Prelims Exam Topics

PANGOLIN TRAFFICKING HUBS

GS 3: Environment

Context

A study published in PLoS biology used advanced population genomics to map trafficking routes of the world's three most-traded pangolin species.

Key findings of the research

- **Methodology:** Researchers targeted 671 genome locations that differentiate pangolin population and used 122 museum specimens to fill geographic data gaps where wild pangolins are now too rare.
- **Trafficking overlap:** Domestic trade moves pangolins ~454 km on average
- **India link:** International seizures in China show evidence of a trafficking network from northeastern India (Arunachal Pradesh and Assam)

Pangolins

- **About:** Pangolins are the only insectivorous, nocturnal, solitary mammals in the world covered entirely in overlapping keratin scales (same material as human nails) that account for over 20% of their body weight.
- **Key features:** Long sticky tongue (longer than their body) to extract ants and termites, have no teeth but powerful claws for digging and they curl into a ball when threatened.
- **Habitat:** Found across Sub-Saharan Africa and South & Southeast Asia. They prefer forests, grasslands, and agricultural land near forests.
- **Diet & Ecological role:** Feed almost exclusively on ants and termites and a single pangolin can consume up to 20,000 insects in one night and are called 'nature's pest controller'.
- **Reproduction:** Extremely slow as females give birth to only 1 offspring per year (rarely 2) with a long gestation (~120-150 days)
- **Reason behind trafficking**: Scales of pangolins are used in traditional Chinese medicine (TCM) for treating skin conditions, arthritis, and lactation problems.

Conservation status

Indian Pangolin (Manis crassicaudata)	IUCN: Endangered | CITES: Appendix I | WPA 1972: Schedule I
Chinese Pangolin (Manis	IUCN: Critically Endangered | CITES: Appendix I | WPA 1972:

pentadactyla)	Schedule I
Sunda Pangolin (Manis javanica)	IUCN: Critically Endangered | CITES: Appendix I
White-bellied Pangolin (Phataginus tricuspis)	IUCN: Vulnerable | CITES: Appendix I
All 8 species	Listed on CITES Appendix I since 2016: The highest protection; all international commercial trade banned
India	All trade and hunting banned under Wildlife Protection Act 1972 Schedule I. (Same level of protection as tiger and elephant)

INDIA–NORWAY GREEN STRATEGIC PARTNERSHIP

GS 2: IR

Context

India and Norway elevated bilateral ties to a **Green Strategic Partnership** during Prime Minister Narendra Modi's first-ever visit to Norway,

Key Decisions Taken During the Meeting

- **Green Strategic Partnership:** India–Norway ties elevated to a Green Strategic Partnership focusing on clean energy, climate resilience and sustainability.
- **IPOI Cooperation:** Norway joined India's Indo-Pacific Oceans Initiative (IPOI) to enhance maritime cooperation.
- **High-Tech & AI Cooperation:** Collaboration expanded in AI, start-ups and innovation ecosystems.
- **DPI Partnership: Agreements** signed on digital health and DPI, including Global South cooperation using India's DPI model.
- **Space Cooperation:** ISRO and the Norwegian Space Agency signed an MoU for space-sector collaboration.
- **Science & Innovation Agreements**: CSIR/DSIR and Norwegian institutions signed agreements on sustainability, circular economy, offshore energy, healthcare and geoscience.
- **Research & Academic Cooperation:** Joint Declaration signed for cooperation in sustainability, ocean science and academic exchange programmes

About Norway

- **Location:** Nordic country in Northern Europe situated on the Scandinavian Peninsula.
- **Capital:** Oslo.
- Bilateral trade: Bilateral trade ~$3 billion; Norway exports oil, gas, seafood, fertilisers; India exports pharma, textiles, machinery
- **Sovereign Wealth Fund**: Hosts the world's largest sovereign wealth fund — Government Pension Fund Global.
- **Major International Groupings:** Member of NATO, Nordic Council, Arctic Council and European Economic Area (EEA); not a member of the EU.
- **Arctic Significance:** Important Arctic state with strategic relevance in polar governance, shipping and climate studies.
- **Renewable Energy**: Nearly all domestic electricity generated through hydropower.
- **Blue Economy Expertise:** Globally recognised for shipping, fisheries, offshore energy and marine technology

INDIAN SPACE STARTUPS SIGN STRATEGIC COLLABORATIONS IN ITALY

GS 3: S&T

Context

Nine Indian space-tech startups, led by Indian National Space Promotion and Authorization Centre (IN-SPACe), signed multiple strategic partnerships during **Space Meetings Veneto 2026** held in Venice.

Notable Partnerships

- **Astrobase–Impulso Space MoU:** Astrobase Space Technologies signed an MoU with Impulso Space for mission management and launch-service collaboration.
- **Kepler Aerospace–Apogeo Space Agreement:** Kepler Aerospace partnered with Apogeo Space for Ground Station as a Service (GSaaS), CubeSat systems and satellite mission operations.
- **VyomIC Collaboration:** VyomIC announced strategic cooperation in next-generation navigation and resilient infrastructure technologies.

India–Italy Space Engagement:

- **India–Italy Strategic Framework:** Cooperation aligned with the 2025–2029 India–Italy Joint Strategic Action Plan announced during the G20 Summit 2024

About IN-SPACe

Full form	Indian National Space Promotion and Authorisation Centre
Established	2020, under the Department of Space (DoS)
Role	Single-window nodal agency for promotion, handholding, and authorisation of all private space sector entities in India
Key function	Grants permissions for launch, satellite operations, ground stations, and remote sensing by non-government entities
Significance	Operationalises India's Space Policy 2023 — opens space sector to private players and FDI
Different from	ISRO (research & national missions); NSIL/Antrix (commercial arm of ISRO); IN-SPACe is specifically for private sector enablement

Indian Space Ecosystem

- **India's space economy:** ~$8 billion currently; target $44 billion by 2033 (IN-SPACe projection).
- **Indian Space Policy 2023:** Opens satellite data, launch, ground station segments to private players; allows 100% FDI in space sector.
- **Key private players:** Skyroot Aerospace (first private rocket — Vikram-S, 2022), Agnikul Cosmos (first 3D-printed engine rocket), Pixxel (Earth observation constellation), Dhruva Space.
- **Target of Indian Space Economy**: India aims to increase its share in the global space economy from around 2% to 8% by 2033.

SMILE MISSION

GS 3: S&T

Context

The joint China–Europe **SMILE (Solar wind Magnetosphere Ionosphere Link Explorer)** mission was launched.

About the SMILE Mission

- **Launched by** : Joint space-science mission of the European Space Agency (ESA) and the China National Space Administration (CNSA).
- **Objective:** To study interaction between solar wind and Earth's magnetosphere and improve understanding of space weather.

- **Scientific Instruments:** Carries four instruments: **Soft X-ray Imager (SXI), Magnetometer., Light Ion Analyser (LIA) and Ultraviolet Imager (UVI)**
- **Key Scientific Goal:** Capture first-ever X-ray images of Earth's magnetosphere interacting with solar wind.
    - Earth's magnetosphere is a magnetic shield protecting the atmosphere and life from harmful charged particles and solar radiation.
- **Importance for Space Weather:** Helps improve forecasting of solar storms, solar flares and coronal mass ejections (CMEs).
- **Utility:** Better prediction of space weather can protect satellites, GPS, communication systems, electricity grids and astronauts.
- **Special Feature:** Unlike earlier missions, SMILE provides a complete real-time view of solar wind–magnetosphere interaction.

Mains Exam Topics

IMPROVING EFFICIENCY OF FERTILIZER USE IN INDIA

GS 3 Agriculture

Context

India's structural fertiliser trap where over-application depletes soil health and forces even greater fertiliser use combined with dangerous import dependence for both urea and phosphatics, makes reforming fertiliser policy a national food security.

The Fertilizer Trap — Understanding the Cycle

- **The trap mechanism:** Excessive fertiliser use depletes soil organic matter ⟶ reduces soil's water and nutrient holding capacity ⟶ forces farmers to apply even more fertiliser to maintain yields ⟶ never-saturating demand loop.
- **Scale of waste:** Over ₹2 lakh crore in annual fertiliser subsidies; roughly 2/3 is lost as air and water pollution (ammonia, nitrous oxide, phosphate runoff), not converted to food.
- **Nitrogen loss:** Most applied urea nitrogen is lost as ammonia to air pollution — a major contributor to India's air quality crisis and greenhouse gas emissions (N2O is ~300x more potent than CO2).
- **Soil health:** Long-term dependence on chemical fertilisers has caused organic carbon decline in Indian soils — ICAR data suggests most Indian agricultural soils are now deficient in organic carbon.

Import Dependence

- **Urea:** India produces 80% domestically; 50%+ imported in 2025-26 (60% increase YoY) as urea prices globally doubled due to the West Asia war.
- **Phosphatic fertilisers:** Almost entirely imported — India lacks commercial rock phosphate deposits; depends on Morocco, China, Jordan.
- **West Asia impact:** India's fertiliser import bill rose 80% in 2025-26; global fertiliser prices rose 46% (Dec 2025–Apr 2026); urea prices doubled.
- **Strategic gap:** Unlike petroleum (where India has a small SPR), India has no strategic fertiliser reserve — disruptions directly hit kharif/rabi sowing.

Structural Distortions in Policy

- **MSP-procurement mismatch:** Government actually procures only rice, wheat, and sugarcane at MSP; these three crops consume over 2/3 of all urea — incentivising over-application.
- **Urea outside NBS:** Urea is excluded from the Nutrient Based Subsidy (NBS) scheme — keeping urea artificially cheap and encouraging over-use relative to P&K fertilisers, causing nutrient imbalance.
- **Neem-coated urea:** Introduced to improve nitrogen use efficiency — but could not prevent nitrogen loss as ammonia; only partially effective.
- **Dalhan Mission underperformance:** Dalhan Aatmanirbharta Mission (Oct 2025, ₹11,440 crore) promised 100% MSP procurement of Tur, Urad, Masoor — but area under pulses grew only 1.26% in April 2026 vs a 10% fall over the preceding four years.

Challenges

- **Inter-ministerial coordination failure:** Agriculture, Chemicals (fertilisers), Food (MSP/procurement) ministries work in silos — the National Nitrogen Steering Committee's tenure expired with none of its recommendations implemented.
- **Farmer income risk:** Transitioning to organic inputs risks short-term yield decline; without assured income support, farmers resist change.
- **Supply chain for organics:** Biochar, compost, and manure supply chains are fragmented and lack standardisation — preventing scale-up.
- **Political economy of subsidies:** Urea subsidy reform is politically sensitive; any price increase or rationalisation faces electoral backlash.
- **Green ammonia viability:** Produced from electrolysis using solar power — promising but not feasible in water-stressed regions and still economically uncompetitive.

Way Forward

- **Pulse/legume rotations:** Incentivise pulse-cereal rotations; legumes fix atmospheric nitrogen (need 0-10% of urea used for cereals); Supreme Court endorsed this in March 2026.
- **Organic waste recycling:** Triple recycling of manure, compost, biochar; coordinated trials show up to 50% of recommended chemical fertiliser doses can be replaced with no yield loss.
- **Rice germplasm:** India's own research shows existing rice germplasm can double nitrogen use efficiency (grain yield per unit urea) — policy adoption needed.
- **Include urea in NBS:** Bring urea under Nutrient Based Subsidy to rationalise N:P:K use ratios and reduce over-application.

- **Revive Interministerial Nitrogen Committee:** Reconstitute the National Nitrogen Steering Committee with a time-bound mandate.

GENDER, CAREGIVING AND THE LAW IN INDIAN RESEARCH FUNDING

GS 2: Social Justice

Context

Age relaxation for women researchers is a constitutionally valid and empirically necessary corrective measure to offset structural caregiving burdens and gender inequities within India's research ecosystem.

The core problem

- **Double Burden:** Women researchers often enter postdoctoral careers during the same life stage when domestic and caregiving responsibilities peak, creating a structural "double burden."
- **Underrepresentation**: AISHE 2021-22 data shows that higher education faculty remain male-dominated, with women significantly underrepresented in central universities and science and technology institutions.
- **Low Participation:** Data from SERB indicates lower application rates and lower success rates for women researchers in competitive grants and fellowships.
- **Structural Barriers**: Missed grant cycles and fragmented academic records often arise from structural constraints rather than lack of competence or merit.
- **Legislative Exclusion:** The Maternity Benefit (Amendment) Act, 2017 grants 26 weeks of maternity leave, but many researchers on fellowships or contractual appointments are excluded from its protection.
- **Caregiving Blindness:** Existing policy frameworks recognise maternity but fail to recognise caregiving as a broader social responsibility that may include fathers or those caring for elderly dependents.

Constitutional and Legal Basis

- **Article 15(3)**: Article 15(3) empowers the State to make special provisions for women and children, thereby constitutionally validating affirmative support measures in research funding.
- **Substantive Equality:** Article 16's guarantee of equality of opportunity supports substantive equality rather than mere formal equality, permitting corrective measures for historically disadvantaged groups.
- **Equal Outcomes:** Substantive equality recognises that identical treatment can perpetuate inequality when underlying social conditions are unequal.

- **Constitutional Morality**: Article 51A(e) obligates citizens to renounce practices derogatory to women's dignity, and systemic exclusion of women from research spaces contradicts this constitutional spirit.
- **Judicial Validation:** In Vijay Lakshmi vs Punjab University, the Supreme Court upheld measures favouring women when they address demonstrable structural disadvantages.

Associated challenges

- **Childcare Deficit:** Women researchers often lack institutional childcare support during critical phases such as proposal writing and fieldwork.
- **Precarious Employment:** Researchers on fellowships, project appointments, and temporary contracts remain outside the effective protection of maternity benefits.
- **Retention Crisis:** The absence of re-entry pathways disproportionately harms women's long-term academic progression and retention.
- **Mentorship Deficit:** Limited representation of women in senior academic and leadership positions weakens mentorship opportunities for younger women researchers.
- **Rigid Institutions:** Flexible work arrangements and caregiving-sensitive evaluation systems remain inadequate across most Indian research institutions.
- **Evaluation Bias**: Unconscious bias within grant evaluation committees may disadvantage applicants with non-linear career trajectories.

Way forward

- **Grant Extensions**: Research grants should include no-cost extensions for documented caregiving periods to prevent penalisation for temporary career interruptions.
- **Re-entry Fellowships**: Dedicated re-entry fellowships should support women returning to academia after caregiving-related breaks.
- **Childcare Infrastructure**: Mandatory childcare and crèche facilities should be extended to all research institutions and grant-funded positions.
- **Data Transparency:** Funding agencies such as Science and Engineering Research Board, Department of Science and Technology, and Department of Biotechnology should mandatorily publish gender-disaggregated data on grant applications, approvals, and funding distribution.
- **Research Equity:** A caregiving-sensitive research ecosystem would improve both gender justice and the long-term quality of India's scientific workforce.

FEDERALISM AT CROSSROADS

GS 2: Polity, Federalism

Context

Rising tensions over delimitation, fiscal transfers, and cultural identity have deepened India's federal fault lines, making consultation, compromise, and consensus essential for national unity.

Two deep fault lines

- **Democratic Deficit:** Parliamentary seat allocation based on population threatens to reduce southern states' representation despite their success in achieving population stabilisation.
- **Population Penalty:** Southern states fear they are being politically penalised for developmental achievements and lower fertility rates.
- **Seat Redistribution:** Hindi-heartland states such as UP, Bihar, MP, and Rajasthan are projected to gain Lok Sabha seats due to higher population growth.
- **Fiscal Imbalance:** Southern and western states contribute disproportionately higher tax revenues compared to the transfers they receive from the Centre.
- **Redistributive Formula:** Finance Commission criteria prioritise equity and need-based redistribution over economic contribution and tax effort.

Key Data

Over-represented States (projected)	UP, Bihar, MP, Rajasthan: Gain seats post-delimitation due to higher population growth
Under-represented States (projected)	Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Telangana: Projected to lose seats
Net donor States	Karnataka, Tamil Nadu, Maharashtra, Gujarat, Haryana contribute more to centre than they receive
Net recipient States	UP, Bihar, Odisha, Jharkhand, NE states receive more than they contribute
Finance Commission formula	Heavy weightage to population, area, and forest cover partly weights against economic performance
15th FC recommendation	Retained 2011 census (not 2021) for population in devolution formula for temporary relief to the Southern states.

Constitutional and legal provisions

- **Union of States**: Article 1 defines India as a "Union of States," reflecting the indestructible nature of both the Union and the states.
- **Fiscal Federalism:** Article 280 establishes the Finance Commission to balance equity-based redistribution with incentives for efficiency and development.
- **Misuse of Article 356**: President's Rule was historically misused for partisan purposes before judicial safeguards were introduced.
- **Legislative Division:** The Seventh Schedule divides powers among Union, State, and Concurrent Lists to maintain constitutional balance.
- **Central Override**: Articles 249 and 250 allow Parliament to legislate on State List matters in national interest or emergencies.
- **GST Consensus Model:** Article 279A created the GST Council as an institutional model of cooperative federalism based on negotiation and consensus.
- **Floor Test Principle:** The S.R. Bommai judgment mandated floor tests and parliamentary oversight before imposing President's Rule.

Challenges to Cooperative federalism

- **Asymmetric Bargaining:** Smaller states often wield disproportionate political influence in coalition politics compared to larger contributor states.
- **Political Incentives:** Central governments tend to favour greater centralisation, while regional parties often benefit electorally from confrontation.
- **Delimitation Pressure:** The constitutionally mandated delimitation process after the 2026 Census creates urgency without adequate political consensus.
- **Weak institutional role:** Unlike the Planning Commission, NITI Aayog lacks financial allocation powers, reducing its effectiveness in Centre-State coordination.
- **Water Disputes:** Long-pending disputes such as Cauvery, Krishna, and Mahadayi weaken inter-state trust and cooperative spirit.

Way forward

- **FC Reform**: Finance Commission formulas should assign greater weightage to tax effort, fiscal discipline, and economic performance.
- **Contribution Incentives**: High-performing states may be provided a separate "contribution bonus" within fiscal devolution frameworks.

- **Inter-State Dialogue:** The Inter-State Council under Article 263 should function as a regular platform for structured federal consultation.
- **Balanced Representation:** Extending the population freeze or evolving a hybrid representation formula can reduce fears of political marginalisation.
- **GST Model Expansion**: Consensus-driven institutional mechanisms similar to the GST Council should be extended to sectors like health, education, and policing.
- **Consensus Governance:** Cooperative decision-making is essential to preserving India's unity within its culturally and economically diverse federal structure.

BIOENERGY AND INDIA'S ENERGY TRANSITION

GS 3: Environment

Context

Rising energy-security concerns and waste-management challenges are increasing India's focus on commercially viable bioenergy solutions

Opportunity for Biogas & Bioenergy

- **Large Biomass Resource Base:** India generates nearly 750 million tonnes of biomass annually, including around 230 million tonnes surplus agricultural biomass.
- **Reducing Import Dependence:** Efficient biomass utilisation could replace a significant share of fossil-fuel imports. (India imports ~85% crude oil and is among top LNG importers globally)
- **CBG Potential:** India's compressed biogas (CBG) potential is estimated at 40–62 MMTPA, but current installed capacity remains below 1% of potential.
- **Waste-to-Energy Opportunity:** India's municipal solid waste generation may rise to 165 million tonnes by 2031 and 436 million tonnes by 2050, creating huge feedstock potential.
- **Climate & Air Pollution Benefits:** Bioenergy can reduce stubble burning, landfill methane emissions and urban air pollution. (Crop-residue burning contributes significantly to winter pollution in North India)
- **Rural Economy & Employment:** Bioenergy ecosystems support farmers, MSMEs and rural jobs through feedstock aggregation and decentralised energy systems. (**CBG projects** in Odisha alone estimated to generate ~21,000 jobs by 2030)

Various Technologies for Bioenergy

- **Gasification**

- **Suitable Feedstock:** Best suited for dry biomass such as crop residue, husk, woody biomass and solid organic waste.
- **Process:** Biomass undergoes drying, pyrolysis and partial oxidation at 800–1000°C to produce syngas.
- **Output & Uses:** Produces syngas used for heat, electricity, methanol, ethanol, renewable methane and hydrogen production. (Important for future clean-fuel ecosystems)
- **Additional Benefit:** Produces biochar for soil enhancement and carbon sequestration.

- **Anaerobic Digestion**
  - **Suitable Feedstock:** Best suited for sewage, food waste, animal manure and industrial organic waste.
  - **Process:** Microorganisms decompose organic matter in oxygen-free conditions to produce biogas.
  - **Output:** Produces methane-rich biogas and nutrient-rich digestate. (Useful for cooking fuel, electricity and bio-CNG production)
  - **Key Applications**: Relevant for dairy clusters, urban waste systems, sewage plants and agro-industrial hubs.

Challenges

- **Feedstock Variability:** Biomass differs in moisture, density and ash content, reducing efficiency and operational reliability.
- **Poor Waste Segregation:** Only around 50% of collected municipal waste undergoes proper treatment in India.
- **High Logistics Costs:** Transporting bulky biomass over long distances reduces economic viability. (Biomass collection remains fragmented and seasonal)
- **Low Technology Penetration:** India's bioenergy deployment remains far below potential despite abundant feedstock availability.
- **Policy & Financing Gaps**: Investors face uncertainty regarding feedstock supply, pricing mechanisms and long-term policy stability.
- **Operational Challenges:** Anaerobic digestion requires continuous feedstock supply and stable biological conditions for efficient operation.

Government Schemes & Initiatives for Biogas

- **SATAT Scheme (2018):** Launched by the Ministry of Petroleum & Natural Gas to promote production of Compressed Biogas (CBG) from biomass and waste. (Target: 5,000 CBG plants; implemented through OMCs like IOCL, BPCL and HPCL)
- **GOBARDhan Scheme:** Launched under Swachh Bharat Mission to convert cattle dung and organic waste into biogas, CBG and bio-fertilisers. (Focus on circular economy and rural sanitation)
- **National Bioenergy Programme**: Implemented by the Ministry of New and Renewable Energy (MNRE) for promoting waste-to-energy, biomass briquettes, pellets and biogas plants. (Approved outlay: ₹1,715 crore for Phase-I)
- **Waste-to-Energy Programme**: Supports projects converting urban, industrial and agricultural waste into biogas, bio-CNG and electricity. (Promotes scientific waste management)

Way Forward

- **Integrated Waste Management**: Match suitable technologies with appropriate feedstock — gasification for dry waste and digestion for wet waste.
- **Expand Decentralised Energy Systems:** Promote localised bioenergy plants for villages, MSMEs and agro-industrial clusters. (Reduces logistics cost and improves rural energy access)
- **Strengthen Policy Support:** Expand SATAT, GOBARDhan and CBG blending obligations with long-term regulatory certainty.
- **Improve Waste Segregation & Collection:** Strengthen municipal segregation and feedstock aggregation systems for reliable supply chains.
- **Promote Carbon Markets & Incentives**: Expand carbon-credit mechanisms and financial incentives for bioenergy projects. (CBG already included under carbon-credit trading framework)
- **Invest in R&D & Innovation: S**upport advanced gasification, biomethane upgrading and hydrogen-from-biomass technologies for future clean-energy systems