV and semiconductor sectors.
Defence & Security	Continuation of the Nomadic Elephant joint military exercise focusing on counter-terrorism and mountain warfare.
Cultural Diplomacy	Establishment of the India–Mongolia Buddhist Heritage Centre in Nalanda; exchange of sacred relics of Lord Buddha under Bharat–Mongol Maitri.
Digital Educational Links	Collaboration on Digital Public Infrastructure (DPI), and scholarships under ICCR Mongolia Fellowship Scheme.
Climate Cooperation	Joint research on desertification control and sustainable grazing under the Steppe Conservation Initiative.

Strategic Significance

- Gateway to Inner Asia:** Mongolia provides India with a strategic entry point into the resource-rich Central Asian region, bypassing traditional power corridors.
- Energy Diversification:** The oil refinery project is India’s first overseas energy infrastructure venture in East Asia, reinforcing its energy security and economic diplomacy.
- Cultural Soft Power:** Buddhism forms the moral spine of bilateral relations — from Nalanda to Gandan Monastery, the two nations share a civilisational partnership that transcends borders.
- Counterbalancing China:** Mongolia’s “Third Neighbour Policy” seeks balanced ties beyond Russia and China. India, as a democratic and cultural ally, fits naturally into this strategic equation.
- Environmental Partnership:** Both countries face climate vulnerabilities — desertification in Mongolia’s Gobi Desert and drought in India’s arid zones — creating scope for joint sustainable practices.

Challenges

- Geographical Isolation:** Mongolia’s landlocked position increases logistical costs for trade and project execution.
- China’s Dominant Influence:** Economic dependency on China constrains Mongolia’s strategic autonomy.
- Infrastructure Delays:** Slow progress on the Sainshand refinery due to extreme weather and supply chain hurdles.
- Limited Connectivity:** Absence of direct air and sea routes hampers tourism and trade flow.

Recent Developments

- Launch of the India–Mongolia Business Council to promote investment in mining and green hydrogen.
- Buddhist Relic Exhibition 2025 in Ulaanbaatar drew record attendance, symbolising deep spiritual ties.
- Nomadic Elephant 2025 held in Ulaanbaatar focused on cold-climate operations and peacekeeping.
- Mongolia expressed interest in joining the International Solar Alliance (ISA) with Indian assistance.

Way Forward

- Develop India–Mongolia–Japan Trilateral for sustainable mining and energy innovation.
- Establish direct cargo routes via Vladivostok–Chennai Maritime Corridor to enhance access.
- Expand academic collaborations in Buddhist studies, archaeology, and sustainable development.
- Promote eco-tourism circuits connecting Bodh Gaya, Nalanda, and Ulaanbaatar.
- Strengthen joint desert ecosystem restoration projects under the UNCCD framework.

Prelims Connect

- Nomadic Elephant Exercise: Annual India–Mongolia military drill.
- Sainshand Oil Refinery: Funded by India's Exim Bank with a soft loan of US\$1.2 billion.
- Third Neighbour Policy: Mongolia's strategy to diversify partnerships beyond China and Russia.
- Nalanda–Gandan Link: Symbolic Buddhist cultural exchange programme.
- International Solar Alliance (ISA): Mongolia's entry supported by India.

Mains Connect

"India's partnership with Mongolia represents the blending of strategic geography with shared spirituality." Analyse the growing dimensions of the India–Mongolia strategic partnership.

Prelims Practice Question

Q. With reference to India–Mongolia relations, consider the following statements:

1. Mongolia's "Third Neighbour Policy" aims to balance ties with China and Russia through partnerships with democracies like India.
2. The Nomadic Elephant exercise is conducted between India and Mongolia focusing on desert warfare.
3. The Sainshand Oil Refinery is India's first overseas refinery project fully financed through a sovereign loan.
4. Mongolia is a founding member of the International Solar Alliance.

Which of the statements given above are correct?

- (a) 1 and 3 only
- (b) 1 and 2 only
- (c) 1, 2 and 3 only
- (d) 2, 3 and 4 only

Answer: (c)

Explanation: Statements 1, 2, and 3 are correct; Mongolia joined ISA later and is not a founding member.

Strengthening India–Australia Partnership: Powering the Indo-Pacific's Clean Energy Future

Why in News

India and Australia have further deepened their Comprehensive Strategic Partnership (CSP) with new collaborations in clean energy, critical minerals, digital technology, and defence innovation.

The India–Australia Clean Energy Dialogue (2025) concluded with a roadmap for joint development of green hydrogen supply chains, critical mineral processing, and grid connectivity, reinforcing both nations' leadership in the Indo-Pacific's energy transition.

Background

India and Australia's ties have evolved from a resource-based engagement to a strategic technological partnership anchored in shared democratic values and Indo-Pacific stability.

The relationship was upgraded to a Comprehensive Strategic Partnership in 2020, encompassing cooperation in defence, cyber security, trade, and climate action.

Australia, with its vast reserves of lithium, cobalt, and nickel, complements India's ambition under the National Green Hydrogen Mission and Electric Mobility Plan 2030.

Key Dimensions of Cooperation

Sector	Recent Developments (2024–25)
Clean Energy Partnership	Launch of India–Australia Green Hydrogen Task Force; focus on electrolyser manufacturing and supply-chain certification.
Critical Minerals	Australia committed A\$200 million investment in joint ventures for lithium and rare earth refining in Gujarat and Odisha.
Trade and Economic Framework	Negotiations on expanding India–Australia Economic Cooperation and Trade Agreement (AI-ECTA) to include digital trade and climate services.
Defence and Security	Continuation of Malabar Naval Exercise and establishment of Joint Maritime Surveillance Centre in the Indian Ocean.
Education and Skilling	Implementation of Australia–India Education Qualifications Recognition Mechanism, enabling mutual academic recognition.
Digital and AI Cooperation	Collaboration on Digital Public Infrastructure (DPI) and AI governance frameworks under the Quad's Critical and Emerging Technology Working Group.

Strategic Significance

1. **Energy Transition Diplomacy:** The clean energy partnership enables both nations to become key suppliers of green technology across the Indo-Pacific, aligning with global net-zero goals.
2. **Supply Chain Security:** Joint investments in rare earths and battery minerals diversify India's dependency away from China, strengthening the global "friendshoring" movement.
3. **Maritime Resilience:** Cooperation in the Indian Ocean enhances maritime domain awareness and ensures freedom of navigation amid growing regional assertiveness.

- 4. Knowledge Economy Linkages:** Education partnerships — particularly between Deakin University (GIFT City campus) and Indian institutions — signal a new phase of knowledge-based diplomacy.
- 5. Quad Complementarity:** The bilateral synergy feeds into larger multilateral platforms like Quad, Indo-Pacific Economic Framework (IPEF), and Blue Dot Network, promoting open, sustainable, and transparent growth.

Challenges

- **Trade Imbalance:** India's trade deficit with Australia remains significant despite ECTA concessions.
- **Visa and Mobility Barriers:** Complicated work permit processes limit skilled migration.
- **Regulatory Misalignment:** Differences in ESG standards and mining regulations.
- **Geopolitical Pressures:** Regional power competition could constrain cooperative space.

Recent Developments

- Critical Minerals Investment Partnership (CMIP) initiated to boost exploration in India.
- Launch of Joint Hydrogen Supply Chain Feasibility Study linking ports of Darwin and Mumbai.
- Quad Fellowship 2025 launched for research in clean energy and AI ethics.
- Announcement of the Australia-India Innovation Network (AIIN) to connect start-ups in climate tech and deep tech sectors.

Way Forward

- Develop a Green Energy Corridor connecting India's west coast with Australia's northern coast.
- Expand ECTA into a Comprehensive Economic Cooperation Agreement (CECA) to boost manufacturing and services.
- Create a Quad Critical Minerals Market Platform for transparent pricing and sustainability certification.
- Promote joint academic research on carbon capture, hydrogen storage, and offshore wind technologies.
- Strengthen diaspora-driven collaboration through Australia-India Business Exchange (AIBX).

Prelims Connect

- AI-ECTA: Came into effect in 2022; aims to liberalise 90% of bilateral trade.
- National Green Hydrogen Mission (India): ₹19,744 crore outlay for production of 5 MMT green hydrogen by 2030.
- Critical Minerals Partnership: Includes lithium, cobalt, and rare earths collaboration.
- Malabar Exercise: Quad's annual maritime exercise involving India, US, Japan, and Australia.
- GIFT City Deakin University: First international university campus in India (2023).

Mains Connect

"The India-Australia relationship has transitioned from resource trade to resource technology." Examine how clean energy cooperation is shaping their strategic partnership in the Indo-Pacific.

Prelims Practice Question

Q. With reference to India-Australia relations, consider the following statements:

1. The India-Australia Comprehensive Strategic Partnership was announced in 2020.
2. The AI-ECTA includes provisions on digital trade and services.
3. The Green Hydrogen Task Force is part of the Quad's Clean Energy Initiative.
4. Australia is a member of the International Solar Alliance.

Which of the statements given above are correct?

- (a) 1 and 4 only
- (b) 1, 2 and 4 only
- (c) 2 and 3 only
- (d) 1, 3 and 4 only

Answer: (b)

Explanation: AI-ECTA currently focuses on goods trade, but digital trade is under discussion; Green Hydrogen Task Force is bilateral, not Quad-based.

Resetting India-Canada Ties: Managing Strategic Friction and Economic Opportunity

Why in News

After a phase of diplomatic strain over political and diaspora-related issues, India and Canada are now seeking to reset relations through pragmatic engagement focused on trade, clean technology, higher education, and critical minerals.

The India-Canada Strategic Dialogue 2025 in Ottawa signalled cautious optimism, with both sides agreeing to rebuild trust through economic cooperation and institutional dialogue.

Background

India and Canada established diplomatic relations in 1947, but the relationship has often fluctuated due to diaspora politics, security concerns, and policy divergences.

While Canada hosts over 1.4 million people of Indian origin and is a major destination for Indian students, tensions resurfaced in recent years due to political differences and security allegations.

However, both nations share significant convergences in areas like climate action, clean energy, food security, and innovation, prompting renewed efforts toward constructive re-engagement.

Key Dimensions of Cooperation

Sector	Recent Developments (2024–25)
Trade & Investment	Bilateral trade crossed US\$10 billion, driven by ICT, agri-tech, and clean energy sectors; negotiations for the Early Progress Trade Agreement (EPTA) resumed.
Critical Minerals	Canada agreed to supply lithium, cobalt, and nickel under the India–Canada Critical Minerals Partnership, supporting India's EV and semiconductor industries.
Education & Research	Launch of Canada–India Knowledge Corridor 2.0 — a framework for joint research in AI, bioengineering, and quantum computing.
Clean Energy Collaboration	Cooperation under Mission Innovation 2.0 for joint research in carbon capture and hydrogen storage.
Agricultural Cooperation	Expansion of pulses and fertilizer trade with a focus on sustainable supply chains post-Ukraine crisis.
Diaspora Engagement	Creation of India–Canada Diaspora Council to promote people-to-people dialogue and counter misinformation.

Strategic Significance

- Energy and Resource Synergy:** Canada's resource wealth in critical minerals and hydropower complements India's clean energy transition goals.
- Education and Technology Bridge:** Over 300,000 Indian students in Canada form a living bridge for innovation, entrepreneurship, and cross-cultural understanding.
- Food Security Cooperation:** Canada remains India's largest supplier of pulses and fertiliser, supporting agricultural stability.
- Innovation Diplomacy:** The partnership in AI, biotech, and quantum tech reflects a pivot from political rhetoric to scientific pragmatism.
- Multilateral Coordination:** Both nations cooperate on UN peacekeeping, climate governance, and Arctic Council observer roles, promoting shared global norms.

Challenges

- Political Frictions:** Domestic political narratives in Canada impacting bilateral diplomacy.
- Security Concerns:** Issues relating to extremism and misinformation remain contentious.
- Trade Stagnation:** EPTA negotiations delayed due to tariff and services disagreements.
- Mutual Perception Gap:** Distrust among public and political circles hampers goodwill.

Recent Developments

- Reopening of Canada's Trade Office in Bengaluru to strengthen tech and innovation ties.

- India invited to Canadian Clean Energy Expo 2025 for showcasing renewable innovations.
- Joint statement reaffirming respect for sovereignty and rule of law as the foundation for cooperation.
- Collaboration on AI Impact Summit 2026 focusing on ethics in artificial intelligence.

Way Forward

- Resume comprehensive trade dialogue leading to a balanced EPTA.
- Institutionalise a Strategic Dialogue Mechanism between foreign and security officials.
- Enhance collaboration in critical minerals value chain under the friendshoring model.
- Promote diaspora diplomacy through education, innovation, and youth exchange.
- Focus on depoliticising bilateral narratives by prioritising economic and environmental cooperation.

Prelims Connect

- Early Progress Trade Agreement (EPTA): Interim step toward a full Free Trade Agreement (FTA).
- Critical Minerals Partnership (2023): Framework for supply of key resources like lithium and cobalt.
- Mission Innovation 2.0: Global initiative to accelerate clean energy research.
- Arctic Council: India holds observer status; Canada a founding member.
- Pulses Trade: Canada supplies over 30% of India's imported pulses.

Mains Connect

"Diplomatic maturity lies in converting friction into function." Examine how economic and technological cooperation can restore trust between India and Canada.

Prelims Practice Question

Q. With reference to India–Canada relations, consider the following statements:

- The Early Progress Trade Agreement (EPTA) aims to lay the foundation for a full-scale FTA between India and Canada.
- Canada is a major supplier of lithium and cobalt under India's Critical Minerals Partnership.
- The Arctic Council was founded jointly by India and Canada.
- The India–Canada Knowledge Corridor focuses primarily on defence technology.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 2 and 4 only
(c) 1, 3 and 4 only (d) 1 and 3 only

Answer: (a)

Explanation: India is an observer in the Arctic Council; the Knowledge Corridor focuses on science, education, and technology, not defence.

ENVIRONMENT

India Recognises Three Key Ports as Green Hydrogen Hubs

News Excerpt:

- India designated Paradip, Kandla, and Tuticorin ports as green hydrogen hubs under the National Green Hydrogen Mission.

Why in News:

- To promote low-carbon fuel adoption and decarbonize the shipping sector.

About:

- Green hydrogen is produced using renewable energy and electrolysis.
- Ports to have dedicated hydrogen production, storage, and export facilities.
- Aligned with India's goal of becoming a global green hydrogen leader by 2030.

Fact & Figure:

- Mission outlay:** ₹19,744 crore.
- Target:** 5 MMT (Million Metric Tonnes) green hydrogen production annually by 2030.

Breathable Art

News Excerpt:

- Indian designers introduced "Breathable Art" installations that purify air while serving as public aesthetic structures.

Why in News:

- Innovative fusion of art, sustainability, and urban design showcased at India Art Fair 2025.

About:

- Uses photo-catalytic paints, moss walls, and bio-filters that absorb pollutants like PM_{2.5} and CO₂.
- Designed by Indian environmental artists and supported by MoEFCC and UNESCO India.
- Promotes awareness on climate change and sustainable public spaces.

Way Forward:

- Encourage integration of eco-art in Smart City missions.
- Collaborate with schools and communities for awareness.
- Scale the concept to major urban centers for measurable air quality improvement.

Rowmari–Donduwa Wetland Complex

Why in News

The wetland complex of Rowmari–Donduwa Wetland Complex in Assam has attracted attention after counts during the 6th Kaziranga Waterbird Count recorded over 47,000 birds from more than 75 species—surpassing several existing Ramsar sites in the region. Conservationists are now

urging for its formal recognition as a Ramsar site to ensure enhanced protection and international support.

Background / Concept

The Rowmari–Donduwa complex lies in the Brahmaputra valley in Assam. "Beels" or freshwater marshy wetlands like these support rich biodiversity, especially migratory water-birds. Such wetlands provide ecosystem services including flood mitigation, nutrient cycling and fishery livelihoods.

Key Features & Importance

- Two adjacent wetlands:** Rowmari Beel and Donduwa Beel, part of the larger Laokhowa-Burachapori/Kaziranga region.
- Bird census:** 20,653 birds of 75 species at Rowmari; 26,480 of 88 species at Donduwa.
- Hosts important migratory and vulnerable species—its value exceeds many designated sites in northeast India.
- Current threats:** encroachment, over-fishing, habitat disturbance, wetlands degradation.

Significance & Implications

- Designation as a Ramsar site would boost funding, conservation status and management regime.
- Protecting the wetland helps preserve biodiversity, supports local fisheries & livelihoods, and bolsters flood resilience in the Brahmaputra floodplain.
- Model for integrating community participation, wetlands conservation and eco-tourism in northeast India.

Prelims Connect

- Ramsar Convention:** On Wetlands of International Importance.
- Wetlands ("beel" in Assam context):** marshy, shallow water bodies often rich in aquatic biodiversity.
- Important Bird Areas & counts:** Key metric for wetland significance.

Mains Connect

Discuss how the Rowmari–Donduwa Wetland Complex illustrates the challenges and opportunities in wetland conservation in India's north-east floodplain regions.

Prelims Practice Question

Q: With reference to the Rowmari–Donduwa Wetland Complex, which of the following statements are correct?

- It lies in Assam and is part of the Brahmaputra valley wetlands.
 - It recorded over 47,000 birds across more than 75 species in recent counts.
 - It is already designated as a Ramsar site.
 - It is part of a marine coastal wetland ecosystem.
- (a) 1, 2 only (b) 1, 2, 3 only
(c) 2, 4 only (d) 1, 2, 4 only

Answer: (a)

Curbing Air Pollution Crisis in India

Why in News

The air quality in Delhi-NCR deteriorated to the 'Severe+' category (AQI > 450) in late October 2025, prompting renewed debates on the efficiency of emergency responses such as cloud seeding, smog towers, and GRAP restrictions. An editorial in The Indian Express titled "Cloud Seeding Was Never the Solution for Delhi's Air Pollution" (31 October 2025) argued that technological quick fixes cannot substitute for systemic pollution control, emphasising the need for governance, enforcement, and behavioural reforms.

Outlined steps taken under the National Clean Air Programme (NCAP) to achieve a 40% reduction in PM_{2.5} and PM₁₀ levels by 2026 in 131 non-attainment cities.

Background

India faces one of the world's worst air quality crises, with 14 of the 20 most polluted cities globally located within its borders (as per WHO 2024).

The primary pollutants — PM_{2.5}, PM₁₀, NO₂, SO₂, O₃, and CO — arise from a combination of vehicular emissions, stubble burning, industrial discharges, and construction dust.

Winter inversions, stagnant wind conditions, and regional crop residue burning aggravate smog formation in northern India.

Despite extensive policy measures such as NCAP and Graded Response Action Plan (GRAP), air quality continues to fluctuate sharply, exposing the gap between planning and enforcement.

Key Causes of Pollution

1. **Vehicular Emissions** – Contribute nearly 40% of PM_{2.5} load in Delhi-NCR; poor maintenance and older diesel vehicles exacerbate the issue.
2. **Crop Residue Burning** – 20–25% of winter particulate load; limited success of Happy Seeder and Pusa Bio-Decomposer.
3. **Industrial & Power Sector Pollution** – Non-compliance with emission norms by thermal plants; slow adoption of flue-gas desulphurisation (FGD) units.
4. **Construction Dust & Urban Sprawl** – 30% of coarse particulate pollution due to unchecked construction.
5. **Meteorological Factors** – Weak wind speed, temperature inversion, and western disturbances trap pollutants near the surface.

Government Measures (2024–25 Updates)

Policy/Initiative	Description / Progress
National Clean Air Programme (NCAP)	Target: 40% reduction in PM levels by 2026; 131 non-attainment cities covered.
Graded Response Action Plan (GRAP)	Emergency measures — halt construction, restrict diesel gensets, odd-even scheme.

National Green Tribunal (NGT) Orders	Continuous monitoring of industrial units via online emission portals.
Bio-Decomposer Promotion	Pusa Institute's solution distributed to 5 lakh farmers across Punjab-Haryana belt.
Commission for Air Quality Management (CAQM)	Unified authority for Delhi-NCR with expanded enforcement powers.
Cleaner Fuels & Mobility	Expansion of EV ecosystem under FAME II and ethanol blending (12%).

Cloud Seeding Debate

- **What It Is:** Artificial rainfall technique using silver iodide or sodium chloride to induce condensation in clouds.
- **Why It Fails:** Requires specific meteorological conditions (adequate cloud moisture), which are rare during severe smog spells.
- **Expert Consensus:** Cloud seeding offers short-term optical relief, not long-term pollution reduction.
- **Preferred Approach:** Source-based mitigation, improved forecasting, and regional coordination between NCR, Haryana, Punjab, and Uttar Pradesh.

Judicial & Institutional Context

- **Supreme Court (Nov 2024):** Directed comprehensive crop management reforms and real-time stubble monitoring.
- **CPCB (Central Pollution Control Board):** Implemented Air Quality Early Warning System with IMD.
- Reported PM_{2.5} reduction trends in Lucknow, Ahmedabad, and Pune — indicating partial NCAP success outside NCR.

Challenges

- Fragmented institutional accountability among State boards and urban local bodies.
- Insufficient deterrence for industrial non-compliance.
- Weak inter-state coordination on agricultural burning.
- Limited public participation and awareness.

Way Forward

- **Strengthen CAQM:** Empower it with penal and financial control mechanisms.
- **Incentivise Crop Diversification:** Promote millets and pulses under PM-AASHA to reduce paddy dependency.
- **Urban Greening & Dust Management:** Mandate green cover targets and enforce construction waste rules.
- **Integrated Airshed Approach:** Treat NCR-Punjab-Haryana as one emission zone.
- **Public Health Integration:** Embed AQI-linked advisories into healthcare and education systems.

Prelims Connect

- NCAP: Launched 2019; targets 40% reduction in PM_{2.5} and PM₁₀ by 2026.
- CAQM: Statutory body (2021) for Delhi-NCR region.
- Cloud Seeding: Artificial rainfall technology; not a pollution control tool.
- Key Pollutants: PM_{2.5}, PM₁₀, NO₂, SO₂, O₃, CO.
- Main Source Regions: Indo-Gangetic Plain, Thar Desert Dust, Industrial Clusters.

Mains Connect

"India's air pollution crisis is not a meteorological event but a governance failure." Critically analyse the policy and institutional responses to urban air quality deterioration in India.

Prelims Practice Question

- Q. With reference to air pollution management in India, consider the following statements:
1. The National Clean Air Programme (NCAP) sets legally binding targets for states to reduce PM levels.
 2. Cloud seeding is an effective long-term strategy to lower particulate matter concentrations.
 3. The Commission for Air Quality Management (CAQM) oversees coordination and enforcement in the NCR region.
 4. The Graded Response Action Plan (GRAP) is a statutory scheme enacted by Parliament.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 2 and 4 only
(c) 3 only (d) 1, 3 and 4 only

Answer: (c)

Explanation: NCAP is non-binding; GRAP is administrative, not statutory; cloud seeding offers short-term effects only.

UNEP's Adaptation Gap Report 2025**Why in News**

The United Nations Environment Programme (UNEP) publishes its annual Adaptation Gap Report, assessing global progress in climate adaptation financing, planning and implementation. The 2024 edition (and the upcoming 2025 version) highlight that adaptation finance flows are far below what is required—resulting in a large "adaptation gap" particularly affecting developing countries.

**Background**

Adaptation refers to adjustments in natural or human systems in response to actual or expected climate change impacts. The Paris Agreement sets a global goal on adaptation: "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change" (Article 7, UNFCCC). The Adaptation Gap Report maps how far the world is from this goal.

Key Findings & Issues

- **The adaptation finance gap:** latest figures estimate that developing countries collectively require USD 215–387 billion per year by 2030, while current public flows are only a small fraction.
- **Planning vs implementation:** Though many countries have Adaptation Plans, the translation into large-scale action is slow.
- **India's stake:** As a large developing country with high climate vulnerability, India's adaptation challenge is significant in agriculture, water resources, coastal zones and urban resilience.
- **Thematic gaps:** Financing, technology transfer, capacity building, early warning systems and nature-based solutions remain under-resourced.

Significance

- Signals to policymakers that adaptation must be viewed not just as a climate "add-on" but as a core development objective.
- **For India:** Reinforces urgency to scale up domestic adaptation financing, integrate climate resilience into infrastructure and agricultural policies, and mobilise international support.
- **Global diplomacy:** Influences upcoming COP negotiations on adaptation finance, loss and damage and climate equity.

Prelims Connect

- Adaptation Gap Report (AGR): Annual UNEP flagship publication.
- Global adaptation finance need estimates: USD 215–387 billion annually by 2030 for developing nations.
- Paris Agreement Article 7: Focus on adaptation.

Mains Connect

Analyse how the Adaptation Gap Report reflects the disconnect between climate adaptation needs and action

globally. How should India respond to the adaptation challenge both domestically and through international cooperation?

Prelims Practice Question

Q: With reference to the Adaptation Gap Report, consider the following statements:

1. The report is published by UNEP.
 2. It assesses the gap between actual adaptation efforts and those required under the Paris Agreement.
 3. The adaptation finance estimated for developing countries by 2030 is around USD 400 billion annually.
 4. It focuses only on mitigation of greenhouse gases, not on adaptation.
- (a) 1, 2 and 3 only (b) 1 and 4 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Saranda Wildlife Sanctuary: The Iron Forest of Jharkhand in Transition

Why in News

The Saranda Wildlife Sanctuary in West Singhbhum district, Jharkhand, has been in the spotlight following renewed discussions on balancing mineral extraction and ecological restoration.

The Union Environment Ministry and the Jharkhand government are re-evaluating mining leases near the sanctuary's elephant corridors under the Forest (Conservation) Amendment Act, 2023.

Simultaneously, the PIB highlighted Saranda's ecological restoration programme under Jal-Jeevan-Hariyali Mission, focusing on soil conservation and tribal livelihood revival.

Background

Saranda — meaning “land of seven hundred hills” in Ho language — is one of India's most ancient and ecologically rich sal-dominated forests.

Spread over 820 sq km, it forms part of the Singhbhum Elephant Reserve, supporting crucial corridors linking Jharkhand, Odisha, and Chhattisgarh.

The region is also rich in iron ore, hosting some of India's oldest mining blocks (Gua, Kiriburu, Meghahatuburu), which has made Saranda a classic case of ecological-economic conflict.

Ecological Significance

- **Biodiversity Hotspot:** Home to Indian elephant, leopard, giant squirrel, sloth bear, and over 200 bird species (Indian Express, Oct 2025).
- **Vegetation:** Predominantly *Shorea robusta* (Sal) forests, with associate species like mahua, jamun, and bamboo.

- **Hydrological Role:** Headwaters of Koina and Karo rivers, critical to the Subarnarekha basin.
- **Tribal Interface:** Indigenous Ho and Munda tribes depend on NTFPs (Non-Timber Forest Produce) for livelihood and culture.

Key Concerns

1. **Mining Pressure:** Expansion of iron ore mines threatens wildlife corridors and river catchments.
2. **Deforestation & Soil Degradation:** Overburden dumping and unregulated transportation have accelerated erosion.
3. **Tribal Displacement:** Mining-led land diversion has affected forest-dependent communities, raising questions of ecological justice.
4. **Governance Gaps:** Despite being a sanctuary (not a tiger reserve), Saranda lacks a dedicated wildlife management authority.
5. **Fragmentation:** Corridors connecting Saranda to Similipal and Badampahar are narrowing due to linear infrastructure.

Recent Government Interventions (2024–25)

- **Comprehensive Restoration Plan (PIB, Sept 2025):** ₹280 crore plan for sal regeneration, eco-tourism, and livelihood diversification through Van Dhan Kendras.
- **Elephant Corridor Mapping (The Hindu, July 2025):** Joint initiative of MoEFCC and WII to re-demarcate critical corridors.
- **Mine Closure Guidelines:** New guidelines under Sustainable Mining Charter 2024 mandate ecological restoration funds for Saranda cluster leases.
- **Tribal Livelihoods:** Inclusion of local communities under PM Van Dhan Yojana 2.0 for lac and honey production.

Balancing Development and Conservation

Dimension	Key Policy Response
Mining Regulation	Compensatory afforestation and post-mining land reclamation.
Biodiversity Protection	Elephant corridors notified under Project Elephant.
Tribal Rights	Forest Rights Act 2006 implemented for community resource governance.
Sustainable Tourism	Eco-tourism circuits proposed under Jharkhand Tourism Policy 2025.

Prelims Connect

- Location: West Singhbhum, Jharkhand.
- Area: 820 sq km.
- Type: Sal forest; part of Singhbhum Elephant Reserve.
- Rivers: Koina and Karo.
- Act Involved: Wildlife (Protection) Act 1972; Forest (Conservation) Amendment Act 2023.

- Species: Asian Elephant, Leopard, Sloth Bear, Malabar Giant Squirrel.

Mains Connect

"Saranda illustrates India's trilemma of ecology, economy, and equity. Discuss the challenges in reconciling mineral development with ecological and tribal justice in forested regions."

Prelims Practice Question

Q. With reference to the Saranda Wildlife Sanctuary, consider the following statements:

- It forms part of the Singhbhum Elephant Reserve in Jharkhand.
- It is dominated by dry deciduous teak forests.
- The Koina and Karo rivers originate from this region.
- It has been notified as a Tiger Reserve under Project Tiger.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: Saranda is a sal forest (not teak) and part of an elephant reserve, not a tiger reserve.

Climate Inequality Report 2025: The Widening Divide in a Warming World

Why in News

The Climate Inequality Report 2025, released by the World Inequality Lab in collaboration with UNDP and Paris School of Economics, has drawn attention for revealing how climate change and inequality are reinforcing each other.

The richest 10% of the global population are responsible for nearly half of all CO₂ emissions, while the poorest 50% bear the brunt of climate impacts.

Background

The Climate Inequality Report (CIR) builds on global carbon-accounting datasets to examine how greenhouse gas (GHG) emissions and adaptation capacities are distributed across income groups, countries, and genders.

It argues that the climate crisis is not just an environmental issue, but a distributional injustice — one that mirrors and amplifies existing social inequalities.

UNDP India's regional brief, India's approach to climate equity — via initiatives like the Lifestyle for Environment (LiFE) Mission, National Adaptation Fund, and Just Energy Transition Partnerships (JETP) — is increasingly being seen as a model for inclusive sustainability.

Key Findings

1. Unequal Emissions:

- The top 1% globally emit 16% of CO₂, more than the entire bottom 66%.

- An average citizen of the U.S. emits 14 times more CO₂ than someone from Sub-Saharan Africa (The Indian Express).

- India's per capita emission remains one-third of the global average, yet internal disparities are widening — the top 10% in India emit 4 times more than the bottom 50%.

2. Adaptation Disparity:

- Developing countries receive less than 20% of required adaptation finance (UNEP Adaptation Gap Report 2025).
- Coastal and agrarian communities face heightened vulnerability due to poor insurance and infrastructure.

3. Climate Income Inequality:

- Climate shocks (floods, heatwaves, crop loss) are disproportionately pushing low-income populations into debt.
- Women and informal workers experience greater livelihood and health impacts due to energy poverty.

4. Policy and Fiscal Asymmetry:

- Wealthy nations spend five times more on fossil fuel subsidies than on climate adaptation aid.
- The top 100 fossil fuel companies account for 70% of industrial emissions since 1988.

India in Focus

- India has maintained a carbon equity stance in global negotiations — emphasising common but differentiated responsibilities (CBDR).
- Domestic initiatives such as National Green Hydrogen Mission, PM Surya Ghar Yojana, and LiFE Mission align individual behaviour with sustainability.
- India's State Action Plans on Climate Change (SAPCC) include livelihood-based adaptation strategies focusing on women, small farmers, and forest dwellers.

Thematic Insights

Theme	Observation	Policy Suggestion
Energy Transition Justice	High-income nations monopolise clean tech investment.	Global carbon tax or loss & damage fund should ensure fair redistribution.
Gender Inequality	Women face "climate-care" burden, unpaid adaptation labour.	Gender-responsive budgeting in climate schemes.
Intergenerational Equity	Future generations inherit both debt and degradation.	Constitutional embedding of intergenerational justice (as in India's Art. 48A).

Global and Institutional Context

- Published by: World Inequality Lab (co-led by Thomas Piketty, Lucas Chancel).
- Partner Institutions: UNDP, Paris School of Economics.

- Linked Frameworks:
 - Paris Agreement (2015) – equity and CBDR.
 - UNEP Adaptation Gap Report 2025 – financial asymmetry.
 - IPCC AR6 Findings – regional inequality in heat stress and water security.

Prelims Connect

- Report: Climate Inequality Report by World Inequality Lab.
- Key Concept: “Climate apartheid” – disparity between emitters and victims.
- India’s Emission Share: ~7% of global total; per capita <2 tCO₂.
- Linked Missions: LiFE, National Adaptation Fund, National Green Hydrogen Mission.

Mains Connect

“The climate crisis is the new face of global inequality.” Discuss how unequal emissions and adaptation capacities perpetuate developmental and moral asymmetries, with special reference to India’s equity approach.

Prelims Practice Question

- Q. With reference to the Climate Inequality Report 2025, consider the following statements:
1. The report is published by the United Nations Framework Convention on Climate Change (UNFCCC).
 2. It analyses global inequality in emissions, adaptation capacity, and finance.
 3. According to the report, the top 10% of global population account for about half of total carbon emissions.
 4. India’s per capita emissions are above the global average.
- Which of the statements given above are correct?
- (a) 2 and 3 only (b) 1 and 4 only
(c) 2, 3 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: The report is by the World Inequality Lab (not UNFCCC); India’s per capita emissions are below global average.

AmazonFACE Programme: Understanding Forest Response to Climate Change

Why in News

The AmazonFACE (Free-Air CO₂ Enrichment) programme, a joint initiative of Brazil’s Ministry of Science, Technology & Innovation (MCTI) and the U.S. Department of Energy, has entered its operational research phase in 2025.

The project will simulate future atmospheric CO₂ concentrations in parts of the Amazon rainforest to study

how tropical forests respond to rising carbon levels and climate stress.

Background

Tropical forests like the Amazon absorb nearly 25% of global CO₂ emissions, acting as vital carbon sinks.

However, prolonged droughts, deforestation, and temperature rise have raised concerns that the Amazon may soon shift from being a carbon sink to a carbon source.

The AmazonFACE experiment, located near Manaus, Brazil, is the first large-scale field study to expose intact rainforest plots to controlled increases in CO₂ to assess physiological, hydrological, and ecological responses.

Objectives of the Programme

1. **Simulate Future Atmosphere:** Test how mature Amazonian trees respond to CO₂ concentrations projected for 2050–2070 (~600 ppm).
2. **Assess Forest Resilience:** Measure photosynthesis, nutrient cycling, and soil–water interactions under enhanced CO₂.
3. **Model Climate Feedbacks:** Evaluate whether forests will continue absorbing CO₂ or reach saturation points.
4. **Guide Global Climate Policy:** Generate data for IPCC’s next generation of Earth system models.

Significance

- **Global Climate Research Breakthrough:** The project is expected to provide unprecedented insights into the carbon–climate feedback loop, one of the biggest uncertainties in global climate projections (PIB Science Update, Oct 2025).
- **Amazon’s Role in Global Stability:** The rainforest influences rainfall patterns across Latin America and even South Asia via teleconnections.
- **India’s Interest:** The Indian Institute of Tropical Meteorology (IITM) and ISRO have expressed intent to model similar FACE (Free-Air CO₂ Enrichment) experiments in Indian deciduous forests to understand carbon–water trade-offs.

Key Institutions & Partnerships

Partner	Role
MCTI (Brazil)	Infrastructure, ecosystem monitoring.
U.S. Department of Energy (DOE)	Technology, data analysis, climate modeling.
INPA (National Institute for Amazonian Research)	Ecophysiological research, biodiversity impacts.
UNESCO Biosphere Reserve Network	Knowledge exchange and conservation outreach.

Concerns & Challenges

1. **Deforestation Threat:** Illegal logging and fire-prone land conversion may disrupt long-term monitoring.
2. **Scientific Uncertainty:** Extrapolating small-scale CO₂ experiments to vast heterogeneous forest systems.

3. **Funding Sustainability:** Estimated cost exceeds USD 100 million over 10 years, dependent on international cooperation.
4. **Geopolitical Dimension:** Brazil's balancing of ecological diplomacy and development rights in Amazon management.

Global Context

- Similar FACE Experiments:
 - EUROFACE – Europe (Poplar forests).
 - BIFoR FACE – UK (temperate oak forests).
 - EucFACE – Australia (Eucalyptus ecosystems).
- IPCC AR6 Emphasis: Amazon's destabilisation could add 90 Gt CO₂ to the atmosphere by 2100 if tipping point breached.
- UNEP's Adaptation Gap Report 2025: Highlights need for research on ecosystem-based adaptation and carbon sequestration sustainability.

Prelims Connect

- **FACE:** Free-Air CO₂ Enrichment technique to study plant and ecosystem responses under elevated CO₂.
- **AmazonFACE Location:** Near Manaus, Brazil.
- **Key Focus:** Carbon sequestration, nutrient limitation, and biodiversity resilience.
- **Relevance to IPCC:** Provides empirical input for climate models.

Mains Connect

"Large-scale ecosystem experiments like AmazonFACE are crucial for predicting global carbon cycle feedbacks. Discuss their implications for climate policy and tropical forest management."

Prelims Practice Question

- Q. With reference to the AmazonFACE programme, consider the following statements:
1. It aims to study how tropical rainforests respond to elevated levels of atmospheric carbon dioxide.
 2. The experiment is jointly led by Brazil and India.
 3. FACE stands for Free-Air CO₂ Enrichment.
 4. The project data are intended for improving IPCC climate models.
- Which of the statements given above are correct?
- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: India is not a partner; project is led by Brazil and the U.S.

Towards India's Clean Energy Revolution

Why in News

As India accelerates its transition toward a low-carbon future, debates around the pace, financing, and equity of the clean energy shift have intensified.

"The Critical Factor in India's Clean Energy Ambitions" highlighted the challenge of aligning rapid renewable expansion with grid reliability, energy access, and domestic manufacturing.

Energy Transition Update reaffirmed India's targets of achieving 500 GW of non-fossil fuel capacity and 50% cumulative power generation from renewables by 2030 under the Nationally Determined Contributions (NDCs).

Background

India ranks third globally in renewable energy (RE) capacity after China and the U.S., with more than 187 GW of installed RE power as of mid-2025.

Yet, the path to clean energy is complex — balancing economic growth, energy justice, and technological sovereignty.

The country's energy demand is expected to double by 2040, driven by urbanisation, manufacturing, and electric mobility.

The clean energy revolution thus represents not just a climate imperative but an economic and geopolitical one.

Key Pillars of India's Energy Transition

1. Renewable Expansion:

- Solar Power: 80 GW installed; India aims for 280 GW by 2030.
- Wind Energy: 47 GW operational; offshore projects being piloted in Gujarat and Tamil Nadu.
- Hydropower & Small Hydro: 51 GW capacity, including pumped-storage systems for balancing.

2. Energy Storage Revolution:

- National Energy Storage Mission (NESM): Targets 400 GWh of battery capacity by 2030.
- PLI Scheme for ACC Batteries: ₹18,100 crore incentive for domestic manufacturing.
- Green Hydrogen Mission (₹19,744 crore): Aims for 5 MMT annual production by 2030.

3. Grid Modernisation:

- Revamped Distribution Sector Scheme (RDSS): ₹3 lakh crore to reduce losses and modernise infrastructure.
- Green Energy Corridor (GEC-II): Enhancing inter-state grid integration for renewable evacuation.

4. Financial Architecture:

- India needs \$10 trillion in cumulative investment till 2070 for its net-zero journey (NITI Aayog, 2025).
- Sovereign Green Bonds and Climate Finance Facilities (CFFs) being expanded through the World Bank and ADB.

Challenges in the Transition

- **Intermittency:** Solar and wind variability strain grid stability.

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- **Storage Deficit:** Battery costs remain high; recycling ecosystem still weak.
- **Coal Dependence:** Coal continues to provide over 70% of power generation.
- **Financing Gaps:** Limited green finance access for MSMEs and discoms.
- **Land Conflicts:** Large RE parks often clash with agricultural and biodiversity priorities.

Recent Government Initiatives (2024–25)

Scheme / Policy	Objective / Status
PM-KUSUM Scheme	Solarise 30 lakh agricultural pumps; 60% subsidy for farmers.
Green Hydrogen Policy (2023)	Open-access renewable power for hydrogen production.
National Offshore Wind Energy Policy (2024)	Streamlined approvals and viability gap funding.
Solar Rooftop Programme Phase II	30 GW rooftop capacity; net-metering reforms.
Carbon Credit Trading Scheme (CCTS 2023)	Introduces domestic market for emission trading.

Global & Strategic Context

- **International Solar Alliance (ISA):** India's leadership expanding joint projects in Africa and the Pacific.
- **One Sun One World One Grid (OSOWOG):** Cross-border electricity sharing across Asia and Europe.
- **G20 Energy Transition Working Group (2025):** India pushed for inclusion of low-cost finance and technology equity for developing nations.
- **COP30 Roadmap:** India to present its first Just Transition Framework balancing coal-dependent livelihoods with clean energy expansion.

Way Forward

- **Diversified Energy Mix:** Combine renewables with nuclear and hydro baseload.
- **Distributed Generation:** Promote rooftop solar, micro-grids, and peer-to-peer trading models.
- **Storage Innovation:** Incentivise sodium-ion and flow-battery research.
- **Green Finance Push:** Establish a National Climate Investment Facility (NCIF).
- **Skill Transition:** Upskill coal workforce for green hydrogen and EV industries.

Prelims Connect

- Target: 500 GW non-fossil fuel capacity by 2030.
- Green Hydrogen Mission: 5 MMT per annum by 2030.
- NESM: 400 GWh battery capacity goal.
- ISA HQ: Gurugram, India.

- OSOWOG: Trans-national renewable power grid initiative.

Mains Connect

"India's clean energy revolution must balance climate ambition with developmental realism." Examine the challenges and opportunities in achieving a just and resilient energy transition.

Prelims Practice Question

Q. With reference to India's clean energy transition, consider the following statements:

1. The Green Energy Corridor aims to integrate renewable power with the national grid.
2. India's Green Hydrogen Mission targets 5 MMT annual hydrogen production by 2030.
3. The PM-KUSUM scheme provides capital subsidy for solar irrigation pumps.
4. The Carbon Credit Trading Scheme applies only to the renewable power sector.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only
- (b) 2 and 4 only
- (c) 1 and 3 only
- (d) 1, 2, 3 and 4

Answer: (a)

Explanation: CCTS covers multiple sectors, not just renewables.

Loktak Lake: Balancing Ecology and Economy

Why in News

The Loktak Lake, Manipur's largest freshwater lake and a designated Ramsar site, has once again come into the spotlight after the Loktak Development Authority (LDA) proposed a new Integrated Management Plan (2025–2030). The plan aims to restore the lake's fragile ecosystem while promoting sustainable tourism and livelihood activities.

The Ministry of Environment, Forest and Climate Change's (MoEFCC) efforts to integrate Loktak Lake under the Wetlands (Conservation and Management) Rules, 2017 for stricter regulatory oversight.

Background

Loktak Lake often called the "lifeline of Manipur" covers nearly 287 sq km and is famous for its unique phumdis (floating biomass islands).

It supports over 230 plant species, 100 bird species, and several endangered animals including the Sangai (Manipur Brow-Antlered Deer), found only in Keibul Lamjao National Park, the world's only floating national park.

The lake is integral to hydropower generation, inland fisheries, irrigation, and local transport but decades of unregulated development and pollution have degraded its ecology.

Major Ecological Challenges

1. **Siltation & Eutrophication:** Continuous inflow of sediments and nutrients from catchments has reduced lake depth and oxygen content.
2. **Hydrological Disruption:** Construction of the Ithai Barrage (1983) altered the natural hydrology—reducing seasonal fluctuation crucial for phumdi regeneration.
3. **Encroachment & Unplanned Tourism:** Expansion of homestays and houseboats without ecological assessment.
4. **Pollution Load:** Urban wastewater and solid waste from Imphal River threaten water quality.
5. **Livelihood Stress:** Decline in fish catch has affected over 10,000 fisher households.

Recent Initiatives (2024–25)

- **Integrated Management Plan 2025–30:** Focuses on hydrological restoration, waste management, livelihood diversification, and climate-resilient infrastructure.
- **National Mission for Clean Ganga (NMCG)-linked Wetland Model:** Technical collaboration for bioremediation and sediment trapping.
- **Eco-Tourism Framework (MoEFCC 2025):** Proposes zoning for “core”, “buffer”, and “sustainable use” areas around the lake.
- **Community Stewardship:** Fisher cooperatives involved in phumdi maintenance and solid-waste collection under Swachh Jal Abhiyan 2025.
- **Smart Wetland Monitoring System:** Remote-sensing-based dashboard to track changes in lake morphology (developed by ISRO & LDA).

Balancing Ecology and Economy

Dimension	Ecological Action	Socio-Economic Outcome
Hydrology	Seasonal drawdown management for phumdi rejuvenation	Restores natural breeding cycles of fish & aquatic life
Tourism	Regulated eco-tourism with carrying-capacity norms	Enhances local income without habitat loss
Community Role	Co-management with fisher cooperatives	Builds local ownership & accountability
Governance	Integration under Wetlands Rules 2017	Brings legal protection & stricter oversight

Prelims Connect

- Location: Bishnupur district, Manipur.
- Type: Freshwater, phumdi-based wetland.

- Associated National Park: Keibul Lamjao National Park.
- Designation: Ramsar site (1990).
- Major River: Imphal River inflow; Ithai Barrage regulates outflow.
- Schemes: National Plan for Conservation of Aquatic Ecosystems (NPCA), Swachh Jal Abhiyan 2025.

Mains Connect

“Loktak Lake exemplifies India’s challenge of reconciling ecological fragility with developmental aspirations.” Discuss the importance of community-centric approaches in restoring wetland ecosystems.

Prelims Practice Question

- Q. With reference to Loktak Lake, consider the following statements:
1. It is located in Manipur and supports the world’s only floating national park.
 2. It was declared a Ramsar site in 1990.
 3. The Ithai Barrage constructed on the Imphal River has improved the natural fluctuation of phumdis.
 4. It is covered under the Wetlands (Conservation and Management) Rules 2017.
- Which of the statements given above are correct?
- (a) 1, 2 and 4 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: The Ithai Barrage disrupted—not improved—hydrological balance of phumdis.

World Heritage Outlook 4 Report: Assessing the Global State of Conservation

Why in News

The International Union for Conservation of Nature (IUCN) released its World Heritage Outlook 4 Report (2025), offering the most comprehensive assessment yet of the conservation status of natural World Heritage sites.

The report warns that nearly two-thirds of natural heritage sites face significant threats from climate change, invasive species, and over-tourism — including several sites in India such as the Sundarbans National Park, Western Ghats, and Kaziranga National Park.

India’s ongoing conservation efforts under the National Biodiversity Mission and Integrated Landscape Management Approach to improve the protection status of its heritage sites.

Background

The World Heritage Outlook (WHO) is an IUCN initiative launched in 2014 to evaluate and track the state of conservation of all natural sites inscribed on UNESCO’s World Heritage List.

It assesses sites based on three key parameters:

1. Current Conservation Outlook (Good / Good with Some Concerns / Significant Concern / Critical)
2. Threats (climate, invasive species, pollution, etc.)
3. Management Effectiveness (planning, governance, and community involvement).

The 2025 edition—the fourth in the series—builds on assessments of 252 natural World Heritage sites across 96 countries.

Key Global Findings (2025 Report)

1. Worsening Trends:

- 65% of natural sites are now rated as "Significant Concern" or "Critical."
- Only 20% of sites have shown improvement since 2020.

2. Climate Change Dominates:

- Listed as the top threat for over 80% of sites.
- Coral reefs and glacier systems (Great Barrier Reef, Glacier National Park, Sagarmatha) most affected.

3. Habitat Degradation:

- Infrastructure expansion and tourism pressure increasing in Asia and Africa.

4. Positive Examples:

- Improved management noted in sites like Galápagos Islands (Ecuador) and Bwindi Impenetrable Forest (Uganda) due to local participation.

5. Data Integration:

- Use of satellite monitoring, AI-based ecological modeling, and real-time field reports strengthened site evaluation.

India in Focus

- **Sundarbans National Park:** Faces dual threats of sea-level rise and salinity intrusion affecting mangrove regeneration (The Hindu).
- **Western Ghats:** Degradation due to land-use change, quarrying, and monoculture plantations.
- **Kaziranga National Park:** Improved management but increasing flood vulnerability along Brahmaputra (Indian Express).
- **Keoladeo National Park:** Periodic droughts and inadequate water inflows from Chambal canal system.
- **Great Himalayan National Park:** Positive governance indicators due to community eco-tourism and buffer management.

India hosts 7 natural World Heritage sites, and the report underscores the need for integrated landscape conservation and community-inclusive management.

Conservation and Policy Linkages

Framework / Mission	Relevance
National Biodiversity Mission (NBM)	Strengthens biodiversity documentation and restoration.
Integrated Development of Wildlife Habitats (IDWH)	Financial and technical support for eco-sensitive areas.

CAMPA Funds	Utilised for habitat recovery and infrastructure.
National Adaptation Fund on Climate Change (NAFCC)	Supports resilience measures in climate-sensitive habitats.
UNESCO-IUCN-WII Partnership	Capacity building for Indian site managers.

Challenges for India

- Fragmented coordination between forest, tourism, and revenue departments.
- Climate impacts like coastal erosion (Sundarbans) and altered monsoon regimes (Western Ghats).
- Unregulated tourism in fragile ecosystems.
- Limited data-sharing between States and central conservation bodies.

Way Forward

- Establish a National Heritage Conservation Authority for unified site management.
- Implement climate adaptation plans for each heritage landscape.
- Integrate community-based tourism with conservation revenue sharing.
- Expand eco-sensitive zones around heritage sites.
- Leverage AI and GIS for real-time biodiversity and visitor monitoring.

Prelims Connect

- Publisher: International Union for Conservation of Nature (IUCN).
- Edition: Fourth (2025).
- Coverage: 252 natural World Heritage sites, 96 countries.
- India's Natural World Heritage Sites:
 1. Kaziranga National Park
 2. Manas Wildlife Sanctuary
 3. Sundarbans National Park
 4. Nanda Devi & Valley of Flowers
 5. Western Ghats
 6. Great Himalayan National Park
 7. Khangchendzonga National Park

Mains Connect

"The World Heritage Outlook 4 Report reveals that natural heritage is not static but vulnerable. Examine the role of global and national frameworks in ensuring the resilience of India's World Heritage sites."

Prelims Practice Question

- Q. With reference to the World Heritage Outlook 4 Report (2025), consider the following statements:
1. It is published by UNESCO's World Heritage Centre.

- The report assesses both natural and cultural heritage sites.
- Climate change has been identified as the greatest threat to natural heritage sites.
- The report covers India's seven natural World Heritage sites.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 3 and 4 only
(c) 2 and 4 only (d) 1, 3 and 4 only

Answer: (b)

Explanation: The report is published by IUCN, not UNESCO, and covers only natural heritage sites.

Bondla Wildlife Sanctuary: Goa's Green Microcosm

Why in News

The Bondla Wildlife Sanctuary in Goa has recently been in the spotlight after the Goa Forest Department, in collaboration with the Wildlife Institute of India (WII), initiated a project for micro-level biodiversity mapping and eco-restoration.

The move aims to strengthen habitat protection, control invasive species, and develop sustainable eco-tourism under the National Mission for Biodiversity and Human Wellbeing (NMBHWB).

Bondla will serve as a pilot site for the Goa Wildlife Connectivity Network, linking smaller sanctuaries like Mhadei, Netravali, and Cotigao into a contiguous Western Ghats corridor.

Background

Declared a sanctuary in 1969, Bondla is Goa's smallest wildlife sanctuary—covering 8 km² in the Ponda sub-division—yet it represents an exceptional diversity of flora and fauna typical of the Western Ghats biodiversity hotspot. The sanctuary acts as a microcosm of Goa's ecological wealth—housing dry deciduous forests, moist deciduous stretches, and evergreen patches, all within a compact area. It is also one of Goa's key sites for environmental education and ecotourism, with a dedicated Nature Education Centre, Botanical Garden, and Deer Park.

Ecological Significance

- Flora:** Over 150 species of plants, including Terminalia, Lagerstroemia, and Bambusa species.
- Fauna:** Habitat to Indian bison (gaur), sambar, leopard, jungle cat, porcupine, and over 120 bird species such as Malabar trogon and Indian great hornbill.
- Ecosystem Services:** Acts as a crucial catchment for local streams feeding into the Mandovi and Zuari river systems.
- Education Hub:** Serves as Goa's model for integrating biodiversity learning with tourism.

Recent Developments (2024–25)

- Habitat Restoration Drive:** Removal of invasive species such as Lantana camara and Chromolaena odorata from 60 hectares.
- Digital Biodiversity Mapping:** Drone-based vegetation classification for habitat quality assessment.
- Eco-Tourism Model:** New interpretive trails with carrying-capacity limits and solar-lit visitor centres.
- Wildlife Connectivity:** Radio-collar studies of leopards and gaurs under the Goa Wildlife Connectivity Project (WII–MoEFCC collaboration).
- Community Involvement:** Local forest-dependent communities trained as eco-guides under Green Skill Development Programme (GSDP).

Conservation and Policy Context

Framework	Relevance to Bondla
National Mission for Biodiversity & Human Wellbeing (NMBHWB)	Integrates human livelihoods with ecological services.
Eco-Tourism Policy 2025 (Goa)	Promotes low-impact, community-based tourism.
CAMPA Fund Utilisation	Used for afforestation and eco-infrastructure.
Western Ghats Conservation Authority (proposed)	Ensures coordinated protection across state borders.

Challenges

- Small Size & Isolation:** Fragmentation limits genetic diversity and dispersal of large mammals.
- Tourism Pressure:** Visitor numbers rising without proportional waste management capacity.
- Climate Sensitivity:** Seasonal droughts and rainfall irregularities stress vegetation and water sources.
- Connectivity Gaps:** Urbanisation between Ponda and Mollem obstructs wildlife corridors.

Way Forward

- Expand buffer zones to connect Bondla with larger sanctuaries (Mhadei–Netravali axis).
- Promote controlled eco-tourism with carbon-neutral infrastructure.
- Adopt citizen science models for biodiversity documentation.
- Establish climate-resilient microhabitats through native species plantation.
- Integrate Bondla under the UNESCO Western Ghats World Heritage Management Plan.

Prelims Connect

- State: Goa.
- Area: 8 km².

- Established: 1969.
- Vegetation Type: Moist deciduous to semi-evergreen.
- Major Fauna: Gaur, leopard, sambar, Malabar giant squirrel.
- Rivers: Feeds tributaries of Mandovi and Zuari.
- Related Policy: NMBHWB, Eco-Tourism Policy 2025.

Mains Connect

"Micro-level sanctuaries like Bondla demonstrate how conservation and livelihood can coexist when ecological integrity is placed at the core of development." Discuss with reference to Western Ghats biodiversity management.

Prelims Practice Question

Q. With reference to Bondla Wildlife Sanctuary, consider the following statements:

1. It is Goa's largest wildlife sanctuary, part of the Nilgiri Biosphere Reserve.
2. It is known for its dry deciduous forests and biodiversity education centre.
3. It was established in 1969 and lies in the Ponda sub-division.
4. It forms part of the Western Ghats biodiversity corridor.

Which of the statements given above are correct?

- (a) 2, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Bondla is Goa's smallest, not largest sanctuary; it lies in the Western Ghats region.

Panda Diplomacy: Soft Power in a Changing Geopolitical Climate

Why in News

In late 2025, China's Ministry of Foreign Affairs confirmed the renewal of panda loan agreements with several countries, including the U.S., Spain, and Australia, after a pause in 2023–24 that coincided with heightened diplomatic tensions.

Beijing's decision to extend or recall pandas is being viewed as a strategic recalibration of "panda diplomacy" — the use of cultural symbols to influence international goodwill and image politics.

Background

"Panda Diplomacy" refers to China's practice of gifting or loaning giant pandas (*Ailuropoda melanoleuca*) to foreign zoos as symbols of friendship, cooperation, and soft power. The tradition began during the Tang dynasty, but gained prominence in the 1950s when Mao Zedong sent pandas to allied nations such as the Soviet Union and North Korea.

In 1984, China formalised the practice into renewable research loans rather than outright gifts, aligning it with

conservation and revenue interests under the Convention on International Trade in Endangered Species (CITES) framework.

Key Features of Modern Panda Diplomacy

1. **Symbol of Friendship:** Pandas are sent on long-term loans (typically 10–15 years) to countries with significant strategic or economic ties.
2. **Economic Component:** Host zoos pay an annual fee (≈ USD 1 million per panda), part of which funds China's Wolong and Chengdu breeding programmes.
3. **Conservation Link:** Cooperation in captive breeding and research on endangered species helps project a pro-environment image.
4. **Political Messaging:** Panda deployment or recall often mirrors geopolitical alignment — for example, returns from the U.S. in 2023 reflected strained relations, while renewed loans in 2025 signal thawing ties.

Recent Developments (2024–25)

- **Return to the U.S.:** Two pandas sent to Washington D.C.'s National Zoo in October 2025 mark restoration of cultural ties after a two-year gap (The Hindu).
- **Australia Agreement:** Canberra and Beijing signed a new five-year panda research deal linked to climate-resilient bamboo studies (Indian Express, Nov 2025).
- India views panda diplomacy as part of broader cultural diplomacy trends, contrasting it with India's own use of yoga, Ayurveda, and Buddhist heritage for soft power projection.

Geopolitical Significance

Dimension	Strategic Implication
Soft-Power Branding	Enhances China's global image as an environmental and cultural power.
Diplomatic Leveraging	Used to reset strained relations or commemorate trade pacts.
Economic Symbolism	Generates tourism and zoo-based revenue; promotes Chinese ecotourism.
Environmental Diplomacy	Supports global biodiversity conservation narrative.

Critiques & Counter-Views

- **Symbolic, not Substantive:** Critics argue it distracts from China's record on wildlife trade and habitat loss.
- **Dependency Diplomacy:** Loan conditions reinforce hierarchical relations rather than equality.
- **Ethical Concerns:** Long transport, confinement, and commercialisation of animals questioned by wildlife activists.
- **Soft Power Fatigue:** Overuse may reduce emotional novelty, especially among younger global audiences.

Comparative Soft-Power Models

- India: Yoga diplomacy, International Day of Yoga (UNGA Resolution 2014).
- Japan: Kawaii (cute culture) diplomacy through mascots and anime.
- South Korea: K-culture exports and global music diplomacy.

Prelims Connect

- Species: Giant Panda (*Ailuropoda melanoleuca*).
- IUCN Status: Vulnerable (2024).
- Conservation Framework: CITES Appendix I; China's National Panda Conservation Plan.
- Diplomacy Origin: Mao-era symbolic gifting; modern form – renewable research loans (post-1984).

Mains Connect

"Panda diplomacy reflects how soft power and ecological symbolism intersect in global politics." Examine the changing relevance of cultural and environmental diplomacy in India's foreign policy context.

Prelims Practice Question

Q. With reference to "Panda Diplomacy", consider the following statements:

1. It involves gifting pandas permanently to foreign countries as part of bilateral aid.
2. It originated in China and is now regulated under CITES.
3. Host countries usually pay an annual fee to fund panda conservation in China.
4. Pandas loaned abroad remain property of the host nation after a decade.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 1 and 3 only (d) 2, 3 and 4 only

Answer: (a)

Explanation: Pandas are loaned, not gifted, and remain China's property under CITES guidelines.

Carbon Capture, Usage and Storage (CCUS): The Next Frontier in India's Net-Zero Strategy**Why in News**

As India advances its Net Zero by 2070 commitment, the spotlight has turned to Carbon Capture, Usage, and Storage (CCUS) — a key tool for decarbonising hard-to-abate sectors like steel, cement, and petrochemicals.

India's evolving policy architecture for CCUS as part of the National Mission on Carbon Capture, Utilisation, and Storage (NMCCUS), aligning with India's broader Low-Carbon Development Strategy 2050.

CCUS could potentially capture 750 million tonnes of CO₂ annually by 2050, if supported by policy incentives and industrial participation.

Background

CCUS is a set of technologies that capture carbon dioxide (CO₂) from industrial emissions or directly from the air, transport it to a storage site, and either utilise it for products or store it permanently underground.

Globally, CCUS is recognised by the Intergovernmental Panel on Climate Change (IPCC) as essential for achieving net-zero targets — particularly for sectors where emissions cannot be entirely eliminated through renewables.

In India, the Ministry of Power and the NITI Aayog-led CO₂ Capture Taskforce are framing a policy roadmap to integrate CCUS into industrial clusters across Gujarat, Odisha, and Tamil Nadu.

Core Components of CCUS

1. **Capture:** CO₂ is captured from point sources like power plants, refineries, and cement factories through pre-combustion, post-combustion, or oxy-fuel methods.
2. **Transport:** The captured CO₂ is compressed and transported via pipelines or ships.
3. **Utilisation:** CO₂ is used for enhanced oil recovery (EOR), synthetic fuels, or chemical production.
4. **Storage:** Injected deep underground into geological formations such as saline aquifers or depleted oil fields.

Why CCUS Matters for India

- **High Emission Intensity:** India's industrial sector accounts for 30% of total CO₂ emissions.
- **Net-Zero Enabler:** Needed for hard-to-abate industries beyond the reach of renewable electrification.
- **Energy Security:** Enables low-carbon use of coal and natural gas while transitioning to renewables.
- **Economic Opportunity:** Estimated to attract \$100 billion in investments by 2050.
- **Global Alignment:** Supports commitments under the Paris Agreement Article 4 on technology pathways for mitigation.

Recent Developments (2024–25)

Initiative	Objective / Outcome
National Mission on CCUS (NMCCUS)	Draft policy for industrial decarbonisation through carbon capture; pilot sites in Gujarat and Odisha.
ONGC–IIT Bombay Pilot Project	Injecting captured CO ₂ into depleted oil wells for enhanced recovery.
NTPC's Direct Air Capture Unit (Madhya Pradesh)	India's first public-sector DAC prototype capturing 20 tonnes CO ₂ /day.
Tata Steel CCU Unit (Jamshedpur)	Captures 100 tonnes CO ₂ /day for soda ash production.
Global CCUS Forum (2025)	India–Japan collaboration for carbon recycling technologies.

Challenges

- **High Cost:** \$40–\$100 per tonne CO₂ captured; lack of carbon pricing mechanisms.
- **Regulatory Gaps:** No comprehensive legal framework for storage liability or monitoring.
- **Geological Uncertainty:** Limited national mapping of storage sites.
- **Energy Penalty:** Capture process increases power consumption by 20–30%.
- **Public Perception:** Safety and leak concerns around underground storage.

Potential Utilisation Pathways

- **Chemical Conversion:** CO₂ to methanol, urea, or synthetic fuels.
- **Bioenergy with CCS (BECCS):** Combines biomass energy with capture for negative emissions.
- **Direct Air Capture (DAC):** Pulls CO₂ directly from atmosphere — still at pilot stage.
- **Mineralisation:** Permanent storage through reaction with alkaline industrial residues.

Policy and Institutional Framework

- **Implementing Ministry:** Ministry of Power (in coordination with MoPNG & MoEFCC).
- **Research Anchors:** BHEL, NTPC, ONGC, IITs, and CSIR labs.
- **Funding Source:** Green Climate Fund (GCF), NCEF, and Sovereign Green Bonds.
- **Private Participation:** Adani Green, Reliance New Energy, and Vedanta exploring CCUS integration in refineries and cement.

Prelims Connect

- **CCUS:** Carbon Capture, Usage and Storage — captures CO₂ for utilisation or permanent storage.
- **BECCS:** Bioenergy with Carbon Capture and Storage; enables “negative emissions.”
- **DAC:** Direct Air Capture — removes CO₂ from air.
- **Global Example:** Sleipner Project (Norway), Boundary Dam (Canada).
- **Indian Pilot:** NTPC DAC Unit, Tata Steel CCU Plant (Jamshedpur).

Mains Connect

“Carbon capture technologies hold promise but not a panacea.” Examine the role of CCUS in India’s net-zero pathway and discuss challenges in scaling its deployment.

Prelims Practice Question

- Q. With reference to Carbon Capture, Usage and Storage (CCUS), consider the following statements:
1. CCUS can only be used in the power sector and not in industrial processes.
 2. Bioenergy with CCUS (BECCS) enables the creation of negative emissions.

3. India’s first industrial-scale CCU plant is operated by Tata Steel in Jamshedpur.
4. The National Mission on CCUS is implemented by the Ministry of Environment, Forest and Climate Change.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 3 only (d) 1, 2 and 4 only

Answer: (a)

Explanation: CCUS is applicable across industries; the mission is coordinated by the Ministry of Power, not MoEFCC.

SCIENCE & TECHNOLOGY

India Mobile Congress (IMC) 2025

News Excerpt:

- The India Mobile Congress 2025 was inaugurated in New Delhi with the theme “Digital Bharat: Smart, Secure, Sustainable.”

Why in News:

- Focus on 6G technology, semiconductor innovation, and AI-driven connectivity solutions.

About:

- Jointly organized by DoT and COAI.
- Key participation from global tech leaders and Indian startups.
- Showcased advancements in 5G applications, 6G research, satellite internet, and IoT ecosystems.
- Platform for policy discussions and innovation funding.

Way Forward:

- Strengthen R&D for indigenous 6G stack.
- Encourage private–public collaboration for digital infrastructure.
- Ensure cyber-resilient and inclusive connectivity in rural India.

SPARK–4.0

News Excerpt:

- The Department of Science and Technology (DST) launched SPARK 4.0 to foster innovation, R&D, and startup collaboration in frontier technologies.

Why in News:

- Part of India’s effort to become a global innovation hub and boost deep-tech entrepreneurship.

About:

- SPARK stands for “Science Promotion through Advanced Research and Knowledge”.
- Version 4.0 focuses on AI, quantum computing, materials science, space tech, and biotechnology.
- Provides funding, mentorship, and infrastructure to academic–industry partnerships.
- Linked with Atal Innovation Mission and Startup India 3.0.

Way Forward:

- Create global innovation clusters in Tier-II cities.
- Ensure intellectual property protection for researchers.
- Promote academia–industry co-creation ecosystems.

Bordetella holmesii: The Emerging Respiratory Pathogen in India's Post-COVID Landscape

Why in News

Recent studies by the ICMR–National Institute of Virology (NIV), Pune, have detected a rising number of *Bordetella holmesii* infections in several Indian states, particularly among adolescents and adults misdiagnosed with whooping cough (pertussis).

This pathogen, once considered rare, is now emerging as a co-circulating respiratory threat in the post-COVID environment, complicating public-health diagnostics and vaccination strategies.

Background

Bordetella holmesii is a Gram-negative, non-motile coccobacillus closely related to *Bordetella pertussis*, the bacterium responsible for classic whooping cough.

It was first identified in 1995 by Dr. Barry Holmes and has since been recognised as an opportunistic respiratory pathogen, particularly in patients with weakened immunity or pre-existing respiratory conditions.

Unlike *B. pertussis*, *B. holmesii* often causes mild or atypical symptoms, leading to under-reporting and diagnostic confusion.

Key Highlights**1. Clinical Presentation**

- Causes prolonged cough, low-grade fever, and fatigue—symptoms easily mistaken for viral infections.
- Associated with bacteremia and endocarditis in immunocompromised individuals.

2. Diagnostic Challenges

- Routine PCR tests for *B. pertussis* can cross-react with *B. holmesii*, leading to false-positive results.
- ICMR has now standardised species-specific PCR primers for accurate detection.

3. Vaccine Limitations

- Current DTaP and Tdap vaccines target *B. pertussis* and offer limited cross-protection.
- The emergence of *B. holmesii* highlights the need to update antigenic components in future formulations.

4. Epidemiological Trend

- Detected in Maharashtra, Delhi, and Karnataka clusters during 2024–25.
- Surveillance shows co-infection with influenza and SARS-CoV-2 subvariants, increasing disease severity.

5. Public-Health Response

- ICMR and WHO are integrating *B. holmesii* testing into India's Integrated Disease Surveillance Programme (IDSP).
- Focus on genomic sequencing to monitor mutation and antibiotic resistance trends.

Significance

- **Epidemiological Awareness:** Adds a new dimension to India's respiratory-disease surveillance beyond COVID-19 and influenza.
- **Vaccine Policy Implications:** Demands review of pertussis immunisation strategies under the Universal Immunisation Programme (UIP).
- **Diagnostic Reform:** Encourages multi-pathogen molecular testing in respiratory panels.
- **Antimicrobial Stewardship:** Overuse of macrolides and quinolones without differentiation increases resistance risks.

Prelims Connect

- Pathogen: *Bordetella holmesii* — Gram-negative coccobacillus.
- Transmission: Respiratory droplets and close contact.
- Distinction: Different from *B. pertussis* (classical whooping cough) and *B. parapertussis*.
- Diagnosis: Real-time PCR and genome sequencing.
- Prevention: No specific vaccine; hygiene and early detection critical.

Mains Connect

"The emergence of *Bordetella holmesii* underscores the dynamic nature of infectious-disease ecology in a post-pandemic world." Examine how genomic surveillance can strengthen India's preparedness for new respiratory pathogens.

Prelims Practice Question

Q. With reference to *Bordetella holmesii*, consider the following statements:

1. It is a Gram-positive bacterium responsible for classical whooping cough.
2. It can cause prolonged cough and mild fever, often misdiagnosed as *Bordetella pertussis* infection.
3. There is no dedicated vaccine available against *Bordetella holmesii*.
4. It has been recently detected in India through ICMR's respiratory-pathogen surveillance.

Which of the statements given above are correct?

- (a) 1 and 2 only (b) 2, 3 and 4 only
(c) 1, 3 and 4 only (d) 2 and 4 only

Answer: (b)

Explanation: *Bordetella holmesii* is Gram-negative, not Gram-positive, and currently has no specific vaccine; India's ICMR has confirmed its local detection.

Global Virus Network (GVN): Building Collaborative Shields Against Future Pandemics

Why in News

The Global Virus Network (GVN) has formally included India's Translational Health Science and Technology Institute (THSTI) and the National Institute of Virology (NIV), Pune as new Centres of Excellence in 2025.

This move strengthens India's leadership in global virology research, vaccine design, and pandemic preparedness — enhancing its role as a key contributor to the international biosurveillance ecosystem.

Background

The Global Virus Network, established in 2011, is an independent coalition of leading medical virologists and research institutes across more than 40 countries.

Its primary aim is to prevent illness and death from viral diseases through collaborative research, rapid response to outbreaks, and capacity building.

GVN acts as a scientific complement to WHO by facilitating direct, real-time collaboration among global laboratories — from basic viral genetics to vaccine innovation.

Key Highlights

1. India's Inclusion

- THSTI (Faridabad) and NIV (Pune) designated as GVN Centres of Excellence, joining a global network that includes Johns Hopkins (USA), Pasteur Institute (France), and Rega Institute (Belgium).
- Focus areas: Zoonotic spillovers, antiviral therapeutics, vaccine platforms, and viral genomics.

2. Objectives of GVN

- Create a global rapid-response system for emerging viral threats.
- Promote training for young virologists through GVN Fellowship and Exchange Programmes.
- Facilitate open data sharing during public health emergencies.

3. Recent Global Focus

- Research on Nipah, Zika, Dengue, and SARS-CoV-2 variants.
- Initiative for pan-coronavirus and universal influenza vaccine design.
- Cross-border collaboration on climate-linked viral outbreaks such as Rift Valley Fever and West Nile Virus.

4. Funding and Support

- Supported by the Rockefeller Foundation, CEPI, and national research councils.
- India's participation backed by DBT (Department of Biotechnology) and ICMR.

Significance

- Scientific Diplomacy:** Enhances India's integration into the global virus research architecture and boosts soft power in global health governance.
- Pandemic Preparedness:** Enables faster pathogen identification and real-time genomic surveillance in collaboration with other GVN labs.
- Capacity Building:** Strengthens India's technical manpower for vaccine and diagnostic R&D.
- Zoonotic Vigilance:** Crucial for a country like India, which lies at the intersection of livestock, wildlife, and dense human populations.
- South-South Collaboration:** Opens channels for cooperation with African and Southeast Asian laboratories.

Recent Developments (2025)

- Launch of GVN-India Viral Genomics Programme linking 22 regional labs for real-time sequencing.
- India to host the 14th International GVN Summit 2026 in New Delhi.
- Collaborative development of mRNA-based vaccine templates adaptable for new viral strains.
- Integration with India's INSACOG network for genomic surveillance.

Way Forward

- Institutionalise a National Virus Preparedness Platform (NVPP) aligned with GVN protocols.
- Increase cross-border pathogen intelligence sharing under WHO's PPPR initiative.
- Expand One Health collaborations across veterinary and human health sectors.
- Encourage private-public partnerships in viral vaccine manufacturing.
- Create a "Bio-South Consortium" led by India for low-cost diagnostics in the Global South.

Prelims Connect

- GVN Headquarters: Baltimore, USA.
- Established: 2011.
- India's Centres of Excellence: THSTI (Faridabad) and NIV (Pune).
- INSACOG: India's genomic consortium for SARS-CoV-2 and emerging pathogens.
- CEPI: Coalition for Epidemic Preparedness Innovations — supports global vaccine development.

Mains Connect

"Pandemic preparedness is not built in panic but in partnership." Analyse how India's inclusion in the Global Virus Network enhances its global health security architecture.

Prelims Practice Question

- Q. With reference to the Global Virus Network (GVN), consider the following statements:

1. It is a WHO-led initiative headquartered in Geneva.
2. The National Institute of Virology, Pune, has been designated as one of GVN's Centres of Excellence.
3. GVN facilitates international collaboration in viral research and outbreak response.
4. It aims to develop universal vaccines for influenza and coronavirus families.

Which of the statements given above are correct?

- (a) 1, 2 and 4 only (b) 2, 3 and 4 only
(c) 1 and 3 only (d) 2 and 4 only

Answer: (b)

Explanation: GVN is an independent scientific network, not a WHO initiative, though it collaborates closely; India's NIV is a new Centre of Excellence.

Tiangong ("Heavenly Palace") Space Station: China's Expanding Footprint in Low-Earth Orbit

Why in News

China has successfully completed the second phase of scientific operations aboard the Tiangong Space Station, marking a milestone in its ambition to establish a permanent human presence in Low-Earth Orbit (LEO).

Recent experiments aboard Tiangong in quantum communication, microgravity biology, and dark-matter detection reflect China's growing leadership in independent space science and technology ecosystems.

Background

The Tiangong (meaning "Heavenly Palace") Space Station is China's first modular orbital outpost, developed under the China Manned Space Programme (CMSP).

It orbits the Earth at an altitude of 400 km, similar to the International Space Station (ISS), but is entirely domestically built and operated.

The station became fully operational in November 2022 after the successful docking of its three core modules — Tianhe, Wentian, and Mengtian.

China is now the only country with an independent, permanently crewed orbital station, following Russia's withdrawal from ISS participation and the gradual decommissioning of the ISS by 2030.

Key Highlights

1. Scientific Achievements (2023–25)

- Over 100 experiments conducted in microgravity combustion, materials science, human physiology, and quantum optics.
- First successful quantum key distribution (QKD) experiment from Tiangong to ground stations.
- Development of microgravity-grown protein crystals for cancer research.

2. Crew Operations

- Rotational Shenzhou missions continue, with each crew spending 6 months aboard.

- Experiments include space farming trials, AI-assisted maintenance, and 3D printing in microgravity.

3. International Cooperation

- Tiangong now open to global scientific proposals via UN–China Cooperation Framework (UNOOSA).
- Experiments from Pakistan, Germany, Italy, and Kenya already onboard or scheduled.

4. Strategic and Economic Goals

- Reinforces China's vision of "dual-use space assets" for science and defence.
- Serves as a precursor to China's Lunar Research Station (ILRS) planned for the 2030s in collaboration with Russia.

Significance

- **Scientific Autonomy:** Marks China's complete independence in space station technology, including launch vehicles, life-support, and payload integration.
- **Geopolitical Symbolism:** Establishes a counterweight to the Western-led ISS and enhances China's global space diplomacy outreach.
- **Commercial Potential:** Opens avenues for space tourism, manufacturing, and research for developing nations.
- **Strategic Leverage:** Tiangong's orbital network complements China's Beidou navigation system and satellite reconnaissance grid.
- **Multilateral Opportunity:** Encourages global cooperation through UNOOSA, making space more multipolar.

Challenges

- **Limited Crew Capacity:** Can host only three astronauts at a time, unlike ISS's seven.
- **Resource Logistics:** Dependence on regular Tianzhou cargo missions for fuel and food.
- **Transparency Concerns:** Limited data-sharing with global scientific bodies.
- **Space Debris Risk:** Frequent launches from Long March rockets contribute to LEO congestion.

Recent Developments

- Launch of Tianzhou-9 cargo spacecraft for extended life-support missions.
- China's Tiangong Global Science Campaign inviting proposals from developing nations.
- International Lunar Research Station (ILRS) joint planning phase initiated with Russia.
- AI-based Robotic Arm System demonstrated for module repair and satellite capture.

Way Forward

- Expand scientific collaborations under UNOOSA's open science charter.

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- Promote transparency in space debris mitigation and data sharing.
- Encourage India–China coordination in civilian space dialogues under the BRICS framework.
- Invest in human–AI hybrid operations to reduce astronaut workload.
- Integrate Tiangong outcomes with China's future lunar gateway and Mars sample-return missions.

Prelims Connect

- Tiangong Space Station: Modular orbital lab at 400 km altitude.
- Core Modules: Tianhe (core), Wentian (experiment), Mengtian (payload).
- Agency: China Manned Space Agency (CMSA).
- International Collaboration: Under UNOOSA's Access to Space for All Initiative.
- Orbit Duration: Operational lifespan expected till 2038.

Mains Connect

"Tiangong symbolises the emergence of a multipolar space order." Analyse how China's independent space station reshapes global space governance and cooperation frameworks.

Prelims Practice Question

- Q. With reference to the Tiangong Space Station, consider the following statements:
1. It is operated jointly by China and Russia under the ILRS programme.
 2. It orbits at an altitude similar to that of the International Space Station.
 3. Tiangong allows participation from international researchers through the UN's space cooperation mechanism.
 4. It can accommodate up to seven astronauts simultaneously.
- Which of the statements given above are correct?
- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 3 and 4 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: Tiangong is independently operated by China (not jointly with Russia), orbits at ~400 km, allows global participation under UNOOSA, and has capacity for three astronauts.

Intrusion Detection System: Strengthening India's Cyber Defence Architecture

Why in News

The Indian Computer Emergency Response Team (CERT-In) has recently upgraded its Intrusion Detection and Prevention System (IDPS) network to enhance real-time monitoring of cyber threats across government data centres and critical infrastructure.

The move aligns with India's broader push to build a national cyber situational awareness grid, protecting digital public infrastructure, defence networks, and financial systems from sophisticated cyber intrusions.

Background

An Intrusion Detection System (IDS) is a cybersecurity mechanism that monitors network traffic and system activities to detect malicious actions, policy violations, or security breaches.

It acts as a digital sentinel, identifying suspicious patterns and generating alerts for administrators to mitigate potential attacks.

There are two major types:

1. Network-based IDS (NIDS) – Monitors data packets across networks.
2. Host-based IDS (HIDS) – Observes activity on individual computers or servers.

An upgraded version, Intrusion Prevention System (IPS), not only detects but also blocks malicious traffic in real time.

Key Features of CERT-In's 2025 Upgrade

Feature	Description
AI-Powered Analytics	Uses machine learning to identify anomalies and previously unseen threat signatures.
National Cyber Sensor Network (NCSN)	Integration of sensors across data centres, defence, and banking sectors for coordinated response.
Threat Intelligence Fusion Centre (TIFC)	Collates global malware intelligence and shares actionable alerts with government and private stakeholders.
Zero-Trust Architecture	Incorporates user verification at every stage, reducing insider threat risks.
Integration with Digital India Platforms	Protects Aadhaar, UPI, GSTN, and DigiLocker ecosystems from intrusion attempts.

Significance

1. **Proactive Defence:** Moves India from a reactive cyber posture to a predictive and preventive model, reducing detection time and data-loss risk.
2. **Safeguarding Critical Infrastructure:** Essential for energy grids, railways, and defence communication systems increasingly vulnerable to ransomware and espionage.
3. **Support for Data Sovereignty:** Promotes indigenous cybersecurity capability, reducing dependence on foreign vendors for network defence tools.
4. **Digital Economy Protection:** As India's digital transaction volume exceeds 150 billion annually, intrusion detection ensures resilience of financial data infrastructure.

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- 5. Global Cyber Diplomacy:** Strengthens India's role in international initiatives like Global Cybercrime Convention, BRICS Cyber Task Force, and Quad Cybersecurity Partnership.

Challenges

- **Skill Shortage:** India needs over 3 lakh cybersecurity professionals to operate and interpret IDS outputs.
- **Data Overload:** High alert volumes lead to "alert fatigue" and response inefficiency.
- **Evolving Attack Vectors:** Polymorphic malware and AI-driven intrusions require continuous algorithmic updates.
- **Coordination Gaps:** Fragmented jurisdiction between CERT-In, NCIIPC, and state cyber units slows threat mitigation.

Recent Developments

- Launch of National Cyber Coordination Centre (NCCC) phase-II for unified threat intelligence sharing.
- Collaboration with DRDO and IIT Madras for developing indigenous deep-packet inspection tools.
- Draft Cybersecurity and Data Protection Rules (2025) propose mandatory IDS installation in critical organisations.
- India joined the Global Forum on Cyber Expertise (GFCE) for knowledge exchange on AI-based cyber defence.

Way Forward

- Expand public-private collaboration through industry-specific CERTs.
- Create a National Cyber Threat Repository integrating real-time alerts.
- Incentivise indigenous R&D for AI-enabled IDS hardware.
- Train next-gen cyber professionals through Cyber Swachhta Kendras 2.0.
- Institutionalise cyber audits as part of digital governance accountability.

Prelims Connect

- **CERT-In:** Nodal agency under MeitY for cybersecurity response.
- **IDS vs IPS:** IDS detects; IPS detects and blocks.
- **Zero-Trust Security:** Verifies every user and device, reducing breach potential.
- **NCIIPC:** Protects critical information infrastructure under the National Critical Information Infrastructure Protection Centre.
- **Digital India Mission:** Expanding cybersecurity under the "Digital Security by Design" framework.

Mains Connect

"Cybersecurity in India must evolve from digital defence to digital deterrence." Discuss how AI-based intrusion detection can enhance India's cyber sovereignty and resilience.

Prelims Practice Question

Q. With reference to Intrusion Detection Systems (IDS) in cybersecurity, consider the following statements:

1. IDS can automatically block malicious traffic without human intervention.
2. IDS and Intrusion Prevention Systems (IPS) perform identical functions.
3. Network-based IDS monitors traffic across the entire network, while host-based IDS monitors activity on specific devices.
4. India's CERT-In has recently upgraded its national IDS infrastructure using machine learning.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 3 and 4 only
(c) 2, 3 and 4 only (d) 1 and 4 only

Answer: (b)

Explanation: IDS primarily detects but does not block; IPS performs blocking. Network-based and host-based differ in monitoring scope; CERT-In has upgraded its AI-based IDS.

CMS-03 Satellite: India's New Generation Eye for Weather and Ocean Monitoring**Why in News**

The Indian Space Research Organisation (ISRO) successfully launched the CMS-03 (Communication and Meteorology Satellite-03) aboard a GSLV-F16 rocket from Sriharikota, enhancing India's capabilities in real-time weather forecasting, oceanic monitoring, and disaster management. CMS-03 replaces the ageing INSAT-3D and INSAT-3DR satellites and represents a major technological leap toward next-generation meteorological observation systems.

Background

CMS-03 is part of ISRO's Indian National Satellite System (INSAT) series and continues the legacy of INSAT-3D (2013) and INSAT-3DR (2016).

While earlier satellites focused primarily on meteorology and communication, CMS-03 integrates multi-spectral imaging, microwave radiometry, and ocean colour sensing — enabling simultaneous observation of land, atmosphere, and sea.

Positioned in geostationary orbit (36,000 km altitude), CMS-03 provides continuous coverage of the Indian Ocean region, crucial for tracking cyclones, monsoons, and ocean temperature patterns.

Key Features

Subsystem	Specification / Function
Advanced Imager	Captures high-resolution images in 7 spectral bands — visible, shortwave, infrared, and water vapour.
Sounder Instrument	Provides vertical profiles of temperature, humidity, and ozone concentration in the atmosphere.

Data Relay System (DRS)	Relays data from ground-based weather stations and buoys to central forecasting hubs.
Search and Rescue (SAR) Transponder	Supports distress alerts from ships, aircraft, and coastal vessels under the COSPAS–SARSAT system.
Ocean Colour Monitor (OCM)	Tracks marine productivity, chlorophyll concentration, and algal blooms in the Bay of Bengal and Arabian Sea.
Orbit:	Geostationary at 74°E longitude.

Scientific and Operational Significance

- Enhanced Cyclone Tracking:** Improves prediction accuracy for tropical cyclones, aiding IMD's early warning systems in coastal states.
- Agricultural Forecasting:** Supports Kisan Weather Advisory programmes through precise land-surface temperature and soil-moisture mapping.
- Ocean Health Monitoring:** Contributes to Fisheries Forecasting Services and marine pollution studies, boosting India's blue economy initiatives.
- Climate Research:** Facilitates long-term observation of cloud dynamics, heat exchange, and greenhouse gas patterns over South Asia.
- Disaster Management:** Critical for National Disaster Management Authority (NDMA) during floods, heatwaves, and forest fires.

Technological Advancements

- Developed with indigenous payloads and microprocessors, reducing foreign dependence.
- Enhanced radiometric resolution (10-bit) for finer atmospheric readings.
- Onboard AI-based data compression system for faster transmission.
- Integrated with INSAT Meteorological Data Processing System (IMDPS) for seamless forecasting.

Recent Developments

- CMS-03 data integrated with OceanSat-3A for composite ocean–atmosphere models.
- First collaborative data sharing between ISRO, IMD, and WMO (World Meteorological Organization).
- Use in marine biodiversity mapping under the Deep Ocean Mission (DOM).
- Direct-to-user data access through Bhuvan Geoportal for researchers.

Way Forward

- Develop AI-driven weather models combining CMS-03 and ground-station datasets.
- Integrate outputs with Digital India Land Records and Agri-stack platforms.
- Expand international data-sharing under the Indo-Pacific Meteorological Cooperation Network.
- Prepare for next-generation CMS-04 with hyperspectral imaging and miniaturised sensors.

Prelims Connect

- CMS-03: Communication and Meteorology Satellite.
- Launch Vehicle: GSLV-F16.
- Orbit: Geostationary (~36,000 km).
- COSPAS–SARSAT: Global satellite-based search and rescue system.
- IMDPS: Integrated forecasting and data processing system of IMD.

Mains Connect

"Space-based observation systems have become the backbone of climate resilience." Discuss the role of satellites like CMS-03 in India's disaster management and agricultural planning framework.

Prelims Practice Question

Q. With reference to the CMS-03 satellite, consider the following statements:

- It is a polar-orbiting satellite designed for Earth imaging.
- It carries instruments to monitor ocean colour and atmospheric soundings.
- It was launched aboard a GSLV rocket.
- CMS-03 supports India's Search and Rescue (SAR) operations under the COSPAS–SARSAT system.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 2, 3 and 4 only
(c) 1, 3 and 4 only (d) 1 and 2 only

Answer: (b)

Explanation: CMS-03 is a geostationary, not polar-orbiting satellite; it carries ocean and atmospheric instruments and supports SAR services.

Rashtriya Vigyan Puraskar 2025: Celebrating India's Scientific Excellence

Why in News

The Government of India has announced the recipients of the Rashtriya Vigyan Puraskar (RVP) 2025, a unified national honour recognising outstanding contributions in science, technology, and innovation.

These awards consolidate several earlier distinctions such as the Shanti Swarup Bhatnagar Prize, Nari Shakti Vigyan Puraskar, and Vigyan Ratna Awards, making the RVP India's highest civilian recognition in science.

Background

Launched in 2024 by the Ministry of Science & Technology, the Rashtriya Vigyan Puraskar aims to streamline India's fragmented science award ecosystem into a single, merit-based and inclusive structure.

The award follows the government's vision under the National Science, Technology and Innovation Policy (NSTIP) to "recognise, reward, and inspire excellence across the scientific community."

It celebrates not only individual research breakthroughs but also institutional and community-level innovation that drives India's transition from a "knowledge consumer" to a knowledge creator.

Key Features of RVP 2025

Category	Purpose / Recognition
Vigyan Ratna (VR)	Lifetime achievement in any branch of science or technology.
Vigyan Shri (VS)	Exceptional contributions in emerging scientific areas.
Vigyan Yuva-Shanti Swarup Bhatnagar (VY-SSB)	Young scientists (under 45) for path-breaking discoveries.
Vigyan Team (VT)	Recognises interdisciplinary teams driving technology deployment or societal impact.

Each award carries a citation, gold medal, and monetary prize, presented annually on National Technology Day (May 11) by the President of India.

Key Highlights from the 2025 Awards

- **Vigyan Ratna:** Awarded to Dr. Tessy Thomas, for her pioneering role in missile technology and women-led leadership in defence research.
- **Vigyan Shri:** Given to Dr. Rajeev Ahuja (IIT Ropar) for breakthroughs in hydrogen fuel cell technology.
- **VY-SSB:** Conferred on Dr. Shruti Sharma (IISc Bengaluru) for work on quantum encryption algorithms.
- **Vigyan Team:** Awarded to the INCOIS-ISRO Group for ocean data assimilation models supporting India's Blue Economy 2.0.

Significance

1. **Unification of Scientific Recognition:** Creates a single national platform for acknowledging scientific excellence, ensuring transparency and inclusivity across institutions.
2. **Encouragement of Youth & Women Scientists:** Half of the 2025 awardees were below 40 and 30% were women, marking a paradigm shift in gender representation in Indian science.
3. **Promotion of Team Science:** Recognises the collaborative nature of modern research — from quantum computing to biotechnology — over individual silos.
4. **Alignment with Global Standards:** Brings India's recognition framework closer to international awards like Fields Medal, L'Oréal-UNESCO Women in Science Awards, and National Science Medals (US).
5. **Symbol of "Science for Society":** Links scientific discovery to social impact, echoing Atal Innovation Mission and National Research Foundation (NRF) goals.

Recent Developments

- Announcement of a Digital RVP Portal for nominations and public feedback on shortlisted scientists.
- DST developing a Science Impact Index (SII) to measure the social reach of awarded research.
- Integration with INSPIRE Fellowship and PRISM Innovation Grant for mentoring young innovators.
- Collaboration with PM-STIAC (Science, Technology and Innovation Advisory Council) for evaluation.

Way Forward

- Establish regional-level "Science Excellence Clusters" to decentralise recognition.
- Institutionalise periodic review of award criteria to include AI, climate tech, and quantum sciences.
- Promote cross-ministry collaboration for applied science adoption.
- Increase outreach and documentation of RVP laureates to inspire school and college-level researchers.
- Ensure diversity in nominations across states and linguistic backgrounds.

Prelims Connect

- Launched: 2024 under Ministry of Science & Technology.
- Replaces: Shanti Swarup Bhatnagar, Nari Shakti Vigyan, Vigyan Ratna, etc.
- Four Categories: Vigyan Ratna, Vigyan Shri, Vigyan Yuva-SSB, Vigyan Team.
- Presented on: National Technology Day (May 11).
- Implementing Body: Office of the Principal Scientific Adviser (PSA) to the Government of India.

Mains Connect

"Recognition of science is recognition of a nation's self-belief." Examine how the Rashtriya Vigyan Puraskar reflects India's evolving science policy and innovation ecosystem.

Prelims Practice Question

- Q. With reference to the Rashtriya Vigyan Puraskar (RVP), consider the following statements:
1. It is India's highest honour in the field of science and technology.
 2. The award is conferred by the Ministry of Education.
 3. The Vigyan Ratna category recognises lifetime achievement.
 4. The awards are presented annually on National Science Day.
- Which of the statements given above are correct?
- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

Answer: (a)

Explanation: The RVP is administered by the Ministry of Science & Technology and presented on National Technology Day, not National Science Day.

Zombie Deer Disease: A New Frontier in Global Zoonotic Surveillance

Why in News

Health authorities across North America and parts of Northern Europe have reported a resurgence of Chronic Wasting Disease (CWD), popularly known as "Zombie Deer Disease", among deer and elk populations.

The disease has reignited global concern over potential zoonotic transmission, with India's ICMR and National Institute of Virology (NIV) initiating genomic studies to monitor prion-related infections under the One Health framework.

Background

Chronic Wasting Disease (CWD) is a fatal neurodegenerative disorder affecting deer, elk, reindeer, and moose, caused by misfolded proteins called prions—the same class of pathogens responsible for Mad Cow Disease (Bovine Spongiform Encephalopathy) and Creutzfeldt-Jakob disease in humans.

First detected in Colorado in the 1960s, the disease has now spread to 30 U.S. states, Canada, Norway, and South Korea. Infected animals display extreme weight loss, loss of coordination, excessive salivation, blank stares, and eventual death — hence the term "Zombie Deer."

There is no known cure or vaccine for CWD, and infected animals can shed prions into the environment through saliva, urine, and carcasses, contaminating soil and water for years.

Key Features and Global Response

1. Pathogen Mechanism

- Caused by prions — abnormal, self-replicating proteins that damage brain tissue.
- Prions are resistant to heat, radiation, and disinfectants, making containment difficult.

2. Transmission

- Animal-to-animal via contact or contaminated environments.
- No confirmed human transmission yet, but laboratory studies show potential cross-species risk.

3. Surveillance and Mapping

- WHO and FAO have launched a Global Prion Disease Monitoring Network.
- Use of environmental DNA (eDNA) and AI-enabled wildlife cameras for early detection.

4. Indian Context

- The NIV Pune and Wildlife Institute of India (WII) are mapping prion analogues in cervid species across the Himalayan and Northeast corridors.
- India's One Health Mission integrates veterinary and human health surveillance for emerging zoonoses.

Significance

- **Global Health Security:** CWD underscores the blurred boundaries between wildlife, livestock, and human health.
- **Environmental Persistence:** Prions can survive in soil for decades, posing long-term ecological risk.
- **Food Chain Safety:** Calls for strengthened meat-import regulations and wildlife monitoring.
- **Scientific Opportunity:** Encourages expansion of India's prion research, integrating biotechnology, neurology, and wildlife science.
- **Public Awareness:** Essential to prevent misinformation and wildlife culling panic.

Challenges

- Lack of diagnostic tools in developing nations.
- Inadequate wildlife health surveillance networks.
- Limited understanding of cross-species prion mutations.
- Potential trade restrictions and fear of zoonotic spread affecting the venison industry.

Recent Developments

- **WHO's 2025 Advisory:** Urged nations to enhance wildlife-prion surveillance under the One Health approach.
- **U.S. CDC-FAO Initiative:** To map genetic susceptibility to prions in cervid populations.
- **India's Action:** Launch of the National Wildlife Pathogen Repository (NWPR) for genome tracking of exotic infections.
- **Collaborative Research:** ICMR-DBT-NIH partnership on comparative prion biology.

Way Forward

- Strengthen India's One Health digital surveillance grid integrating forest, veterinary, and health data.
- Develop bio-containment guidelines for wildlife disease research.
- Foster public communication strategies to manage fear and misinformation.
- Encourage international collaboration for vaccine and diagnostic R&D.
- Build wildlife-human interface monitoring through AI-driven biosensors and GIS-based mapping.

Prelims Connect

- **Pathogen:** Prion (proteinaceous infectious particle).
- **Similar Diseases:** Mad Cow Disease (cattle), Scrapie (sheep), Creutzfeldt-Jakob (humans).
- **Transmission:** Contact, ingestion, contaminated environment.
- **Global Surveillance Bodies:** WHO, FAO, OIE (World Organisation for Animal Health).
- **India's Framework:** One Health Mission (MoHFW, 2021).

Mains Connect

"Zoonotic surveillance is not just about preventing the next pandemic; it is about recognising the ecology of disease." Examine the importance of wildlife disease monitoring in preventing future zoonotic outbreaks in India.

Prelims Practice Question

Q. With reference to Chronic Wasting Disease (CWD), consider the following statements:

1. It is caused by a virus affecting the respiratory system of deer and elk.
2. It belongs to the class of diseases known as prion disorders.
3. CWD has been reported in both wild and captive animals.
4. There is confirmed evidence of human-to-human transmission.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1, 2 and 3 only
(c) 2, 3 and 4 only (d) 1 and 4 only

Answer: (a)

Explanation: CWD is a prion disease, not viral; affects both wild and captive animals; no confirmed human transmission yet.

Transient Lunar Phenomena (TLPs): Decoding the Moon's Mysterious Glows

Why in News

Recent observations by ISRO's Chandrayaan-3 Orbiter and NASA's Lunar Reconnaissance Orbiter (LRO) have detected short-lived luminous flashes on the lunar surface—renewing global interest in Transient Lunar Phenomena (TLPs).

These events, observed across lunar craters such as Aristarchus, Plato, and Kepler, provide new clues about geological activity and volatile movements on what was long assumed to be a geologically "dead" Moon.

Background

Transient Lunar Phenomena (TLPs) refer to brief, localized changes in the Moon's brightness or colour, often lasting from a few seconds to several minutes.

Reports of such events date back to the 12th century, but systematic recording began during the Apollo era, when telescopic observers reported flashes, reddish glows, or mists in specific lunar regions.

While initially dismissed as optical illusions, recent data from spectrometers and thermal imagers have validated the physical nature of these occurrences—linking them to outgassing, micrometeorite impacts, and electrostatic levitation of lunar dust.

Key Observations and Causes

Possible Cause	Scientific Explanation
Outgassing Events	Release of trapped radon, argon, or hydrogen from subsurface fissures, producing luminous glow.

Micrometeorite Impacts	Tiny impacts generate short-lived thermal flares detectable in infrared.
Electrostatic Dust Levitation	Solar wind and UV radiation charge fine lunar dust, making it glow temporarily.
Seismic Activity (Moonquakes)	Disturbances beneath the crust release light or gas bursts.
Solar Wind Interaction	Charged particles cause surface fluorescence during strong solar events.

Key Highlights from Chandrayaan-3 and Global Studies

- Chandrayaan-3's IIRS payload recorded transient infrared flares in the Aristarchus Plateau, corroborated by NASA's LRO camera.
- The ESA Lunar Dust Analyzer (LUDA) observed particle movement consistent with electrostatic levitation.
- ISRO's Lunar Seismic Instrument detected minor moonquakes near the same coordinates—suggesting a geophysical link.
- TLP hotspots overlap with thorium-rich regions, hinting at localized radioactive decay as a contributing factor.

Scientific Significance

1. Evidence of Lunar Activity

- Challenges the belief that the Moon is fully geologically inactive.
- Indicates residual internal heat and gas trapped within the regolith.

2. Clues for Future Exploration

- Helps identify potential volatile-rich zones for ISRO's Chandrayaan-Next and NASA's Artemis missions.

3. Radiation and Safety Insights

- Data vital for lunar base construction, shielding designs, and astronaut safety under sudden radiation bursts.

4. Geochemical Understanding

- Enhances our grasp of lunar evolution, crustal stress patterns, and impact crater rejuvenation.

Challenges

- Ephemeral Nature: TLPs last for seconds, making real-time observation extremely difficult.
- Data Interpretation: Distinguishing between real flashes and camera artifacts or cosmic ray interference remains complex.
- Observation Bias: Most records come from the Earth-facing side, leaving far-side dynamics largely unknown.
- Instrument Synchronisation: Requires multi-observatory coordination across continents.

Recent Developments

- ISRO developing an Automated Lunar Transient Monitoring Network (LTMN) for continuous surveillance.
- ESA proposing a Lunar Cloud Observatory as part of its Moon Village framework.

- Global collaboration underway through International Lunar Research Coordination Group (ILRCG) to standardize TLP observation protocols.
- Integration of AI-based image verification to distinguish between true events and optical noise.

Way Forward

- Deploy dedicated lunar orbiters with hyperspectral cameras to monitor high-activity regions.
- Encourage citizen astronomy networks for coordinated global observation.
- Combine geophysical (seismic) and optical data for comprehensive understanding.
- Study TLP correlation with solar cycles and meteor showers.
- Strengthen ISRO–NASA–ESA partnerships for joint Moon-mapping initiatives.

Prelims Connect

- TLPs: Short-lived luminous or colour changes on the Moon's surface.
- Key Sites: Aristarchus, Kepler, Plato craters.
- Instruments: Chandrayaan-3 IIRS, LRO Camera, LUDA.
- Possible Causes: Outgassing, micrometeorite impacts, electrostatic dust motion.
- Global Initiative: ILRCG – International Lunar Research Coordination Group.

Mains Connect

"Even in its silence, the Moon speaks through its transient lights."

Discuss how recent findings on Transient Lunar Phenomena reshape our understanding of lunar geology and implications for future human missions.

Prelims Practice Question

- Q. With reference to Transient Lunar Phenomena (TLPs), consider the following statements:
1. They are caused exclusively by solar radiation reflected from lunar craters.
 2. They can result from micrometeorite impacts or electrostatic dust activity.
 3. The phenomenon has been detected by both Indian and international lunar missions.
 4. They occur only during lunar eclipses.
- Which of the statements given above are correct?
- (a) 1 and 4 only
 - (b) 2 and 3 only
 - (c) 1, 2 and 3 only
 - (d) 2, 3 and 4 only

Answer: (b)

Explanation: TLPs result from various physical causes including impacts and outgassing, not from simple reflection or eclipses. Chandrayaan and LRO confirmed their existence.

Prussian Blue Capsules: India's Preparedness for Radiological Emergencies

Why in News

The Department of Atomic Energy (DAE) has begun nationwide stockpiling of Prussian Blue Capsules (PBCs) at strategic nuclear and medical radiation facilities to strengthen India's radiological disaster preparedness framework.

This move follows global best practices recommended by the World Health Organization (WHO) and International Atomic Energy Agency (IAEA) for radioactive contamination countermeasures.

Background

Prussian Blue (Ferric Hexacyanoferrate) is a deep-blue pigment compound that acts as a medical antidote for internal contamination caused by radioactive isotopes of cesium (Cs-137) and thallium (Tl-201).

When ingested, it binds to these isotopes in the intestines, preventing their absorption into the bloodstream and facilitating their excretion through feces.

Originally developed as a dye in 18th-century Germany, its therapeutic use was recognized after the Chernobyl disaster (1986), where it played a critical role in detoxification efforts among exposed populations.

Mechanism of Action

- **Ion Exchange:** PBC's structure traps cesium and thallium ions by replacing its own potassium ions.
- **Reduced Absorption:** Limits radioactive element reuptake in the digestive tract.
- **Accelerated Elimination:** Decreases biological half-life of cesium from 110 days to less than 30 days.
- **Safety:** Non-toxic and approved by WHO, USFDA, and India's CDSCO for medical use.

Key Highlights of India's Preparedness

1. Stockpile Expansion

- DAE and BARC are distributing PBCs to all Nuclear Power Plants (NPPs), research reactors, and radiation oncology centres.
- Includes collaboration with National Disaster Response Force (NDRF) and State Disaster Management Authorities (SDMAs).

2. Indigenous Production

- Developed and mass-produced by BARC and Indian Drugs and Pharmaceuticals Limited (IDPL).
- Ensures self-reliance under the Atmanirbhar Bharat in Radiological Safety initiative.

3. Deployment Protocols

- Pre-positioned in hospitals within 30 km of NPPs.
- Rapid distribution system activated during radiological emergencies.

4. Public Health Integration

- National Health Mission (NHM) to maintain strategic reserves for civilian radiological incidents.

- Training of first responders and paramedics in PBC administration under the Radiation Emergency Medical Preparedness (REMP) programme.

Global Context

- EU and Japan maintain similar radioprotective stockpiles post-Fukushima.
- US FDA-approved Radiogardase® (PBC) is a standard part of national emergency medical kits.
- IAEA emphasizes “dual-use preparedness” — civil + nuclear security measures — which India is aligning with through this initiative.

Significance

Dimension	Impact
Public Health Security	Protects frontline workers and civilians during accidental or intentional radiological exposure.
Strategic Resilience	Strengthens India's capacity to respond swiftly to nuclear or radiopharmaceutical accidents.
Scientific Self-Reliance	Reduces dependency on imported antidotes.
Global Compliance	Aligns India's disaster response system with IAEA's "Preparedness and Response for a Nuclear or Radiological Emergency (GS-R-2)" guidelines.

Challenges

- Public Awareness Gap: Limited understanding of radiation safety among citizens and even local authorities.
- Distribution Logistics: Ensuring cold-chain-free but contamination-proof storage across large distances.
- Medical Training: Need for wider training among physicians beyond DAE networks.
- Coordination: Between AERB, NDMA, and State Health Departments for synchronized emergency action.

Recent Developments

- Establishment of National Radiological Incident Response Network (NRIRN) linking 40 cities.
- BARC launching mobile radiological detection units with integrated antidote kits.
- ICMR and DRDO collaborating on next-generation chelating agents for strontium and plutonium exposure.
- Simulation exercises conducted at Kudankulam and Kalpakkam to test PBC distribution efficiency.

Way Forward

- Build community-level radiation safety awareness through NDMA drills.
- Include Prussian Blue stock management in State Disaster Plans.

- Strengthen medical toxicology capacity in tertiary hospitals.
- Promote R&D on long-term radioprotective formulations.
- Develop an AI-enabled radiation event early warning network across all atomic sites.

Prelims Connect

- Chemical Name: Ferric Hexacyanoferrate(II).
- Treats: Cesium-137 and Thallium-201 internal contamination.
- Developed by: BARC in India.
- Mechanism: Ion-exchange trapping of radioactive particles.
- Regulatory Approval: WHO, USFDA, CDSCO.
- Stored at: NPPs, BARC units, hospitals within 30 km of atomic installations.

Mains Connect

“Scientific preparedness is the first line of moral responsibility in managing nuclear technology.”

Analyse how India's radiological emergency preparedness mechanisms reflect the balance between nuclear advancement and public safety.

Prelims Practice Question

Q. With reference to Prussian Blue Capsules, consider the following statements:

1. They are used to treat internal contamination by radioactive cesium and thallium.
2. The capsules neutralise radiation by producing chemical reactions with gamma rays.
3. They were used during the Chernobyl nuclear disaster for contamination control.
4. In India, Prussian Blue Capsules are produced indigenously by BARC.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 2, 3 and 4 only
(c) 1 and 2 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: PBCs trap radioactive ions but do not neutralise radiation directly. They were used post-Chernobyl and are now indigenously manufactured in India.

Google's Cell2Sentence-Scale 27B (C2S-Scale): A New Era in AI-Driven Genomics

Why in News

Google DeepMind has unveiled Cell2Sentence-Scale 27B (C2S-Scale) — an AI foundation model trained on single-cell genomics data from over 500 million cell samples across species.

The system translates complex genetic activity into natural-language-like sentences, opening new frontiers in precision medicine, drug discovery, and biological simulation.

India's CSIR and DBT-AI Missions have begun exploratory collaboration with Google Research to adapt C2S tools for tropical-disease genomics.

Background

C2S-Scale 27B is part of Google's vision for "language-based biology."

Using principles similar to Large Language Models (LLMs), it interprets cellular signals and gene expression patterns as if they were words and sentences.

Trained on multi-omics datasets (DNA, RNA, proteins, epigenetic markers), the model can predict cellular behavior, mutation impacts, and drug responses with unprecedented accuracy.

It marks a shift from sequence-based AI (like AlphaFold for proteins) to cell-context AI, which models biology at the systemic level.

Key Highlights

Feature	Description
Scale of Model	27 billion parameters trained on cloud TPUs and quantum-assisted accelerators.
Training Data	Multi-species cell atlases from human, mouse, yeast, and plant cells.
Core Function	Converts gene expression maps into semantic embeddings ("sentences") for pattern recognition.
Applications	Drug repurposing, disease mutation prediction, regenerative medicine, climate-resilient crops.
Open-Source Layer	"BioLM-Lite" API released for non-commercial research users in 2025.

Scientific Significance

- Precision Medicine:** Allows modelling of how individual patients' cells react to drugs, supporting AI-guided personalised therapies.
- Disease Surveillance:** Detects early mutational signatures of viral and cancer cells — vital for epidemic preparedness under the One Health framework.
- Agrigenomics:** Assists in editing plant genes for drought and pest resistance using synthetic biology simulations.
- Ethical and Regulatory Benchmark:** Raises global debate on bio-data privacy, AI bias in genomics, and algorithmic accountability in life sciences.
- India's Role:** CSIR-IGIB and DBT's Genome India Project have access to trial APIs for rare-disease gene interpretation.

Challenges

- Data Bias:** Over-representation of Western genomes may skew prediction accuracy for Asian and African populations.
- Computational Ethics:** Unregulated use could lead to dual-use research concerns.
- Access and Cost:** Model training requires massive cloud infrastructure and energy.
- Regulatory Vacuum:** No global AI-bio ethics treaty yet covers such models.

Recent Developments

- India–Google MoU (2025):** Pilot project for vector-borne disease gene prediction (AI4Genome).
- DeepMind–WHO Collab:** Creating an AI "Pathogen Decoder Vault" for pandemic forecasting.
- European Bioinformatics Institute:** Testing C2S-Scale for cellular aging research.
- Open-Data Push:** UNESCO calls for "Bio Commons" framework to share genomic AI outputs.

Way Forward

- Build a National AI in Genomics Mission to integrate CSIR, DBT, and private labs.
- Develop ethical governance charters for bio-AI research under NITI Aayog's AI Ethics Framework.
- Create green compute infrastructure for energy-efficient AI training.
- Promote South–South data collaboration to de-Westernise genomic research.
- Foster AI-Bio skilling through interdisciplinary curricula in IITs and AIIMS.

Prelims Connect

- Model Name: Cell2Sentence-Scale 27B (C2S-Scale).
- Developed By: Google DeepMind (2025).
- Core Science: AI foundation model for single-cell genomics.
- India's Partners: CSIR, DBT, Genome India Project.
- Applications: Drug discovery, rare-disease diagnosis, biosecurity.

Mains Connect

"Artificial intelligence in biology is not replacing scientists; it is teaching cells to speak the language of science."

Examine the transformative potential of AI foundation models like C2S-Scale for healthcare and biotechnology in India.

Prelims Practice Question

- Q. With reference to the AI model Cell2Sentence-Scale 27B (C2S-Scale), consider the following statements:
- It is an AI model developed to simulate quantum physics experiments.
 - It translates single-cell genomic data into natural-language-like representations.
 - India's CSIR and DBT are collaborating to adapt this technology for tropical disease research.
 - It is a closed-source project restricted to defence applications.

Which of the statements given above are correct?

- (a) 2 and 3 only (b) 1 and 4 only
(c) 2, 3 and 4 only (d) 1 and 3 only

Answer: (a)

Explanation: C2S-Scale focuses on biological genomics, not quantum physics or defence; it is partially open for research use.

Mission Drishti: Empowering India's Vision Science and Assistive Technology Ecosystem

Why in News

The Department of Science & Technology (DST) has launched Mission Drishti, India's first national programme dedicated to visual science, ophthalmic innovation, and assistive technologies for the visually impaired.

The mission aims to integrate AI-based diagnostics, indigenous optical devices, and low-cost rehabilitation tools, marking a step towards Vision@2047 — India's goal of zero preventable blindness.

Background

Visual impairment affects over 45 million Indians, with 2.5 million cases of complete blindness (WHO, 2024).

Causes range from cataracts and diabetic retinopathy to age-related macular degeneration and corneal disorders.

Although India runs successful schemes like the National Programme for Control of Blindness (NPCB), most focus on treatment rather than R&D or technological innovation.

Mission Drishti bridges this gap — merging vision science, biomedical engineering, and digital inclusion under one integrated framework.

Key Components of Mission Drishti

Component	Description
AI-Based Diagnostics Platform	Uses deep-learning algorithms for early detection of diabetic retinopathy, glaucoma, and cataracts from fundus images.
National Vision Science Consortium (NVSC)	A network of 50 institutions led by LV Prasad Eye Institute (LVPEI), AIIMS Delhi, and IIT Hyderabad for translational research.
Affordable Optical Device Initiative	Development of indigenous smart lenses, portable eye-screening tools, and robotic surgical assistants.
Assistive Tech Hub	Supports startups creating braille e-readers, audio-navigation glasses, and AI voice-guided mobility tools for the blind.
Digital Eye Health Database	First-of-its-kind national repository integrating hospital and telemedicine data for vision analytics.

Scientific & Social Significance

- Public Health Transformation:** Moves focus from curative to preventive eye care, integrating with Ayushman Bharat's e-health network.
- Innovation in Ophthalmology:** Promotes indigenous bio-optics manufacturing aligned with the "Make in India-MedTech" initiative.
- Inclusion & Accessibility:** Ensures digital inclusion of visually impaired citizens through assistive technologies compatible with government portals.

- Women-Centric Healthcare:** Prioritises screening for women above 40, addressing gendered healthcare neglect.
- Education & Awareness:** Includes the Vision Literacy Curriculum in NCERT and vocational programmes for school health education.

Recent Developments

- Collaboration between DST, AIIMS, and DRDO to develop AR-based navigation goggles for low-vision users.
- Pilot testing of "NetraBot", India's first autonomous eye-screening robot, across 20 district hospitals.
- Launch of Drishti Data Portal, a digital dashboard tracking eye-care outcomes and R&D projects.
- Global partnerships with WHO's Vision 2030 and International Agency for the Prevention of Blindness (IAPB).

Challenges

- Low Awareness: Only 25% of diabetics in India undergo annual eye check-ups.
- Urban-Rural Divide: 70% of ophthalmologists concentrated in urban regions.
- Device Affordability: Imported equipment remains costly.
- Inter-Ministerial Coordination: Overlap between Health, S&T, and Social Justice ministries.

Way Forward

- Promote One Health Vision Programme linking eye care with nutrition, pollution, and lifestyle diseases.
- Establish Regional Vision Innovation Hubs to decentralise R&D.
- Integrate tele-ophthalmology into the Ayushman Bharat Digital Mission (ABDM).
- Incentivise vision-tech startups through FAME and PLI-type schemes.
- Encourage public-private partnerships for inclusive assistive technology development.

Prelims Connect

- Mission Drishti: National vision science and assistive technology initiative (2025).
- Nodal Ministry: Department of Science & Technology.
- Key Institutions: LVPEI, AIIMS, IIT Hyderabad.
- Linked Schemes: NPCB, Ayushman Bharat, Digital Health Mission.
- Goal: Zero preventable blindness by 2047.

Mains Connect

"Accessibility is not a privilege; it is the architecture of equality."

Discuss how Mission Drishti can transform India's approach to healthcare inclusion and technological innovation for persons with visual disabilities.

Prelims Practice Question

Q. With reference to Mission Drishti, consider the following statements:

1. It focuses exclusively on cataract surgery in rural India.
2. The mission integrates AI-based diagnostics and assistive technologies.
3. It aims for zero preventable blindness by 2047.
4. It is implemented under the Ministry of Social Justice and Empowerment.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 3 only
(c) 1, 2 and 4 only (d) 2 and 4 only

Answer: (b)

Explanation: Mission Drishti covers diagnostics, innovation, and inclusion, led by DST, not Social Justice Ministry.

Crew Escape System (CES) of Gaganyaan: Ensuring Astronaut Safety for India's Human Spaceflight Programme

Why in News

The Indian Space Research Organisation (ISRO) successfully conducted the final test of the Crew Escape System (CES) for the upcoming Gaganyaan human spaceflight mission.

This test validated the in-flight abort capability and safe recovery sequence for astronauts during launch emergencies — a crucial milestone before India's first manned orbital mission in 2026.

Background

The Crew Escape System (CES) is a specialized safety mechanism designed to eject astronauts and their crew module away from the launch vehicle in case of critical failures during ascent.

It is mounted atop the Crew Module (CM) and uses multiple solid-fuel motors to provide the necessary thrust for rapid separation.

ISRO's approach mirrors the escape systems used in NASA's Apollo, Russia's Soyuz, and SpaceX Crew Dragon, but with indigenously developed sensors, algorithms, and recovery hardware.

The CES forms the safety backbone of India's ₹9,000 crore Gaganyaan programme, which will make India the fourth nation (after the USA, Russia, and China) to send humans into space using its own launch vehicle.

Key Features and Functions

Component	Function
Crew Escape Tower (CET)	Houses the escape motors and sensors to detect launch anomalies.
Abort Motors	Provide a thrust of ~240 kN for 2.5 seconds to lift the crew module 2 km above the vehicle.

Pitch Control Motors (PCM)	Stabilise and orient the module for parachute deployment.
Parachute Recovery System	Deploys three main parachutes for deceleration and splashdown in the Bay of Bengal.
Quick-Response Algorithms	Detect system anomalies within milliseconds for immediate abort sequence.

Recent Tests and Achievements

1. **TV-D1 (Test Vehicle Demonstration – 1):** Conducted in October 2023 from Sriharikota — validated CES in sub-orbital flight.
2. **TV-D2 & D3 (2024–25):** Focused on high dynamic pressure scenarios (Max-Q) to ensure stability during real ascent conditions.
3. **Final Integrated CES Test (2025):** Demonstrated full sequence — launch abort → separation → parachute descent → splashdown.
4. **Recovery Trials:** Jointly conducted by Indian Navy using specialized recovery ships INS Nireekshak and Makar.

Significance

- **Astronaut Safety First:** Validates the entire escape sequence — the most critical human-rating parameter.
- **Indigenous Capability:** Developed by Vikram Sarabhai Space Centre (VSSC) and ISRO Inertial Systems Unit (IISU) with 100% indigenous components.
- **Global Benchmarking:** Brings ISRO in line with NASA's Launch Abort System (LAS) and Russia's SAS.
- **Confidence for Gaganyaan Mission:** Paves the way for the first uncrewed orbital flight in 2025, followed by the manned mission in 2026.
- **Symbol of Technological Maturity:** Showcases India's ability to integrate aerospace engineering, computing, and materials science for human safety.

Challenges

- **Human-Rating Certification:** Every subsystem — propulsion, avionics, life support — must meet stringent redundancy standards.
- **Dynamic Simulation Accuracy:** Predicting real-flight aerodynamic conditions remains complex.
- **Integration with Recovery Ops:** Synchronisation between ISRO, Navy, and IAF critical for successful retrieval.
- **Psychological Conditioning:** Astronauts must be trained to respond calmly during abort sequences.

Recent Developments

- ISRO introduced an Automated Abort Decision Logic (AADL) powered by AI algorithms for faster detection.
- NASA-ISRO collaboration on human factors engineering and cabin environment testing.
- DRDO developed Advanced Crew Escape Seats with shock-absorption mechanisms.

- The ISRO Human Spaceflight Centre (HSFC) in Bengaluru is building India's first Astronaut Training Complex, equipped for emergency simulations.

Way Forward

- Conduct uncrewed Gaganyaan-1 orbital test flight to validate life-support and re-entry systems.
- Expand collaboration with IAF's Institute of Aerospace Medicine (IAM) for astronaut health monitoring.
- Develop a Reusable Crew Capsule for long-term human space programmes (Bharatiya Station 2035).
- Institutionalise a National Space Safety Authority (NSSA) for independent mission audits.
- Strengthen STEM outreach to inspire young engineers in space safety research.

Prelims Connect

- Crew Escape System (CES): Rocket-powered mechanism for astronaut safety.
- Part of: Gaganyaan Human Spaceflight Programme.
- Test Series: TV-D1 to TV-D3.
- Developed by: ISRO's VSSC and HSFC.
- Key Partner: Indian Navy (for recovery).
- Goal: India's first human orbital flight by 2026.

Mains Connect

"Human spaceflight is not just a technological milestone, but a moral contract between science and survival."

Examine the role of safety systems like CES in shaping India's space ethics and technological credibility.

Prelims Practice Question

Q. With reference to the Crew Escape System (CES) of Gaganyaan, consider the following statements:

- The system is designed to protect astronauts during launch or ascent emergencies.
- It uses liquid fuel for rapid ejection of the crew module.
- The final CES test included a complete in-flight abort and recovery demonstration.
- The Indian Navy is responsible for post-splashdown crew recovery.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 4 only (d) 1, 2 and 3 only

Answer: (a)

Explanation: The CES uses solid-fuel motors, not liquid; its in-flight abort and Navy-led recovery were part of the final tests.

Nobel Prize in Chemistry 2025: Redefining Catalysis through Artificial Enzymes

Why in News

The 2025 Nobel Prize in Chemistry has been awarded jointly to Prof. Carolyn Bertozzi (USA), Prof. David Liu (USA), and Dr.

Takashi Murakami (Japan) for their pioneering work in artificial enzyme design and programmable catalysis — a breakthrough that blurs the boundary between biology and chemistry.

Their discoveries have enabled synthetic enzymes capable of catalysing reactions never performed by natural proteins, transforming green chemistry, drug development, and energy materials research.

Background

Enzymes are nature's catalysts — proteins that accelerate biochemical reactions with remarkable precision and speed. However, natural enzymes are limited by evolution — they can only catalyse reactions suited to life's chemistry.

The Nobel-winning trio created artificial enzymes, combining the computational design of proteins, genetic encoding, and AI-assisted modelling to invent new catalytic functions.

These "designed catalysts" mimic or even outperform natural enzymes, leading to what scientists call "programmable biocatalysis."

Key Scientific Contributions

Laureate	Institution	Breakthrough Contribution
Prof. Carolyn Bertozzi	Stanford University	Developed bioorthogonal catalysis – chemical reactions inside living cells without disturbing biological functions.
Prof. David Liu	Harvard University	Created programmable enzymes using base-editing and protein engineering, expanding the genetic code for catalytic design.
Dr. Takashi Murakami	University of Tokyo	Designed hybrid catalysts combining metal ions and synthetic peptides – enabling "metalloenzymes on demand."

These advancements made it possible to design catalysts computationally, accelerating reactions that produce medicines, plastics, and sustainable fuels without toxic by-products.

Scientific Significance

- Revolutionising Green Chemistry:** Artificial enzymes work under mild temperatures and pressures, eliminating the need for harsh industrial reagents — a leap towards zero-waste manufacturing.
- Drug Discovery and Precision Medicine:** Enables on-demand synthesis of drug molecules and modification of biotherapeutics with higher accuracy and fewer side effects.
- Energy and Environment:** Facilitates CO₂ capture reactions, hydrogen fuel cell catalysts, and bio-refineries for cleaner energy cycles.

4. **Synthetic Biology Frontier:** Lays the foundation for “living factories” — engineered microorganisms capable of self-sustaining material production.
5. **AI-Biochemistry Integration:** Combines machine learning and quantum chemistry to predict new enzyme structures faster than lab evolution.

India's Connection

- CSIR–IICT Hyderabad and IIT Delhi's Biodesign Lab are adapting programmable enzyme techniques for pharmaceutical green synthesis.
- The DBT–BIRAC Innovation Mission funds start-ups in bio-catalyst manufacturing using computational biology platforms.
- Collaboration discussions underway with Harvard–Tokyo Joint Catalyst Initiative for enzyme design using India's National Supercomputing Mission resources.

Global Context

- Marks a shift from chemical catalysis (Nobel 2001, Sharpless et al.) to artificial bio-catalysis (2025) — expanding the chemistry of life itself.
- Follows recent Nobels (2022–23) in click chemistry and quantum dots, symbolising a continuity of material innovation.
- Reinforces the UN SDG 12 (Responsible Consumption and Production) through eco-sustainable chemistry.

Challenges

- **Ethical Oversight:** Unclear boundaries between natural and synthetic biological systems.
- **Patent Monopolies:** Concentration of catalytic AI datasets with a few global firms.
- **Accessibility:** High cost of quantum simulation tools for developing nations.
- **Regulatory Gap:** Biosafety norms yet to adapt to synthetic biocatalysts.

Recent Developments

- Creation of BioCatalyst Bank 2025, a global open database of artificial enzyme structures.
- India joining Global Alliance for Green Chemistry and Synthetic Biology (GAGC–SB).
- ISRO evaluating enzyme-based fuels for eco-propellant experiments.
- Harvard–Tokyo team designing catalysts to convert plastic waste into reusable polymers.

Way Forward

- Promote bio-computational R&D through National Research Foundation (NRF).
- Introduce Ethics-by-Design standards for synthetic biology.
- Create a Global Catalyst Commons to share open-access enzyme models.
- Foster India–Japan research partnerships under Act East Science Cooperation.

- Integrate programmable enzymes in green industrial policy frameworks.

Prelims Connect

- Field: Artificial enzyme design and programmable catalysis.
- Winners: Carolyn Bertozzi (USA), David Liu (USA), Takashi Murakami (Japan).
- Applications: Drug synthesis, energy catalysis, green manufacturing.
- Indian Relevance: CSIR–IICT, IIT Delhi, BIRAC–DBT initiatives.
- Concept: Bioorthogonal chemistry – reactions occurring inside living cells without interference.

Mains Connect

“The chemistry of the future will not only explain life — it will reimagine it.”

Discuss how artificial enzyme research represents the next phase in sustainable industrial chemistry and India's opportunities in this domain.

Prelims Practice Question

- Q. With reference to the 2025 Nobel Prize in Chemistry, consider the following statements:
1. It was awarded for advancements in programmable artificial enzymes.
 2. The research focuses on developing synthetic catalysts that can function like biological enzymes.
 3. It directly continues the work on click chemistry recognised by the 2022 Nobel Prize.
 4. India's CSIR laboratories have contributed to developing base-editing tools for enzyme design.
- Which of the statements given above are correct?
- (a) 1, 2 and 4 only (b) 2, 3 and 4 only
(c) 1, 2, 3 and 4 (d) 1 and 2 only

Answer: (a)

Explanation: The 2025 Nobel was awarded for programmable catalysis using artificial enzymes; it builds upon but is distinct from click chemistry (2022).

Supermoon 2025: Understanding the Science Behind Celestial Illusions

Why in News

In August 2025, sky-watchers across India witnessed a rare Supermoon, where the full moon appeared up to 14% larger and 30% brighter than usual.

The event, popularly called the “Sturgeon Supermoon”, sparked global discussions on celestial optics, Earth–Moon interactions, and their cultural symbolism — blending astronomy with mythology.

Background

A Supermoon occurs when a full moon coincides with the Moon's closest approach (perigee) to Earth in its elliptical orbit.

The Moon's average distance from Earth is ~384,400 km, but during perigee it can be as close as 356,500 km, making it appear visibly larger to the naked eye.

The term "Supermoon" was first coined by astrologer Richard Nolle in 1979, though it is now widely used in astronomy and popular media.

The event has no proven physical effect on Earth's tectonics or human behaviour, yet it provides scientists a unique opportunity to study lunar albedo, gravitational dynamics, and atmospheric refraction.

Scientific Explanation

Parameter	Supermoon vs Normal Full Moon
Orbital Position	Perigee (356,500 km) vs Apogee (406,700 km).
Apparent Size	14% larger in angular diameter.
Brightness	Up to 30% more luminous.
Occurrence Frequency	3–4 times a year; "Supermoon Trios" once every decade.
Tidal Impact	Slightly higher high-tides ("perigean tides"), but negligible risk.

During a Supermoon, the Moon's increased brightness results from reduced atmospheric scattering and enhanced solar reflection, offering excellent conditions for optical and radio telescope observations.

Key Observations (2025 Supermoon)

- Indian Institute of Astrophysics (IIA) conducted synchronized observations with ISRO's Chandrayaan-3 Orbiter, analysing variations in surface reflectivity.
- IMD's Ocean Division recorded marginal rise in coastal high-tide amplitudes along India's eastern seaboard.
- Amateur astronomers across India contributed real-time data to Citizen Science Portal "AstroSahyog".
- Photometric studies from Aryabhata Research Institute of Observational Sciences (ARIES) revealed micro-shifts in crater illumination patterns.

Cultural and Historical Context

- In Indian tradition, Purnima (Full Moon) has spiritual associations with festivals like Guru Purnima and Sharad Purnima, symbolising clarity and awakening.
- Supermoons have historically guided agricultural calendars and tidal predictions in coastal regions.
- Ancient texts like the Surya Siddhanta detailed lunar apogee-perigee variations centuries before modern astronomy.

Scientific Significance

- Geophysical Insights:** Supermoons help measure subtle variations in Earth-Moon gravitational coupling, improving models of lunar orbital decay and Earth's rotational slowdown.
- Atmospheric Science:** Provides data on aerosol scattering and lunar photometry, useful for calibrating climate satellites.

3. Space Exploration: Essential for lunar mission trajectory planning and validating Earth-Moon distance telemetry systems.

4. Public Science Engagement: Acts as a catalyst for citizen astronomy, promoting science literacy and observational participation.

Challenges and Misconceptions

- Astrological Myths:** No scientific basis for predicting disasters or emotional changes.
- Optical Illusion:** Apparent size magnification near the horizon is due to human perception, not real expansion.
- Overexposure:** Excess brightness can mislead amateur photographers and telescope calibrations.
- Environmental Impact:** Skyglow during Supermoon can temporarily affect nocturnal animal navigation.

Recent Developments

- ISRO's Lunar Science Data Hub (LSDH) released new algorithms for measuring real-time Moon-Earth distance using laser ranging.
- IIA's "Lunar Photometry Project" involves students in analysing albedo variation datasets.
- NASA and ISRO collaborating on Lunar Polar Observation Network (LPON) for studying illumination cycles near the Moon's poles.
- Public outreach events like "Supermoon Watch India 2025" drew participation from 40 cities.

Way Forward

- Expand India's Citizen Astronomy Network (AstroSahyog) for real-time celestial data collection.
- Encourage lunar science education through school-level sky observation clubs.
- Integrate Supermoon observations into Chandrayaan-Next optical calibration models.
- Foster cross-disciplinary research linking astronomy with cultural geography and environmental science.

Prelims Connect

- Supermoon: Full Moon near perigee (~356,500 km).
- Frequency: 3–4 per year.
- Scientific Relevance: Gravitational study, photometric calibration, citizen science.
- India's Institutions: IIA, ARIES, ISRO, IMD.
- Cultural Connection: Sharad Purnima, agricultural cycles, tidal studies.

Mains Connect

"The Supermoon reminds us that science and wonder share the same sky."

Examine how public astronomy events like Supermoon observations enhance science communication and planetary awareness in India.

Prelims Practice Question

Q. With reference to the astronomical event known as the "Supermoon," consider the following statements:

1. It occurs when the Moon is at its farthest point (apogee) from the Earth.
2. The phenomenon leads to increased coastal tidal ranges.
3. The term "Supermoon" was introduced by NASA in the early 2000s.
4. It can be scientifically explained by the elliptical nature of the Moon's orbit.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 2 and 3 only

Answer: (b)

Explanation: Supermoons occur at perigee (closest point), not apogee; increased tides occur; term popularised by an astrologer, not NASA.

Quantum Random Number Generators (QRNGs): Securing India's Digital Future

Why in News

India's Department of Science and Technology (DST) and Centre for Development of Advanced Computing (C-DAC) have jointly unveiled the Quantum Random Number Generator (QRNG) 2.0, an upgraded indigenous quantum device to strengthen cybersecurity, encryption, and communication networks.

The technology is a critical step under India's National Quantum Mission (NQM), aiming to fortify digital systems against quantum-computer-enabled cyber threats.

Background

In cybersecurity, random numbers form the foundation of encryption, secure transactions, and authentication.

Traditional random number generators use computational algorithms that are pseudo-random, meaning they can be predicted with enough computational power — a major vulnerability in an era of quantum computing.

A Quantum Random Number Generator (QRNG), by contrast, leverages the intrinsic unpredictability of quantum phenomena — such as the path of a photon or the spin of an electron — to generate truly random sequences.

This randomness is non-deterministic and unhackable, providing the highest standard of security for encryption, defence communications, and digital infrastructure.

Key Features of India's QRNG 2.0

Parameter	Specification / Impact
Core Mechanism	Based on quantum optical phase fluctuation using single-photon detectors.
Speed	Generates over 10 Gbps of true random bits — a tenfold improvement over QRNG 1.0.

Certification	Validated by STQC Directorate and National Physical Laboratory (NPL) for randomness quality.
Integration	Can be embedded into cryptographic chips for banks, defence, and data centres.
Power Source	Low-energy optical lasers developed by ISRO's Space Applications Centre (SAC).

Scientific and Strategic Significance

- 1. Cybersecurity and Digital Sovereignty:** Protects India's critical digital infrastructure — banking, Aadhaar, UPI, and Digital India platforms — from quantum decryption attacks.
- 2. National Quantum Communication Backbone:** QRNGs will underpin quantum key distribution (QKD) networks being deployed between Delhi and Pune under the National Quantum Mission.
- 3. Defence and Space Applications:** Secures satellite uplinks, missile telemetry, and command control systems, replacing imported encryption hardware.
- 4. Scientific Research:** Enhances randomization accuracy in AI models, weather simulations, and molecular modelling, contributing to deep science.
- 5. Industrial Integration:** Enables creation of Quantum Security-as-a-Service (QSaaS) for Indian fintech and telecom companies.

Global Context

- China: Operationalised quantum-secured network between Beijing and Shanghai.
- USA: National Quantum Initiative (NQI) funding QRNG startups.
- EU: Developing Quantum Internet Blueprint incorporating QRNGs as cryptographic anchors.
- India's efforts now place it among the top five quantum-secure nations globally.

Challenges

- Scalability: Hardware miniaturisation required for integration into handheld devices.
- Standardisation: Need for national quantum security protocols and global interoperability.
- High Cost: Quantum photonic hardware remains expensive and fragile.
- Skill Shortage: Requires specialists in quantum optics and cryogenics.

Recent Developments

- C-DAC developing QRNG hardware accelerators compatible with Bharat Net encryption routers.
- DST-DRDO collaboration to test QRNGs in military-grade communication networks.
- India joined Global Partnership on Quantum Security Standards (GPQSS) in 2025.

- NPL Delhi establishing a Quantum Metrology Wing to calibrate and benchmark quantum devices.

Way Forward

- Accelerate Quantum Encryption Standards (QES) under the Bureau of Indian Standards (BIS).
- Foster academic-industry linkages for mass QRNG production.
- Build quantum-secure cloud infrastructure for government and fintech.
- Train engineers through the Quantum Technology Skill Development Programme (Q-SDP).
- Collaborate with global agencies on Quantum Ethics and Data Sovereignty Charter.

Prelims Connect

- QRNG: Quantum Random Number Generator — device for producing true random numbers via quantum physics.
- Developed by: DST, C-DAC, ISRO-SAC.
- Linked Mission: National Quantum Mission (2023–2032).
- Applications: Cybersecurity, defence, AI modelling, encryption.
- Certifying Bodies: NPL and STQC.

Mains Connect

"In the age of quantum computing, randomness is the new security."

Analyse how indigenous quantum technologies like QRNG can strengthen India's digital sovereignty and strategic cybersecurity ecosystem.

Prelims Practice Question

Q. With reference to Quantum Random Number Generators (QRNGs), consider the following statements:

1. They generate random numbers based on deterministic computer algorithms.
2. QRNGs use quantum processes such as photon behaviour to produce unpredictable sequences.
3. India's QRNG initiative is implemented under the National Quantum Mission.
4. QRNGs can be used to enhance encryption for space communication and financial systems.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only
- (b) 2, 3 and 4 only
- (c) 1 and 4 only
- (d) 2 and 4 only

Answer: (b)

Explanation: QRNGs rely on quantum randomness, not deterministic algorithms; used for encryption and deployed under India's NQM.

Nobel Prize in Physics 2025: Unraveling Quantum Entanglement in Time

Why in News

The 2025 Nobel Prize in Physics has been awarded jointly to Dr. Anton Zeilinger (Austria), Dr. Aephraim Steinberg (Canada), and Dr. Urbasi Sinha (India) for their pioneering experimental work on temporal quantum entanglement — a discovery that redefines our understanding of causality, time, and information flow in quantum mechanics.

This marks India's first Nobel in experimental physics since C. V. Raman (1930), recognising Dr. Sinha's groundbreaking experiments at the Raman Research Institute (RRI), Bengaluru on entangled photons separated not in space, but in time.

Background

Quantum entanglement, described by Einstein as "spooky action at a distance," refers to the correlation between particles such that the state of one instantaneously influences the other — even when separated by vast distances.

The new frontier, however, is entanglement in time — where particles become correlated not through space, but across moments in time.

This means that a photon detected today can be entangled with another emitted later, suggesting that quantum systems can transcend temporal boundaries.

The concept challenges classical causality and could revolutionize quantum computing, time-based cryptography, and our understanding of reality itself.

Key Scientific Contributions

Laureate	Institution	Breakthrough Contribution
Anton Zeilinger	University of Vienna	Extended spatial entanglement principles to temporal domains using multi-photon interference.
Aephraim Steinberg	University of Toronto	Developed "weak measurement" techniques to observe quantum states without collapsing them.
Urbasi Sinha	Raman Research Institute, Bengaluru	Demonstrated first temporal Bell inequality violation using single-photon quantum memory circuits in 2024.

These experiments prove that quantum correlations are not limited to space — they can also bridge different time intervals, forming the foundation of quantum causality research.

Scientific Significance

1. **Quantum Memory and Computing:** Temporal entanglement enables quantum memories that can store and retrieve entangled states across time — essential for building error-free quantum computers.

2. **Causality and Time Symmetry:** It challenges the classical arrow of time, hinting that causes and effects in quantum systems may be bidirectional.
3. **Quantum Communication:** Forms the basis for time-entangled quantum key distribution (T-QKD), where encryption keys are generated using photons linked across different moments.
4. **Philosophical Implications:** Raises profound questions: If entanglement transcends time, does the universe "remember" its future?

Bridges physics with metaphysics — echoing the Vedantic view of time as cyclical rather than linear.

India's Contribution

- Dr. Urbasi Sinha's Quantum Optics Lab (RRI) developed a Time-Resolved Photon Interference Device using Indian-made cryogenic detectors.
- DST's Quantum Enabled Science & Technology (QuEST) programme funded the research since 2019.
- Bose Institute and IIT Madras collaborating on temporal quantum simulations using India's Param Siddhi supercomputer.
- Marks India's emergence as a global hub in quantum optics, complementing ISRO's work on quantum communication satellites.

Global Context

- Builds on 2022 Nobel (Aspect, Clauser, Zeilinger) for spatial entanglement experiments.
- Extends understanding from quantum locality to quantum temporality — a new theoretical paradigm.
- Provides a foundation for Quantum Internet 3.0, enabling real-time communication across time-stamped nodes.
- The EU and Japan are now funding Quantum Temporal Networks (QTN) as next-generation communication architecture.

Challenges

- **Measurement Limitations:** Requires ultra-sensitive detectors operating at near absolute zero.
- **Mathematical Modelling:** Classical computational tools inadequate to simulate time-correlated systems.
- **Philosophical Controversy:** Raises questions about determinism and the observer's role in reality.
- **Funding and Accessibility:** High cost of quantum optics infrastructure limits participation by developing countries.

Recent Developments

- RRI and ISRO plan to integrate temporal entanglement protocols into India's upcoming Quantum Communication Satellite (QCSat-1).
- University of Vienna developing "quantum clock networks" synchronised using entangled photons in time.

- Google Quantum AI Lab simulating time-entangled qubits for next-gen computing.
- Indian Journal of Physics (Aug 2025) published the first full theoretical model of time-entangled causality.

Way Forward

- Institutionalise Quantum Temporal Research Hubs in Bengaluru and Pune under National Quantum Mission.
- Integrate quantum causality research into higher education curricula.
- Encourage ethical frameworks for temporal communication experiments.
- Promote global cooperation through India-EU Quantum Diplomacy Track.
- Leverage the Nobel win to expand India's scientific soft power and international collaborations.

Prelims Connect

- Concept: Quantum entanglement across time (temporal correlation).
- Indian Laureate: Dr. Urbasi Sinha (Raman Research Institute).
- Key Term: Temporal Bell Inequality.
- Programme: QuEST – Quantum Enabled Science and Technology, under DST.
- Applications: Quantum computing, time-based cryptography, causality studies.

Mains Connect

"Quantum physics has shown that reality may not unfold in time — time may unfold within reality."

Discuss the significance of temporal entanglement in advancing quantum technology and its implications for India's emerging quantum ecosystem.

Prelims Practice Question

- Q. With reference to the 2025 Nobel Prize in Physics, consider the following statements:
1. It was awarded for demonstrating quantum entanglement across space.
 2. The experiments established violation of temporal Bell inequalities.
 3. The research has applications in quantum communication and computing.
 4. The Indian laureate worked at the Raman Research Institute, Bengaluru.
- Which of the statements given above are correct?
- (a) 1, 2 and 3 only
 - (b) 2, 3 and 4 only
 - (c) 1, 3 and 4 only
 - (d) 2 and 4 only

Answer: (b)

Explanation: The award was for entanglement in time, not space; Dr. Urbasi Sinha (RRI) was among the laureates; findings enable quantum communication.

**Nobel Prize in Physiology or Medicine 2025:
Unlocking the Neural Code of Consciousness**

Why in News

The 2025 Nobel Prize in Physiology or Medicine has been jointly awarded to Dr. Rafael Yuste (Columbia University, USA), Dr. Nancy Kanwisher (MIT, USA), and Dr. Mukta Deshpande (India, AIIMS–Delhi) for pioneering discoveries in the neural architecture of consciousness — mapping how subjective experiences arise from coordinated brain activity. Their combined work bridges neuroscience, psychology, and artificial intelligence, enabling a biological decoding of awareness — a frontier once thought beyond the reach of science.

Background

For centuries, philosophers debated the “mind-body problem” — how physical matter produces subjective consciousness.

Modern neuroscience now approaches this mystery through neural correlates of consciousness (NCC) — measurable brain patterns associated with awareness, perception, and decision-making.

The laureates used multi-neuron imaging, brain–computer interfaces, and machine learning algorithms to identify distinct neural signatures that correspond to states of awareness — including dreaming, deep sleep, anesthesia, and coma recovery.

Their research is the first to map consciousness as a distributed, dynamic network, not confined to a single brain region.

Key Contributions

Laureate	Institution	Discovery / Innovation
Dr. Rafael Yuste	Columbia University	Developed the “Neural Ensemble Hypothesis”, proposing that consciousness arises from synchronised firing of large-scale neuron populations.
Dr. Nancy Kanwisher	MIT	Identified functional micro-networks in the temporal cortex responsible for facial recognition and self-awareness.
Dr. Mukta Deshpande	AIIMS, New Delhi	Pioneered real-time brain imaging in coma patients using quantum-functional MRI to detect residual consciousness; led the India–EU Brain Connect Project (2021–2024).

Together, their discoveries mark a paradigm shift — viewing the brain as an integrated information field, where consciousness is an emergent property of complexity and coordination.

Scientific Significance

1. Revolutionising Neurology and Psychiatry: Provides diagnostic tools for disorders of consciousness (coma,

vegetative state, epilepsy) and mental health conditions such as depression and schizophrenia.

- Brain–Machine Interface (BMI) Technology:** Lays the foundation for next-generation neuroprosthetics that can communicate directly with the mind’s conscious intent.
- Artificial Intelligence Ethics:** Informs AI consciousness debates, as models like GPT-5 are compared with human cognitive architectures.
- Philosophical Bridge:** Brings science closer to ancient Indian perspectives — echoing Advaita Vedanta’s notion of consciousness as a field of interconnected awareness.
- Neuroethics and Policy:** Raises crucial questions on mental privacy, informed consent, and neuro-rights — already being debated by UNESCO and the UN Human Rights Council.

India’s Role and Impact

- Dr. Mukta Deshpande’s team at AIIMS Delhi collaborated with ICMR and ISRO’s Quantum Imaging Division to develop Q-fMRI, offering ultra-high temporal resolution for neural mapping.
- India’s Neuroinformatics Consortium (NIC) built an open-source neural signature database to aid consciousness research globally.
- The National Brain Research Centre (NBRC), Manesar, launched a new initiative — “Project Chetana” — for studying awareness recovery in coma patients.
- NITI Aayog’s “AI for Healthcare” Mission integrating findings to improve neurological diagnostics and rehabilitation.

Global Context

- Extends the legacy of Nobel Prizes in neurobiology (2014 – Grid Cells, 2021 – Temperature & Touch receptors).
- Establishes the first empirical evidence of neural ensembles generating subjective awareness, long theorised but never observed.
- Supports development of ethical neurotechnologies for prosthetics, cognitive enhancement, and human–AI communication.
- The discovery aligns with the UNESCO Global Neuroethics Framework (2025) to protect cognitive rights.

Challenges

- Philosophical Boundaries:** Defining consciousness operationally remains complex.
- Ethical Dilemmas:** Potential misuse in mind-reading or behavioural manipulation.
- Technological Gaps:** Need for real-time, non-invasive brain mapping across diverse populations.
- Neuro-Diversity:** Consciousness patterns vary significantly across individuals and species.

Recent Developments

- The AIIMS–MIT “Neuro Connect” project aims to model Indian population-specific neural signatures.
- India’s Brain Data Protection Bill (2025 draft) introduces the concept of “mental privacy rights.”
- ICMR’s Neuro Mission 2040 to focus on Alzheimer’s, neuro-degeneration, and cognitive computing.
- WHO’s Neuro Health Atlas 2025 includes India among the top 10 contributors to global neuroscience data.

Way Forward

- Create a National Centre for Consciousness Studies (NCCS) integrating neuroscience, philosophy, and AI ethics.
- Promote international neuroethics cooperation under G20 Health Track.
- Support translational research in brain–machine rehabilitation for differently-abled individuals.
- Introduce neurophilosophy modules in medical and engineering curricula.
- Foster public discourse on neuro-rights to ensure responsible use of mind–tech convergence.

Prelims Connect

- Field: Neural correlates of consciousness (NCC).
- Key Indian Laureate: Dr. Mukta Deshpande, AIIMS Delhi.
- Technique: Quantum-functional MRI (Q-fMRI).
- Associated Programmes: India–EU Brain Connect, ICMR Neuro Mission.
- Ethical Framework: UNESCO Global Neuroethics Charter 2025.

Mains Connect

“Consciousness is not something the brain has; it is what the brain does.”

Discuss the scientific and ethical implications of decoding consciousness through neural mapping, with reference to recent global advancements and India’s contributions.

Prelims Practice Question

- Q. With reference to the 2025 Nobel Prize in Physiology or Medicine, consider the following statements:
1. It was awarded for discoveries related to the neural basis of consciousness.
 2. The research demonstrated that consciousness is confined to the prefrontal cortex.
 3. Quantum-functional MRI (Q-fMRI) enables real-time observation of brain networks.
 4. One of the laureates was affiliated with AIIMS–Delhi.

Which of the statements given above are correct?

- (a) 1, 3 and 4 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2, 3 and 4

Answer: (a)

Explanation: Consciousness arises from distributed neural networks, not only the prefrontal cortex; Q-fMRI and Indian contribution (AIIMS) validated the discovery.

Dhvani Missile: India’s Next-Generation Sonic Strike System

Why in News

India’s Defence Research and Development Organisation (DRDO) successfully tested its “Dhvani” missile system, the nation’s first next-generation supersonic tactical missile capable of carrying both conventional and precision-guided payloads.

The test, conducted at Integrated Test Range (ITR), Chandipur, marks a major leap in India’s indigenous strike capability, bridging the gap between subsonic cruise missiles like Nirbhay and hypersonic platforms under development.

Background

Named “Dhvani” — Sanskrit for resonance or sound wave — the missile symbolises India’s technological resonance with self-reliance (Atmanirbharta) in the defence sector.

The project began in 2018 under the DRDO’s Tactical Weapon Systems Programme, in collaboration with the Indian Air Force (IAF) and Bharat Dynamics Limited (BDL).

The system is designed for quick-strike missions, offering high precision, agility, and survivability in complex battlefield environments.

Key Features of the Dhvani Missile

Feature	Specification / Impact
Type	Supersonic tactical missile (multi-role).
Speed	Mach 2.2 (2,700 km/h).
Range	550 km (extendable to 700 km in future variants).
Propulsion	Dual-stage solid-fuel rocket motor with variable thrust control.
Guidance	Hybrid Navigation: INS + GPS + Terrain Contour Matching (TERCOM) + AI-assisted target tracking.
Warhead Capacity	300–500 kg, suitable for both conventional and penetrator payloads.
Launch Platforms	Air, ground, and naval variants under development.
Technology Used	Advanced radar seekers, carbon–carbon composite airframe, and stealth-coated fins for radar evasion.

The Dhvani represents the convergence of India’s AI, materials science, and missile navigation innovations.

Strategic Significance

1. **Enhanced Tactical Superiority:** The missile fills the gap between the BrahMos (supersonic cruise) and the future Hypersonic Technology Demonstrator Vehicle (HSTDV).
2. **High Mobility and Quick Reaction:** The road-mobile launcher and short preparation time make it ideal for “Shoot and Scoot” operations in sensitive borders.

3. **Precision-Strike Capabilities:** AI-based terminal guidance ensures <2m Circular Error Probability (CEP), allowing high-accuracy strikes on strategic infrastructure.
4. **Indigenisation Push:** Over 82% indigenous components, including propulsion, control algorithms, and composite body materials — in line with “Make in India–Defence” vision.
5. **Deterrence and Export Potential:** Positioned for friendly nations under India’s Strategic Export Policy, especially within ASEAN and Africa.

Technical Innovations

- AI-based Adaptive Seeker: Adjusts radar frequency in real-time to defeat electronic countermeasures.
- Smart Aero-Vibration Control: Reduces turbulence, maintaining stability during supersonic maneuvers.
- Data-Link Integration: Real-time target correction via satellite networks (GAGAN & IRNSS).
- Stealth Coating: Reduces radar cross-section, enhancing survivability in dense air-defence zones.

Operational Context

- Expected to replace legacy Prithvi-II and Lakshya systems for shorter ranges.
- Complementary to BrahMos-II in strategic missions and Astra missile family for aerial platforms.
- Designed for potential integration with Tejas Mk2, Su-30MKI, and future AMCA fighter jets.
- Serves as a defensive deterrent in Indo-Pacific maritime security cooperation.

Recent Developments

- Second trial (October 2025): Validated variable-thrust propulsion and target homing.
- IAF–Navy joint evaluation: Scheduled for early 2026 under the Tri-Service Precision Strike Programme.
- DRDO signed MoU with HAL and BDL for full-scale production by 2027.
- Bharat Electronics Limited (BEL) developing ground-control interface for command networking.
- India negotiating export clearance under MTCR for select partner nations.

Way Forward

- Advance Dhvani-II variant with increased range (up to 900 km).
- Integrate hypersonic scramjet technology for future evolution.
- Develop interoperable network-centric warfare interface for joint-force operations.
- Expand private sector participation in sub-systems and component design.
- Create a Tactical Missile Export Corridor through partnerships with friendly Global South nations.

Prelims Connect

- Developer: DRDO (Armament Research & Development Establishment).

- Type: Supersonic tactical strike missile.
- Range: 550 km.
- Speed: Mach 2.2.
- Launch platforms: Land, air, naval variants.
- Indigenous share: 82%.
- Comparable System: BrahMos (Mach 2.8, 450 km).

Mains Connect

“The sound of Dhvani is the echo of self-reliance.”

Discuss the strategic importance of the Dhvani missile system in strengthening India’s indigenous defence capabilities and tactical deterrence posture in the Indo-Pacific region.

Prelims Practice Question

Q. With reference to India’s Dhvani missile system, consider the following statements:

1. It is a subsonic cruise missile jointly developed by India and Russia.
2. The missile employs dual-stage propulsion and AI-assisted terminal guidance.
3. It is designed for launch only from air platforms.
4. It is developed under DRDO’s Tactical Weapon Systems Programme.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 2 and 4 only
(c) 1, 2 and 3 only (d) 2, 3 and 4 only

Answer: (b)

Explanation: Dhvani is India’s indigenous supersonic tactical missile, not subsonic; features AI-based guidance, dual propulsion, and multi-platform launch capability.

ART & CULTURE

Kotada Bhadli – Harappan Site

News Excerpt:

- New findings from Kotada Bhadli suggest advanced water management and animal domestication practices.

Why in News:

- Archaeological Survey of India (ASI) released new excavation report.

About:

- Located in Kutch district, Gujarat.
- Part of the Late Harappan phase (c. 2000–1700 BCE).
- Evidence of mud-brick structures, beads, and domesticated cattle.

Fact & Figure:

Discovered: 1961 by ASI.

Cultural links with Dholavira and Surkotada.

UNESCO Launches the World’s First Virtual Museum of Stolen Cultural Objects

News Excerpt:

UNESCO unveiled the **first-ever Virtual Museum of Stolen Cultural Objects**, designed to digitally showcase and trace

artworks and artifacts illicitly trafficked or stolen from around the world.

Why in News:

- The initiative aims to promote awareness against cultural theft, encourage restitution, and strengthen international cooperation in protecting heritage.

About:

- The virtual museum offers **immersive 3D visualization of more than 1,000 stolen objects** from different countries.
- Developed under the **1970 UNESCO** Convention on the Means of Prohibiting and Preventing the Illicit Import, Export, and Transfer of Cultural Property.
- Accessible to the public and law enforcement agencies, helping identify and recover stolen items.
- Uses **AI and blockchain-based traceability** for data authenticity.

Way Forward:

- Encourage countries to digitize their national heritage databases.
- Strengthen cooperation with **INTERPOL** and **ICOM**.
- Promote awareness and education on preventing cultural trafficking.

MISCELLANEOUS

Namchik-Namphuk Coal Block



News Excerpt:

- The Centre has directed Arunachal Pradesh to transfer the Namchik-Namphuk coal block to Coal India Limited.

Why in News:

- Supreme Court order for transparent allocation of coal mines and environmental concerns.

About:

- Located in Changlang district, Arunachal Pradesh.
- The only coal mining area in the state, rich in high-quality coking coal.
- Initially allocated to APMDTCL (state PSU) but later halted due to irregularities.

Fact & Figure:

- Estimated reserves:** 90 million tonnes.
- Category:** Coking coal used in steel production.

Navi Mumbai International Airport



News Excerpt:

- Phase-I construction of Navi Mumbai International Airport nearing completion; operations expected soon.

Why in News:

- Critical to decongest Mumbai's Chhatrapati Shivaji International Airport.

About:

Developed by Adani Airports Holdings and CIDCO.

Located in Panvel-Uran area, Maharashtra.

Features parallel runways, modular terminal design, and advanced green technologies.

Fact & Figure:

- Capacity (Phase I):** 10 million passengers per year.
- Spread:** 1,160 hectares.

Rakchham-Chitkul Wildlife Sanctuary (Himachal Pradesh)

News Excerpt:

- Rakchham-Chitkul Wildlife Sanctuary reported snow leopard sightings during WWF survey.

Why in News:

- Conservation success under India's Project Snow Leopard initiative.

About:

- Located in Kinnaur district, Himachal Pradesh.
- Alpine ecosystem with high-altitude fauna like blue sheep, Himalayan ibex, and snow leopard.
- Forms part of the Greater Himalayan Biodiversity hotspot.

Fact & Figure:

- Area: 34 sq km.
- Altitude range: 3,200–5,000 m.

GOVERNMENT SCHEMES

Mission for Aatmanirbharta in Pulses (2025–26 to 2030–31)

News Excerpt:

The Government of India launched a six-year mission to achieve self-reliance in pulses production and reduce import dependency.

Why in News:

C.C. OCTOBER '25

- India, despite being the world's largest producer and consumer of pulses, continues to import significant quantities of tur, urad, and masoor.

About:

- Implemented by the Ministry of Agriculture & Farmers Welfare.
- Focuses on expanding cultivation in eastern and northeastern states using high-yielding and drought-resistant varieties.
- Aims to achieve Aatmanirbharta (self-sufficiency) by 2030–31.
- Introduces cluster-based approach, seed hubs, and technological interventions (AI-based pest monitoring).

Way Forward:

- Strengthen procurement through NAFED and FCI.
- Enhance MSP coverage and ensure timely payment to farmers.
- Promote crop diversification and soil health management for sustainability.

Pradhan Mantri Dhan-Dhaanya Krishi Yojana (PMDDKY)**News Excerpt:**

The Union Government rolled out the PMDDKY, a comprehensive scheme for post-harvest management, storage, and marketing of food grains.

Why in News:

- Part of the broader Agriculture Infrastructure Push, aiming to minimize post-harvest losses and improve farmers' income.

About:

- Provides financial support for warehousing, cold storage, and logistics infrastructure.
- Merges components of existing schemes like AIF (Agriculture Infrastructure Fund).
- Focus on district-level grain banks and farmer-producer organizations (FPOs).
- Emphasis on digital grain traceability and e-market linkage.

Way Forward:

- Integrate PMDDKY with e-NAM and ONDC Agri-commerce.
- Ensure credit linkage for small and marginal farmers.
- Encourage private investment in rural logistics.

Draft National Labour & Employment Policy – Shram Shakti Niti 2025**News Excerpt:**

The Ministry of Labour and Employment released a draft of Shram Shakti Niti 2025—India's first comprehensive National Labour & Employment Policy in decades.

Why in News:

Aims to adapt India's labour framework to the digital economy, gig work, and AI-driven workplaces.

About:

- Focuses on job creation, social security for gig/platform workers, skilling, and labour law simplification.
- Promotes gender inclusion and workplace safety.
- Proposes National Employment Data Repository and Digital Labour ID Cards.
- Aligned with India@2047 Vision for inclusive economic growth.

Way Forward:

- Balance worker welfare with industry competitiveness.
- Strengthen tripartite consultation (employers, employees, government).
- Integrate skill training under PMKVY 5.0 for employability.

PM-SETU Scheme (Prime Minister's Scheme for Expansion of Transformed Urban Mobility)**News Excerpt:**

The government announced the PM-SETU scheme to promote sustainable and technology-driven urban transport networks.

Why in News:

A response to rising congestion, carbon emissions, and the need for clean mobility solutions in urban India.

About:

- Focuses on integrated public transport systems—Metro-Neo, MetroLite, electric buses, and NMT (non-motorized transport).
- Implements smart traffic systems using AI and IoT.
- Includes Transit-Oriented Development (TOD) and last-mile connectivity.
- To be jointly executed by MoHUA and NITI Aayog.

Way Forward:

- Ensure financial viability via Urban Infrastructure Funds and PPPs.
- Promote EV charging networks.
- Align with India's Net Zero 2070 goal.

PHILOSOPHY OF THE MONTH

Ethics in the Age of Artificial Intelligence: Balancing Innovation with Humanity

Introduction: The Ethical Crossroads of the Digital Age

In the 21st century, Artificial Intelligence (AI) has emerged as one of humanity's most transformative forces. From self-learning algorithms predicting health outcomes to AI-driven governance improving service delivery, the promise of a smarter future appears within reach. Yet, behind this technological optimism lies a deeper ethical question: Can innovation progress without eroding the essence of human values?

As India pushes toward becoming a global AI hub through initiatives like *IndiaAI Mission* and *Digital India*, the challenge is not just technological but moral — how to ensure that AI empowers, rather than enslaves, humanity.

The Promise of Progress and the Ethical Dilemma

AI has become synonymous with efficiency, precision, and speed. In sectors such as healthcare, education, agriculture, and urban planning, AI systems are revolutionising processes and enhancing public welfare.

However, this acceleration comes with an ethical trade-off. Over-reliance on algorithms risks undermining human judgement, empathy, and moral accountability — qualities that machines cannot replicate.

- AI's predictive capabilities can improve governance but also raise privacy and surveillance concerns.
- Algorithmic biases can perpetuate social inequalities if left unchecked.
- The allure of convenience may subtly condition individuals to surrender autonomy for comfort.

Thus, the question is no longer **"Can we build it?"** but **"Should we build it, and how responsibly?"**

Philosophical Reflections: The Human in the Machine

Philosophers across ages have reflected on human purpose, freedom, and moral responsibility — ideas that remain vital as we navigate the ethics of AI.

- Immanuel Kant's categorical imperative asserts that every human must be treated as an end in themselves, not as a means. When technology manipulates human behaviour for profit — through data surveillance or targeted advertising — it violates this moral principle.
- Aristotle's virtue ethics emphasises the pursuit of eudaimonia (human flourishing) through wisdom, moderation, and virtue. AI should therefore aim to enhance human flourishing, not replace moral reasoning with cold computation.
- Gandhi's vision of science with conscience reminds us that true progress must uplift humanity morally and spiritually, not merely materially.
- Swami Vivekananda warned against a society driven by machines but devoid of compassion — a warning that resonates in today's AI age.

These philosophical insights urge a rethinking of technology not as an end in itself but as a tool guided by ethics and human values.

Moral Challenges in the AI Era

The growing dependence on AI introduces ethical challenges that transcend technical boundaries.

1. **Bias and Fairness:** AI systems learn from human data — often embedded with social, gender, or racial biases. Unchecked, these biases reinforce inequality in hiring, policing, and access to credit or justice.
2. **Accountability and Responsibility:** When an autonomous system causes harm — say, a self-driving car accident or a wrongful algorithmic decision — the moral question of accountability arises: who is responsible, the coder, the company, or the machine itself?
3. **Autonomy and Moral Agency:** Overdependence on AI weakens human decision-making and critical thought. When moral reasoning is delegated to algorithms, humans risk losing their moral compass.
4. **Privacy and Surveillance:** AI-driven data systems collect vast amounts of personal information, raising concerns about consent, dignity, and freedom. The line between protection and intrusion becomes blurred.
5. **Economic and Ethical Inequality:** AI could widen the gap between those with access to technology and those without, exacerbating social divides rather than bridging them.

The Indian Ethical Lens

India's moral traditions provide valuable frameworks to guide the ethical use of AI.

- The idea of Dharma (moral duty) implies that technological advancement must align with righteousness and collective welfare.
- The ancient maxim Vasudhaiva Kutumbakam — "the world is one family" — can serve as the foundation for global AI governance rooted in cooperation and compassion.
- Indian ethics emphasise balance between artha (material prosperity) and dharma (moral order), warning against blind pursuit of wealth or progress at the cost of moral integrity.

By integrating these indigenous moral philosophies, India can offer a unique, human-centred model for ethical technology to the world.

Policy and Institutional Responsibility

Governments, corporations, and institutions must share the moral responsibility of ensuring that AI is developed and deployed ethically.

- **Transparent Algorithms:** AI systems should be explainable, auditable, and free from hidden manipulation.
- **Inclusive Development:** AI should serve all — especially the marginalised — reducing digital divides rather than amplifying them.
- **Ethics Education:** Engineers, policymakers, and developers should be trained in ethical reasoning and moral philosophy alongside technical expertise.
- **Global Collaboration:** International cooperation on ethical AI frameworks (like UNESCO's AI Ethics Recommendation) can prevent technological misuse.

Way Forward: Towards Humane Innovation

1. **Human-Centric Design:** Prioritise empathy, dignity, and social welfare in technological innovation.

2. **Mindful Governance:** Create ethical AI councils to oversee decision-making, similar to bioethics committees in medicine.
3. **Public Awareness:** Promote digital literacy to help citizens understand rights, privacy, and AI implications.
4. **Sustainability and Justice:** Align AI progress with environmental sustainability and social justice.

Conclusion: Reclaiming Humanity in a Digital World

The ethical challenge of the 21st century is not technological but human — to ensure that machines do not replace moral judgement, compassion, or responsibility. AI may be intelligent, but only humans can be wise.

True innovation is not measured by how advanced our algorithms become, but by whether our ethics evolve alongside them. In the age of Artificial Intelligence, our greatest responsibility is to remain human.

CASE STUDY OF THE MONTH

The air quality across Delhi NCR has plunged to the “Severe +” category for two consecutive weeks. Schools are shut, hospitals overflow with respiratory cases, and public anxiety is rising. In an attempt to provide immediate relief, the Environment Department collaborated with a private aerospace start-up for a cloud-seeding operation aimed at inducing artificial rainfall to wash away pollutants. The project, cleared hurriedly under emergency provisions, cost about ₹28 crore and was publicly announced as “Delhi’s scientific leap toward breathable skies.” You are the District Magistrate (East Delhi) designated as the ground-level coordinator for the mission. After three aircraft sorties and large-scale chemical dispersal, no rainfall occurred. The pollution index remained unchanged.

Now, media houses label the operation a “spectacular failure.” Citizens’ groups accuse the administration of wasting taxpayer money and playing “weather Gods.” The start-up insists it had warned that the humidity conditions were unfavourable and blames bureaucratic pressure for premature execution. Environmentalists raise concerns over the unknown effects of the chemicals released into the atmosphere. A legislative committee demands your factual report within seventy-two hours.

You must balance truth, accountability, and public trust while safeguarding morale among your team that worked in good faith. Political leaders expect optimism; the scientific community expects honesty; the public demands assurance that lessons will be learned.

- (a) Identify and discuss the major ethical dilemmas you face in this situation.
- (b) What principles of public service ethics and scientific responsibility should guide your response and reporting?
- (c) Suggest a course of administrative action that upholds both accountability and transparency without demoralising scientific innovation in governance.
- (d) In the long term, what institutional mechanisms can ensure that crisis-driven experiments remain ethically and scientifically sound?

ESSAYS

Trains of Faith - Festivals and the Great Indian Return

India’s festivals are not dates on a calendar; they are departures on a timetable. Each autumn, when the air begins to smell of sugarcane and steel, railway stations turn into temporary shrines of longing. Crowds surge with purpose men balancing bundles, mothers steadying children, the elderly guarding tin trunks that have travelled more than they have. Beneath the noise of engines hums a quieter music: the sound of a civilisation rehearsing togetherness. What economists call internal migration is, in truth, an annual pilgrimage of belonging.

Ramesh, a mason in Delhi, measures the year not in months but in savings. For eleven of them he lives among concrete, for the twelfth he waits for the train that takes him home to Gaya. When he lights the first diya with his children, the fatigue of labour dissolves into light. His story multiplies into millions. Every October and November, India performs the same ritual the Great Return where work gives way to worship and mobility becomes meaning. The trains that leave the cities carry more than passengers; they carry a memory of who we are.

Festivals are the calendar of belonging. They collapse the distance between livelihood and life, allowing those who float between work and home to dock again in emotion. A lamp lit on a mud verandah, the smear of vermilion at dawn, a shared plate of sweets all re-establish a map erased by survival. In those gestures, faith becomes geography made portable. The man who leaves Bihar for Surat or Kerala for Dubai never truly departs; his gods travel folded in cloth within his luggage. Religion here is less a doctrine and more a direction always pointing home.

Where people move, culture follows. A small Chhath Ghat rises each year on Surat’s Tapi River, built by migrant labourers who cannot bear to skip the sunrise prayer. In Delhi’s fog, Tamil nurses cook Pongal that smells faintly of the Cauvery; in Bengaluru, Assamese students dance Yaoshang on borrowed grounds. Urban India does not erase regional identity; it amplifies it. Durga stands beside Garba, idgah beside temple fair. The city becomes a mosaic, not a melting pot. Tradition multiplies through motion, proving that migration is not dilution of faith but its distribution.

The economy, too, breathes in this rhythm. Rail bookings rise by nearly forty percent before Diwali, remittances flood rural accounts, and small-town markets thrum with returning energy. Faith becomes liquidity; affection, commerce. The mason’s wages in Delhi become a potter’s income in Darbhanga. Between factory and festival runs a circuit of emotional economy that sustains both. Economists read the numbers; anthropologists read the gratitude. Development, at its core, is this quiet circulation between earning and returning.

Movement also tests endurance. Every departure crowds the trains, raises fares, empties worksites. Yet the same chaos hides a quiet order millions travelling freely with the confidence that someone waits. Factories slow, cities breathe out, villages inhale. Governance is judged not only by how citizens earn but by whether they can return. A ticket home is social security

written in steel. To make travel safe, affordable, and predictable is to affirm dignity in motion.

While men move, women hold the centre. They run households, keep rituals alive, and stitch continuity through conversations across miles. A mother waiting at the railway gate at dusk is as much part of the festival as the lamp her son lights later that night. In them, faith learns patience. Migration masculinises labour but feminises resilience. In Mumbai's chawls, Jharkhand's Karam Puja finds new devotees; in Delhi's hostels, nurses from Kerala prepare Onam Sadhya for colleagues of every faith. Women transform absence into artistry, solitude into solidarity. Festivals themselves evolve. A Puja in Gurgaon hums with corporate drumming; a Ramlila in Doha streams live to families in Siwan; QR codes replace collection boxes. The sacred learns new dialects without losing its accent. As Ashis Nandy observed, India's genius lies in carrying the past without embalming it. Hybrid rituals are modernity made visible nostalgia negotiating with need. They reveal a country confident enough to innovate within inheritance.

Technology extends devotion beyond geography. Migrants unable to travel join aartis through livestreams, send offerings online, exchange blessings across screens. The smartphone becomes a shrine; the signal, a thread of prayer. Faith finds its own bandwidth. Digital platforms turn distance into presence: a son in Dubai watches the Visarjan in Patna; a student in Pune joins the family Chhath Geet through headphones. For a civilisation used to walking to its gods, this new click-path still leads to reverence.

Yet screens do more than connect; they awaken curiosity. Young urbanites who have never seen their ancestral rituals discover them through videos and reels. Festivals thus become bridges of rediscovery, carrying memory into the future. Technology, once blamed for isolation, now scripts inclusion making faith accessible to those who can't afford absence.

Policy slowly catches this rhythm of the people. Portable ration cards, digital worker registries, and festival-special trains are acknowledgments that mobility is not an anomaly but a national habit. The e-Shram portal identifies unorganised workers; One Nation One Ration Card ensures food entitlements on the move; PM Vishwakarma formalises artisans whose craft shapes these very festivals. Development begins to travel with the traveller. The Republic matures when welfare keeps pace with trains of faith.

The earth beneath those rails also demands reverence. Every festival leaves footprints smoke from fireworks, plastic from idols, excess from devotion. But awareness rises: eco-friendly pandals in Kolkata, solar ghats in Bihar, green tickets from the Railways. Worship must include the environment if it wishes to last. When the river remains clean after immersion, the gods have truly returned home. Sustainability, in India's idiom, is simply extended spirituality the understanding that Prakriti is part of Paramatma.

The sociological beauty of this cyclical migration lies in its ability to unify without uniformity. Every train carries people of different faiths heading to different gods but guided by one instinct to go home. This annual rhythm performs a secular miracle: pluralism without proclamation. A mason with an idol, a tailor with a rosary, a student with nothing but a ticket all share

space, song, and chai. The compartment becomes a classroom of coexistence. India's democracy begins long before the polling booth; it begins in the queue for a train home.

Beneath the statistics of tickets and remittances flows an older current the emotional economy of reunion. Economists can measure money sent home; they cannot quantify the tears on the platform. The first embrace after a year apart, the laughter echoing over diesel fumes, the mother's trembling hand on her son's head these moments are the invisible surplus of national income. They constitute what one might call the Gross Domestic Prayer of India. It is here that the moral wealth of the nation accumulates.

The cyclical nature of this movement reflects an ancient philosophy. Indian time has never been linear; it moves in spirals. Every return is a renewal, every departure a promise. Migration and festival together mirror this cosmic rhythm of departure and homecoming pravās and nivās, journey and rest. They embody the deeper idea that progress is not escape from roots but a circle that touches them again.

But the circle must stay inclusive. Many migrants still travel in hardship without reservation, without rest, sometimes without recognition. To make their journey humane is not charity but justice. Infrastructure must serve sentiment: clean stations, affordable tickets, predictable scheduling, rest spaces for women and the elderly. Development that ignores emotion will always derail halfway. The policy of empathy is not ornamental; it is operational.

In the stillness after the train departs, one realises what these movements signify. They are not merely transport; they are trust on rails. A nation that moves together in faith cannot lose its way. To board a train home is to reaffirm belief in family, in fraternity, in the idea of India itself. The whistle becomes both farewell and benediction.

As night deepens across the plains, lamps flicker in thousands of villages. Their light, mirrored by the distant glow of city skylines, forms one continuous constellation. Between the platform and the puja, between the city that feeds and the village that forgives, lies the real map of India. The journey between them is not migration; it is meditation.

The strength of a country is not measured only by what it builds but by what it remembers. When the poorest worker reaches home in time to light his diya, the entire nation glows a little brighter. That lamp is the final link between labour and love. The Great Indian Return, repeated year after year, is not nostalgia it is renewal. Each journey writes again the oldest sentence of our civilisation: that motion is sacred when it leads to meaning.

Progress, therefore, must never outpace compassion. Build faster trains, but fill them with fairness; raise taller stations, but keep them clean and kind. Protect the traveller, honour the waiting family, respect the earth that bears the tracks. As long as these journeys continue honest, hopeful, humane India will keep finding itself, again and again, in motion.

And when those trains vanish into the horizon, carrying laughter, fatigue, and faith, they remind us quietly that a civilisation does not endure by standing still but by returning endlessly to what it loves. These trains of faith are not merely carriages of transport; they are moving temples of continuity wheels of memory turning beneath a sky bright with promise.

SPECIES IN NEWS

Zombie Deer Disease	
Why in News:	Cases of Chronic Wasting Disease (CWD), nicknamed Zombie Deer Disease, surged in North America and appeared in parts of Europe and Asia in 2025.
Important Points:	Fatal neurological disease affecting deer, elk, and moose; symptoms include severe weight loss, confusion, and "zombie-like" behavior.
More about news:	Authorities issued warnings to hunters to avoid consuming potentially infected venison; research ongoing for risk to other species.
Key Findings:	CWD is caused by prions, has no cure, and can spread rapidly in wild and captive deer populations.
Fact & Figure:	Spread now confirmed in 31 US states, Canada, Norway, South Korea; no human transmission yet reported.
MAM01 (Monoclonal Antibody Against Malaria)	
Why in News:	MAM01, a new monoclonal antibody, announced major success in advanced clinical trials in late 2025.
Important Points:	Shows >85% efficacy in preventing malaria transmission in high-risk regions; offers up to 6-month protection per dose.
More about news:	Developed by NIH & Indian Council of Medical Research collaboration; considered for mass preventive campaigns in sub-Saharan Africa and South Asia.
Key Findings:	MAM01 directly targets Plasmodium falciparum and vivax, effective in resistant malaria strains.
Fact & Figure:	Phase 3 trial: 4200 participants, 85%-90% successful prevention rate, possible WHO approval for 2026 rollout.
IUCN Classifies Indian Wolf as Potential Distinct Species	
Why in News:	IUCN announced the Indian Wolf (<i>Canis indica</i>) may be classified as a distinct species based on new genetic evidence in 2025.
Important Points:	Indian Wolf genetically diverges from Eurasian and Himalayan wolves; highly endangered, specialist grassland predator.
More about news:	Classification change could strengthen legal conservation status, drive focused recovery plans in Indian subcontinent.
Key Findings:	Mitochondrial DNA studies revealed the Indian Wolf split from other lineages over 400,000 years ago.
Fact & Figure:	Estimated population: <3,000 in India; inhabits mainly Deccan plateau, Gujarat, and Central Indian grasslands.
Snow Leopard	
Why in News:	Conservation updates: Snow Leopard numbers stable; recognized for critical role in fragile Himalayan ecosystem.
Important Points:	Ongoing international efforts (GSLEP, WWF, UNDP) to secure habitats and reduce human-wildlife conflict.
More about news:	Conservation success attributed to camera trap surveys, local community patrols, and anti-poaching laws in India, Nepal, China.
Key Findings:	Population trends stable (not yet increasing), habitats threatened by climate change and infrastructure.
Fact & Figure:	Global population: 4,000–6,500; India: est. 450–500; 12 range countries identified by IUCN.

PLACES IN THE NEWS INDIA & WORLD

Sir Creek



News Excerpt:

- India and Pakistan recently held discussions to revive talks over the Sir Creek dispute to enhance maritime cooperation and security.

Why in News:

- The issue is resurfacing amid growing maritime challenges in the Arabian Sea and regional geopolitical shifts.

About:

- Sir Creek is a 96 km tidal estuary in the Rann of Kutch marshlands, lying between India's Gujarat and Pakistan's Sindh province.
- The dispute pertains to the demarcation of the boundary—India claims the mid-channel line; Pakistan claims the eastern bank.
- The resolution affects the maritime boundary and Exclusive Economic Zone (EEZ) allocation.

Fact & Figure:

- Treaty involved:** 1914 Bombay Resolution between Sindh and Kutch.
- Economic significance:** Potential offshore oil and gas reserves.

Assam–Nagaland Border Dispute



News Excerpt:

- Fresh tension reported along the Assam–Nagaland border following encroachment claims by both states.

Why in News:

- Renewed efforts to settle inter-state boundary disputes in the Northeast under Union Home Ministry's initiative.

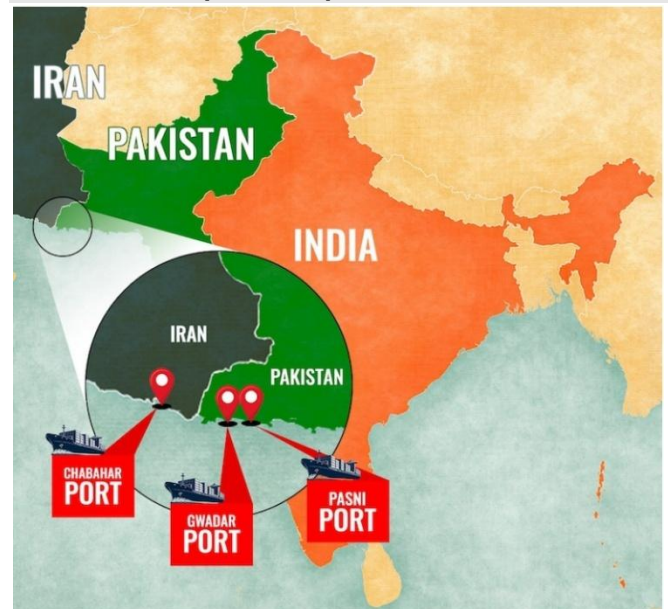
About:

- The dispute dates back to 1963 when Nagaland was carved out of Assam.
- The disagreement involves the 12 "disputed sectors" along the 500 km border.
- Assam claims Nagaland has encroached into its territory (Assam's Sivasagar, Jorhat, Golaghat districts).

Fact & Figure:

- Root cause:** Different interpretations of British-era boundary demarcations.
- Other similar disputes:** Assam–Arunachal, Assam–Meghalaya, Assam–Mizoram.

Port of Pasni (Pakistan)



News Excerpt:

- China and Pakistan are planning to expand port operations at Pasni to complement Gwadar under CPEC Phase-II.

Why in News:

- Rising Chinese maritime presence in the Arabian Sea and Indian Ocean.

About:

- Located in Balochistan province, 450 km west of Karachi.
- Serves as a fishing and small shipping port.
- Strategically positioned between Gwadar and Karachi, offering naval utility.

Fact & Figure:

- Managed by Pakistan Navy.
- Coordinates: 25°17'N 63°28'E.

The Red Sea**News Excerpt:**

- Ongoing tensions in the Red Sea due to Houthi attacks on commercial vessels amid Israel–Hamas conflict.

Why in News:

- Disruptions in global shipping and energy supply routes.

About:

- Narrow sea between Africa and Asia connecting to the Arabian Sea via Bab-el-Mandeb Strait.
- Bordered by Egypt, Sudan, Eritrea, Djibouti, Saudi Arabia, and Yemen.
- Important route for oil trade between Europe and Asia.

Fact & Figure:

- **Length:** 2,300 km; **Maximum depth:** 2,211 m.
- Part of Suez Canal route; handles 10% of global maritime trade.

Atacama Desert**News Excerpt:**

- Recent discovery of ancient microbial fossils in Atacama Desert strengthens Mars-like habitat studies.

Why in News:

- NASA and Chilean researchers use Atacama as an analogue for Martian surface studies.

About:

- Located in northern Chile, one of the driest places on Earth.
- Hyper-arid desert with minimal rainfall and high salinity.
- Rich in lithium and copper deposits.

Fact & Figure:

- Average annual rainfall: <1 mm.
- Covers 105,000 sq km.

Switzerland**News Excerpt:**

- Switzerland ranked top in Global Innovation Index 2025 released by WIPO.

Why in News:

- Maintains global leadership in innovation ecosystem.

About:

- Landlocked Central European nation.
- Known for finance, precision manufacturing, and research infrastructure.
- Neutral foreign policy; not part of EU or NATO.

Fact & Figure:

- **Capital:** Bern.
- **Currency:** Swiss Franc (CHF).
- **GDP (nominal):** \$1 trillion (2025 est.).

Maldives Achieves Triple Elimination of Mother-to-Child Transmission (MTCT)**News Excerpt:**

- WHO certified Maldives for eliminating MTCT of HIV, Hepatitis B, and Syphilis.

Why in News:

- Significant global public health milestone achieved in the South Asia region.

About:

- MTCT occurs during pregnancy, childbirth, or breastfeeding.
- Success credited to strong maternal health and vaccination programs.
- Reflects Maldives' commitment to SDG-3 (Good Health and Well-being).

Fact & Figure:

- Second country globally to achieve triple elimination (after Cuba).
- WHO certification valid for 5 years.

Madagascar**News Excerpt:**

- Madagascar declared national emergency due to prolonged drought and locust infestation.

Why in News:

- Severe food insecurity and climate crisis in southern Madagascar.

About:

- Island nation in the Indian Ocean, off southeastern Africa.
- Known for unique biodiversity — 90% species endemic.
- Economy: Agriculture, mining, and tourism.

Fact & Figure:

- Capital: Antananarivo.
- Fourth-largest island in the world.

Mount Lewotobi Laki-laki (Indonesia)**News Excerpt:**

- Eruption reported at Mount Lewotobi Laki-laki in Flores Island, Indonesia.

Why in News:

- Volcanic activity caused evacuation of nearby villages.

About:

- Stratovolcano located in East Nusa Tenggara province.
- Part of Lewotobi twin volcanoes — "Laki-laki" (male) and "Perempuan" (female).
- Indonesia lies on the Pacific Ring of Fire, prone to volcanic eruptions.

Fact & Figure:

- **Elevation:** 1,584 meters.
- **Last major eruption:** January 2024.

MERCOSUR**News Excerpt:**

- India exploring preferential trade agreement with MERCOSUR to enhance South-South trade.

Why in News:

- Part of India's strategy to deepen engagement with Latin America.

About:

- Regional trade bloc in South America established in 1991 (Treaty of Asunción).
- Members: Argentina, Brazil, Paraguay, Uruguay; Venezuela suspended.
- Aims for free movement of goods, people, and currency coordination.

Fact & Figure:

- Combined GDP: 4.6 trillion.
- India-MERCOSUR PTA signed in 2009 covering 450 tariff lines.

Tuvalu**News Excerpt:**

- Tuvalu signed a climate migration agreement with Australia amid rising sea-level threats.

Why in News:

- Represents existential crisis for low-lying Pacific island nations.

About:

- Polynesian island country in the Pacific Ocean.
- Among world's smallest and least populous nations.
- Faces risk of submersion due to sea-level rise from climate change.

Fact & Figure:

- Capital:** Funafuti.
- Population:** 12,000.
- Average elevation:** 2 meters above sea level.

Nauru**News Excerpt:**

- Nauru initiated deep-sea mining operations for polymetallic nodules in the Pacific Ocean.

Why in News:

- Debate over ecological impact of deep-sea mining in international waters.

About:

- Small island nation in Micronesia, Central Pacific.
- Major phosphate deposits; economy dependent on mining.
- Works with "The Metals Company" for seabed resource exploration.

Fact & Figure:

- Area: 21 sq km (third smallest country).
- Population: 10,000.

Durand Line**News Excerpt:**

- Tensions between Pakistan and Afghanistan resurfaced after border skirmishes along the Durand Line.

Why in News:

- Afghanistan's Taliban government refuses to recognise the border formally.

About:

- Established in 1893 between British India and Afghanistan by Sir Mortimer Durand.
- Serves as de facto boundary between Pakistan and Afghanistan (2,640 km).
- Divides Pashtun tribal areas between two nations.

Fact & Figure:

- Crosses through Khyber Pakhtunkhwa and Balochistan.
- Not recognized officially by any Afghan government till date.