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INDEX

Sl. No.	Topics	Page No.
<u>MAINS ANALYSIS</u>		
1	"The Indo-Pacific: Geopolitics, Maritime Security And The Emerging Asian Order."	1
2	India's Energy Transition: Towards An Integrated, Secure And Sustainable Energy Future	2
3	Access To Justice And The Right To Speedy Trial: Strengthening India's Criminal Justice System	3
4	West Asia In Transition: India's Strategic Interests In An Emerging Multipolar Order	4
5	AI-Driven Warfare: Challenges And Opportunities For India's National Security	5
6	Climate Variability And India's Economic Resilience	6
7	India–Australia Strategic Partnership: A Pillar Of The Indo-Pacific	7
8	Right To Be Forgotten In The Digital Age	8
9	India's Biofuel Transition: Lessons From Brazil's Ethanol Success	10
10	Landslide Resilience Through Early Warning Systems	11
11	AI-Enabled Judiciary: Opportunities, Risks And The Future Of Justice Delivery	12
12	Nuclear Energy: Balancing Self-Reliance, Safety And Global Cooperation	13
13	India–US Defence Technology Partnership: Bridging The Gap Between Strategic Convergence And Technological Collaboration	14
14	One Nation, One Election (ONOE): Reforming India's Electoral Cycle	15
15	Transforming India's Demographic Dividend Through Comprehensive Education Reforms	17
16	Strengthening India's Semiconductor Ecosystem: From Manufacturing To Technological Self-Reliance	18
17	Global Governance Of Artificial Intelligence: Shaping An Inclusive, Secure And Rules-Based AI Order	19
18	Revisiting The Anti-Defection Law: Balancing Political Stability With Legislative Accountability	20
19.	Interlinking Of Rivers In India: Balancing Water Security, Ecological Sustainability And Cooperative Federalism	21
20	Reforming The WTO: Balancing Multilateral Consensus With Emerging Plurilateral Agreements	23
21	US–Saudi Nuclear Cooperation: Implications For West Asian Geopolitics, Nuclear Non-Proliferation And India's Strategic Interests	24
22	Artificial Intelligence And Quantum Computing: Transforming India's Healthcare Ecosystem	25
23	Reforming India's Public Examination System: Ensuring Transparency, Integrity And Public Trust	27
24	From Geography Of Borders To Geometry Of Interests: The Evolution Of India's Foreign Policy	28
25	Integrated Theatre Commands: Transforming India's Warfighting Architecture For 21st Century Conflicts	29
26	Artificial Intelligence As India's Next Digital Public Infrastructure	30
<u>PRELIMS BOOSTER</u>		
1	Overseas Citizen of India(OCI)	32
2	Climate Tipping points	32
3	Financial Stability Report (FSR)	32



4	Purchasing Managers' Index (PMI)	32
5	Telecommunications Act, 2023	33
6	Graded Response Action Plan (GRAP)	33
7	Vikram-1	33
8	Nord Stream Gas Pipelines	33
9	Employees' Provident Funds Scheme, 2026	34
10	Indus Waters Treaty (IWT)	34
11	Fixed Dose Combination (FDC) Drugs	34
12	Nameri Tiger Reserve	35
13	Direct Seeded Rice (DSR)	35
14	Gaganyaan Mission	35
15	Synthetic Cell	35
16	Indira Point	36
17	INS Mahendragiri (Project 17A Stealth Frigate)	36
18	India–Indonesia Relations	36
19	Zebra Finch (<i>Taeniopygia guttata</i>)	36
20	Mission Drishti	37
21	Section 301 (US Trade Act, 1974)	37
22	India's Crude Oil Imports & Russia's Increasing share	37
23	Astra Missile System	38
24	Prambanan Temple Conservation Project	38
25	Repatriation of Antiquities from Australia	38
26	India-Australia Relations	39
27	India–Australia Military Exercises	39
28	Weekly Basal Insulin (Insulin Icodec / Awiqli)	39
29	National CAMPA approves Conservation Projects for Four Species	39
30	Inflation & Monetary Policy Committee (MPC)	40
31	Gaganyaan – Crew Module System Tests	40
32	Reusable Launch Vehicles (RLVs)	40
33	Places in News	41
34	Biogas & Compressed Biogas (CBG)	41
35	Interstellar Sugar, Astrobiology & Space Chemistry	41
36	India–Australia Civil Nuclear Cooperation	41
37	Trial in Absentia (Section 356, BNSS, 2023)	42
38	Ravidassia community & Guru Ravidas	42
39	Bhojshala Complex	42
40	Jagannath Rath Yatra	43
41	Kudankulam Nuclear Power Plant (KKNPP)	43
42	India Semiconductor Mission (ISM) 2.0	43
43	Specified Non-Financial Assets (SNFA)	44



44	Corporate Average Fuel Economy (CAFE) Norms	44
45	HPV (Human Papillomavirus)	44
46	Polymer Currency Notes	45
47	Mansbal Lake	45
48	Indus Waters Treaty (IWT)	45
49	National Maritime Heritage Complex (NMHC), Lothal	45
50	Electronic Gold Receipts (EGRs)	45
51	Vikram-1 Launch Vehicle	46
52	Long Duration Energy Storage (LDES)	46
53	Magnetic Levitation (Maglev) train	47
54	Qdenga (TAK-003)	47
55	Beta Pictoris d	47
56	White-bellied Heron (<i>Ardea insignis</i>)	48
57	Prevention of Insults to National Honour (Amendment) Bill, 2026	48
58	Internet Shutdowns in India – Legal Framework	49
59	First Oral PCSK9 Inhibitor – Lipfendra (Enlicitide)	49
60	Places in News: Around Bab-el-Mandeb	49
61	Project Kusha (Long-Range Surface-to-Air Missile)	50
62	Kutki (Picrorhiza kurroa)	50
63	INS Malvan	50
64	Qdenga (TAK-003): India's First Approved Dengue Vaccine	51
65	UNESCO World Heritage Committee – New Inscriptions	51
66	Black Sea Region: Places in News	51
67	National Investment Policy for Urea (NIPU)-2026	51
68	CBDT issues Crypto Asset Reporting Guidance aligned with OECD's CARF	52
69	Places in News – Sudan	52
70	Western Ghats Ecologically Sensitive Area (ESA)	52
71	SHeat2: Oral Therapy for Cervical Cancer	52
72	Nominal Effective Exchange Rate (NEER) & Real Effective Exchange Rate (REER)	53
73	Prevention of Insults to National Honour Act, 1971	53
74	Retrospective Environmental Clearance (Supreme Court Judgment)	53
75	IRDAI Reforms for the Insurance Sector (2026)	54
76	Chandrayaan-5 (LUPEX – Lunar Polar Exploration Mission)	54
77	Cloudbursts in India	55
78	NavIC (Navigation with Indian Constellation)	55



MAINS ANALYSIS

1. "The Indo-Pacific: Geopolitics, Maritime Security and the Emerging Asian Order."

Syllabus Mapping: GS-2: Bilateral, regional and global groupings and agreements involving India and/or affecting India's interests.

The Indo-Pacific has emerged as the world's foremost geopolitical and geoeconomic theatre, shaping global trade, maritime security and the evolving balance of power. It lies at the heart of India's vision of a free, open, inclusive and rules-based maritime order.

Why has the Indo-Pacific evolved into the principal geopolitical & geoeconomic theatre?

1. **Centre of Global Economic Activity:** The Indo-Pacific has emerged as the world's economic engine, accounting for the largest share of global trade, manufacturing and investment flows. Eg: **As per World Economic Forum**, the region contributes **around 60% of global GDP** and **over 65% of the world's population**.
2. **Maritime Trade Artery:** The Indo-Pacific hosts the world's busiest Sea Lines of Communication (SLOCs), nearly **60% of global maritime trade** passes through the Indo-Pacific, including chokepoints such as the **Strait of Malacca** and **Strait of Hormuz**.
3. **Epicenter of Great Power Competition:** Strategic competition among the **US, China, India, Japan and Australia** has made the Indo-Pacific the focal point of global power politics.
4. **Centre for emerging minilateralism:** The region has become the hub of new strategic and economic groupings shaping the future global order. Eg: **QUAD, ASEAN, IPEF, etc.**
5. **Supply Chain Geopolitics:** The Indo-Pacific dominates global semiconductor manufacturing, digital infrastructure, rare earth processing and advanced technology supply chains. Eg: **Taiwan, South Korea, Japan and ASEAN economies are central to global semiconductor and electronics production.**

Why is the Indo-Pacific Significant for India?

1. **Energy Security:** India imports nearly **85% of its crude oil requirements**, much of which passes through the Indo-Pacific. (Mo. Petroleum & Natural Gas)
2. **Trade and Economic Prosperity:** The region is India's principal trade corridor and a major destination for exports, investments and global value chains. More than **50% of India's external trade** is linked to the Indo-Pacific region. (Mo. External Affairs)
3. **Strategic Balancing:** The Indo-Pacific provides India an opportunity to strengthen partnerships and preserve a **free, open and inclusive maritime order** amid China's growing strategic footprint. India's participation in **QUAD and IPOI** a
4. **Becoming the Net Security Provider in the Indian Ocean:** India's geographic location enables it to secure SLOCs, provide HADR assistance, combat piracy and ensure stability across the Indian Ocean Region. **Mission SAGAR**, anti-piracy deployments.
5. **Blue Economy and Maritime Resources:** India's **7,500 km coastline** and an **Exclusive Economic Zone (EEZ) of over 2 million sq. km** provide significant blue economy opportunities.

Challenges to India's Strategic Interests:

1. **China's Maritime Expansion and Strategic Encirclement:** China's growing naval presence, String of Pearls strategy and military bases in the Indian Ocean challenge India's maritime dominance and strategic space. Eg: **China's first overseas military base in Djibouti and increasing PLA Navy deployments in the Indian Ocean.**
2. **Vulnerability of Sea Lines of Communication (SLOCs):** Conflicts in the South China Sea, Red Sea and Strait of Hormuz threaten India's trade and energy imports by disrupting critical maritime routes.
3. **Great Power Rivalry and Strategic Autonomy:** Intensifying US-China competition compels India to balance strategic partnerships while preserving its policy of strategic autonomy. Eg: **India's participation in the QUAD alongside continued engagement with BRICS and SCO reflects its multi-alignment strategy.**
4. **Non-Traditional Maritime Security Threats:** Piracy, maritime terrorism, Illegal, Unreported and Unregulated (IUU) fishing, trafficking and cyber threats undermine regional stability and maritime commerce. Eg: **Rising Houthi attacks in the Red Sea have disrupted global shipping and increased freight costs.**
5. **Weak Regional Institutional Architecture:** Unlike Europe, the Indo-Pacific lacks a comprehensive regional security framework, limiting coordinated responses to emerging threats. Eg: **Security cooperation remains fragmented across ASEAN, QUAD, IORA and BIMSTEC.**

Suggested measures:

1. **Strengthen Maritime Capabilities:** Enhance naval modernisation, Maritime Domain Awareness (MDA), coastal surveillance and indigenous defence manufacturing to safeguard India's maritime interests. Eg: Expansion of the **Information Fusion Centre-Indian Ocean Region (IFC-IOR)** and Mission-Based Deployments by the Indian Navy.
2. **Deepen Strategic Partnerships:** Strengthen cooperation through **QUAD, IORA, BIMSTEC, ASEAN and the Indo-Pacific Oceans Initiative (IPOI)** for HADR, maritime security and capacity building.



3. **Build Resilient Trade and Connectivity Networks:** Accelerate initiatives such as IMEC, Act East Policy, Sagarmala and supply-chain diversification to reduce strategic vulnerabilities.
4. **Promote a Rules-Based Maritime Order:** Advocate freedom of navigation, peaceful dispute resolution and respect for UNCLOS (1982) to ensure stability in the Indo-Pacific.
5. **Reduce Strategic Dependencies:** Diversify energy sources, critical minerals, semiconductor supply chains and digital infrastructure to minimise vulnerabilities arising from geopolitical disruptions. Eg: India's participation in initiatives like the **Minerals Security Partnership** and semiconductor mission.

A stable, inclusive and rules-based Indo-Pacific is indispensable not only for India's strategic interests but also for sustaining a balanced and multipolar global order.

2. India's Energy Transition: Towards an Integrated, Secure and Sustainable Energy Future

Syllabus Mapping: GS3: Indian Economy and issues relating to planning, mobilization of resources, growth, development and employment. (Energy transition, financing, energy security)

India is the **world's third-largest energy consumer**, with energy demand projected to nearly double by 2047. While expanding domestic energy production remains important, achieving energy security requires building an **integrated ecosystem** that ensures **availability, affordability, accessibility, sustainability and resilience**.

Why India Needs an Integrated Energy Ecosystem?

1. **Energy Import Dependence:** Despite increasing domestic production, India remains heavily dependent on imported crude oil, natural gas and critical minerals, exposing it to geopolitical shocks and price volatility. **Eg: India imports nearly 85% of its crude oil and around 50% of its natural gas.**
2. **Availability Does Not Ensure Accessibility:** Energy production is meaningful only when supported by universal access, last-mile connectivity and reliable distribution. **Eg: Saubhagya Scheme addressed electrification, but ensuring quality and uninterrupted supply remains an ongoing challenge.**
3. **Energy Must Remain Affordable:** Higher production alone cannot protect consumers from high tariffs, transmission losses or volatile global fuel prices. Eg: Global crude oil shocks during the Russia-Ukraine conflict increased domestic fuel and electricity costs.
4. **Sustainability Cannot Be Ignored:** Increasing fossil fuel production without clean alternatives would undermine India's climate commitments and increase environmental costs. Eg: **India has pledged Net Zero by 2070 and 50% cumulative installed electric capacity from non-fossil sources by 2030.**
5. **Grid and Storage Infrastructure are Equally Critical:** Energy generation without robust transmission networks, storage systems and smart grids cannot ensure uninterrupted supply. Renewable energy integration requires Green Energy Corridors and Battery Energy Storage Systems (BESS).

Challenges in Building an Integrated Energy Ecosystem

1. **Renewable Integration Bottlenecks:** Rapid expansion of renewable energy is constrained by grid intermittency, inadequate storage and transmission bottlenecks.
2. **Financial Stress in the Power Sector:** Loss-making DISCOMs, high AT&C losses and weak cost recovery undermine reliable electricity supply and private investment.
3. **Critical Mineral Dependency:** India's clean energy transition is constrained by heavy dependence on imported lithium, cobalt, nickel and rare earth elements.
4. **High Capital and Financing Requirements:** Energy transition demands massive investments in renewables, storage, hydrogen and grid modernisation, creating financing constraints. Eg: **NTI Aayog estimates India may require over US\$10 trillion to achieve Net Zero by 2070.**
5. **Policy and Regulatory Fragmentation:** Multiple ministries, regulators and state-level policies often result in fragmented planning and implementation across the energy value chain.
6. **Energy Trilemma:** Balancing energy security, affordability and environmental sustainability while meeting rapid economic growth remains India's biggest long-term challenge.

Suggested Measures and Pillars of an Integrated Energy Ecosystem

1. **Diversified Energy Mix:** Diversify the energy basket through domestic production, critical mineral security and diversified import sources to ensure uninterrupted supply.



2. **Integrated Energy Infrastructure:** Develop smart grids, Green Energy Corridors, gas pipelines, LNG terminals, battery storage and EV charging networks to ensure seamless energy flow. Eg: National Green Energy Corridor Project facilitates renewable energy integration.
3. **Clean Energy Transition:** Scale up solar, wind, hydro, nuclear, bioenergy and green hydrogen to reduce carbon intensity while meeting rising energy demand. Eg: **India targets 500 GW of non-fossil electricity capacity by 2030.**
4. **Strategic Energy Security:** Expand Strategic Petroleum Reserves, diversify import sources and secure critical minerals through overseas partnerships. Eg: **National Critical Mineral Mission.**
5. **Modernise Grid and Storage Infrastructure:** Expand **Green Energy Corridors**, battery energy storage systems, pumped hydro and smart grids to integrate variable renewable energy efficiently. Eg: **National Electricity Plan (CEA)** envisages large-scale battery and pumped-storage capacity.
6. **Robust Energy Governance and Market Reforms:** Improve DISCOM finances, implement smart metering, deepen power market reforms and strengthen regulatory coordination. Eg: **Revamped Distribution Sector Scheme (RDSS).**
7. **Scale up Green Finance and Innovation:** Mobilise climate finance, sovereign green bonds and public-private partnerships while investing in green hydrogen, battery technologies and carbon capture. Eg: **National Green Hydrogen Mission** and **India's Sovereign Green Bonds.**

The future of India's energy sector lies not in maximizing energy production, but in optimizing the entire energy ecosystem—where energy security, economic competitiveness and climate responsibility reinforce each other to power **Viksit Bharat@2047.**

3. Access to Justice and the Right to Speedy Trial: Strengthening India's Criminal Justice System

Syllabus Mapping: GS 2: Structure, organisation and functioning of the Executive and the Judiciary, Separation of powers between various organs dispute redressal mechanisms and institutions.

The **Right to Speedy Trial**, recognised by the Supreme Court in **Hussainara Khatoun v. State of Bihar (1979)** as an intrinsic part of **Article 21**, is fundamental to ensuring substantive justice. In a criminal justice system, **delayed justice weakens deterrence, violates individual liberty and erodes public confidence**, making timeliness as essential as fairness in upholding the rule of law.

Importance of Right to Speedy Trial in Upholding Constitutional Values

1. **Safeguards Life and Personal Liberty:** The Right to Speedy Trial prevents arbitrary and prolonged deprivation of liberty, giving substantive meaning to **Article 21 following substantive due process.**
2. **Strengthens the Rule of Law:** Delayed justice weakens deterrence, public trust and institutional legitimacy, undermining constitutional governance. Nearly **5 crore cases**, including **3.85 crore criminal cases**, are pending in Indian courts.
3. **Upholds the Presumption of Innocence:** Lengthy incarceration of undertrials amounts to punishment before conviction. Around **76% of prison inmates are undertrial prisoners.** (NCRB Prison Statistics)
4. **Procedural Fairness:** Delayed proceedings increase hostile witnesses, fading memories and loss of evidence, affecting the quality of adjudication. The Supreme Court in **P. Ramachandra Rao v. State of Karnataka** reiterated that unreasonable delay violates fair trial guarantees.
5. **Inclusive Justice:** Speedy justice prevents economic and social inequalities from becoming barriers to constitutional remedies. **Article 39A** mandates equal justice and free legal aid.
6. **Victim-Centric Justice:** Timely trials reduce secondary victimisation, improve witness confidence and reinforce faith in the justice system. The **BNSS, 2023** introduces statutory timelines for several stages of criminal investigation and trial.

Causes of Judicial Delays

1. **Judicial Capacity Deficit:** Vacancies and a low judge-population ratio result in excessive caseloads and slower disposal. India has around **21 judges per million population**, against the **Law Commission's recommendation of 50.**
2. **Procedural Inefficiency:** Frequent adjournments and lengthy procedural requirements prolong criminal trials. Eg: The **Malimath Committee** recommended stricter control over adjournments.
3. **Case Congestion:** An increasing inflow of criminal cases has outpaced disposal rates. As per NJDG, over **3.85 crore criminal cases** are pending.
4. **Investigative Deficit:** Poor investigation quality, delayed charge sheets and weak prosecution lead to repeated trial delays. Eg: The **Second Administrative Reforms Commission** advocated separation of investigation from law and order.
5. **Forensic Infrastructure Deficit:** Inadequate laboratories and delayed forensic reports stall trials, especially in serious offences.
6. **Judicial Infrastructure Gap:** Insufficient courtrooms, judicial staff and digital infrastructure reduce case disposal efficiency. The **India Justice Report 2025** highlights gaps in court infrastructure and staffing.
7. **Compulsive Litigation:** Government-related litigation constitutes a substantial share of pending cases, as acknowledged in policy discussions on judicial reform.



Roadmap for Timely and Fair Justice

1. **Judicial Capacity Building:** Fill vacancies, establish more courts and achieve the **50 judges per million** benchmark.
2. **Institutionalise Time-Bound Criminal Justice:** Strictly implement the timelines introduced under the **Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023** for investigation, charge-sheet filing and trial to operationalise the constitutional right to speedy justice.
3. **Build a Technology-Driven Judiciary:** Scale up **e-Courts Phase III**, AI-enabled case listing, e-filing, virtual hearings and digital case-flow management to reduce delays and improve judicial efficiency.
4. **Strengthen Scientific Investigation:** Expand forensic laboratories, DNA facilities and digital evidence management while fully implementing BNSS provisions.
5. **Introduce Differentiated Case Management:** Categorise cases based on complexity and urgency, with strict timelines for petty offences, undertrial cases and senior citizen matters. Recommended by the **245th Law Commission Report**.
6. **Institutionalise Undertrial Justice:** Strengthen **Undertrial Review Committees**, simplify bail procedures and expand legal aid through **National Legal Services Authority** to ensure justice for vulnerable sections.
7. **Responsible Litigation:** Implement the **National Litigation Policy** to reduce avoidable appeals and frivolous government litigation.
8. **Deepen ADR and Community Justice:** Operationalise the **Mediation Act, 2023**, strengthen Lok Adalats and plea bargaining for compoundable offences to reduce the burden on regular courts.
9. **Outcome-Oriented Judiciary:** Introduce court-wise dashboards, disposal benchmarks and periodic judicial performance audits while preserving judicial independence.

A constitutional democracy is measured not by the speed of convictions but by the speed and fairness of justice. Realising the promise of Article 21 requires transforming the criminal justice system into one that is timely, technology-driven and citizen-centric.

4. West Asia in Transition: India's Strategic Interests in an Emerging Multipolar Order

Syllabus Mapping: GS2: Bilateral, regional and global groupings and agreements involving India and affecting India's interests

West Asia is witnessing a strategic realignment driven by regional conflicts, shifting alliances and great-power competition. As India's extended neighbourhood, the region presents significant opportunities in energy security and connectivity, while simultaneously testing its diplomacy and strategic autonomy.

Changing Geopolitical Landscape of West Asia

1. **Regional Order in Transition:** The traditional **US security umbrella** is being recalibrated as Gulf states diversify defence partnerships and reduce overdependence on a single guarantor.
2. **Pragmatic Regionalism:** Regional states are increasingly prioritising **economic diversification, investment and strategic partnerships** over ideological or sectarian alignments. The **Al-Ula Declaration (2021)** ended the Gulf diplomatic rift, while Gulf States maintain relations with both the US and China.
3. **Emergence of Geo-economic Competition:** West Asia has evolved into a critical hub for **connectivity corridors, logistics, energy investments and global supply chains**, making economics central to regional geopolitics. Eg: Competing initiatives such as **IMEC, China's Belt and Road Initiative (BRI)** and the **International North-South Transport Corridor (INSTC)**.
4. **Transformation of the Iran Question:** Iran has evolved from being viewed primarily as an isolated regional actor into the central variable shaping Gulf security, maritime stability and nuclear diplomacy. Eg: Even after the 2026 conflict, Gulf States continued engagement with Tehran rather than confrontation.

Strategic Opportunities for India

1. **Strengthening Energy Security and Energy Transition:** West Asia remains India's principal energy partner while emerging as a key collaborator in **green hydrogen, renewables and clean technologies**, supporting India's long-term energy transition. Eg: the **India-Saudi Arabia Strategic Partnership Council** and **India-UAE CEPA** have expanded cooperation in clean energy.
2. **Emerging Connectivity and Trade Corridors:** West Asia's strategic location provides India with an opportunity to become a major player in Eurasian connectivity through multimodal corridors. Eg: **India-Middle East-Europe Economic Corridor (IMEC), Chabahar Port** and the **International North-South Transport Corridor (INSTC)**.
3. **Deepening Strategic Partnerships with Regional Middle Powers:** The rise of Saudi Arabia, UAE and Qatar as autonomous regional actors enables India to pursue **issue-based partnerships** without being constrained by bloc politics. Eg: Comprehensive Strategic Partnerships with the **UAE and Saudi Arabia**; expanding defence cooperation with Gulf States.
4. **Technology and Innovation Partnerships:** Gulf countries are investing heavily in AI, semiconductors, fintech and digital infrastructure, opening avenues for India's technology ecosystem. Eg: The **India-UAE Virtual Trade Corridor**, cooperation in digital public infrastructure, fintech and artificial intelligence.



5. **Leadership in the Emerging Multipolar Order:** India's balanced engagement with **Israel, Iran, Saudi Arabia, UAE and Palestine** enhances its credibility as a trusted and independent partner capable of engaging all stakeholders.
6. **Maritime Security and Indian Ocean Cooperation:** Growing concerns over maritime security have expanded opportunities for India to enhance naval cooperation, HADR and Maritime Domain Awareness in the Indian Ocean. Eg: **Operation Sankalp**, anti-piracy deployments in the Gulf of Aden and cooperation with Gulf navies.

Challenges for India

1. **Energy Supply Vulnerability:** Regional conflicts can disrupt oil supplies and increase import costs. Eg: Red Sea crisis and Strait of Hormuz tensions.
2. **Multi-alignment Dilemma:** Maintaining relations with Israel, Iran and Arab Gulf states has become increasingly complex.
3. **Chokepoint Vulnerability:** Attacks in the Red Sea threaten critical Sea Lines of Communication. Eg: Houthi attacks disrupted commercial shipping.
4. **Geopolitical Contestation:** US-China rivalry in West Asia complicates India's strategic choices.
5. **Diaspora Security:** Conflict could endanger Indian nationals and affect remittance flows. Eg: **Operation Ajay** (Israel) and **Operation Sindhu** (Iran evacuation).
6. **Geo-economic Disruption:** Regional instability may delay projects like IMEC and affect India's connectivity ambitions.

Way Ahead

1. **Calibrated Multi-Alignment:** Deepen issue-based engagement with stakeholders while preserving strategic autonomy and avoiding bloc politics.
2. **Diversify Energy and Build Future Energy Partnerships:** India–Saudi Green Hydrogen Task Force and India–UAE Energy Security Partnership.
3. **Fast-Track Strategic Connectivity Corridors:** Operationalise IMEC, Chabahar Port and INSTC to reduce logistical vulnerabilities and enhance India's access to Europe, Central Asia and Africa.
4. **Deepen Geo-economic Partnerships:** Leverage CEPA with UAE, sovereign wealth funds and investments in AI, logistics, semiconductors and infrastructure to strengthen India's economic footprint.
5. **Promote a Rules-Based and Inclusive Regional Order:** Support peaceful dialogue, UNCLOS, freedom of navigation and respect for sovereignty while advocating a **two-state solution** and regional stability.

By combining strategic autonomy with geo-economic statecraft, India can transform the changing geopolitics of West Asia into a catalyst for its long-term national interests.

5. AI-Driven Warfare: Challenges and Opportunities for India's National Security

Syllabus Mapping: GS-3: Role of external state and non-state actors in creating challenges to internal security; Science and Technology—developments and their applications.

Artificial Intelligence (AI) is redefining warfare by shifting military advantage from **physical platforms** (tanks, aircraft, ships) to **algorithms, data and autonomous systems**. Conflicts such as the **Russia–Ukraine War** and **Israel– Hamas conflict** have demonstrated that future wars will increasingly be characterised by **intelligent decision-making, autonomous weapons and algorithmic superiority**, making AI a critical determinant of national power.

How AI is Transforming the Character of Warfare?

1. **Algorithmic Superiority:** Military superiority is increasingly determined by **algorithms, computing power and data intelligence** rather than the size or sophistication of conventional platforms. Eg: AI-enabled targeting systems in the **Russia–Ukraine war** enhanced precision despite limited conventional assets.
2. **Autonomous Warfare:** AI is enabling autonomous drones, loitering munitions, unmanned ground vehicles and maritime systems capable of surveillance, target acquisition and precision strikes with minimal human intervention. Eg: Extensive deployment of **FPV drones** and AI-assisted loitering munitions in Ukraine.
3. **Decision-Centric and Faster Warfare:** AI processes battlefield intelligence in real time, shortening the **Observe–Orient–Decide–Act (OODA)** loop and enabling commanders to take faster and more accurate decisions.
4. **Multi-Domain Operations:** AI seamlessly integrates **land, air, sea, space and cyber operations**, creating a unified battlespace with real-time coordination across domains.
5. **Predictive Warfare:** AI enables predictive analytics for target identification, logistics optimisation and predictive maintenance, improving operational efficiency while minimising collateral damage.



6. **Cognitive Warfare:** AI has expanded warfare beyond the physical battlefield into the information domain through **deepfakes, disinformation, psychological operations and cyber influence campaigns**. Eg: AI-generated deepfakes and misinformation during the **Russia–Ukraine conflict**.

Implications for India's National Security

1. **Technological Asymmetry with Adversaries:** China's rapid military AI integration and Pakistan's growing use of autonomous systems could widen India's capability gap, necessitating accelerated defence modernisation. Eg: China's **Next Generation Artificial Intelligence Development Plan (2017)** aims to make the PLA a world-class "intelligentised" force by 2049.
2. **Enhanced Border Surveillance and Situational Awareness:** AI can transform monitoring across the **LAC and LoC** through autonomous ISR, satellite analytics and predictive threat detection. Eg: AI-enabled drones, satellite imagery and sensor fusion for real-time surveillance.
3. **Rising Threat of Autonomous and Drone Warfare:** Low-cost AI-enabled drones and swarm technologies can target military installations and critical infrastructure, challenging conventional air defence systems.
4. **Strategic Deterrence and Military Modernisation:** AI will become a decisive factor in conventional deterrence, precision strike capability and multi-domain operations, making technological superiority a key determinant of military power. Eg: The **Chief of Defence Staff** has emphasised AI, cyber and space as pillars of future warfare.
5. **Transformation of Military Decision-Making:** AI enhances command-and-control systems through real-time intelligence fusion, predictive analytics and faster operational planning, improving combat effectiveness. Eg: AI-assisted **Battlefield Management Systems (BMS)** and decision-support platforms.
6. **Opportunity for Defence Industrial Transformation:** AI can catalyse indigenous defence manufacturing, dual-use innovation and civil-military technology partnerships, strengthening strategic autonomy. Eg: **iDEX, ADITI, Defence AI Council (DAIC)** and the **India Semiconductor Mission**.

Challenges in Building AI-Enabled Defence Capabilities

1. **Technological Dependence:** India remains dependent on foreign AI chips, GPUs, sensors, advanced semiconductors and defence electronics, limiting strategic autonomy in AI warfare.
2. **Fragmented Defence AI Ecosystem:** Limited coordination among **DRDO, Services, DPSUs, startups, academia and private industry** slows AI innovation and deployment.
3. **Data and Computing Infrastructure Deficit:** AI-enabled warfare requires secure military datasets, cloud infrastructure and High-Performance Computing (HPC), areas where India is still developing capabilities.
4. **Human Capital and Doctrinal Gap:** The armed forces require AI-skilled personnel, specialised military doctrines and organisational adaptation to effectively integrate AI into joint operations.

Measures to Build AI-Enabled Defence Capabilities

1. **Formulate a National Defence AI Strategy:** Develop a unified AI roadmap integrating the **Army, Navy, Air Force, DRDO, DPSUs, startups and academia** to ensure joint capability development.
2. **Accelerate Indigenous AI and Semiconductor Ecosystem:** Promote indigenous development of AI chips, defence electronics, autonomous platforms and secure hardware to reduce import dependence. Eg: **India Semiconductor Mission**
3. **Build Secure Defence Data Infrastructure:** Develop interoperable military data platforms, secure cloud infrastructure and indigenous Large Language Models (LLMs) for defence applications.
4. **Strengthen Defence Innovation Ecosystem:** Expand collaboration among **DRDO, iDEX, ADITI, startups, MSMEs and academia** for rapid development and deployment of AI-enabled defence technologies.

6. Climate Variability and India's Economic Resilience

Syllabus Mapping: GS3: Indian Economy and issues relating to planning, mobilization of resources, growth, development and employment; Conservation, environmental pollution and degradation, environmental impact assessment.

Climate change has evolved from an environmental concern into a **systemic macroeconomic risk**, affecting growth, inflation, fiscal stability and financial systems. The increasing frequency and intensity of extreme weather events, highlight how climate variability can significantly influence India's economic resilience and developmental trajectory.

Climate Change as a Macroeconomic Risk

1. **Climate-Induced Growth Slowdown:** Extreme weather events reduce agricultural output, industrial productivity and labour efficiency, lowering long-term GDP growth. Eg: The **RBI** identifies climate change as a major macro-financial risk to India's economy.



2. **Fuels Inflationary Pressures:** Extreme weather disrupts food and energy supply chains, leading to persistent food inflation and price volatility. **Eg:** Heatwaves and erratic monsoons have repeatedly pushed up prices of vegetables and cereals in India.
3. **Worsens Fiscal Sustainability:** Governments incur higher expenditure on disaster relief, reconstruction, climate adaptation and social protection, increasing fiscal pressures. **Eg:** The **Economic Survey 2024–25** highlights rising public expenditure on climate adaptation and disaster resilience.
4. **Financial Stability Risks:** Climate shocks increase credit defaults in agriculture, insurance claims and risks to banking and financial institutions. **Eg:** RBI has proposed a **Disclosure Framework on Climate-related Financial Risks**.
5. **Reduces Employment and Labour Productivity:** Heat stress and climate extremes disproportionately affect agriculture, construction and informal sectors, lowering productivity and incomes. **Eg:** The **ILO** estimates that heat stress could reduce **5.8% of India's working hours by 2030**, equivalent to **34 million full-time jobs**.
6. **Increases Inequality and Poverty:** Climate shocks disproportionately affect vulnerable households, widening regional and socio-economic disparities. **Eg:** The **World Bank** estimates climate change could push millions into poverty without adequate adaptation measures.
7. **Agricultural Slowdown and Food Security Risks:** Inefficient monsoon reduces crop yields, lowers agricultural growth and threatens food security, particularly for rain-fed agriculture. **Eg:** Around **52% of India's net sown area remains rain-fed**, making it highly vulnerable to monsoon variability. (*Ministry of Agriculture*)
8. **Weakens Rural Demand and Consumption:** Crop losses and declining farm incomes reduce rural purchasing power, adversely affecting consumption-led economic growth.
9. **Raises Energy and Water Security Risks:** Climate variability lowers hydropower generation, stresses reservoirs and increases electricity demand during heatwaves. **Eg:** Heatwaves have pushed India's peak electricity demand to record highs in recent years.

Measures to Strengthen Economic Resilience

1. **Climate Mainstreaming:** Integrate climate risk assessments into fiscal policy, public investment, infrastructure planning and macroeconomic decision-making. **Eg:** **Economic Survey 2024–25** advocates integrating climate resilience into development planning.
2. **Climate Resilience:** Invest in climate-resilient agriculture, flood-resilient cities, drought-proofing and resilient infrastructure under a long-term adaptation strategy. **Eg:** **National Adaptation Fund for Climate Change (NAFCC)** and **Coalition for Disaster Resilient Infrastructure (CDRI)**.
3. **Climate Intelligence:** Expand AI-enabled weather forecasting, impact-based warnings and climate-risk mapping for evidence-based policymaking. **Eg:** **Mission Mausam** and IMD's **Impact-Based Forecasting**.
4. **Climate-Smart Agriculture:** Promote climate-smart farming, micro-irrigation, drought-resistant crop varieties and universal crop insurance to reduce monsoon dependence. **Eg:** **PMKSY** and **PMFBY**
5. **Green Finance:** Expand sovereign green bonds, blended finance, carbon markets and ESG investments to bridge the climate financing gap. **Eg:** **India's Sovereign Green Bonds** and the **Green Credit Programme**.
6. **Climate Financial Resilience:** Integrate climate-risk disclosures, stress testing and sustainable finance into banking and insurance regulation. **Eg:** **RBI Framework on Climate-related Financial Risks (2024)**.
7. **Whole-of-Government Approach:** Strengthen Centre–State coordination and convergence across climate, agriculture, water, disaster management and urban planning. **Eg:** **National Action Plan on Climate Change (NAPCC)** and **State Action Plans on Climate Change (SAPCCs)**.
8. **Resource Security:** Diversify the energy mix, improve water-use efficiency and accelerate renewable energy deployment to reduce climate vulnerabilities. **Eg:** **National Green Hydrogen Mission**, **Jal Jeevan Mission** and the target of **500 GW non-fossil capacity by 2030**.

The future of India's economy will depend not merely on the pace of growth, but on the resilience of that growth against climate uncertainty.

7. India–Australia Strategic Partnership: A Pillar Of The Indo-Pacific

Syllabus Mapping: GS-2: Bilateral, regional and global groupings and agreements involving India and/or affecting India's interests; Effect of policies and politics of developed and developing countries on India's interests.

India–Australia relations have undergone a strategic transformation from a **Commonwealth-based relationship** to a **Comprehensive Strategic Partnership (2020)**, driven by converging interests in the **Indo-Pacific**, **resilient supply chains**, **critical minerals**, **maritime security** and **emerging technologies**. Today, the partnership is central to advancing a **free, open and inclusive Indo-Pacific**.

Evolution of India–Australia Relations: From Diplomatic Engagement to Multidimensional Strategic Partnership



1. **From Commonwealth Legacy to Strategic Convergence:** - The relationship has evolved beyond historical Commonwealth ties to one driven by shared geopolitical interests and strategic trust. Eg: Elevation to Comprehensive Strategic Partnership (2020).
2. **From Political Dialogue to Defence and Security Cooperation:** Defence has emerged as a core pillar through institutionalised military exercises, logistics cooperation and maritime security. Eg: Mutual Logistics Support Arrangement 2020
3. **From Trade Relations to Geo-economic Partnership:** Economic engagement now extends beyond trade to critical minerals, supply chains, clean energy and emerging technologies. Eg: ECTA (2022), Critical Minerals Investment Partnership.
4. **From Sectoral Engagement to Comprehensive Cooperation:** Relations now encompass cyber security, AI, education, space, climate action, migration and people-to-people exchanges. Eg: Migration and Mobility Partnership Arrangement (MMPA, 2023) and Education Qualification Recognition Mechanism.

Significance for India's Indo-Pacific Vision

1. **Upholds a Rules-Based Maritime Order:** Both countries advocate a free, open, inclusive and rules-based Indo-Pacific, anchored in UNCLOS 1982, ensuring freedom of navigation and overflight. Eg: Shared commitment through the Quad and East Asia Summit (EAS).
2. **Strengthens Maritime Security in the Indian Ocean:** Enhanced naval cooperation improves surveillance, interoperability and protection of critical Sea Lines of Communication (SLOCs). Eg: AUSINDEX, Malabar Exercise
3. **Balances China's Expanding Maritime Influence:** Strategic convergence helps preserve a favourable balance of power and deter unilateral actions in the Indo-Pacific. Eg: Joint support for a Free and Open Indo-Pacific (FOIP) through the Quad.
4. **Strengthens Minilateralism and Regional Governance:** India and Australia leverage platforms like the Quad, IORA and ADMM-Plus to promote collective security and regional stability. Eg: Joint initiatives on HADR, cyber security and critical technologies.

Significance for India's Economic Security

1. **Critical Mineral Security:** Australia is a reliable supplier of lithium, cobalt and rare earths essential for EVs, batteries and clean technologies. Eg: India–Australia Critical Minerals Investment Partnership.
2. **Supply Chain Resilience:** Diversification away from concentrated supply chains enhances India's manufacturing and economic resilience. Eg: Supply Chain Resilience Initiative (SCRI) involving India, Australia and Japan.
3. **Trade and Investment Expansion:** The ECTA has accelerated bilateral trade, investments and market access. Eg: Bilateral trade has crossed US\$24 billion after ECTA.
4. **Technology and Innovation Partnership:** Collaboration in semiconductors, quantum technologies, cyber security and clean energy supports India's technological competitiveness. Eg: India–Australia cooperation under the Critical and Emerging Technology framework.

Challenges in India–Australia Strategic Partnership

1. **Trade and Market Access Barriers:** Differences over agriculture, services, labour mobility and investment continue to delay a comprehensive economic partnership. Eg: CECA negotiations remain unresolved.
2. **China's Strategic Shadow:** Divergent economic dependence on China and regional sensitivities occasionally constrain strategic coordination. Eg: China remains Australia's largest trading partner.
3. **Limited Defence Industrial Cooperation:** Collaboration remains focused on exercises, with limited progress in co-development and defence manufacturing. Eg: Low defence technology transfers despite the CSP (2020).
4. **Critical Mineral Processing Constraints:** While Australia is resource-rich, India lacks adequate refining and processing capabilities. Eg: Dependence on third-country processing for lithium and rare earths.

Way Forward

1. **Conclude the Comprehensive Economic Cooperation Agreement (CECA):** Expand ECTA into a comprehensive agreement covering investment, services and digital trade.
2. **Institutionalise Critical Mineral Value Chains:** Promote joint exploration, processing, recycling and strategic reserves to strengthen supply chain resilience. Eg: India–Australia Critical Minerals Investment Partnership.
3. **Deepen Defence and Maritime Cooperation:** Expand defence co-production, intelligence sharing, logistics support and joint military exercises. Eg: AUSINDEX, MLSA and the 2+2 Ministerial Dialogue.
4. **Build Trusted Technology Partnerships:** Strengthen collaboration in AI, quantum computing, cyber security, space and semiconductors through joint R&D and innovation ecosystems.
5. **Strengthen Indo-Pacific Development Cooperation:** Jointly support resilient infrastructure, HADR, blue economy initiatives and capacity building in the Indian Ocean and Pacific Island countries. Eg: IPOI, CDRI and Pacific Islands cooperation.
6. **Enhance People-to-People and Knowledge Partnerships:** Expand cooperation in higher education, skilled migration, research and innovation to build long-term strategic trust. Eg: Migration and Mobility Partnership Arrangement (2023).

8. Right to be Forgotten in the Digital Age

Syllabus Mapping: GS2: GS-II: Issues relating to citizens' rights, privacy, governance and the balance between Fundamental Rights in the digital age.



The exponential growth of digital platforms has made personal information **permanent, searchable and globally accessible**, intensifying the demand for a **Right to be Forgotten (RTBF)**. While recognised as a facet of the **Right to Privacy under Article 21** in *Justice K.S. Puttaswamy (2017)*, its implementation requires balancing **individual dignity** with **freedom of expression, open justice and public interest**.

What is Right to be Forgotten?

The Right to be Forgotten is understood as an individual's claim to restrict or erase access to personal information that is no longer relevant, especially when its continued availability causes disproportionate harm. In India, RTBF is traced to **Article 21**, following the Supreme Court's judgment in *Justice K.S. Puttaswamy v. Union of India (2017)*, which recognised privacy as intrinsic to life, dignity, and autonomy. The Court acknowledged informational self-determination as a core component of privacy in a data-driven society.

Challenges Associated with the Right to be Forgotten in the Digital Age

1. **Balancing Competing Fundamental Rights:** RTBF requires reconciling **Article 21 (Privacy)** with **Article 19(1)(a) (Freedom of Speech)**, **open justice** and **public interest**, making absolute enforcement constitutionally difficult.
2. **Digital Permanence of Information:** Once information is published online, it is replicated across search engines, archives, mirror websites and social media, making complete erasure practically impossible.
3. **Absence of a Comprehensive Legal Framework:** The **DPDP Act, 2023** provides only a limited right to erasure and does not expressly define the scope, procedure or exceptions for RTBF.
4. **Open Justice and Judicial Transparency:** Removing or anonymising court records may undermine judicial transparency, legal precedents and public confidence in the justice system.
5. **AI and Algorithmic Replication:** Generative AI models, web crawlers and recommendation algorithms can retain, reproduce or amplify personal information even after it has been deleted from the original source.
6. **Cross-Border Data and Jurisdictional Issues:** Data stored across multiple jurisdictions makes enforcement difficult due to differing privacy laws and limited extraterritorial jurisdiction.

Significant Case laws and Judicial Interpretations

1. **Justice Puttaswamy (2017) Judgement:** Recognised **Right to Privacy as a Fundamental Right** under Article 21; established **informational privacy** as the constitutional foundation of RTBF.
2. **Jorawar Singh Mundy Vs UOI (2021):** SC directed **Google and legal databases to de-index** acquittal-related judgments, recognising reputational harm in the digital era.
3. **Laksh Vir Singh Yadav Vs HC of Delhi (2026):** Landmark judgment holding RTBF to be a **facet of informational privacy under Article 21**. Laid down a structured framework favouring **de-indexing, masking and anonymisation** over deletion, while balancing **privacy, open justice and public interest**.

Building a Balanced Right to be Forgotten Framework

1. **Operationalise the DPDP Framework:** Fully implement the **Digital Personal Data Protection Act, 2023** and the **DPDP Rules, 2025** to provide a clear mechanism for consent withdrawal, data erasure and grievance redressal.
2. **Strengthen the Data Protection Board of India:** Empower the **Data Protection Board (DPB)** with functional independence, technical expertise and appellate procedures to **adjudicate RTBF claims** transparently.
3. **Enact a Dedicated Statutory RTBF Framework:** Provide explicit statutory recognition to RTBF by clearly defining eligibility, scope, timelines and exceptions, instead of relying solely on case-by-case judicial development.
4. **Institutionalise the Proportionality Test:** Mandate that every RTBF request be assessed through the **doctrine of proportionality**, balancing privacy, freedom of speech, open justice and public interest.
5. **Prefer De-indexing and Anonymisation over Deletion:** Adopt the principle of **minimum necessary restriction** by removing search visibility or anonymising identities while preserving judicial records and historical archives. **Eg:** Delhi High Court in *Laksh Vir Singh Yadav (2026)* preferred de-indexing/anonymisation over complete deletion.
6. **Strengthen Platform Accountability:** Require search engines, social media platforms and AI developers to establish **time-bound RTBF grievance mechanisms**, transparency reports and periodic compliance audits under the DPDP regime.

Global Best Practices

1. **European Union – General Data Protection Regulation (Article 17):** Recognises the **Right to Erasure**, allowing individuals to seek deletion of personal data while balancing **freedom of expression, public interest and legal obligations**.
2. **UK: The Information Commissioner's Office (ICO)** follows a **case-by-case proportionality assessment**, balancing privacy, public interest and freedom of expression.

As India builds a Digital India, it must also build a constitutional digital republic where the right to remember and the right to be forgotten coexist in constitutional harmony.



9. India's Biofuel Transition: Lessons From Brazil's Ethanol Success

Syllabus Mapping: GS-3: Conservation, environmental pollution and degradation, environmental impact assessment; Infrastructure: Energy; Science and Technology—developments and their applications.

India, the world's **third-largest energy consumer**, imports nearly **85% of its crude oil**, making energy diversification a strategic necessity. With the **E20 target advanced to 2025–26** and the launch of the **Global Biofuels Alliance (G20, 2023)**, biofuels have emerged as a key pillar of India's energy transition. Brazil's five-decade ethanol programme offers valuable lessons for achieving energy security, decarbonisation and rural transformation.

Why Biofuel Transition is Critical for India?

1. **Strengthening Energy Security:** Biofuels reduce India's dependence on imported fossil fuels, enhancing resilience against geopolitical disruptions and global oil price volatility. Eg: Current Iran and Strait of Hormuz crisis
2. **Promoting Rural Prosperity:** Biofuel production creates diversified income sources for farmers through remunerative markets for sugarcane, maize, damaged food grains and agricultural residues.
3. **Enabling Circular Economy:** Conversion of crop residues, municipal solid waste and used cooking oil into biofuels reduces waste, stubble burning and environmental pollution. Eg: **2G Ethanol Plants, SATAT and GOBARdhan** initiatives.
4. **Accelerating Climate Action:** Biofuels lower lifecycle greenhouse gas emissions, supporting India's **Panchamrit commitments, Net Zero by 2070** and decarbonisation of the transport sector.
5. **Driving Green Industrialisation:** Biofuel expansion promotes investments in biorefineries, flex-fuel vehicles, compressed biogas and advanced biofuel technologies, creating green jobs and new industries.

Challenges Before India

1. **Feedstock Concentration:** India's ethanol programme remains heavily dependent on **sugarcane and sugar-based feedstocks**, creating regional concentration and supply risks.
2. **Water-Intensive Feedstock:** Sugarcane cultivation has a **high water footprint**, making large-scale ethanol expansion environmentally unsustainable in water-stressed regions. Maharashtra and Karnataka continue to cultivate sugarcane despite recurring droughts.
3. **Food–Fuel–Fodder Trade-off:** Diversion of food grains and fertile agricultural land for ethanol production raises concerns over **food security, livestock feed availability and inflation**. Eg: Debate over the use of **maize and rice** for ethanol amid food price pressures.
4. **Weak Advanced Biofuel Ecosystem:** Commercial production of **2G ethanol, Sustainable Aviation Fuel (SAF) and advanced biofuels** remains limited due to high costs and technological barriers.
5. **Inadequate Biofuel Infrastructure:** Limited **biorefineries, ethanol storage, transportation networks, dispensing stations and flex-fuel vehicles** constrain large-scale adoption.
6. **Fragmented Biomass Supply Chains:** Collection, aggregation and transportation of crop residues remain inefficient, increasing feedstock costs and affecting commercial viability.

Lessons from Brazil: Opportunities for India

1. **Diversified Feedstock Strategy:** Brazil's success stems from utilising **multiple feedstocks** (sugarcane, corn and advanced biomass), reducing dependence on a single crop. Eg: **National Policy on Biofuels**
2. **Integrated Bio-Refinery Ecosystem:** Brazil has developed integrated biorefineries producing ethanol, bioelectricity, biogas and value-added bio-products, maximising resource efficiency. Eg: **PM JI-VAN Yojana** for 2G ethanol plants.
3. **Flex-Fuel Mobility Revolution:** Brazil's widespread adoption of **Flex-Fuel Vehicles (FFVs)** has created stable domestic demand for ethanol.
4. **Stable Long-Term Policy Support:** Brazil's **Proalcool Programme** ensured consistent policy, pricing and investment, enabling industry confidence.
5. **Farmer-Centric Rural Development:** Brazil transformed ethanol into a driver of rural employment, value addition and agro-industrial growth. India can integrate **FPOs, cooperatives and sugar mills** into biofuel value chains to increase farmers' income.

Way ahead

1. **Integrated Biofuel Ecosystem:** Move beyond ethanol to promote **Compressed Biogas (CBG), Sustainable Aviation Fuel (SAF), biodiesel and green methanol**, creating a diversified biofuel ecosystem. Eg: **National Bioenergy Programme (2022–27)**.
2. **Innovation-Led Transition:** Scale up research in **2G/3G biofuels, algae-based fuels, enzyme technologies and biomass conversion** through industry–academia collaboration.
3. **Circular Bioeconomy:** Create efficient systems for biomass aggregation, storage and logistics through **FPOs, cooperatives and private participation** to ensure reliable feedstock supply.
4. **Promote Sustainable Feedstock and Resource Efficiency:** Encourage **non-food feedstocks**, crop diversification and water-efficient crops while integrating biofuel expansion with natural resource conservation.



5. **Position India as a Global Biofuel Leader:** Leverage the **Global Biofuels Alliance** to harmonise standards, promote technology transfer, mobilise investments and expand South–South cooperation.

A sustainable biofuel ecosystem can transform India's energy transition from being import-dependent to innovation-driven, making biofuels a catalyst for energy security, climate action and rural transformation.

10. Landslide Resilience Through Early Warning Systems

Syllabus Mapping: GS3: Disaster and Disaster Management.

India is among the world's most landslide-prone countries, with nearly **12.6% of its geographical area** vulnerable to landslides. The increasing frequency of extreme rainfall and unplanned development has highlighted the need to shift from a **reactive disaster response** to **anticipatory risk reduction**, where **Early Warning Systems (EWS)** form the first line of defence.

Why are Landslides Increasing in India?

1. **Climate-Induced Slope Instability:** Climate change has increased the frequency of **high-intensity, short-duration rainfall**, saturating slopes and triggering slope failures. **Eg: Wayanad (2024)** and recurrent landslides in **Himachal Pradesh** following cloudbursts.
2. **Unscientific Infrastructure Development:** Road widening, hydropower projects, tunnelling and hill cutting destabilise fragile slopes by altering natural drainage and geological stability. **Eg: Char Dham Road Project** has raised concerns over slope destabilisation in the Himalayas.
3. **Ecosystem Degradation:** Loss of forest cover reduces root reinforcement, increases surface runoff and weakens soil cohesion, making slopes more vulnerable. **Eg: Plantation expansion and quarrying in the Western Ghats.**
4. **Expansion into Hazard-Prone Areas:** Rapid urbanisation, tourism and settlements on **unstable** hill slopes increase both the frequency of slope failures and disaster exposure. **Eg: Construction along hill slopes in Shimla, Mussoorie and Joshimath.**
5. **Geological Fragility of the Himalayas:** The **young fold mountains**, active tectonics and seismicity make the Himalayan region inherently prone to landslides. **Eg: Around 70% of India's landslides occur in the Himalayan belt** (GSI).
6. **Mining and Quarrying Activities:** Unregulated extraction of minerals and stone disturbs slope geometry and weakens rock formations. **Eg: Quarrying concerns highlighted in parts of Kerala's Western Ghats.**
7. **Weak Hazard Zonation and Risk-Informed Planning:** Limited integration of **landslide susceptibility maps** into urban planning and infrastructure development results in repeated exposure to high-risk zones.

Challenges in Developing Effective Landslide Early Warning Systems in India

1. **Complex and Localised Nature of Landslides:** Unlike cyclones or floods, landslides are highly **site-specific**, triggered by a combination of geology, rainfall, slope stability and land use, making prediction difficult.
2. **Limited Monitoring and Observation Network:** Sparse deployment of **rainfall gauges, ground sensors, geotechnical instruments and real-time monitoring stations** reduces forecasting accuracy in vulnerable regions.
3. **Data and Technology Gaps:** Fragmented geological, hydrological and meteorological databases, along with limited AI-based modelling, constrain accurate impact-based forecasting.
4. **Weak Last-Mile Dissemination:** Warnings often fail to reach remote hill communities due to poor digital connectivity, language barriers and inadequate community awareness.
5. **Poor Integration with Land-Use Planning:** Landslide susceptibility maps are not adequately integrated into infrastructure approvals, urban planning or road construction. **Eg: Continued construction in high-risk zones despite GSI Landslide Susceptibility Zonation maps.**
6. **Institutional Coordination Challenges:** Multiple agencies—IMD, NDMA, SDMAs, ISRO and local bodies—often operate in silos, delaying coordinated risk communication and response.
7. **Climate Change and Dynamic Hazard Profiles:** Changing rainfall patterns, cloudbursts and glacial processes are making historical landslide thresholds less reliable, demanding continuous recalibration of forecasting models. **Eg: Increasing cloudburst-induced landslides in Himachal Pradesh and Uttarakhand.**

Role of Early Warning Systems in Building Landslide Resilience

1. **Shift from Reactive Relief to Anticipatory Risk Reduction:** Early Warning Systems enable authorities to act **before disasters strike**, minimising casualties and economic losses rather than merely responding after the event. **Eg: National Landslide Forecasting Centre (NLFC, 2025)** issues district-level landslide forecasts.
2. **Protecting Lives through Impact-Based Forecasting:** Risk-based warnings facilitate timely evacuation of vulnerable communities significantly reducing fatalities. **Eg: Pre-emptive evacuations during extreme rainfall in Nilgiris and Sikkim.**
3. **Enabling Risk-Informed Development Planning:** Hazard forecasts support safer infrastructure siting, hill-road engineering and land-use regulation, preventing creation of new disaster risks. **Eg: GSI's Landslide Susceptibility Zonation (LSZ) maps.**



4. **Building Climate-Resilient Infrastructure:** Forecast-based maintenance and temporary closures protect highways, railways, hydropower projects and communication networks from cascading failures. **Eg:** Monitoring vulnerable stretches along **Char Dham routes** and the **Konkan Railway**.
5. **Technology-Enabled Risk Intelligence:** Integration of **LiDAR, remote sensing, Doppler Weather Radars and satellite observations** enables real-time monitoring and high-precision forecasting.
6. **Strengthening Community-Centric Preparedness:** Last-mile dissemination through mobile alerts, local volunteers and Panchayats converts scientific forecasts into timely community action. **Eg: Common Alerting Protocol (CAP) under NDMA.**
7. **Minimising Socio-Economic Disruptions:** Early action protects livelihoods, tourism, agriculture and critical supply chains by enabling preventive closures and contingency planning. **Eg:** Temporary suspension of tourism and traffic during red alerts.
8. **Operationalising the Sendai Framework:** Multi-hazard Early Warning Systems strengthen disaster resilience by prioritising prevention, preparedness and resilience-building over relief-centric approaches. **Eg: UN's Early Warnings for All Initiative (2027) and Sendai Framework (2015–30).**

11. AI-Enabled Judiciary: Opportunities, Risks and the Future of Justice Delivery

Syllabus Mapping: **GS-2:** Separation of powers between various organs, dispute redressal mechanisms and institutions.

GS-3: Science and Technology—developments and their applications and effects in everyday life.

The emergence of Artificial Intelligence has transformed justice delivery from **paper-based courts to technology-enabled courts**, enabling faster legal research, digital case management and improved access to justice. As India advances towards a digital judiciary, the challenge lies in harnessing AI's efficiency while preserving the constitutional values that underpin judicial decision-making.

Why does the Indian judiciary need AI?

1. **Addressing Judicial Pendency:** India's judiciary faces an enormous backlog, necessitating technology-enabled solutions to improve case management and reduce delays. **Eg: Over 5 crore cases** are pending across Indian courts (National Judicial Data Grid).
2. **Enhancing Access to Justice:** AI can make justice more accessible through multilingual translation, virtual legal assistance and digital court services, especially for rural and marginalised citizens.
3. **Improving Judicial Efficiency:** Routine administrative functions such as case classification, scheduling, transcription and legal research can be automated, allowing judges to focus on adjudication.
4. **Process Optimisation:** AI can streamline workflows, standardise document management and reduce procedural inconsistencies without interfering with judicial discretion.
5. **Reducing the Cost and Time of Litigation:** Automation of repetitive tasks lowers litigation costs, reduces procedural delays and improves ease of doing business. **Eg: Faster document scrutiny, e-filing and virtual hearings.**
6. **Realising the Constitutional Promise of Speedy Justice:** AI can strengthen the effective enforcement of **Article 21**, where the **Right to Speedy Trial** has been recognised as an integral part of the right to life and personal liberty. **Eg: Hussainara Khatoon v. State of Bihar (1979).**

Applications of AI in Courts

1. **AI-Assisted Legal Research and Precedent Discovery:** AI rapidly analyses statutes, precedents and case laws, enabling judges to identify relevant legal principles and improve the quality of legal research. **Eg: SUPACE (Supreme Court Portal for Assistance in Court Efficiency).**
2. **Smart Case Management and Pendency Reduction:** AI assists in case categorisation, scheduling, workload allocation and prioritisation of old and urgent matters, improving judicial efficiency. **Eg: e-Courts Phase III.**
3. **Real-Time Transcription and Court Documentation:** AI-powered speech recognition generates real-time transcripts of court proceedings, reducing manual documentation and improving judicial records. **Eg: AI-based live transcription in the Supreme Court.**
4. **Language-Inclusive Justice:** AI-powered translation tools enable judgments and court records to be translated into regional languages, improving accessibility and inclusivity. **Eg: SUVAS (Supreme Court Vidhik Anuvaad Software).**
5. **AI-assisted Legal Aid and Citizen Services:** Conversational AI can guide litigants regarding filing procedures, court fees, case status and legal information, improving accessibility without offering legal advice. **Eg: AI chatbots under the e-Courts ecosystem.**
6. **Predictive Court Analytics:** AI can generate dashboards on pendency, disposal rates, adjournment patterns and infrastructure gaps, enabling evidence-based judicial administration.

Challenges & Risks of AI in Judiciary

1. **Algorithmic Bias and Discriminatory Outcomes:** AI systems trained on historical judicial data may perpetuate existing social, gender or caste biases, undermining equality before law.



2. **Absence of Judicial Reasoning and Human Empathy:** Judicial decisions require constitutional interpretation, appreciation of evidence, equity and compassion—qualities that AI cannot replicate. **Eg:** Bail, sentencing, child custody and constitutional cases require contextual adjudication.
3. **Black-Box Algorithms and Lack of Explainability:** Opaque AI models make it difficult to understand or challenge the basis of AI-generated recommendations, affecting procedural fairness.
4. **Privacy and Confidentiality of Judicial Data:** AI systems process vast volumes of sensitive judicial records, increasing risks of data breaches and misuse of personal information.
5. **Threat to Judicial Independence:** Over-reliance on AI-generated recommendations may subtly influence judicial discretion, compromising the independence of judges.
6. **Cybersecurity and Systemic Risks:** Judicial AI systems may be vulnerable to hacking, ransomware attacks, data poisoning and manipulation of digital evidence.
7. **Digital Divide and Unequal Access:** Uneven digital infrastructure, limited digital literacy and language barriers may exclude vulnerable litigants from AI-enabled justice systems.

Towards Responsible AI in India's Judiciary

1. **Adopt a Human-in-the-Loop Model:** AI should assist judges in research, case management and administration, while **all judicial decisions remain exclusively with human judges.**
2. **Develop a Judicial AI Governance Framework:** The Supreme Court should formulate **ethical AI guidelines** covering transparency, accountability, explainability and permissible use of AI in courts. **Eg:** Align with **UNESCO Recommendation on the Ethics of AI (2021).**
3. **Mandate Explainable and Auditable AI:** Only **Explainable AI (XAI)** systems with periodic independent bias and accuracy audits should be deployed in judicial processes.
4. **Strengthen Judicial Data Governance:** Develop secure judicial data-sharing protocols, anonymisation standards and privacy safeguards in accordance with the **DPDP Act, 2023.**
5. **Build Capacity of Judges and Court Staff:** Institutionalise continuous training on AI, digital evidence, cybersecurity and algorithmic ethics through the **National Judicial Academy** and State Judicial Academies.
6. **Adaptive AI Regulation:** Create an interdisciplinary **Judicial AI Oversight Committee** comprising judges, technologists, ethicists and legal experts to periodically evaluate AI deployment.

The future of India's judiciary lies in harnessing Artificial Intelligence as a force multiplier while preserving judicial independence, constitutional morality and human conscience.

12. Nuclear Energy: Balancing Self-Reliance, Safety And Global Cooperation

Syllabus Mapping: GS-3: Infrastructure; Energy; Science and Technology—developments and their applications and effects in everyday life.

Amid rising energy demand and the global transition towards low-carbon development, nuclear energy has emerged as a strategic pillar of India's energy future. Its ability to **provide** reliable, round-the-clock clean electricity makes it indispensable for ensuring energy security while supporting long-term climate goals.

Why Nuclear Energy is Central to India's Energy Transition?

1. **Baseload Reliability:** Unlike solar and wind, nuclear power generates **24×7 uninterrupted electricity**, ensuring grid stability and complementing variable renewable energy.
2. **Accelerates Decarbonisation:** Nuclear power generates electricity with **near-zero operational carbon emissions**, making it indispensable for achieving **Net Zero 2070** and **Panchamrit** commitments.
3. **Energy Sovereignty:** Expanding nuclear energy reduces dependence on imported fossil fuels and protects the economy from geopolitical disruptions and oil price volatility. **Eg:** India imports nearly **85% of its crude oil** and over **50% of its natural gas.**
4. **Grid Firming:** Stable nuclear generation complements intermittent renewables by balancing the grid and ensuring round-the-clock electricity supply.
5. **High Energy Density:** Nuclear plants generate significantly higher electricity per unit land than most renewable energy sources, reducing land acquisition pressures. **Eg:** A **1 GW nuclear plant** requires substantially less land than an equivalent solar installation.
6. **Diversified Energy Mix:** A diversified energy mix with nuclear, renewables, hydro and storage reduces overdependence on any single energy source, making the transition more resilient.

Challenges in Expanding Nuclear Energy in India



1. **Capital-Intensive Infrastructure:** Nuclear power projects require substantial upfront investment, long construction periods and delayed returns, affecting financial viability.
2. **Technology and Supply Chain Dependence:** India continues to rely on international collaboration for certain advanced reactor technologies, specialised components and enriched fuel. **Eg:** Cooperation with **Russia (Kudankulam)** and **France (Jaitapur project)**.
3. **Radioactive Waste Management:** Safe storage, transportation and long-term disposal of high-level radioactive waste remain technically complex and socially sensitive.
4. **Investment Uncertainty:** The **Civil Liability for Nuclear Damage Act, 2010** has discouraged foreign suppliers and limited private investment due to supplier liability concerns.
5. **Economic Competitiveness:** Falling costs of solar, wind and battery storage create economic competitiveness challenges for capital-intensive nuclear projects.

Why Global Cooperation Remains Indispensable?

1. **Securing Reliable Nuclear Fuel Supplies:** India's limited domestic uranium reserves make diversified international fuel partnerships essential for uninterrupted reactor operations and long-term energy security. **Eg:** Uranium supply agreements with **Kazakhstan, Canada, Australia, Uzbekistan and Namibia**.
2. **Access to Advanced Nuclear Technologies:** Global collaboration accelerates deployment of **Generation III+, Generation IV reactors and Small Modular Reactors (SMRs)**, shortening the technology gap. **Eg:** **Russia (VVER reactors at Kudankulam)**.
3. **Strategic Capacity Building:** International collaboration brings capital, engineering expertise and project execution capabilities required to rapidly scale nuclear power.
4. **Global Nuclear Governance:** Adoption of international safety standards, peer reviews and emergency preparedness enhances operational safety and public confidence. **Eg:** **IAEA Safety Standards, Convention on Nuclear Safety and Operational Safety Review Team (OSART)** missions.

Way Forward: Towards a Safe, Self-Reliant and Globally Integrated Nuclear Ecosystem

1. **Atmanirbhar Nuclear Ecosystem:** Fast-track indigenous **700 MW PHWRs**, operationalise the **Prototype Fast Breeder Reactor (PFBR)** and accelerate the **three-stage thorium programme** to achieve long-term energy sovereignty.
2. **Next-Generation Reactors:** Promote indigenous **Small Modular Reactors (SMRs)**, advanced reactors and AI-enabled nuclear systems through mission-mode R&D. **Eg:** **Nuclear Energy Mission (Budget 2025–26)**.
3. **Build a Complete Domestic Nuclear Value Chain:** Strengthen uranium exploration, fuel fabrication, heavy water production, reactor components, reprocessing and waste management through greater industry participation.
4. **Deepen Strategic Global Partnerships:** Expand cooperation with the **IAEA** and partner countries for fuel security, advanced reactor technologies, nuclear safety, fusion research and supply-chain resilience.
5. **Safety-by-Design:** Establish an independent **Nuclear Safety Regulatory Authority (NSRA)**, enhance emergency preparedness, cybersecurity and periodic safety audits in line with **IAEA Safety Standards**.
6. **Mobilise Investment and Accelerate Project Execution:** Facilitate long-term financing, streamline approvals and encourage responsible private-sector participation to expedite nuclear capacity expansion.
7. **Integrated Energy Transition:** Position nuclear alongside renewables, storage and green hydrogen to build a diversified, resilient and low-carbon energy system.

India's nuclear future lies not in choosing between self-reliance, safety and global cooperation, but in harmonising all three to power a secure, sustainable and Viksit Bharat.

13. India–US Defence Technology Partnership: Bridging the Gap Between Strategic Convergence and Technological Collaboration

Syllabus Mapping: GS-2: India–US bilateral relations and strategic partnerships affecting India's interests.

India and the United States have emerged as key strategic partners in the evolving Indo-Pacific order, with defence cooperation becoming a central pillar of bilateral relations. Foundational defence agreements, expanding military exercises and new technology initiatives have significantly deepened the strategic partnership over the past decade.

Strategic Convergence in India–US Defence Relations

1. **Institutionalisation of Defence Partnership:** The relationship has evolved through comprehensive institutional frameworks, ministerial dialogues and defence agreements, enabling long-term strategic cooperation. **Eg:** **2+2 Ministerial Dialogue, Major Defence Partner (2016), COMPACT (2025)**.



2. **Enhanced Military Interoperability:** Foundational defence agreements have enabled secure communications, logistics support, geospatial intelligence sharing and seamless joint operations. **Eg: LEMOA (2016), COMCASA (2018), BECA (2020), SOSA (2024)**
3. **Shared Indo-Pacific Strategic Vision:** Both countries view a **Free, Open, Inclusive and Rules-Based Indo-Pacific** as central to maintaining regional stability and freedom of navigation. **Eg: QUAD, Indo-Pacific Oceans Initiative, Maritime Domain Awareness.**
4. **Operational Synergy:** Regular tri-service and multilateral exercises have strengthened operational readiness, interoperability and joint response capabilities. **Eg: Yudh Abhyas, Tiger Triumph, Cope India, Malabar Exercise.**
5. **Collaboration in Emerging Security Domains:** Defence cooperation now extends beyond conventional military engagement to include cyber security, space, AI, critical technologies and resilient supply chains. **Eg: iCET and INDUS-X.**
6. **Trusted Strategic Partnership:** India and the US increasingly perceive each other as indispensable partners in ensuring a stable balance of power in the Indo-Pacific while respecting India's strategic autonomy. **Eg: India-US Joint Leaders' Statements (2023 & 2025).**

Why Defence Technology Collaboration Remains Limited?

1. **Reluctance to Share Critical Technologies:** The US continues to retain tight control over **high-end defence technologies** due to national security concerns and export-control regulations.
2. **Divergent Strategic Priorities:** India's doctrine of **Strategic Autonomy** contrasts with the US alliance-based security architecture, limiting exclusive defence technology partnerships.
3. **Buyer-Seller Relationship Dominance:** Defence engagement has largely centred on procurement of platforms rather than **joint design, co-development and IP sharing.**
4. **Export Control and Regulatory Constraints:** Stringent US export control laws, licensing procedures and end-use monitoring slow technology transfer and industrial collaboration. **Eg: ITAR (International Traffic in Arms Regulations).**
5. **Procurement and Policy Uncertainties:** Complex procurement procedures, offset policy changes and lengthy acquisition cycles discourage long-term technology partnerships. **Eg: Delays under the Defence Acquisition Procedure (DAP) and evolving offset policies.**
6. **Limited Joint R&D and Innovation:** Existing cooperation has not adequately translated into institutionalised joint research, testing and next-generation defence innovation. **Eg: iCET and INDUS-X** are promising but remain at an early stage of implementation.

Measures to Strengthen a Mutually Beneficial Defence Industrial Partnership

1. **Co-Development Ecosystem:** Shift the partnership towards **joint design, co-development and co-production** of next-generation defence platforms with equitable technology ownership. **Eg: Expand projects under the India-US Defence Industrial Cooperation Roadmap (2023).**
2. **Fast-track Critical Technology Collaboration:** Operationalise collaboration in **jet engines, aero-engines, AI, semiconductors, quantum technologies, cyber security and undersea systems** through time-bound implementation.
3. **Strengthen Defence Innovation and Industrial Ecosystem:** Leverage **INDUS-X** and **iCET** to promote collaboration among startups, MSMEs, academia and defence industries in frontier technologies.
4. **Integrate India into Global Defence Supply Chains:** Encourage US Original Equipment Manufacturers (OEMs) to localise manufacturing, component sourcing and Maintenance, Repair and Operations (MRO) facilities in India under **Make in India.**
5. **Trusted Technology Partnership:** Simplify export licensing, strengthen IPR protection and establish secure technology-sharing mechanisms to facilitate sensitive transfers. **Eg: Catalysing Opportunities for Military Partnership, Accelerated Commerce & Technology (COMPACT).**
6. **Collaborative Innovation:** Expand collaboration between **DRDO, DPSUs, Indian private industry and US defence firms** in hypersonics, space, autonomous systems and advanced materials.
7. **Institutionalise Long-Term Defence Industrial Dialogue:** Strengthen the **2+2 Ministerial Dialogue, Defence Technology and Trade Initiative (DTTI)** to resolve regulatory bottlenecks.

The true potential of India-US defence ties lies not in expanding arms trade, but in building a trusted ecosystem of co-development, co-production and co-innovation that strengthens India's strategic autonomy while advancing shared security interests.

14. One Nation, One Election (ONOE): Reforming India's Electoral Cycle

Syllabus Mapping: GS-2: Salient features of the Representation of People's Act; Functions and responsibilities of the Union and the States, issues and challenges pertaining to the federal structure.



India conducts elections almost every year across different levels of government, imposing significant administrative, financial and governance costs. Against this backdrop, **One Nation, One Election (ONOE)** seeks to synchronise elections to the Lok Sabha and State Legislative Assemblies, aiming to improve governance efficiency while preserving the democratic and federal character of the Constitution.

Transformative Potential of One Nation, One Election

1. **Electoral Synchronisation:** The Constitution originally witnessed **simultaneous elections (1952–1967)**; ONOE seeks to restore this synchronised electoral rhythm disrupted by premature dissolution of legislatures after **1967–70**.
2. **Electoral Externalities:** Frequent elections create recurring political mobilisation, prolonged Model Code of Conduct (MCC) enforcement and perpetual campaign politics. ONOE can minimise these unintended consequences while preserving democratic competition.
3. **Strengthening Deliberative Parliamentary Democracy:** A synchronised electoral calendar enables Parliament and State Legislatures to devote greater time to **law-making, financial scrutiny, Question Hour and committee oversight**, instead of functioning under continuous electoral pressure.
4. **Institutional Optimisation:** Synchronisation optimises the deployment of constitutional institutions such as the **Election Commission of India (ECI)**, security forces and civil administration, improving electoral management.
5. **Promoting Stable Democratic Mandates:** Fixed electoral cycles can provide governments with greater policy certainty and legislative continuity, reducing incentives for short-term electoral populism.
6. **Voter participation:** Staggered elections induce 'voters' fatigue' and present a significant challenge in ensuring their participation.

Constitutional, Federal and Operational Challenges

A. Constitutional Challenges

1. **Fixed Electoral Cycle vs Parliamentary Executive:** India's parliamentary system is based on **collective responsibility**, allowing governments to fall before completing their tenure. ONOE effectively moves towards a quasi-fixed tenure.
2. **Constitutional Amendability:** Implementing ONOE requires amendments to multiple constitutional provisions, many of which require **ratification by at least half of the States under Article 368**. Eg: **Kovind Committee (2024)** identified several constitutional amendments.
3. **Managing Mid-Term Dissolution:** The Constitution presently provides no permanent mechanism for maintaining synchronisation after a **hung House, no-confidence motion or coalition collapse**. Eg: **170th Law Commission Report** suggested a **Constructive Vote of No Confidence**.

B. Federal Challenges

1. **Federal Asymmetry:** Simultaneous elections may allow national political narratives to dominate State elections, weakening the distinct constitutional identity of States.
2. **Erosion of State-Specific Electoral Mandates:** State elections often revolve around local governance, regional aspirations and State-specific issues that may be overshadowed during simultaneous polls.
3. **Requirement of Broad Federal Consensus:** As ONOE affects the constitutional position of States, successful implementation requires extensive consultation and ratification under **Article 368**.

C. Operational Challenges

1. **Massive Electoral Logistics:** Simultaneous elections require an unprecedented scale of **EVMs, VVPATs, polling personnel, polling stations and Central Armed Police Forces**.
2. **Transition Cost:** Although ONOE may reduce long-term expenditure, the initial investment in electoral infrastructure and capacity-building would be substantial.
3. **Institutional Preparedness:** Conducting simultaneous elections across the Union and all States would significantly increase the complexity of planning, coordination and dispute resolution for the Election Commission.

Way Forward: Towards a Constitutionally Robust and Consensus-Based Implementation of ONOE

1. **Phased Electoral Synchronisation:** Instead of a "big bang" approach, synchronise elections in **phases** to minimise constitutional disruption and administrative burden, as per Kovind Committee
2. **Introduce a Constructive Vote of No Confidence:** Replace the existing no-confidence mechanism with a **Constructive Vote of No Confidence**, whereby a government can be removed only if an alternative government is simultaneously elected.
3. **Consensus Federalism:** Undertake extensive consultations with States, political parties, the Election Commission and constitutional experts to ensure consensus driven implementation.
4. **Undertake Comprehensive Constitutional Reforms:** Amend the relevant constitutional provisions governing the tenure and dissolution of legislatures while preserving the core features of **parliamentary democracy and federalism**.
5. **Safeguard the Federal Character of Elections:** Develop institutional safeguards to ensure that **State-specific issues receive adequate political space** and are not eclipsed by national campaigns.



6. **Institutional Preparedness:** Strengthen logistics under the **Election Commission's long-term electoral management plan**.

Eg: **High-Level Committee (2024)** highlighted phased procurement and infrastructure augmentation.

A balanced approach that reconciles electoral efficiency with constitutional safeguards, cooperative federalism and democratic accountability is essential for the successful implementation of One Nation, One Election.

15. Transforming India's Demographic Dividend Through Comprehensive Education Reforms

Syllabus Mapping: GS-2: Issues relating to development and management of Social Sector/Services relating to Education and Human Resources + GS-3: Inclusive growth and issues arising from it; Employment.

India is home to the world's largest youth population, with nearly 65% of its people below the age of 35. This demographic profile presents a unique opportunity to accelerate economic growth through a productive, skilled and knowledge-driven workforce. In this context, the quality and relevance of the education system assume critical importance.

Why Transforming India's Education System is Critical for Realising the Demographic Dividend

1. **Strengthening Human Capital Formation:** According to the **World Bank Human Capital Index**, a child born in India today is expected to achieve only **49% of her productive potential** due to gaps in health and education.
2. **Bridging the Learning Crisis:** Persistent foundational learning deficits reduce future employability, productivity and adaptability, making early learning reforms indispensable.
3. **Future-Ready Workforce:** Aligning education with industry requirements helps bridge the skill mismatch and prepares graduates for emerging sectors such as AI, semiconductors, green energy and advanced manufacturing.
4. **Leveraging the Demographic Window:** The **UNFPA State of World Population Report 2025** notes that India continues to have one of the world's largest youth populations, making investment in education and skills crucial.
5. **Innovation Ecosystem:** Higher education that promotes research, critical thinking and entrepreneurship strengthens India's transition towards an innovation-driven economy.
6. **Inclusive Human Development:** An inclusive education system reduces regional, gender and socio-economic disparities, ensuring that the demographic dividend benefits all sections of society.
7. **Improving Labour Force Participation:** Education that enhances employability, digital literacy and vocational competencies can improve workforce participation, particularly among women.

What Structural Challenges Continue to Constrain India's Education Ecosystem?

1. **Persistent Learning Deficit:** Despite higher enrolment, learning outcomes remain inadequate, particularly in foundational literacy and numeracy, weakening the quality of human capital. Eg: **ASER 2024:** Only **about 50% of Class V students** in government schools could read a Class II-level text, indicating persistent foundational learning gaps.
2. **Skill-Education Mismatch:** Curricula remain insufficiently aligned with evolving industry needs, resulting in low employability despite rising educational attainment.
3. **Inequitable Access to Quality Education:** Significant disparities persist across rural-urban regions, gender and socio-economic groups, limiting equitable human capital development.
4. **Inadequate Public Investment:** Limited investment in education constrains infrastructure, teacher capacity, research and digital learning ecosystems.
5. **Research Deficit:** Indian higher education institutions contribute relatively less to global research and innovation due to fragmented funding and limited academia-industry collaboration. Eg: India spends only **~0.65% of GDP** on Gross Expenditure on Research and Development (GERD), significantly below major innovation-driven economies.
6. **Inadequate Teacher Capacity :** Teacher shortages, uneven teacher quality and inadequate professional development adversely affect classroom outcomes. Eg: **UDISE+ 2023-24:** India has **over 10 lakh teacher vacancies** across school education, affecting pupil-teacher ratios and learning quality.

How Can India Build a Future-Ready Education System for Sustainable Human Capital Development?

1. **Universalise Foundational Literacy and Numeracy:** Prioritise early childhood education and achieve universal FLN to strengthen lifelong learning outcomes and reduce future learning poverty. Eg: **NIPUN Bharat Mission;**
2. **Align Education with Future Labour Market Needs:** Integrate vocational education, AI, coding, digital literacy and apprenticeships to bridge the education-employment gap. Eg: **NEP 2020** (50% vocational exposure)



3. **Strengthen Teacher Capacity and Learning Outcomes:** Invest in continuous teacher training, competency-based pedagogy and performance assessment to improve classroom quality. Eg: **National Professional Standards for Teachers (NPST)** under NEP 2020
4. **Build an Inclusive and Technology-Enabled Learning Ecosystem:** Expand digital infrastructure, multilingual content and assistive technologies to ensure equitable access to quality education. Eg: **PM SHRI Schools**.
5. **Promote Research, Innovation and Multidisciplinary Higher Education:** Strengthen universities as centres of research, innovation and entrepreneurship through greater autonomy and industry collaboration. Eg: Anusandhan National Research Foundation (ANRF) Act, 2023
6. **Increase Public Investment and Improve Governance:** Enhance education financing while ensuring transparent, outcome-based implementation through cooperative Centre-State action. Eg: **NEP 2020** recommends **6% of GDP** on education;
7. **Foster Industry-Academia Partnerships:** Institutionalise collaboration between educational institutions and industry for curriculum design, internships, apprenticeships and applied research. Eg: **Economic Survey 2024-25** emphasises stronger industry-academia linkages for improving employability.
8. **Lifelong Learning Ecosystem:** Shift from rote learning to competency-based education while promoting continuous upskilling and reskilling to meet evolving technological demands. Eg: **National Credit Framework (2023)** enables flexible learning pathways and lifelong education.

India's demographic dividend can become a lasting demographic advantage only through an education system that is equitable, skill-oriented and future-ready.

16. Strengthening India's Semiconductor Ecosystem: From Manufacturing to Technological Self-Reliance

Syllabus Mapping: GS-3: Science & Technology – Developments and their Applications; Indigenization of Technology; Industrial Policy; Investment Models; Infrastructure; Growth & Employment.

The global race for semiconductor leadership has redefined technological power in the twenty-first century. Against this backdrop, India is seeking to build a resilient semiconductor ecosystem to strengthen its position in the global technology landscape.

Why is Strengthening India's Semiconductor Ecosystem Critical?

1. **Ensuring Technological Sovereignty:** Semiconductors form the foundation of critical digital and strategic technologies. Domestic manufacturing reduces external dependence and enhances India's technological autonomy.
2. **Strengthening National Security:** Semiconductors are indispensable for defence electronics, secure communications, cyber infrastructure and space technologies, making trusted domestic manufacturing a strategic necessity.
3. **Building Economic Competitiveness:** A vibrant semiconductor industry can catalyse high-value manufacturing, attract global investments and integrate India into global electronics value chains. Eg: According to **India Semiconductor Mission**, India's semiconductor market is projected to reach **US\$100 billion by 2030**.
4. **Securing Digital and AI Leadership:** **IndiaAI Mission** and **Digital India** require advanced semiconductor capabilities, making chip manufacturing fundamental to India's digital transformation.
5. **Enhancing Supply Chain Resilience:** Recent global disruptions have demonstrated the risks of concentrated semiconductor production. Diversifying manufacturing strengthens India's resilience against geopolitical and economic shocks
6. **Innovation-led Industrialisation:** The semiconductor ecosystem creates high-skilled employment across chip design, fabrication, packaging, testing and research while fostering innovation-driven growth.

Structural Challenges in Developing India's Semiconductor Ecosystem

1. **Absence of Advanced Fabrication Ecosystem:** India lacks commercial wafer fabrication facilities and remains heavily dependent on imported chips for advanced technologies.
2. **Dependence on Foreign Technology:** Critical semiconductor manufacturing equipment, Electronic Design Automation (EDA) software and advanced process technologies remain concentrated among a few global players. Eg: Global semiconductor equipment is dominated by companies such as **ASML, Applied Materials and Lam Research**.
3. **Critical Mineral Vulnerability:** India remains highly dependent on imports of lithium, cobalt, gallium, germanium and rare earth elements essential for semiconductor manufacturing.
4. **Infrastructure and Utility Constraints:** Semiconductor fabs require uninterrupted electricity, ultra-pure water, specialised industrial infrastructure and world-class logistics.
5. **High Capital and Long Gestation Period:** Semiconductor manufacturing involves enormous upfront investments, technological obsolescence and long payback periods, discouraging private investment.
6. **Skilled Workforce Gap:** While India possesses strong chip design capabilities, shortages persist in fabrication engineering, materials science and advanced manufacturing skills.



Roadmap for Achieving Technological Self-Reliance in Semiconductors

1. **Develop an End-to-End Semiconductor Ecosystem:** Move beyond fabrication by strengthening chip design, fabrication, equipment manufacturing and semiconductor materials. Eg: **India Semiconductor Mission (ISM)** adopts a comprehensive ecosystem approach.
2. **Expand Semiconductor Manufacturing Capacity:** Fast-track semiconductor fabs and packaging facilities through fiscal incentives and streamlined approvals.
3. **Strengthen R&D and Indigenous Innovation:** Increase investment in semiconductor research, indigenous chip architecture and next-generation technologies. Eg: **Design Linked Incentive (DLI)** and collaboration with premier institutions.
4. **Build a Future-Ready Semiconductor Workforce:** Expand specialised education, industry-academia partnerships and fabrication-specific skill development programmes. Eg: **Semicon India Future Skills Talent Committee** and specialised semiconductor courses under **AICTE**.
5. **Deepen Strategic Technology Partnerships:** Leverage trusted international collaborations for technology transfer, resilient supply chains and joint innovation. Eg: **India-US Initiative on Critical & Emerging Technology (iCET)**, **QUAD Semiconductor Cooperation**.
6. **Ensure Stable Policy and Investment Support:** Provide long-term fiscal incentives, regulatory certainty and ease of doing business to attract global semiconductor investments. Eg: **Semicon India Programme (₹76,000 crore)** and Production Linked Incentive (PLI) framework.

Building a globally competitive semiconductor ecosystem is not merely an industrial objective but a strategic imperative for achieving technological sovereignty, economic resilience and national security, enabling India to emerge as a trusted hub in the global semiconductor value chain.

17. Global Governance of Artificial Intelligence: Shaping an Inclusive, Secure and Rules-Based AI Order

Syllabus Mapping: GS-2: International Relations – Global Governance, International Institutions & India's Interests

GS-3: Science & Technology – Artificial Intelligence & Emerging Technologies

Artificial Intelligence has emerged as a defining technology of the twenty-first century, reshaping economies, security and global influence. As nations increasingly compete not only to develop advanced AI systems but also to shape the rules governing their use, establishing an inclusive, secure and representative global AI governance framework has become a strategic imperative.

Why Does the World Need a Global AI Governance Framework?

1. **Transnational Governance:** Artificial Intelligence transcends national boundaries through cross-border data flows, cloud infrastructure and digital platforms, making unilateral regulation inadequate. Eg: The **UN Global Digital Compact (2024)** calls for strengthened international cooperation to govern emerging digital technologies.
2. **Responsible AI:** A common governance framework is essential to prevent algorithmic bias, protect privacy, ensure transparency and uphold human rights across jurisdictions. Eg: **UNESCO Recommendation on the Ethics of AI (2021)**—endorsed by **193 Member States**—lays down global ethical principles for AI.
3. **Collective AI Security:** The rapid proliferation of autonomous weapons, AI-enabled cyberattacks, deepfakes and disinformation has transformed AI into a transnational security concern requiring collective oversight. Eg: The **UN New Agenda for Peace (2023)** advocates international norms for the responsible military use of AI.
4. **Addressing Economic and Labour Market Disruptions:** AI is reshaping industries, employment and global value chains, requiring coordinated international policies for responsible innovation, workforce transition and inclusive economic growth. Eg: The **IMF (2024)** estimates that AI could affect **around 40% of global employment**.
5. **Preserving AI as a Global Public Good:** AI should contribute to sustainable development, healthcare, education and climate action rather than becoming an instrument of technological monopoly or strategic exclusion.
6. **Bridging the Global AI Divide:** An inclusive governance framework can ensure equitable access to AI infrastructure, compute capacity, datasets and talent, enabling developing countries to participate meaningfully in the AI revolution. Eg: India's **G20 New Delhi Leaders' Declaration (2023)** and **IndiaAI Mission** advocate **AI for All**.

What are the Key Challenges in Building an Inclusive, Secure and Rules-Based AI Order?

1. **Regulatory Fragmentation:** Divergent national AI regulations create legal uncertainty, increase compliance costs and hinder cross-border innovation, trade and interoperability. Eg: The **EU AI Act**, **US AI Action Plan**, and **China's AI Regulations** reflect contrasting governance philosophies.
2. **Intensifying AI Geopolitics:** The strategic rivalry between major powers has transformed AI into an arena of technological competition, with countries competing over chips, compute, frontier models and global rule-making. Eg: US restrictions on advanced AI chip exports



3. **Compute Inequality:** The concentration of computing infrastructure, advanced semiconductors, datasets and AI capabilities among a few countries risks excluding developing economies from the AI revolution.
4. **Weak Cross-Border Data Governance:** Differences in data protection laws, cross-border data transfer rules and digital sovereignty concerns impede international AI collaboration. Eg: Contrasting approaches under the **EU GDPR**, **India's DPDP Act, 2023**, etc.
5. **Algorithmic Bias and Accountability Deficit:** Opaque AI systems trained on biased datasets can reinforce discrimination while making it difficult to assign responsibility for AI-driven decisions.
6. **AI Oligopoly:** A handful of countries and technology firms dominate advanced AI models, high-performance computing, semiconductor manufacturing and AI research talent, creating structural inequalities.
7. **Institutional Vacuum:** Unlike climate change or international trade, AI lacks a universally accepted multilateral institution capable of setting common standards, resolving disputes and ensuring equitable participation.

How Can the International Community Build an Inclusive, Secure and Rules-Based AI Order?

1. **Establish a UN-Led Global AI Governance Framework:** Create an inclusive multilateral institutional mechanism under the UN to coordinate AI norms, facilitate policy dialogue, resolve disputes and ensure equitable participation of all countries. Eg: Build upon the recommendations of the **UN High-Level Advisory Body on AI (2024)**.
2. **Develop Universally Accepted Ethical Principles:** Adopt common global principles on transparency, fairness, accountability, privacy, explainability and human rights to guide responsible AI development and deployment. Eg: **UNESCO Recommendation on the Ethics of AI (2021)** and the **OECD AI Principles** provide a globally accepted normative foundation.
3. **Adopt Adaptive and Risk-Based Regulation:** Shift from one-size-fits-all regulation to a proportionate, risk-based approach that balances innovation with safety, focusing stricter oversight on high-risk AI systems.
4. **Negotiate a Global AI Framework or Treaty:** Develop an international legal framework to govern frontier AI, autonomous weapons, cross-border data use and AI safety through shared rules and accountability mechanisms. Eg: The **Bletchley Declaration (2023)** and subsequent **AI Safety Summits** have laid the groundwork for coordinated global action.
5. **Collaborative AI Ecosystem:** Promote collaborative AI research, trusted semiconductor supply chains, compute-sharing mechanisms and global talent partnerships to reduce technological asymmetries.
6. **AI Equity:** Strengthen access to computing infrastructure, datasets, digital public infrastructure, financing and AI skills to ensure that developing countries can participate meaningfully in the AI ecosystem. Eg: The **UN Global Digital Compact (2024)** advocates capacity building and equitable access to AI for developing economies.

The future of AI will be determined not merely by technological breakthroughs, but by the strength of the global institutions and norms that govern them. A rules-based, inclusive and human-centric AI order is essential to ensure that AI remains a force for shared prosperity rather than strategic division.

18. Revisiting the Anti-Defection Law: Balancing Political Stability with Legislative Accountability

Syllabus Mapping: GS-2: Parliament, State Legislatures, Constitutional Bodies, Representation of People.

Recent constitutional disputes over defections in **Maharashtra** and **Telangana**, coupled with repeated Supreme Court scrutiny of the Speaker's role, have reignited the debate on the effectiveness of India's Anti-Defection Law. While the **Tenth Schedule**, introduced through the **52nd Constitutional Amendment Act, 1985**, succeeded in promoting political stability, its operation has increasingly raised concerns over legislative autonomy, institutional neutrality and democratic accountability.

How has the Anti-Defection Law strengthened India's parliamentary democracy?

1. **Ensures Stability of Elected Governments:** The Anti-Defection Law prevents opportunistic floor-crossing, reducing the risk of abrupt government collapse and ensuring continuity in governance and policy implementation.
2. **Protects the Electoral Mandate:** By discouraging post-election shifts in political allegiance, the law preserves the mandate entrusted by voters and prevents its distortion through legislative defections.
3. **Reinforces the Principle of Responsible Government:** Stable legislative support enables the Council of Ministers to function effectively under the doctrine of **Collective Responsibility**, ensuring executive accountability to the legislature.
4. **Deters Horse-Trading and Political Corruption:** The law discourages legislators from changing party allegiance for ministerial office, financial inducements or political patronage, thereby promoting ethical governance. Eg: **Recent Example:** Political developments in **Karnataka (2019)** and **Madhya Pradesh (2020)** highlighted concerns over inducement-based defections.
5. **Institutional Legitimacy:** By discouraging unprincipled defections, the law seeks to reinforce citizens' confidence in the integrity and credibility of elected representatives and democratic institutions.
6. **Upholds Constitutional Morality:** The law seeks to ensure that political power is exercised through constitutional processes rather than opportunistic political bargaining.



Why Has the Existing Anti-Defection Framework Come Under Constitutional Scrutiny?

1. **Institutional Bias in the Adjudicatory Process:** The Speaker, despite performing a quasi-judicial function under the Tenth Schedule, has allegedly remained a political actor, raising concerns over impartiality and institutional credibility. Eg: In **Keisham Meghachandra Singh v. Speaker, Manipur Legislative Assembly (2020)**, the Supreme Court suggested that Parliament reconsider entrusting the Speaker with adjudicatory powers.
2. **Procedural Accountability:** The absence of a constitutional or statutory timeline allows prolonged delays in deciding disqualification petitions, often altering political outcomes before legal scrutiny is completed. Eg: In the **Telangana MLA defection case (2025)**, the Supreme Court directed the Speaker to decide pending petitions within a stipulated timeframe after prolonged inaction.
3. **Collective Defection:** The exception permitting mergers by two-thirds of a legislature party has often legitimised collective defections, undermining the objective of curbing political opportunism. Eg: The **Maharashtra political crisis (2022–23)** highlighted controversies surrounding legislative mergers, party identity and the operation of the Tenth Schedule.
4. **Weakening Deliberative Parliamentary Democracy:** The fear of disqualification discourages legislators from expressing dissent or voting according to conscience, thereby weakening Parliament's deliberative role and executive oversight.
5. **Circumvention Through Engineered Resignations:** Political actors increasingly resort to mass resignations instead of formal defections, achieving the same political outcome while escaping the operation of the Tenth Schedule. Eg: **Madhya Pradesh (2020)** demonstrated how governments can be reshaped through coordinated resignations rather than direct defections.
6. **Judicialisation of Legislative Processes:** Frequent intervention by constitutional courts in defection disputes indicates institutional failure within the legislative framework and raises concerns regarding the separation of powers.

Towards a More Accountable and Deliberative Anti-Defection Framework

1. **Ensure Independent and Impartial Adjudication:** as recommended by the **Dinesh Goswami Committee (1990)**, transfer the power to decide defection petitions from the Speaker to an independent constitutional authority or tribunal to eliminate perceptions of political bias and strengthen institutional credibility.
2. **Procedural Certainty:** During the **Telangana defection case (2025)**, the Supreme Court stressed the need for expeditious disposal of pending petitions.
3. **Legislative Independence:** Limit binding whips to votes affecting the survival of the government—such as **Confidence Motions, No-Confidence Motions and Money Bills**—while permitting legislators to vote freely on ordinary legislation.
4. **Institutionalise Inner-Party Democracy:** The **255th Law Commission Report (2015)** advocated strengthening internal democracy as a prerequisite for meaningful legislative accountability.
5. **Anti-Circumvention Framework:** Review the merger provision under the Tenth Schedule to prevent its misuse for legitimising organised defections that undermine the spirit of the law.
6. **Reinforce Electoral Accountability:** Require legislators who voluntarily change party affiliation to resign and seek a fresh electoral mandate, thereby restoring the primacy of voter consent.
7. **Codify Clear Standards under the Tenth Schedule:** Define objective criteria for terms such as 'voluntarily giving up membership', mergers and whip violations to minimise ambiguity and reduce avoidable litigation.
8. **Ethical Constitutionalism:** Legal reforms should be complemented by stronger political ethics, respect for constitutional conventions and a parliamentary culture that values informed debate over partisan conformity.

The Anti-Defection Law must evolve from merely protecting governments to strengthening parliamentary democracy. A constitutional framework that balances political stability with legislative independence can preserve the true spirit of the Tenth Schedule.

19. Interlinking of Rivers in India: Balancing Water Security, Ecological Sustainability and Cooperative Federalism

Syllabus Mapping: GS-1/2/3: Water resource management, Centre–State relations, environmental conservation and sustainable development.

India's growing water demand, recurring floods in some regions and persistent droughts in others have brought river interlinking to the forefront of water resource management. While it offers significant potential for enhancing water security, its implementation must balance ecological sustainability and cooperative federalism.

How Can River Interlinking Contribute to India's Water, Food and Energy Security?

1. **Water Security:** River interlinking facilitates the transfer of water from **water-surplus to water-deficit basins**, reducing regional disparities in water availability and improving long-term water security. Eg: India possesses nearly **18% of the world's population but only about 4% of global freshwater resources**, highlighting the need for efficient spatial redistribution of water.



2. **Improving Agricultural and Food Security:** Assured irrigation through river interlinking can reduce dependence on erratic monsoons, enhance cropping intensity and improve agricultural productivity. Eg: Agriculture consumes nearly **80% of India's freshwater withdrawals**, while around **half of India's net sown area remains rain-fed**, underscoring the need for reliable irrigation.
3. **Hydrological Balancing:** Interlinking can moderate hydrological extremes by diverting excess monsoon flows from flood-prone basins to drought-prone regions, thereby reducing disaster risks. Eg: The **National Perspective Plan (NWDA)** was conceived to address the twin challenges of recurrent floods and droughts through basin-level water transfers.
4. **Augmenting Renewable Energy Security:** Multipurpose river-link projects incorporating reservoirs and canals can facilitate hydropower generation, supporting India's clean energy transition. Eg: The **Ken–Betwa Link Project**, India's first river-link project under implementation, also includes hydropower generation as one of its objectives.
5. **Promoting Regional and Rural Development:** Improved irrigation, drinking water supply and allied infrastructure can stimulate rural livelihoods, reduce regional disparities and strengthen socio-economic development. Eg: The **Ken–Betwa Project** is expected to provide drinking water to **over 6 million people** and irrigation benefits across the drought-prone **Bundelkhand** region.
6. **Boosting Inland Water Transport and Logistics:** Reservoirs and navigable canals developed under selected river-link projects can improve inland connectivity, reduce logistics costs and support low-carbon freight movement.

Why Does River Interlinking Continue to Face Ecological, Economic and Federal Challenges?

Ecological Challenges

1. **Disruption of Riverine Ecology:** River interlinking alters the natural flow regime of rivers by modifying seasonal discharge patterns, sediment transport and nutrient cycles, thereby affecting the ecological balance of aquatic ecosystems. Eg: The **National Green Tribunal (NGT)** has repeatedly stressed the importance of maintaining **Environmental Flows (E-Flows)** to preserve river health.
2. **Threat to Biodiversity and Protected Areas:** The **Ken–Betwa River Link Project** involves diversion of forest land within the **Panna Tiger Reserve**, raising concerns over habitat fragmentation and biodiversity conservation.
3. **Climate and Hydrological Uncertainty:** The concept of 'surplus' and 'deficit' rivers is increasingly questioned as climate change alters monsoon patterns, glacier melt and river flows, making long-term water availability uncertain. Eg: the **Mihir Shah Committee (2016)** advocated basin-wise scientific assessment instead of static surplus-deficit classifications.

Economic Challenges

1. **Economic Sustainability:** high capital costs and long gestation periods raises concerns over fiscal sustainability and cost-effectiveness. Eg: The **Ken–Betwa River Link Project** is estimated to cost **over ₹44,000 crore**.
2. **Displacement and Livelihood Losses:** Construction of reservoirs and canals necessitates large-scale land acquisition, often leading to displacement of local and tribal communities, disruption of livelihoods and complex rehabilitation challenges.
3. **Opportunity Cost of Mega Water Infrastructure:** Excessive focus on large inter-basin transfer projects may divert financial and administrative resources away from decentralised solutions like watershed development, rainwater harvesting, groundwater recharge.

Federal Challenges

1. **Intensification of Inter-State Water Disputes:** River interlinking requires consensus among multiple riparian States. Eg: Disagreements surrounding long-standing disputes over the **Cauvery** and **Krishna** rivers.
2. **Hydro-Diplomacy:** Several proposed links involve international river basins, requiring India to balance domestic water requirements with treaty obligations and diplomatic sensitivities involving neighbouring countries. Eg: The Teesta river dispute between India and Bangladesh.
3. **Fragmented Institutional and Basin Governance:** Water governance in India remains divided across multiple ministries, States and agencies, leading to coordination deficits in planning, environmental clearances and project implementation.

Towards a Sustainable and Cooperative River Interlinking Framework

1. **Basin-Based Integrated Water Resources Management (IWRM):** River interlinking should be planned at the **river basin level** by integrating surface water, groundwater, ecological requirements and land-use planning instead of treating rivers as isolated engineering entities. Eg: National Water Policy 2012.
2. **Strengthen Cooperative Federalism:** Permanent **River Basin Organisations (RBOs)** should facilitate joint planning, data sharing, benefit-sharing and dispute resolution among riparian States, replacing ad hoc negotiations.
3. **Institutionalise Scientific Environmental Safeguards:** Every project should mandate **Environmental Flows (E-Flows)**, cumulative Environmental Impact Assessment (EIA) and biodiversity conservation measures to protect riverine ecosystems. Eg: The **National Green Tribunal (NGT)** has consistently emphasised maintaining **Environmental Flows** for sustainable river management.



4. **Integrate Climate-Resilient Water Planning:** River-link projects should incorporate climate projections, changing monsoon patterns and adaptive reservoir operations to ensure long-term water security under climate uncertainty.
5. **Water Use Efficiency:** The **Mihir Shah Committee (2016)** advocated demand-side management before large-scale inter-basin transfers.
6. **Ensure Scientific Cost–Benefit and Social Impact Assessment:** the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 mandates **Social Impact Assessment** for projects involving land acquisition.
7. **Collaborative Federalism:** Local communities, Gram Panchayats, farmers and indigenous groups should be involved in planning, implementation and monitoring.

A balanced approach that integrates science, sustainability and consensus-building can transform river interlinking from an engineering project into a sustainable development initiative.

UPSC PYQs: 1. [UPSC 2020] The interlinking of rivers can provide viable solutions to the multi-dimensional inter-related problem of droughts, floods and interrupted navigation. Critically examine.

2.[UPSC 2017] Not many years ago, river linking was a concept but it is becoming reality in the country. Discuss the advantages of river linking and its possible impact on the environment.

20. Reforming the WTO: Balancing Multilateral Consensus with Emerging Plurilateral Agreements

Syllabus Mapping: GS-2/3: Important international institutions, international relations, inclusive economic growth and global trade governance.

Established under the **Marrakesh Agreement (1995)**, the World Trade Organization (WTO) has been the cornerstone of the rules-based multilateral trading system. But due to rising geopolitical tensions, technological transformation and prolonged negotiating deadlocks have intensified calls for WTO reform while simultaneously accelerating the emergence of plurilateral agreements among willing members.

Why Has WTO Reform Become Imperative?

1. **Strengthening Institutional Credibility:** Persistent institutional deadlocks have weakened confidence in multilateral trade governance and encouraged countries to pursue alternative arrangements.
2. **Reviving an Effective Dispute Settlement Mechanism:** A credible dispute settlement system is essential for ensuring predictability and legal certainty in international trade. The paralysis of the Appellate Body has undermined the enforceability of WTO obligations. Eg: The WTO Appellate Body has remained non-functional due to vacancies, with the last sitting member's term ending in **November 2020**
3. **Outdated Trade Rules for the Digital Economy:** Existing WTO agreements were negotiated before the emergence of digital trade, cross-border data flows and platform-based commerce. Contemporary trade increasingly requires rules governing e-commerce and digital services.
4. **Negotiation Deadlocks:** The consensus-based decision-making process safeguards inclusiveness but has often slowed negotiations, making it difficult to conclude agreements on contemporary trade issues.
5. **Balancing Developmental Interests of Developing Countries:** Developing economies seek greater policy space to pursue industrialisation, food security and structural transformation while integrating into global value chains.
6. **Responding to Emerging Global Trade Challenges:** Climate policies, industrial subsidies, supply chain resilience and economic security have transformed the global trade landscape, requiring updated institutional responses.

Challenges in Balancing Multilateral Consensus with Emerging Plurilateral Agreements

1. **Erosion of the Consensus-Based Multilateral Framework:** While plurilateral agreements facilitate faster negotiations among interested members, they risk bypassing the WTO's consensus principle, weakening the legitimacy of multilateral rule-making.
2. **Fragmentation of Global Trade Rules:** Multiple Joint Statement Initiatives (JSIs) on issues such as e-commerce and investment facilitation may create overlapping regulatory frameworks, increasing compliance costs and reducing uniformity in global trade rules.
3. **Weakening the Inclusiveness of the WTO:** Plurilateral negotiations often involve only willing members, raising concerns that smaller and least-developed countries may have limited influence in shaping future trade norms.



4. **Dilution of Special and Differential Treatment (S&DT):** Many developing countries fear that issue-specific plurilateral agreements could gradually weaken the long-standing principle of Special and Differential Treatment, limiting their policy space for development.
5. **Marginalisation of Developing Country Priorities:** The growing emphasis on digital trade, investment and environmental standards may divert attention from unresolved issues such as agricultural subsidies, public stockholding and food security.
6. **Unequal Negotiating Capacity:** Developed economies possess greater technical expertise and institutional capacity, enabling them to shape emerging trade rules more effectively than many developing and least-developed countries.
7. **Absence of an Operational Appellate Body:** Even if new agreements are negotiated, the absence of a fully functioning appellate mechanism undermines confidence in dispute resolution and rule enforcement.

Towards a More Effective, Inclusive and Future-Ready WTO

1. **Rule-Based Dispute Resolution:** A credible dispute settlement mechanism is indispensable for preserving the WTO's rules-based trading system. Adopt the pending Multi-Party Interim Appeal Arbitration Arrangement (MPIA)
2. **Promoting Flexible Multilateralism:** Plurilateral agreements should remain **open, transparent and voluntary**, enabling broader participation without undermining the multilateral character of the WTO.
3. **Reaffirm Special and Differential Treatment (S&DT):** Reforms should continue to provide adequate policy space for developing and least-developed countries while promoting their meaningful integration into global trade.
4. **Building a Future-Ready Rulebook:** The WTO should develop transparent and predictable rules on e-commerce, digital trade and cross-border data flows while respecting members' regulatory autonomy.
5. **Strengthen Transparency and Institutional Accountability:** Timely notifications, stronger committee oversight and digital reporting mechanisms can improve compliance, reduce disputes and enhance trust among members. Eg: WTO members are pursuing "Reform by Doing" initiatives to improve the day-to-day functioning of WTO bodies.
6. **Resolving Legacy Development Issues:** Issues relating to agricultural subsidies, public stockholding and food security should be resolved alongside negotiations on emerging trade issues to maintain the legitimacy of the multilateral system.
7. **Fostering Inclusive Capacity Building:** Technical assistance, digital infrastructure and trade facilitation support can enable developing economies to participate more effectively in future trade negotiations.
8. **Strengthening Policy Coherence:** The WTO should strengthen collaboration with institutions such as the IMF, World Bank and UNCTAD to address cross-cutting challenges relating to trade, development and climate resilience.

The future relevance of the WTO lies not in replacing multilateralism with plurilateralism, but in making multilateralism more responsive, inclusive and effective.

21. US–Saudi Nuclear Cooperation: Implications for West Asian Geopolitics, Nuclear Non-Proliferation and India's Strategic Interests

Syllabus Mapping: GS-2/3: India and its neighbourhood & international relations, international institutions, nuclear policy, energy security and strategic interests.

The **2026 US–Saudi Civil Nuclear Agreement (123 Agreement)** marks a significant shift in American nuclear diplomacy by moving away from the traditional "gold standard" followed in the 2009 US–UAE agreement, which prohibited uranium enrichment and spent-fuel reprocessing. The agreement has revived debates on nuclear non-proliferation, regional security and strategic competition in West Asia.

Strategic Implications of the Agreement

Regional Stability

1. **Intensifying Saudi–Iran Rivalry:** Saudi Arabia's enhanced nuclear capabilities may reinforce Iran's perception of strategic encirclement, further complicating efforts to de-escalate regional tensions.
2. **Israel's Security Calculus:** Israel has traditionally opposed the spread of sensitive nuclear technologies in the region. The possibility of Saudi uranium enrichment has therefore generated security concerns despite improving Arab–Israeli engagement under the Abraham Accords.
3. **Regional Arms Competition:** If Saudi Arabia acquires advanced fuel-cycle capabilities, other regional powers may seek comparable arrangements, increasing the risk of competitive nuclear hedging rather than immediate weaponisation.

Nuclear Governance

1. **NPT Credibility:** The agreement tests the credibility of the **Nuclear Non-Proliferation Treaty (NPT)** by balancing a country's right to peaceful nuclear energy with the need to prevent the spread of sensitive nuclear technologies.



2. **Enrichment Rights:** Saudi Arabia's demand for **domestic uranium enrichment** is contentious because the same technology used for civilian purposes can potentially be diverted for military use.
3. **Nuclear Hedging:** Advanced nuclear infrastructure can provide a country with a **latent nuclear capability**—the ability to develop nuclear weapons quickly if strategic circumstances change.
4. **Selective Exceptionalism:** Relaxation of long-standing non-proliferation conditions for strategic partners may encourage demands for similar treatment by other states, potentially weakening the universality of global nuclear norms.
5. **Proliferation Cascade:** If multiple states pursue indigenous enrichment capabilities in response, the cumulative effect could undermine long-term regional and global non-proliferation objectives.

India's Strategic Calculus

Strategic Interests

1. **Energy Security:** Closer US–Saudi cooperation could contribute to greater stability in global energy markets, ensuring reliable crude oil supplies during India's energy transition.
2. **Connectivity Initiatives:** A more stable regional environment can accelerate projects such as the **India–Middle East–Europe Economic Corridor (IMEC)**, strengthening India's trade links with Europe through West Asia.
3. **Investment & Technology:** Saudi Arabia's economic transformation under **Vision 2030** offers opportunities for Indian companies in infrastructure, renewable energy, digital technologies and advanced manufacturing.

Strategic Challenges

1. **Regional Instability:** Escalation of Saudi–Iran or Israel–Iran tensions could threaten regional peace, affecting India's strategic interests across West Asia.
2. **Energy Price Volatility:** Any deterioration in Gulf security may disrupt energy supplies through the **Strait of Hormuz**, leading to higher oil prices and inflationary pressures on India's economy.
3. **Diaspora Security:** Nearly **9 million Indians** reside in the Gulf region. Any military escalation could necessitate large-scale evacuation operations similar to **Operation Raahat (Yemen, 2015)** or **Operation Ajay (Israel–Hamas conflict, 2023)**.
4. **Strategic Balancing:** India must preserve its close strategic partnerships with **Saudi Arabia, Israel and Iran** simultaneously without compromising its policy of strategic autonomy.
5. **Maritime Security:** Increased geopolitical tensions could threaten commercial shipping through the **Strait of Hormuz** and the **Bab-el-Mandeb**, both critical for India's trade and energy imports.
6. **Regional Nuclear Competition:** The spread of sensitive nuclear technologies in India's extended neighbourhood may increase strategic uncertainty and complicate India's long-term security planning.

Policy Response

1. **Balanced Engagement:** Continue pursuing **multi-alignment**, strengthening partnerships with Saudi Arabia, Israel, Iran and the GCC without becoming part of competing regional blocs.
2. **Responsible Nuclear Cooperation:** Support the peaceful use of nuclear energy while insisting that all civilian nuclear programmes remain subject to comprehensive **IAEA safeguards** and transparency measures.
3. **Strengthen Regional Platforms:** Deepen engagement through **I2U2, IMEC, the India–Saudi Strategic Partnership Council and India–GCC cooperation** to enhance regional connectivity and economic resilience.
4. **Support Non-Proliferation:** Advocate a rules-based global nuclear order that balances countries' legitimate developmental aspirations with robust safeguards against proliferation.
5. **Promote Regional Dialogue:** Encourage confidence-building measures and diplomatic engagement among regional stakeholders to reduce strategic mistrust and prevent an arms race.

The agreement reflects the growing convergence of geopolitics, nuclear technology and energy security in an increasingly multipolar world. For India, the challenge lies in balancing strategic autonomy, energy security and regional partnerships while supporting a credible, inclusive and rules-based global nuclear order.

22. Artificial Intelligence and Quantum Computing: Transforming India's Healthcare Ecosystem

Syllabus Mapping: GS-2/3: Health, Science & Technology, Digital Health, Emerging Technologies and Inclusive Development.

Despite transformative initiatives such as **Ayushman Bharat**, **Ayushman Bharat Digital Mission (ABDM)** and **eSanjeevani**, India's healthcare system continues to face persistent challenges of accessibility, affordability and quality. In this context, the convergence of **Artificial Intelligence (AI)** and **Quantum Computing** offers a transformative opportunity to build a more predictive, personalised and patient-centric healthcare ecosystem.

Why Does India's Healthcare System Continue to Face Accessibility, Affordability and Quality Challenges?



1. **Healthcare Accessibility:** Uneven distribution of healthcare infrastructure and specialists limits equitable healthcare access.
2. **Rural-urban Divide:** Primary healthcare facilities often suffer from poor physical connectivity, inadequate diagnostics and workforce shortages, compelling rural populations to depend on distant tertiary hospitals or private providers.
3. **Healthcare Affordability:** High out-of-pocket expenditure continues despite expanding public health insurance coverage.
4. **Health Workforce Gap:** Shortage of doctors, nurses and specialists undermines service delivery capacity. Eg: WHO benchmark: **44.5 health workers/10,000 population**
5. **Disease Burden:** Triple burden of communicable, non-communicable and emerging infectious diseases.
6. **Quality of Care:** Delayed diagnosis and uneven clinical standards reduce treatment effectiveness.

AI-Quantum Convergence: Transforming India's Healthcare

1. **Accelerated Drug Discovery:** AI can rapidly identify promising drug candidates by analysing large biomedical and genomic datasets, while quantum computing can simulate complex molecular interactions that are beyond the capabilities of classical computers. This can significantly reduce the time and cost of developing new drugs and vaccines, particularly for complex diseases.
2. **Precision Healthcare:** Integrates genomic and clinical data to enable personalised treatment for cancer, rare and genetic diseases.
3. **Predictive Diagnostics:** AI-powered analysis of medical imaging, pathology slides and electronic health records can improve diagnostic accuracy, while quantum-enhanced machine learning can identify subtle disease patterns that conventional algorithms may overlook. This enables earlier detection of tuberculosis, cancers, cardiovascular diseases and diabetic retinopathy.
4. **Public Health Intelligence:** Strengthens disease surveillance, outbreak prediction and pandemic preparedness through advanced data modelling.
5. **Healthcare Accessibility:** AI-enabled telemedicine, multilingual virtual assistants and clinical decision-support systems can bridge the shortage of specialists in rural and underserved areas by empowering frontline health workers and strengthening primary healthcare delivery
6. **Smart Healthcare Systems:** AI and quantum-enabled analytics can optimise hospital resource allocation, ICU bed management, supply chains and patient flow, improving operational efficiency while reducing waiting time and healthcare costs.

What are the Challenges in Leveraging AI-Quantum Convergence in Healthcare?

1. **Technological Readiness:** Quantum computing remains nascent with limited scalability and prohibitively high infrastructure costs.
2. **Data Ecosystem:** Fragmented health records and poor interoperability undermine AI model accuracy and reliability.
3. **Digital Divide:** Unequal digital infrastructure limits AI-enabled healthcare adoption in rural and remote areas.
4. **Ethical Governance:** Privacy risks, algorithmic bias and opaque AI models raise ethical concerns.
5. **Regulatory Vacuum:** India does not yet have a comprehensive sector-specific regulatory framework governing AI deployment in healthcare.
6. **Institutional Capacity:** Limited AI-health workforce, indigenous R&D and computing infrastructure constrain innovation.
7. **Cybersecurity Risks:** Digitised health systems increase vulnerability to cyberattacks and data breaches.

Towards an AI-Driven, Quantum-Enabled Healthcare Ecosystem

1. **Digital Health Infrastructure:** Strengthen **Ayushman Bharat Digital Mission (ABDM)** by ensuring interoperable Electronic Health Records (EHRs), standardised health datasets and nationwide digital health integration.
2. **Responsible AI Governance:** Develop a comprehensive regulatory framework for AI in healthcare covering **clinical validation, explainability, algorithmic accountability, liability and patient safety.**
3. **Quantum Research Ecosystem:** Accelerate indigenous quantum computing capabilities through the **National Quantum Mission**, focusing on healthcare applications such as drug discovery, genomics and molecular simulation.
4. **Data Governance:** Create high-quality, anonymised and interoperable national health datasets while ensuring robust privacy, cybersecurity and informed consent mechanisms.
5. **Innovation Ecosystem:** Promote academia-industry-startup collaboration for indigenous AI-health solutions through research grants, medical innovation clusters and regulatory sandboxes.
6. **Inclusive Healthcare Delivery:** Leverage AI-powered telemedicine, multilingual digital health assistants and clinical decision-support systems to bridge rural-urban healthcare disparities.



The convergence of AI and Quantum Computing has the potential to shift India's healthcare paradigm from **reactive treatment to predictive, preventive and personalised care**. These technologies can become key enablers of **accessible, affordable and quality healthcare**, accelerating India's journey towards **Universal Health Coverage and Viksit Bharat 2047**.

23. Reforming India's Public Examination System: Ensuring Transparency, Integrity and Public Trust

Syllabus Mapping: GS-2: Governance, Transparency & Accountability, Education, Public Institutions and E-Governance.

Public examinations are the cornerstone of merit-based recruitment and educational mobility in India. But, repeated incidents of paper leaks, impersonation and organised examination fraud have exposed structural vulnerabilities in the examination ecosystem, raising serious concerns over transparency, fairness and institutional credibility.

Challenges in India's Public Examination System

1. **Institutional Capacity:** The rapid expansion of large-scale examinations has outpaced the institutional capacity of examination agencies, leading to operational vulnerabilities. Eg: The **K. Radhakrishnan Committee (2024)** observed that the NTA conducted over 240 examinations involving 5.4 crore candidates since its inception, stretching existing institutional capacity.
2. **Meritocracy at Risk:** Examination irregularities distort fair competition by rewarding unfair practices over genuine merit.
3. **Testing Lifecycle Vulnerabilities:** Security gaps persist across the entire **testing lifecycle**—from question paper setting and printing to storage, transportation, candidate verification and grievance redressal.
4. **Institutional Fragmentation:** Multiple examination agencies operate with varying standards, protocols and security frameworks, resulting in inconsistent governance and weak institutional coordination.
5. **Technology & Cybersecurity Gaps:** Dependence on physical transportation of question papers, weak cybersecurity and inadequate digital safeguards expose examinations to organised fraud and cyber threats.
6. **Infrastructure Deficit:** Limited availability of secure government examination centres and overdependence on private centres increase operational and security risks.
7. **Emerging Examination Risks:** Traditional examination systems are inadequately equipped to address evolving threats such as AI-enabled cheating, organised impersonation and sophisticated digital fraud.
8. **Legal & Enforcement Gaps:** Delayed investigations and weak coordination among examination authorities and law enforcement reduce deterrence against organised examination crime.

Towards a Credible and Future-Ready Public Examination Ecosystem (Recommendations of K. Radhakrishnan Committee)

Technological Reforms

1. **Secure Digital Architecture:** Adopt a **Zero-Trust Cybersecurity Architecture**, ensuring continuous authentication and encryption across every stage of the examination lifecycle.
2. **AI-Enabled Examination Management:** Committee proposed **AI-powered malpractice detection** and **AI-enabled Grievance Redressal System**.
3. **Adaptive Assessment:** Gradually transition towards **Computer Adaptive Testing (CAT)** and multi-session examinations for large-scale recruitment and entrance tests.
4. **Intranet-Based Localized CBTs (Air-Gapping):** Exam center servers must be strictly air-gapped (disconnected from the global internet) during the exam window, operating entirely on a localized Intranet to block external remote-access interventions.

Institutional Reforms

1. **Professional Examination Agencies:** Ending the "Asset-Light" NTA Model: The government must build sovereign digital testing infrastructure by upgrading state-owned institutions (Kendriya Vidyalayas, IITs, NITs, and AICTE-approved public colleges) into dedicated testing hubs. Eg: Committee recommended restructuring the NTA into a "nimble, zero-error and adaptive organisation."
2. **Secure Testing Infrastructure:** Develop a nationwide network of **Secure Testing Centres (STCs)** with standardised infrastructure, surveillance systems and cybersecurity protocols. Eg: Recommendation to establish **1,000 Secure Testing Centres** across reputed government institutions.
3. **Mandatory STQC Certification:** Any private vendor or digital center empaneled for public exams must undergo mandatory auditing by the Standardisation Testing and Quality Certification (STQC) Directorate (under MeitY) to ensure compliance with international cybersecurity standards (ISO 27001).
4. **Administrative Capacity:** Strengthen technical capacity of officials through regular training in cybersecurity, digital assessment and examination management.



Governance Reforms

1. **End-to-End Examination Integrity:** Secure the entire examination lifecycle—from question setting to evaluation—through standard operating procedures and continuous monitoring. Committee emphasised securing the complete **Testing Lifecycle**.
2. **Transparent & Accountable Governance:** Institutionalise third-party audits, time-bound grievance redressal, public disclosure of examination protocols and independent performance reviews.
3. **Integrated Risk Management:** Strengthen coordination among examination agencies, States, law enforcement and cybersecurity agencies to tackle organised examination fraud. Committee recommended **State & District Coordination Committees** and **multi-layered risk management**.

Legal Reforms

1. **Effective Enforcement:** through time-bound investigation and prosecution. The proposed amendment to Public Examination (Prevention of Unfair Means) Act prescribes imprisonment up to **10 years** and fines up to **₹10 crore** for organised examination fraud.
2. **Regulatory Oversight:** Develop uniform national standards for examination security, digital protocols and accreditation of testing agencies. Committee recommended an **empowered Apex Body** for examination governance.
3. **Vendor Accountability:** Fix statutory responsibility for technology vendors, outsourced agencies and service providers to ensure end-to-end accountability.

The future of India's public examination system lies not only in preventing irregularities but in institutionalising integrity by design. A resilient, technology-driven and candidate-centric examination ecosystem will be critical to preserving meritocracy and public confidence.

24. From Geography of Borders to Geometry of Interests: The Evolution of India's Foreign Policy

Syllabus Mapping: GS-2: India and its Neighbourhood, Bilateral & Regional Relations, Effect of Policies of Developed Countries, International Institutions and India's Strategic Interests.

India's foreign policy has evolved from being primarily shaped by **geographical proximity and territorial considerations** to one increasingly driven by **strategic, economic, technological and maritime interests**. In an era of multipolarity, India's diplomacy reflects a shift from the '**geography of borders**' to the '**geometry of interests**', characterised by issue-based partnerships, multi-alignment and strategic autonomy.

Drivers of India's Shift from Geography to Geometry of Interests

1. **Multipolar World Order:** The transition from a unipolar to a multipolar world has encouraged India to diversify strategic partnerships beyond its immediate neighbourhood. Eg: I2U2 & QUAD.
2. **Changing Nature of National Security:** Security concerns now extend beyond territorial defence to include maritime security, cyber threats, critical technologies and resilient supply chains. Eg: India's **Indo-Pacific Oceans Initiative (IPOI)**.
3. **Geoeconomics:** Trade, connectivity, technology, energy and resilient value chains have become central determinants of foreign policy. Eg: India has concluded CETA with the UK recently.
4. **Critical & Emerging Technologies:** Competition in semiconductors, AI, quantum technologies and trusted digital ecosystems has expanded the scope of strategic partnerships. Eg: **India-US iCET**
5. **Energy & Supply Chain Security:** Energy diversification and resilient supply chains have become strategic priorities amid geopolitical disruptions. Eg: **India-Middle East-Europe Economic Corridor (IMEC)**
6. **Global South Leadership:** India increasingly seeks to shape global governance by acting as a voice for developing countries. Eg: **Global South Summit, African Union's admission into G20 (2023)**.

Pillars of India's Emerging Strategic Architecture

1. **Strategic Autonomy:** Maintain independent decision-making while engaging multiple power centres without alliance commitments.
2. **Issue-Based Coalitions:** Build flexible partnerships based on converging interests rather than ideological blocs. Eg: BRICS
3. **Neighbourhood First Policy:** Prioritise regional stability, connectivity and economic integration in South Asia. Eg: **India-Sri Lanka energy connectivity, Maitri initiatives**.
4. **Act East & Indo-Pacific:** Strengthen strategic, economic and maritime engagement across the Indo-Pacific.
5. **Voice of Global South:** Advocate reforms in multilateral institutions and promote inclusive global governance.
6. **Technology & Connectivity Diplomacy:** Use digital public infrastructure, critical technologies and connectivity corridors as instruments of foreign policy. Eg: **Global Digital Public Infrastructure Repository, IMEC and INSTC**.

Challenges in Realising India's Global Strategic Vision

1. **Strategic Balancing:** Managing relations simultaneously with the US, Russia, Europe, Iran and the Gulf amid intensifying geopolitical rivalry without strategic contradictions requires careful diplomatic calibration.



2. **Neighbourhood Volatility:** Political instability, debt crises and external influence in South Asia complicate India's "Neighbourhood First" policy. Eg: Bangladesh political transition, Sri Lanka debt crisis, etc.
3. **Technology Dependence:** Dependence on imported semiconductors, critical technologies and rare earth supply chains constrains strategic autonomy.
4. **Regional Instability:** Conflicts in West Asia, Myanmar and the Indo-Pacific threaten India's connectivity, trade and energy security.
5. **Institutional Constraints:** Slow reforms in global institutions reduce India's influence despite its rising geopolitical profile.
6. **Implementation Capacity:** Ambitious initiatives such as IMEC, SAGAR and Global South partnerships require sustained financial, technological and diplomatic capacity.

Towards a Future-Ready Indian Foreign Policy

1. **Build Comprehensive National Power (CNP):** Enhance economic competitiveness, defence capabilities, technological innovation and diplomatic capacity to sustain India's global ambitions.
2. **Institutionalise Multi-Alignment:** Deepen issue-based partnerships while preserving independent decision-making in an increasingly polarised global order.
3. **Lead Global Governance Reforms:** Champion reforms of the **UNSC, WTO, IMF and Multilateral Development Banks** while amplifying the concerns of the Global South.
4. **Secure the Indo-Pacific & Neighbourhood:** Strengthen India's role as a **net security provider** along with accelerating regional connectivity, energy integration and development partnerships to reinforce India's leadership in South Asia and the Indo-Pacific Ocean Region.
5. **Economic Statecraft:** Integrate trade, investment, connectivity and resilient supply chains into foreign policy to enhance strategic influence and reduce external vulnerabilities.
6. **Development Diplomacy:** Leverage Digital Public Infrastructure, climate leadership, healthcare and capacity-building initiatives to position India as a trusted development partner. Eg: **Global Biofuels Alliance**.

India's rise demands a foreign policy that transcends the geography of borders and embraces the geometry of interests. By combining strategic autonomy with economic statecraft, civilisational influence and trusted partnerships, India can shape a stable, connected and inclusive multipolar order.

25. Integrated Theatre Commands: Transforming India's Warfighting Architecture for 21st Century Conflicts

Syllabus Mapping: GS-3: Various Security Forces & Agencies; Security Challenges and their Management; Defence Reforms and Indigenisation.

The character of warfare has evolved from service-specific operations to **multi-domain, network-centric and integrated warfare**, where success depends on seamless coordination across land, air, sea, cyber and space domains. In this context, **Integrated Theatre Commands (ITCs)** seek to transform India's military from **platform-centric** to **capability-centric** joint warfighting.

Why Does India Need Integrated Theatre Commands?

1. **Hybrid Warfare:** Modern conflicts are increasingly **technology-driven, non-linear and hybrid**, demanding seamless coordination across multiple military domains.
2. **Multi-Domain Operations:** Future wars require synchronised operations across **land, air, maritime, cyber and space** to achieve operational superiority.
3. **Two-Front Security Challenge:** Simultaneous threats from **China along the LAC** and **Pakistan along the LoC** necessitate unified planning and coordinated military responses. Eg: The **China-Pakistan strategic nexus** has reinforced the need for integrated deterrence.
4. **Resource Optimisation:** Theaterisation enables optimal utilisation of military assets through **joint logistics, common infrastructure and integrated capability development**, reducing duplication.
5. **Jointness & Interoperability:** Integrated commands foster common doctrines, interoperable platforms and coordinated operations among the three Services. Eg: Creation of the **Chief of Defence Staff (2019)** and **Department of Military Affairs (2020)** to institutionalise jointness.
6. **Lessons from Recent Conflicts:** Recent conflicts demonstrate that military success increasingly depends on **joint operations, technological integration and real-time battlefield awareness** rather than service-specific capabilities. Eg: **Iran crisis**
7. **Maritime Imperatives:** India's expanding interests across the **Indian Ocean and Indo-Pacific** require integrated maritime-air-land operations to secure Sea Lines of Communication (SLOCs).



8. **Capability-Based Force Planning:** As recommended by the **Kargil Review Committee** and **Shekatkar Committee (2016)** theatreisation shifts the focus from **service-centric force structures** to **mission-oriented capability development**, enhancing operational effectiveness.

Operational Challenges in India's Theaterisation Journey

1. **Domain Expertise Deficit:** A Theatre Commander may lack deep operational experience across all three Services, affecting integrated decision-making during high-intensity conflicts.
2. **Inter-Service Divergence:** Differences in operational doctrines, organisational cultures and service priorities continue to impede seamless joint planning and execution.
3. **Command & Control Complexity:** Clearly delineating operational authority among the CDS, Theatre Commanders and Service Chiefs remains essential to avoid duplication and delays.
4. **Operational Readiness During Transition:** Reorganising command structures may temporarily dilute combat readiness, particularly amid active border tensions and evolving security threats.
5. **Military Readiness Framework:** India lacks clearly defined readiness metrics to assess the preparedness of integrated theatre commands during peacetime and crises.
6. **Time-Intensive Transition:** Building effective theatre commands requires sustained institutional adaptation, doctrinal evolution and organisational learning rather than mere structural reorganisation.
7. **Air Power Allocation:** The limited availability and strategic flexibility of air assets make permanent allocation across theatres operationally contentious.

Building a Readiness-Centric Theatre Command Model

1. **Readiness-Based Theaterisation:** Implement theatre reforms without compromising operational preparedness through phased transition and periodic readiness audits.
2. **Phased Implementation:** Adopt a calibrated and theatre-specific transition, allowing institutional learning and operational validation before nationwide implementation. Eg: The **Goldwater-Nichols reforms (US)** took nearly a decade to mature, while **China's theatre reforms** were implemented over two years.
3. **Joint Logistics & ISR Integration:** Integrate logistics, maintenance, ammunition management and **Intelligence, Surveillance & Reconnaissance (ISR)** assets to optimise resource utilisation and operational responsiveness.
4. **Common Communication Architecture:** Develop secure, interoperable **C4ISR** networks enabling seamless real-time information sharing and joint command across all domains.
5. **Joint Training & Doctrines:** Institutionalise integrated military education, theatre-specific doctrines and cross-service career pathways to foster a culture of jointness. Eg: Strengthen tri-service institutions such as the **College of Defence Management** and **National Defence College**.
6. **Technology-Enabled Network-Centric Warfare:** Integrate AI, drones, cyber capabilities, space-based surveillance and decision-support systems to enhance battlefield awareness and operational agility.
7. **Independent Readiness Oversight:** Establish a **Defence Readiness Council** to periodically assess operational preparedness and monitor theatre reforms.
8. **Transition Hedging:** Maintain reserve operational structures and contingency plans until new theatre commands achieve full operational capability.

Integrated Theatre Commands represent not merely an organisational restructuring but a strategic transformation towards joint, agile and capability-based warfighting. Their success will ultimately depend on balancing institutional integration with sustained military readiness

26. Artificial Intelligence as India's Next Digital Public Infrastructure

Syllabus Mapping: GS-2/3: E-Governance, Digital Governance, Science & Technology—Developments and their Applications, Artificial Intelligence and Inclusive Development.

India's Digital Public Infrastructure (DPI), built around **Aadhaar, UPI, DigiLocker and ONDC**, has transformed public service delivery through open, interoperable and population-scale digital platforms. As AI becomes a foundational technology, the next frontier lies in developing **Artificial Intelligence as Public Infrastructure (AI-DPI)** that democratises access to compute, data and AI models while ensuring inclusion, trust and innovation.

Why is there a Need to Shift from Traditional DPI to AI-based DPI?

1. **From Digital Access to Intelligent Services:** Traditional DPI enables digital transactions, while AI-DPI enables intelligent, predictive and personalised public service delivery.



2. **Rising Demand for Population-Scale Intelligence:** The growing volume of digital transactions and public data requires AI-driven systems for real-time analysis and evidence-based policymaking. Eg: AI-assisted fraud detection in digital payments and welfare schemes.
3. **Democratising Access to Intelligence:** Just as DPI democratised identity and digital payments, AI infrastructure can democratise access to advanced computing, models and intelligent services for citizens, startups and public institutions. Eg: IndiaAI envisions AI infrastructure as a shared national resource.
4. **Enhancing State Capacity:** AI can augment governance through automation, decision support and predictive analytics, improving efficiency and responsiveness.
5. **Building Digital Sovereignty:** Developing indigenous AI infrastructure reduces dependence on foreign compute, cloud platforms and proprietary foundation models.
6. **Strengthening Economic Competitiveness:** AI is emerging as a general-purpose technology capable of driving productivity, innovation and global competitiveness across sectors.
7. **Next-Generation DPI:** As digital governance matures, embedding AI into DPI can transform static digital platforms into adaptive, interoperable and citizen-centric public infrastructure.

Challenges in Building AI as India's Next Digital Public Infrastructure

1. **AI Colonialism:** Excessive dependence on foreign compute infrastructure, proprietary foundation models and hyperscale cloud providers may constrain India's technological autonomy, policy flexibility and long-term AI competitiveness.
2. **Extractive AI Economy:** India risks remaining a supplier of raw data, AI talent and annotation services while importing high-value AI models and applications, limiting domestic value creation.
3. **Compute Monopoly:** High GPU costs and the concentration of advanced computing infrastructure among a few global firms can restrict AI innovation, competition and equitable access.
4. **Closed AI Ecosystems:** Dependence on proprietary AI models and APIs may create vendor lock-in, reduce interoperability and constrain the development of an open and competitive domestic AI ecosystem.
5. **Regulatory Uncertainty:** The absence of a comprehensive AI governance framework creates uncertainty regarding liability, accountability and safety standards.
6. **Digital Divide & AI Inclusion:** Unequal access to digital infrastructure, AI literacy and multilingual AI tools may exclude rural communities, MSMEs and vulnerable groups from AI benefits.
7. **Energy & Environmental Costs:** Large AI models require energy-intensive data centres, increasing electricity demand, cooling requirements and carbon emissions.
8. **Human Capital Deficit:** Shortage of advanced AI researchers, chip designers and AI engineers constrains India's ability to build globally competitive AI ecosystems.

Towards Building AI as India's Next Digital Public Infrastructure

1. **AI Stack:** Develop an India AI Stack comprising compute infrastructure, trusted datasets, foundation models, interoperable AI gateways and public applications to create an open, scalable and population-scale AI ecosystem
2. **Compute as Infrastructure:** Treat AI compute as a strategic public utility by expanding affordable GPU infrastructure and ensuring equitable access through public investment and competitive markets. Eg: **IndiaAI Mission** aims to build a national AI compute ecosystem.
3. **Open Digital Public Goods:** Promote government-funded **open-weight foundation models** and open standards to accelerate innovation, interoperability and reduce dependence on proprietary AI ecosystems.
4. **National AI Gateway:** Develop a **UPI-like interoperable AI gateway** that enables secure, standardised and seamless access to multiple AI models for governments, businesses and citizens.
5. **AI Data Commons:** Create anonymised, consent-based and interoperable public datasets under robust privacy safeguards to support responsible AI innovation and public service delivery.
6. **Indic AI Ecosystem:** Build multilingual foundation models leveraging India's linguistic diversity to ensure inclusive AI adoption across governance, education, healthcare and justice. Eg: **BHASHINI** provides a strong foundation for Indian language AI.
7. **AI Credits:** Provide subsidised AI compute credits for startups, MSMEs, universities and research institutions to democratise innovation and lower entry barriers.
8. **Responsible AI Governance:** Establish a comprehensive AI governance framework with clear standards for transparency, accountability, safety and human oversight to build public trust. Eg: **IndiaAI Safety Institute**.
9. **AI Talent & Research Ecosystem:** Strengthen AI research, semiconductor design, interdisciplinary education and public-private partnerships to build indigenous AI capabilities. Eg: Dedicated **Centres of Excellence for AI**.

By treating AI as a public digital utility rather than a proprietary technology, India can harness its transformative potential to strengthen governance, accelerate innovation and realise the vision of Viksit Bharat@2047.

PRELIMS BOOSTER

1. Overseas Citizen of India(OCI)

- Digital version of the OCI card (e-OCI) launched by the **Ministry of Home Affairs**.
- **OCI Scheme** was introduced through the **Citizenship (Amendment) Act, 2005** under the **Citizenship Act, 1955**.
- Designed for **Persons of Indian Origin (PIOs)** and their eligible descendants residing abroad.
- **Eligibility**
 - ❑ OCI may be granted to a foreign national who:
 - ❑ Was eligible to become an Indian citizen on **26 January 1950**, or
 - ❑ Belonged to a territory that became part of India after **15 August 1947**, or
 - ❑ Is a child, grandchild or great-grandchild of such a person.
 - ❑ Spouse of an Indian citizen/OCI cardholder (subject to prescribed conditions).
- OCI **cannot** be granted to a person who is or has ever been a citizen of: **Pakistan, Bangladesh** and such other countries as notified by the Central Government.
- **Benefits for OCI card holders:**
 - ❑ Multiple-entry, **lifelong visa** to visit India.
 - ❑ Exemption from registration with **FRRO/FRO** irrespective of duration of stay.
 - ❑ Can purchase residential and commercial property in India (subject to FEMA provisions).
- **OCI Cardholders Cannot**
 - ❑ Vote or contest in elections
 - ❑ Hold Constitutional offices (President, Vice-President, Governor, etc.).
 - ❑ Become Members of Parliament or State Legislature.
 - ❑ Hold public employment in Government.
 - ❑ Purchase agricultural or plantation land.

2. Climate Tipping points

- India raised concerns at the **Bonn Climate Talks (SB 62)** over the interpretation and use of the term "**Climate Tipping Points**."
- According to IPCC, tipping points are 'critical thresholds in a system that, when exceeded, can lead to a significant change in the state of the system, often with an understanding that the change is irreversible.'
- Once crossed, the climate system may shift to a **new stable state** due to **positive feedback mechanisms**.
- Tipping points are **non-linear**—changes accelerate rapidly after the threshold is crossed.

➤ **Major Climate Tipping Elements**

- ❑ **Greenland Ice Sheet** → Irreversible ice-sheet melt → Sea-level rise.
- ❑ **West Antarctic Ice Sheet (WAIS)** → Marine ice-sheet instability.
- ❑ **Atlantic Meridional Overturning Circulation (AMOC)** → Weakening/collapse disrupts global climate.
- ❑ **Amazon Rainforest** → Forest dieback → Transition to savanna.
- ❑ **Arctic Permafrost** → Methane release → Accelerated warming.
- ❑ **Coral Reef Systems** → Mass bleaching and ecosystem collapse.
- **Bonn Climate Talks (SB Sessions):**
 - ❑ Held annually in **Bonn, Germany**.
 - ❑ Mid-year negotiations under the **UNFCCC**.
 - ❑ Prepare technical negotiations before the annual **COP**.

3. Financial Stability Report (FSR)

- **Financial Stability Report (FSR)** is a **biannual publication** released by the **Reserve Bank of India (RBI)**.
- It assesses the **stability, resilience and vulnerabilities** of India's financial system.
- It covers the **banking sector, NBFCs, financial markets, external sector and macro-financial risks**.
- It contains **macro stress tests** to assess the resilience of banks under **baseline, medium and severe stress scenarios**.
- It evaluates key financial soundness indicators such as: **Gross & Net NPAs, Capital Adequacy Ratio (CRAR), Provisioning Coverage Ratio (PCR), Liquidity and profitability indicators**
- The report also examines **systemic risks** arising from: Global geopolitical developments, Financial market volatility, Inflation and interest rates, Climate-related financial risks, Cybersecurity threats and Artificial Intelligence and technological disruptions

4. Purchasing Managers' Index (PMI)

- **PMI** is a **survey-based leading economic indicator** that measures the level of business activity in the **manufacturing and services** sectors.
- It is compiled from monthly surveys of **Purchasing Managers**, who are among the first to observe changes in demand, production and inventories.
- In India, PMI is compiled by **S&P Global**.

- **Types of PMI:** Manufacturing PMI + Services PMI + Composite PMI (Manufacturing + Services)
- **PMI is calculated using five key variables:** New Orders + Output (Production) + Employment + Suppliers' Delivery Times + Stocks of Purchases (Inventories)
- **PMI > 50** → Expansion in business activity
- **PMI = 50** → No change
- **PMI < 50** → Contraction in business activity

5. Telecommunications Act, 2023

- The Government has notified operational rules under the **Telecommunications Act, 2023**, replacing the colonial-era telecom regulatory framework with a modern authorisation-based regime.
- The Act replaces: **Indian Telegraph Act, 1885 & Indian Wireless Telegraphy Act, 1933.**
- The Act replaces the traditional licensing regime with an **authorisation regime**.
- Authorisation is now required for: Establishing telecom networks + Operating telecom services + Providing telecom services
- Existing license holders may continue till expiry or migrate voluntarily to the new regime.
- **Digital Bharat Nidhi (DBN): Replaces Universal Service Obligation Fund (USOF).**
- Supports telecom connectivity in underserved regions & supports research, innovation and future telecom technologies.
- The **Central Government (Dept. Of Telecommunications)** may: Authorise telecom entities + Allocate spectrum + Notify standards relating to telecom equipment.
- The Act permits **lawful interception** of telecommunications on grounds such as: National security + Public safety + Public emergency
- subject to safeguards prescribed by law.
- The Act **formally recognises satellite communication services.**

6. Graded Response Action Plan (GRAP)

- **GRAP** is an **emergency response mechanism** to tackle deteriorating air quality in **Delhi-NCR**.
- It prescribes **graded restrictions** based on the **Air Quality Index (AQI)**.
- It is **reactive**, i.e., measures are imposed as air quality worsens
- Implemented under the **Commission for Air Quality Management (CAQM)**.
- **CAQM** is a **statutory body** established under the **Commission for Air Quality Management in NCR and Adjoining Areas Act, 2021.**

- Covers **Delhi, Haryana, Punjab, Rajasthan and Uttar Pradesh** (NCR & adjoining areas).

GRAP Stage	AQI	Air Quality
Stage I	201–300	Poor
Stage II	301–400	Very Poor
Stage III	401–450	Severe
Stage IV	Above 450	Severe+

- AQI was developed by **Central Pollution Control Board (CPCB)**
- AQI is calculated using **8 pollutants**: Particulate Matter (PM_{2.5} and PM₁₀), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), Ground-level Ozone (O₃), Ammonia (NH₃), and Lead (Pb).

7. Vikram-1

- **Vikram-1** is India's **first privately developed orbital launch vehicle**.
- Developed by **Skyroot Aerospace**, a Hyderabad-based private space startup.
- **Mission Name: Mission Aagaman** (meaning *Arrival*).
- Launch scheduled from **Satish Dhawan Space Centre (SDSC), Sriharikota**.
- It is the **second mission** of Skyroot after the successful **Vikram-S** suborbital flight on **18 November 2022**, which became the **first private Indian rocket to reach space**.
- The maiden flight is a **partially commercial demonstration mission**, with full commercial launches planned after successful validation.
- All stages of the launch vehicle have been **integrated and stacked** at the launch pad.
- **Vikram-1** is designed to place **small satellites into Low Earth Orbit (LEO)**.
- Vikram-1 is a four-stage, all-solid-fuel Small Satellite Launch Vehicle (SSLV class) in first 3 stages and fourth stage is liquid designed to place small satellites into Low Earth Orbit (LEO)
- Payload capability: **480 kg to 500 km Sun-Synchronous Orbit (SSO) & 300 kg to Low-Inclination LEO.**

8. Nord Stream Gas Pipelines

- **Nord Stream** is an offshore **natural gas pipeline system** connecting **Russia** directly with **Germany** through the **Baltic Sea**.
- Constructed to supply Russian natural gas to Europe while **bypassing Ukraine, Poland and Belarus**.
- Consists of:
 - ❑ **Nord Stream 1 (NS1)** – Operational since 2011–12.

- ❑ **Nord Stream 2 (NS2)** – Completed in 2021, but **never commissioned** due to geopolitical tensions.
- Originates from **Vyborg (NS1)** and **Ust-Luga (NS2)** in Russia and terminates at **Lubmin, Germany**.
- The pipelines pass through the **Exclusive Economic Zones (EEZs)** of **Russia, Finland, Sweden, Denmark and Germany**.
- In **September 2022**, underwater explosions damaged **three of the four pipeline strings**, causing one of the world's largest recorded **methane leaks**.
- The incident significantly affected **European energy security**, accelerating diversification away from Russian gas.
- **Nord Stream carries natural gas**, whereas **Druzhba is a crude oil pipeline between Russia and Central & Eastern Europe**.

9. Employees' Provident Funds Scheme, 2026

- The **Ministry of Labour & Employment** has notified the **Employees' Provident Funds Scheme, 2026** under the **Code on Social Security, 2020**, replacing the **Employees' Provident Funds Scheme, 1952**.
- **Administered by the Employees' Provident Fund Organisation (EPFO)**.
- Introduces the concept of **Principal Employer** for contract workers, making the principal employer ultimately responsible for EPF contributions if the contractor defaults.
- Employer must deposit both employer's and employee's contributions, along with administrative charges, within 15 days of the close of every month.
- **EPF Contribution (Unchanged)**
 - ❑ 12% of wages each by employee and employer.
 - ❑ 10% contribution continues for certain notified establishments.
 - ❑ Mandatory contribution applies up to the statutory wage ceiling.
 - ❑ Employees earning above the wage ceiling may contribute voluntarily.
 - ❑ Employers may also make matching voluntary contributions.
- **Revised Partial Withdrawal Rules: Members can now withdraw EPF for:-**
 - ❑ **Illness (Self/Family):** Up to 100% of eligible balance after 12 months of membership.
 - ❑ **Unemployment:** Up to 100% after remaining unemployed for one year.
 - ❑ **Education (Self/Family):** Up to 50% of eligible balance after 12 months; maximum 3 withdrawals during membership.
 - ❑ **Marriage (Self/Family):** Up to 100% of eligible balance; maximum 5 withdrawals during membership.

- ❑ **Housing:** Purchase/construction/renovation/addition of a house or flat.
- ❑ Withdrawal limited to 75% of total fund after 12 months of membership.
- **Maximum 2 withdrawals during membership.**
- A minimum balance of 25% of aggregate contributions must generally be maintained after withdrawal.

10. Indus Waters Treaty (IWT)

- In **April 2025**, India **kept the Treaty in abeyance** following the **Pahalgam terrorist attack**, citing sustained cross-border terrorism and a fundamental change in circumstances.
- The **Indus Waters Treaty (IWT)** was signed between **India and Pakistan** on **19 September 1960** at **Karachi**, with the **World Bank** as a signatory and facilitator.
- Signed by **Prime Minister Jawaharlal Nehru** (India) and **President Ayub Khan** (Pakistan).
- Allocates the **Eastern Rivers (Ravi, Beas and Sutlej)** to **India** and the **Western Rivers (Indus, Jhelum and Chenab)** to **Pakistan**.
- India has **exclusive rights** over Eastern rivers, subject to certain Treaty obligations.
- India is permitted **non-consumptive use, domestic use, irrigation and run-of-the-river hydropower projects** on the Western Rivers, subject to treaty provisions.
- Established the **Permanent Indus Commission (PIC)** with one Commissioner from each country to facilitate cooperation and resolve technical issues.
- Provides a **graded dispute resolution mechanism**—Permanent Indus Commission → Neutral Expert → Court of Arbitration.
- Widely regarded as one of the **world's most successful transboundary water-sharing agreements**, having survived multiple wars and bilateral tensions.
- **Major Indian Projects under IWT**
 - ❑ **Kishanganga Hydroelectric Project** – Jhelum basin.
 - ❑ **Ratle Hydroelectric Project** – Chenab.
 - ❑ **Baglihar Hydroelectric Project** – Chenab.
 - ❑ **Pakal Dul Project** – Marusudar (Chenab tributary).

11. Fixed Dose Combination (FDC) Drugs

- India has periodically **banned several irrational FDCs** in the interest of public health and patient safety.
- **Fixed Dose Combination (FDC)** is a pharmaceutical formulation containing **two or more Active Pharmaceutical Ingredients (APIs)** combined in a **fixed ratio** in a single dosage form.
- Regulated under the **Drugs and Cosmetics Act, 1940** and **New Drugs and Clinical Trials Rules, 2019**.

- **Regulatory Authority:** Central Drugs Standard Control Organisation (CDSCO) under the **Drugs Controller General of India (DCGI)**.
- Aims to improve **patient compliance**, reduce pill burden and enhance therapeutic effectiveness.
- Commonly used for treating **Tuberculosis, HIV/AIDS, Malaria, Diabetes, Hypertension and Cardiovascular diseases**.
- Irrational or unapproved FDCs may increase the risk of **adverse drug reactions, antimicrobial resistance and inappropriate dosing**.
- New FDCs require **prior approval from CDSCO/DCGI** before manufacture or marketing in India.

12. Nameri Tiger Reserve

- **Nameri Tiger Reserve** is located in **Sonitpur district, Assam**, covering an area of **344 sq. km**.
- It is **one of the four Tiger Reserves in Assam**, along with **Kaziranga, Manas and Orang**.
- Shares its northern boundary with **Pakke Tiger Reserve in Arunachal Pradesh**, forming an important transboundary wildlife landscape.
- As per the **2025 State Forest Department estimation**, validated by the **Wildlife Institute of India (WII)**, the tiger population increased from **3 (AITE 2022)** to **12 by the end of 2025**, a **four-fold increase in three years**.
- The revival is attributed to **scientific monitoring, habitat protection and strengthened conservation measures** in the **Nameri–Sonai Rupai landscape**.
- The reserve also witnessed the **return of tigers to Sonai Rupai Wildlife Sanctuary** after more than two decades of local extinction.

13. Direct Seeded Rice (DSR)

- **Direct Seeded Rice (DSR)** is a rice cultivation technique in which **seeds are sown directly into the field** without raising a nursery or transplanting seedlings.
- Eliminates **puddling** (flooding + repeated tillage), thereby **saving water, labour and cultivation cost**.
- Suitable for **water-scarce regions** and years of **deficient monsoon/El Niño**.
- Can reduce **water use by 30–35%** and significantly lower labour requirements.
- DSR fields require **good weed management**, as the absence of standing water promotes weed growth.

- Common weed control involves **herbicides** such as **Imazethapyr**, along with **Herbicide-Tolerant (HT) rice varieties**.
- **HT rice varieties** like **Pusa Basmati-1979** and **Pusa Basmati-1985** were developed by **ICAR–Indian Agricultural Research Institute (IARI)**, New Delhi through **non-GM induced mutation breeding**.
- These varieties possess a **mutated ALS (Acetolactate Synthase) gene**, making them tolerant to **Imazethapyr** herbicide while weeds are eliminated.
- **DSR is not genetically modified (GM) technology**; the herbicide-tolerant trait has been developed through **mutation breeding**, not transgenic methods.
- **ICAR–IARI (Pusa Institute)** is India's premier agricultural research institute under the **Indian Council of Agricultural Research (ICAR)**.

14. Gaganyaan Mission

- **Gaganyaan** is **ISRO's first human spaceflight mission**, aiming to send a **3-member Indian crew to Low Earth Orbit (LEO) (~400 km)** for about **3 days** and safely recover them.
- **SOLVE (Sub-Orbital Launch Vehicle for Experiments)** is a **solid motor-based test platform** developed by ISRO to validate the **crew module parachute and deceleration system** for Gaganyaan.
- The **first ground test** of SOLVE was successfully conducted at the **Satish Dhawan Space Centre (SDSC), Sriharikota**.
- SOLVE is derived from the **PSLV Strap-on Motor** with modifications such as **slow-burn propellant** and **Secondary Injection Thrust Vector Control (SITVC)**.
- During test missions, the **crew module** will be carried to **10–17 km altitude**, separated from the vehicle and recovered using a **10-parachute system** before sea splashdown.
- Other recent Gaganyaan milestones include the **Integrated Air Drop Test (IADT-02)** and **Mission MITRA (Mapping of Interoperable Traits and Response Assessment)** for astronaut preparedness.
- **Launch Vehicle: Human-rated LVM3 (HLVM3)**.
- The mission aims to demonstrate **human spaceflight capability**, including **crew safety, orbital operations and recovery**, making India the **4th country** to independently achieve human spaceflight capability after **Russia, the USA and China**.

15. Synthetic Cell

- Researchers at the **University of Minnesota (USA)** have developed a **synthetic cell** capable of **growth, DNA replication and autonomous division**.

- The cell is built using a **liposome** (artificial lipid membrane) containing the **PURE protein synthesis system**, enabling essential cellular functions.
- It carries a **minimal synthetic genome** (~90,000 base pairs) and replicates DNA using **Phi29 DNA polymerase**.
- Unlike earlier artificial cells, it can **grow by absorbing nutrients** and divide into **daughter cells** through a biologically engineered mechanism.
- Researchers demonstrated **Darwinian evolution**, with beneficial mutations enabling faster growth and reproduction.
- The breakthrough advances **Synthetic Biology** and has potential applications in **drug discovery, biotechnology, artificial cells and understanding the origin of life**.

16 . Indira Point

- **Indira Point** is the **southernmost point of India**, located on **Great Nicobar Island** in the **Andaman & Nicobar Islands**.
- It is home to the **Indira Point Lighthouse**, maintained by the **Directorate of Lighthouses and Lightships (DLL)** under the **Ministry of Ports, Shipping & Waterways**.
- Recently, the **Directorate of Lighthouses and Lightships** sought environmental clearance for **shore protection, lighthouse conservation and limited eco-tourism infrastructure** (museum, convention centre, viewing tower, etc.) at Indira Point.
- The proposed site falls under **ICRZ-IA (ecologically sensitive coastal areas)** and **ICRZ-IVA (marine waters)** under the **CRZ Notification, 2019**, requiring prior environmental clearance.
- The proposal aims to protect the lighthouse from **coastal erosion, wave action and shoreline changes**, while ensuring that **no prohibited CRZ activities** are undertaken.
- Indira Point lies **south of Galathea Bay**, the location of the proposed **Great Nicobar Island Mega Infrastructure Project**.
- The point **subsided by about 4.25 m** following the **2004 Indian Ocean Tsunami** due to tectonic activity, making it a classic example of **land subsidence**.
- **Great Nicobar** is India's **southernmost island** and is separated from **Indonesia** by the **Six Degree Channel**.
- **Great Nicobar Biosphere Reserve** comprises **Campbell Bay National Park** and **Galathea National Park** and is a **UNESCO Biosphere Reserve**.

17. INS Mahendragiri (Project 17A Stealth Frigate)

- **INS Mahendragiri (F38)** is the **sixth Project 17A indigenous stealth frigate** of the **Indian Navy**, commissioned in **July 2026**.
- Designed by the **Indian Navy's Warship Design Bureau (WDB)** and built by **Mazagon Dock Shipbuilders Ltd. (MDL), Mumbai**.
- Features **stealth technology**, **CODOG (Combined Diesel or Gas)** propulsion and **over 75% indigenous content**, reflecting **Aatmanirbhar Bharat** in defence.
- Equipped with **surface-to-surface & surface-to-air missiles**, **anti-submarine warfare (ASW)** systems, **electronic warfare (EW) suite** and an **Integrated Combat Management System (CMS)**.
- Capable of **anti-air, anti-surface and anti-submarine warfare**, besides **maritime security and HADR operations**.
- **Project 17A** is the advanced follow-on class of the **Shivalik-class (Project 17)** stealth frigates, comprising **7 indigenous warships**—**INS Nilgiri, INS Udaygiri, INS Taragiri and INS Mahendragiri (built by MDL, Mumbai); and INS Himgiri, INS Dunagiri and INS Vindhyagiri (built by GRSE, Kolkata)**.

18. India–Indonesia Relations

- The **Prime Minister's July 2026 visit** aims to strengthen the **India–Indonesia Comprehensive Strategic Partnership (CSP)** across **defence, maritime security, critical minerals, food security and the digital economy**.
- India and Indonesia elevated their ties to a **Comprehensive Strategic Partnership** in **2018**.
- Both countries cooperate under the **Shared Vision of India–Indonesia Maritime Cooperation in the Indo-Pacific** and support a **free, open, inclusive and rules-based Indo-Pacific**.
- Defence cooperation includes **bilateral and multilateral exercises, defence industry collaboration, officer training** and the proposed **BrahMos missile export**.
- Indonesia has deployed a **Liaison Officer** at the **Information Fusion Centre–Indian Ocean Region (IFC-IOR), Gurugram**, enhancing **Maritime Domain Awareness (MDA)**.
- **Critical minerals** have emerged as a key area of cooperation, with Indonesia possessing **~21% of the world's nickel reserves** and being a major producer of **copper, bauxite and tin**.

- Indonesia is **India's second-largest trading partner in ASEAN**, with **bilateral trade of about US\$24.8 billion (2025–26)**.
- Both countries cooperate in regional groupings such as the **East Asia Summit (EAS)**, **ASEAN-led mechanisms**, **Indian Ocean Rim Association (IORA)** and **G20**.

19 . Zebra Finch (*Taeniopygia guttata*)

- **Dr. Julie Elie (University of California, Berkeley)** won the **2026 Collier–Dolittle Prize (US\$100,000)** for pioneering research on **two-way interspecies communication** using **zebra finches**.
- The study identified **11 core call types** in zebra finches and showed that the birds classify calls based on **meaning (semantics)** rather than merely **acoustic similarity**.
- Researchers validated the findings through **behavioural experiments**, where the birds themselves correctly distinguished different call categories.
- **Zebra Finch** is a small **passerine (songbird)** native to **Australia**.
- It is one of the **most widely used model organisms** in **neuroscience, animal behaviour and vocal learning** research.
- **Juvenile males learn songs by imitating an adult tutor (usually the father)**, making it an important model for studying **speech acquisition** in humans.
- Vocal learning is found in only a few animal groups, including **songbirds, parrots, hummingbirds, cetaceans (whales & dolphins), bats and humans**.
- Zebra finches exhibit a **critical learning period**, similar to language learning in human children, where auditory feedback is essential for normal song development.
- Their relatively simple and stereotyped songs make them ideal for studying **bioacoustics, neural circuits, communication and AI-based sound analysis**.

20. Mission Drishti

- **Mission Drishti** is the **world's first operational OptoSAR (Optical + Synthetic Aperture Radar) Earth Observation** satellite, developed by Bengaluru-based **GalaxEye Space**.
- It is also **India's largest privately developed Earth Observation (EO) satellite**, launched in May 2026 aboard **SpaceX Falcon 9**.
- The satellite integrates **Electro-Optical (EO) and Synthetic Aperture Radar (SAR) sensors** on a **single platform**, enabling **all-weather, day-and-night Earth observation**.
- **SAR** can penetrate **cloud cover, haze and darkness**, while **EO sensors** provide high-resolution visual imagery, making the two technologies complementary.

- **Mission Drishti** is intended for applications in **defence surveillance, disaster management, agriculture, environmental monitoring, infrastructure planning and maritime domain awareness**.
- Recently, **contact with the satellite was lost** during the **Launch and Early Orbit Phase (LEOP)** after a **geomagnetic solar storm**, which likely affected onboard systems.

21. Section 301 (US Trade Act, 1974)

- The **United States Trade Representative (USTR)** has initiated a **Section 301 investigation** into alleged **forced labour** in Indian imports and has proposed **additional tariffs** on certain products.
- India has opposed the investigation, arguing that it is **generalised, non-product-specific** and inconsistent with the legal threshold prescribed under **Section 301 of the US Trade Act, 1974**.
- **Section 301 (US Trade Act, 1974)**: Empowers the **USTR** to investigate and take **unilateral trade actions**, including imposing tariffs, against countries whose trade practices are considered **unfair or discriminatory** to US commerce.
- **USTR (United States Trade Representative)**: The US government's principal agency responsible for **trade negotiations and enforcement** of US trade policy.
- **Unlike the WTO Dispute Settlement Mechanism**, Section 301 allows the **US to impose trade sanctions unilaterally**, making it a frequently debated instrument in international trade.
- **India has consistently maintained** that trade disputes should be resolved through **WTO-consistent, rules-based and mutually negotiated mechanisms** rather than unilateral tariff actions.

22 . India's Crude Oil Imports & Russia's

Increasing share

- **Russia's share in India's crude oil imports has again crossed 40%**, reaffirming its position as India's largest crude oil supplier amid global geopolitical realignments.
- India follows a policy of **source diversification**, importing crude from **Russia, Iraq, Saudi Arabia, UAE, the US and other producers** to ensure **energy security** and competitive pricing.
- Since India imports **over 85% of its crude oil requirement**, fluctuations in global crude prices directly affect the **Current Account Deficit (CAD), inflation, fiscal balance and exchange rate**.
- To reduce import dependence, the Government is promoting **domestic exploration, Strategic Petroleum Reserves (SPRs), E20 ethanol blending**,

biofuels, compressed biogas (CBG) and electric mobility.

- The increase in Russian imports reflects India's policy of **strategic autonomy**, where energy procurement is guided by **national interest, affordability and energy security**.
- **Strategic Petroleum Reserves (SPRs)**: Located at **Visakhapatnam (AP), Mangaluru & Padur (Karnataka)**.
- **India is the world's third-largest importer and consumer of crude oil**.
- **Russia is a founding member of OPEC+, but not of OPEC. OPEC+ is a grouping of major non-OPEC oil producers (e.g., Russia, Kazakhstan, Mexico).**
- **Top crude oil producers globally: United States, Saudi Arabia and Russia.**
- **Top proven crude oil reserves: Venezuela, Saudi Arabia, Iran, Canada and Iraq.**

23. Astra Missile System

- **India and Indonesia** signed a defence agreement for the **export of Astra Mk-1 BVRAAM**, marking the **first-ever export of the Astra missile system** and strengthening India–Indonesia defence cooperation.
- **Astra is an indigenously developed Beyond Visual Range Air-to-Air Missile (BVRAAM)** designed by **DRDO** for engaging enemy aircraft **beyond visual range**.
- The missile is equipped with an **Active Radar Seeker, mid-course inertial guidance with datalink updates, and terminal active radar homing, enabling fire-and-forget capability**.
- Astra is integrated with the **Su-30MKI** and is being integrated with **LCA Tejas Mk-1A**; future integration is planned for the **Rafale**.
- The Astra programme enhances **Aatmanirbhar Bharat in Defence**, reducing dependence on imported BVR missiles such as the **Meteor** and **R-77**.
- Variants:
 - ❑ **Astra Mk-1**: Range **80–110 km**; operational with the **Indian Air Force**.
 - ❑ **Astra Mk-2**: Under advanced development; range **~160 km** with an improved seeker and propulsion.
 - ❑ **Astra Mk-3 (Gandiva)**: Under development; powered by a **Solid Fuel Ducted Ramjet (SFDR)** engine with an expected **range of over 300 km**.

24. Prambanan Temple Conservation Project

- During the **Prime Minister's visit to Indonesia**, India and Indonesia jointly launched the **Prambanan Temple Conservation Project**, to be implemented by the **Archaeological Survey of India (ASI)** in collaboration with Indonesia's heritage authorities.

- The **10-year project (2026–2036)** aims to restore the **Perwara (subsidiary) temples** of the **UNESCO World Heritage Site**, reflecting the deep **civilisational and cultural ties** between the two countries.
- The project will employ modern conservation techniques such as **LiDAR (Light Detection and Ranging), photogrammetry**, archival research, and structural, hydrological and geotechnical studies.
- The **Prambanan Temple Complex**, built in the **9th century** under the **Mataram Kingdom**, is the **largest Hindu temple complex in Indonesia** and is dedicated to the **Trimurti (Shiva, Vishnu and Brahma)**.
- The complex was inscribed as a **UNESCO World Heritage Site in 1991** and is renowned for its **Ramayana bas-reliefs** and towering **Shiva Temple**.
- **Perwara Temples**: The **224 subsidiary shrines** surrounding the three main temples in the Prambanan complex.
- It strengthens India's role in **global heritage conservation** and reinforces cultural diplomacy under the **Act East Policy** and **MAHASAGAR Vision**.

25 . Repatriation of Antiquities from Australia

- During the **India–Australia Annual Summit (2026)**, Australia agreed to **voluntarily repatriate three Chola-period antiquities** from Tamil Nadu, reaffirming cooperation against illicit trafficking of cultural property.
- The antiquities include:
 - **Metal Trident (Trishula) with Goddess Bhadrakali** (11th century)
 - **Stone Idol of Nandi** (12th century)
 - **Stone Idol of Six-headed Kartikeya (Shanmukha/Murugan)** (12th century)
- The artefacts originated from temples in **Thanjavur** and **Thiruvavur** districts of **Tamil Nadu** and were traced through investigations by the **Idol Wing–CID, Tamil Nadu Police**.
- **UNESCO Convention, 1970** aims to **prevent illicit trafficking of cultural property** and facilitate the **return (restitution/repatriation) of stolen antiquities** to their country of origin.
- **UNIDROIT Convention, 1995** complements the UNESCO Convention by providing **private law mechanisms** for the return of **stolen or illegally exported cultural objects**.
- **Antiquities and Art Treasures Act, 1972** regulates the **export, trade and registration of antiquities** in India; it has now been proposed to be replaced by the **Antiquities and Art Treasures Bill**.

- An **antiquity** under Indian law generally refers to an object **at least 100 years old** (manuscripts, records and documents: **75 years**).
- India also agreed to **repatriate the ancestral remains of an Australian First Nations ancestor** preserved in the Government Museum, Chennai, highlighting mutual respect for indigenous heritage.

26. India-Australia Relations

- **India–Australia Comprehensive Strategic Partnership (CSP)** was established in **2020**.
- **ECTA (Economic Cooperation and Trade Agreement)** between India and Australia came into force in **2022**; negotiations are underway for a **Comprehensive Economic Cooperation Agreement (CECA)**.
- **Australia is a member of:** QUAD, Five Eyes, AUKUS, IORA, Indian Ocean Naval Symposium (IONS), Indo-Pacific Economic Framework (IPEF).
- **India and Australia are members of:** QUAD, G20, East Asia Summit (EAS), IORA and ASEAN Defence Ministers' Meeting Plus (ADMM-Plus).
- **India–Australia Civil Nuclear Cooperation Agreement** was signed in **2014**, enabling **uranium exports** from Australia to India for peaceful purposes.
- Australia possesses **one of the world's largest uranium reserves**.
- India is **not a signatory to the Non-Proliferation Treaty**, but obtained the **Nuclear Suppliers Group waiver (2008)**, allowing civil nuclear commerce.

27. India–Australia Military Exercises

- **AUSINDEX – Bilateral Naval Exercise** between the **Indian Navy and Royal Australian Navy (RAN)**; conducted since **2015**.
- **Pitch Black – Multinational Air Combat Exercise** hosted by the **Royal Australian Air Force (RAAF)**; India participates with the **Indian Air Force**.
- **Malabar – Multilateral Naval Exercise** involving **India, Australia, Japan and the United States (QUAD)**.
- **Talisman Sabre – Australia–US biennial multinational military exercise**; India has participated as an **observer (2021)** and later as a **participant (2023 onwards)**.
- **La Pérouse – Multilateral naval exercise** led by **France** in the Indo-Pacific; India and Australia are participants.
- **Kakadu – Multilateral maritime exercise** hosted by the **Royal Australian Navy**; India is a regular participant.

- **RIMPAC (Rim of the Pacific Exercise)** – World's **largest multinational naval exercise**, hosted by the **United States**; both **India and Australia** participate.

28 . Weekly Basal Insulin (Insulin Icodec / Awigli)

- **Recently**, Novo Nordisk launched **Awigli (Insulin Icodec)** in India—the **world's first once-weekly basal insulin** for adults with **Type 1 and Type 2 diabetes**, reducing injections from **365 to 52 per year**.
- **Insulin Icodec** is a **long-acting basal insulin analogue** that provides a **steady background insulin level** for an entire week through prolonged **albumin binding** and slower receptor clearance.
- It is intended to improve **treatment adherence** and reduce **injection burden**, especially in patients requiring long-term insulin therapy.
- It is **not a replacement for mealtime (bolus) insulin** in all patients; many people with **Type 1 diabetes** still require rapid-acting insulin before meals.
- **Insulin is secreted by β -cells of the Islets of Langerhans** in the pancreas; **glucagon** is secreted by **α -cells**.
- **Basal insulin** maintains blood glucose during **fasting and between meals**, whereas **bolus (prandial) insulin** controls the rise in glucose **after meals**.
- **HbA1c (Glycated Haemoglobin)** reflects the **average blood glucose over the previous 2–3 months** and is the standard indicator for long-term glycaemic control.
- **Insulin** is a **peptide hormone**; therefore, it is **not administered orally** because it is degraded in the gastrointestinal tract.
- **Type 1 Diabetes Mellitus (T1DM):** Autoimmune destruction of **pancreatic β -cells** leading to **absolute insulin deficiency**; lifelong **insulin therapy** is **essential**.
- **Type 2 Diabetes Mellitus (T2DM):** Characterised by **insulin resistance** with progressive **β -cell dysfunction**; accounts for **over 90% of diabetes cases**.

29. National CAMPA approves Conservation Projects for Four Species

- **National CAMPA** has approved four new species-specific conservation projects for the **Gangetic River Dolphin, Snow Leopard, Wild Water Buffalo and Indian Rhinoceros**.
- The projects include **population estimation, habitat restoration, scientific monitoring, recovery planning and landscape-level conservation**.
- They will be implemented with financial support under the **Compensatory Afforestation Fund (CAF)**.
- The approval reflects a shift from afforestation alone towards **species-centric conservation**.

- **CAMPA (Compensatory Afforestation Fund Management and Planning Authority)** is a statutory authority constituted under the **Compensatory Afforestation Fund Act, 2016**.
- It manages funds collected for **Compensatory Afforestation, Net Present Value (NPV) and other forest-related charges** when forest land is diverted for non-forest purposes under the **Forest (Conservation) Act, 1980** (now *Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980*).
- **National CAMPA** functions under the **Ministry of Environment, Forest & Climate Change (MoEFCC)**, while every State/UT has a **State CAMPA**.
- CAMPA funds can be utilised for **afforestation, wildlife conservation, assisted natural regeneration, forest fire prevention, habitat improvement and soil & water conservation**.

30. Inflation & Monetary Policy Committee (MPC)

- **Retail inflation (CPI)** is expected to move close to or slightly above the **RBI's medium-term target of 4%**, largely driven by **transport inflation**, reflecting higher fuel prices and freight costs.
- **Inflation Target: $4\% \pm 2\%$** (i.e., 2%–6%) as notified by the Central Government in consultation with the RBI.
- **MPC Composition (6 Members):**
- **3 from RBI** – Governor (Chairperson), Deputy Governor (Monetary Policy), one RBI nominee.
- **3 external members** appointed by the Central Government.
- **Decision-making:** Each member has **one vote**; in case of a tie, the **RBI Governor has a casting vote**.
- **Quorum: 4 members**.
- **Meeting Frequency: At least four meetings every year** (currently scheduled **bi-monthly**, i.e., six meetings annually).
- If **inflation remains outside the 2%–6% band for three consecutive quarters**, the **RBI must submit a report to the Central Government**
- **Headline Inflation** in India is measured by the **Consumer Price Index (CPI-Combined)** compiled by the **National Statistics Office (NSO), Ministry of Statistics & Programme Implementation (MoSPI)**.

31 . Gaganyaan – Crew Module System Tests

- ISRO successfully completed three major qualification tests of the Gaganyaan Crew Module Systems, validating critical crew safety mechanisms before the human spaceflight mission.
- **The tests included:**

- ❑ **Crew Module Uprighting System (CMUS):** Ensures the crew module automatically returns to an upright position after **splashdown** in the sea.
- ❑ **Umbilical Connect-Disconnect System:** Validates safe separation of electrical, fluid and communication links between the Crew Module (CM) and Service Module (SM) before re-entry.
- ❑ **Apex Cover Separation Test:** Confirms structural integrity and safe separation of the apex cover before deployment of the parachute system.
- Gaganyaan is India's **first indigenous human spaceflight mission**, aimed at demonstrating the capability to send three astronauts to **Low Earth Orbit (LEO ~400 km)** for **about 3 days**, followed by **safe splashdown** in the Indian Ocean.
- The mission will be launched by **LVM3 (Launch Vehicle Mark-3)**, ISRO's heavy-lift launch vehicle.
- **Components of Gaganyaan**
- ❑ **Crew Module (CM):** Habitable, pressurised capsule that carries astronauts; the only reusable component of Gaganyaan.
- ❑ **Service Module (SM):** Provides propulsion, power, thermal control and life-support consumables; separates before atmospheric re-entry.
- ❑ **Crew Escape System (CES):** Emergency abort system that rapidly pulls the Crew Module away from the launch vehicle during launch emergencies.
- **Vyommitra** is ISRO's **half-humanoid robot**, designed to fly on uncrewed Gaganyaan missions.
- **Splashdown** is the controlled landing of a space capsule in the **sea** using parachutes.
- Gaganyaan will orbit in **Low Earth Orbit (LEO)**, which extends up to about **2,000 km** above Earth.
- The **Service Module burns up during re-entry**, while the **Crew Module survives atmospheric re-entry** using its **thermal protection system (heat shield)**.

32. Reusable Launch Vehicles (RLVs)

- Recently, China successfully recovered the **first stage of the Long March-10B reusable rocket**, becoming the latest country to demonstrate reusable launch capability.
- Reusable Launch Vehicles (RLVs) are designed to recover and reuse one or more rocket stages, significantly reducing launch costs and increasing launch frequency.
- Most launch vehicles are multi-stage rockets, where the first stage provides the initial thrust and separates after fuel exhaustion.
- Reusability is considered a key technology for commercial spaceflight, satellite constellations, human spaceflight and deep-space exploration.

- India is also developing Reusable Launch Vehicle (RLV-LEX) technology as part of ISRO's long-term reusable space transportation programme.
- **India's Reusable Space Programme**
- ❑ RLV-TD (Reusable Launch Vehicle–Technology Demonstrator): First successfully tested by ISRO in 2016.
- ❑ RLV-LEX (Landing Experiment): Successfully demonstrated autonomous runway landing in 2023 and 2024.
- ❑ ISRO's reusable launch vehicle aims to reduce launch costs by up to 80% through stage recovery and reuse.
- **Major Reusable Launch Vehicles**
- ❑ Falcon 9 – SpaceX (USA)
- ❑ **New Shepard – Blue Origin (USA)**
- ❑ Long March-10B – China (under development for human lunar missions)
- ❑ RLV-TD / RLV-LEX – ISRO (Technology Demonstrator)

33. Places in News

- **Persian Gulf:** A marginal sea of the Indian Ocean, connected to the **Gulf of Oman** through the **Strait of Hormuz**.
- Surrounded by **Iran, Iraq, Kuwait, Saudi Arabia, Bahrain, Qatar, UAE and Oman**.
- Important islands include **Qeshm, Hormuz and Kish (Iran)** and **Bahrain**.
- **Qeshm Islands:** Largest island in the Persian Gulf + Located close to the **Strait of Hormuz**.
- Declared a **UNESCO Global Geopark** for its unique geological formations.
- **Bandar Abbas:** Iran's largest commercial port + Located on the **Strait of Hormuz**.
- Headquarters of the **Iranian Navy** and a key oil export terminal.

34. Biogas & Compressed Biogas (CBG)

- **Biogas** is produced by **anaerobic digestion** of biodegradable organic matter by **methanogenic archaea**.
- Major constituents: **Methane (50–75%), CO₂ (25–45%)** with traces of **H₂S, H₂, NH₃ and water vapour**.
- **Liquid biogas (LBG):** It is a clean vehicle fuel and an eco-friendly substitute for heating and electricity generation. It is derived from biogas through a liquefaction process and helps in reducing emissions and making it easier to store and transport.
- **Compressed biogas (CBG):** It is a high-density fuel that contains more than 90% methane and is formed by compressing biogas. It replaces conventional fossil fuels and is increasingly used in transportation as an environmentally conscious alternative.

- **Bio-slurry** is the major by-product and is used as a **nutrient-rich organic manure**.
- **Feedstock** includes cattle dung, crop residues, press mud, distillery spent wash, municipal solid waste, sewage sludge and food waste.
- **SATAT (2018)** – Sustainable Alternative Towards Affordable Transportation; implemented by **Ministry of Petroleum & Natural Gas** through Oil Marketing Companies (OMCs) such as IOCL, BPCL and HPCL.
- **GOBARDhan** (Galvanizing Organic Bio-Agro Resources Dhan) is implemented under **Swachh Bharat Mission (Grameen)** by the **Department of Drinking Water & Sanitation, Ministry of Jal Shakti**.
- **National Biofuels Coordination Committee (NBCC)** is the **apex body** for biofuel policy; **Chairperson** – **Union Minister for Petroleum & Natural Gas**.

35. Interstellar Sugar, Astrobiology & Space

Chemistry

- **Recently**, astronomers detected **erythrulose (a four-carbon sugar)** in the **interstellar medium (ISM)** near the centre of the **Milky Way Galaxy**, adding to evidence that life's building blocks may exist in space.
- The discovery was made using **radio telescopes**, which identify molecules through their **characteristic electromagnetic spectra**.
- **Interstellar Medium (ISM):** The matter present **between stars**, consisting of **gas (mainly hydrogen & helium), dust, cosmic rays and magnetic fields**. The ISM is the birthplace of **stars and planetary systems**.
- **Molecular clouds** are the **coldest and densest regions** of the ISM and are the principal sites of **star formation**.
- **Hydrogen** is the **most abundant element** in the Universe, followed by **Helium**.
- **Complex Organic Molecules (COMs)** such as **amino acids, alcohols, aldehydes and sugars** have been detected in interstellar space.
- **Radio telescopes** detect **radio waves** emitted by celestial objects and are extensively used to identify molecules in interstellar clouds.
- Unlike optical telescopes, **radio telescopes can observe through interstellar dust clouds**.
- **James Webb Space Telescope (JWST)** primarily observes in the **infrared**, whereas **Hubble Space Telescope (HST)** mainly observes in the **visible and ultraviolet spectrum**.

36. India–Australia Civil Nuclear Cooperation

- **Recently**, India and Australia finalised the **Administrative Arrangements** under the **India–**

Australia Civil Nuclear Cooperation Agreement (2014), enabling **commercial exports of Australian uranium** to Indian entities for **peaceful civil nuclear purposes**.

- The arrangements operationalise the Agreement by prescribing procedures for **tracking, accounting, transport and verification** of Australian nuclear material supplied to India.
- Australia possesses **one of the world's largest uranium reserves**, making it a key long-term partner for India's clean energy transition.
- The agreement is based on **IAEA safeguards** and Australia's requirement that supplied uranium be used **only for peaceful purposes**.
- **India is not a signatory to the Nuclear Non-Proliferation Treaty (NPT)**, but it has concluded **civil nuclear cooperation agreements** with several countries, including **USA, France, Russia, Canada, Australia, Japan and Kazakhstan**.
- India obtained a **clean waiver from the Nuclear Suppliers Group (NSG)** in **2008**, allowing international civil nuclear trade despite being a non-NPT state.

37. Trial in Absentia (Section 356, BNSS, 2023)

- **Recently**, the NIA sought to invoke **Section 356 of the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023** to conduct the **trial in absentia** of **Hafiz Saeed**, who has been declared a proclaimed offender and is absconding outside India.
- **Trial in Absentia** means conducting a **criminal trial in the absence of the accused**.
- It is provided under **Section 356 of the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023**.
- The provision applies **only to a Proclaimed Offender**, **not** to every absconding accused.
- A person can be tried in absentia **only if**:
 - ❑ He has been **declared a Proclaimed Offender** under **Section 84 of BNSS**.
 - ❑ He has **absconded to evade trial**, and
 - ❑ There is **no immediate prospect of arrest**.
- Trial in absentia is available **only for offences punishable with imprisonment of 10 years or more, life imprisonment or death**.
- Before commencing such trial, the court must ensure:
 - **Two consecutive arrest warrants** issued at least **30 days apart**.
 - Public notice in a **newspaper** giving the accused **30 days** to appear.
 - Notice displayed at the accused's last known residence and served on a relative/friend.
 - Trial can commence **only after 90 days** from the date of framing of charges.
 - If the accused has **no lawyer**, the court must appoint a **defence counsel at State expense**.

- **Witness testimony** may be recorded through **audio-visual electronic means** and preserved for future judicial review.
- If the accused later **appears or is arrested**, the court may permit **cross-examination of witnesses** in the interest of justice.

38. Ravidassia community & Guru Ravidas

- **Recently**, members of the **Ravidassia community** demanded recognition of "**Ravidassia**" as a **separate religion** in the forthcoming Census.
- **Guru Ravidas (c. 15th–16th century)** was a prominent **Bhakti Movement saint** and a leading exponent of the **Nirguna Bhakti tradition**.
- He preached **equality, dignity of labour, universal brotherhood and devotion (Bhakti)**, while rejecting **caste discrimination, untouchability and ritualism**.
- **Guru Ravidas was a contemporary of Kabir and Guru Nanak** and is believed to have been associated with **Sant Mirabai**.
- He was born in **Seer Govardhanpur (Varanasi), Uttar Pradesh**, which is now an important pilgrimage centre.
- **Forty-one (41) hymns** composed by **Guru Ravidas** are included in the **Guru Granth Sahib**, the holy scripture of Sikhism.
- His teachings centred on the ideal of '**Begampura**'—a utopian city free from **caste, inequality, oppression and suffering**.
- The **Ravidassia community** traces its spiritual lineage to **Guru Ravidas** and primarily comprises followers from **Punjab, Uttar Pradesh and adjoining regions**.
- The **Ravidassia religion** formally emerged after the **2009 Vienna (Austria) attack** on **Sant Niranjan Dass** and **Sant Ramanand Dass**.
- The principal scripture of the Ravidassia faith is **Amritbani Guru Ravidass Ji**, which contains the teachings and hymns of **Guru Ravidas**.
- Their principal places of worship are known as **Ravidas Deras** or **Ravidassia Bhawans**, though many followers also worship in **Gurdwaras**.
- **Guru Ravidas Jayanti** is celebrated on **Magh Purnima** (full moon day of the Hindu month of Magha).

39. Bhojshala Complex

- **Bhojshala** is a **protected monument** located in **Dhar district, Madhya Pradesh**.
- It is traditionally associated with **Goddess Saraswati (Vagdevi)** and is believed to have been established during the **Paramara dynasty**.

- The monument is named after **King Bhoja** (c. 1010–1055 CE), one of the most celebrated rulers of the **Paramara dynasty**.
- **King Bhoja** founded the city of **Dhar** as his capital and is renowned as a scholar-king and patron of education, literature and temple architecture.
- The **Paramara dynasty** ruled parts of **Malwa** (present-day Madhya Pradesh) between the 9th and 14th centuries CE.
- Bhojshala is presently a **centrally protected monument** under the **Archaeological Survey of India (ASI)**.
- Ancient Monuments and Archaeological Sites and Remains (AMASR) Act, 1958, provides for the **preservation and protection of ancient monuments and archaeological sites of national importance**.

40 . Jagannath Rath Yatra

- Jagannath Rath Yatra is an ancient Hindu festival that commemorates the annual journey of Lord Jagannath, Lord Balabhadra, and Goddess Subhadra from the Jagannath Temple to the Gundicha Temple in Puri, Odisha.
- **Jagannath Temple** is located at **Puri, Odisha**, one of the **Char Dham** pilgrimage sites established by **Adi Shankaracharya**.
- The present temple was built by **Anantavarman Chodaganga Deva** of the **Eastern Ganga Dynasty** (12th Century CE).
- It is built in the **Kalinga (Rekha Deula)** style of **Nagara architecture**.
- The temple is dedicated to **Lord Jagannath (Vishnu/Krishna)**, **Balabhadra** and **Goddess Subhadra**.
- The idols are made from **sacred Neem wood (Daru)**, unlike the stone idols found in most Hindu temples.
- **Nabakalebara** is the ritual of replacing the wooden idols with newly carved ones at intervals of **12–19 years** (whenever there are **two Ashadha months** in a lunar year).
- The sacred neem tree selected for carving the idols is called **Daru Brahma**.
- The **Nilachakra** atop the temple is made of **Ashtadhatu (eight-metal alloy)**.
- The temple kitchen (**Rosha Ghara**) is regarded as the **largest functioning temple kitchen in the world**.
- **Mahaprasad** offered at the temple is popularly known as **Abadha**.
- The temple is managed under the **Shri Jagannath Temple Act, 1955**.

41. Kudankulam Nuclear Power Plant (KKNPP)

- **Recently**, reports emerged of a **data breach** involving a **contractor's server** associated with the **Kudankulam Nuclear Power Plant (KKNPP)**. NPCIL clarified that the exposed information pertained to **conventional plant systems** and **did not involve nuclear safety or reactor control systems**.
- **Kudankulam Nuclear Power Plant (KKNPP)** is located at **Kudankulam, Tirunelveli district, Tamil Nadu**.
- It is India's **largest nuclear power station** in terms of **installed/planned capacity**.
- The project is implemented by the **Nuclear Power Corporation of India Limited (NPCIL)**.
- KKNPP is being developed under the **India–Russia Inter-Governmental Agreement (1988)**.
- Russia's **Rosatom** is the principal international partner for the project.
- **Units 1 & 2** are operational, while **Units 3–6** are under various stages of construction.
- KKNPP uses **VVER-1000** reactors.
- **VVER** stands for **Water-Water Energetic Reactor (Russian: Vodo-Vodyanoi Energetichesky Reaktor)**.
- VVER is a **Pressurised Water Reactor (PWR)** using:
 - ☐ **Light water as coolant**
 - ☐ **Light water as moderator**
 - ☐ **Low-enriched uranium as fuel**.
- Unlike **Boiling Water Reactors (BWRs)**, **water in a PWR does not boil inside the reactor core**.

42. India Semiconductor Mission (ISM) 2.0

- **Recently**, the Union Cabinet approved **India Semiconductor Mission (ISM) 2.0** with an outlay of **₹1.27 lakh crore** for **2026–2032** to strengthen India's semiconductor ecosystem, promote domestic value addition and build supply-chain resilience.
- **India Semiconductor Mission (ISM)** was launched in **2021** under the **Semicon India Programme**.
- **Nodal Ministry: Ministry of Electronics & Information Technology (MeitY)**.
- **India Semiconductor Mission (ISM)** functions as an **Independent Business Division within Digital India Corporation (DIC)**.
- The mission aims to develop the **entire semiconductor value chain**:
 - **Chip Design**
 - **Wafer Fabrication (Fab)**
 - **ATMP (Assembly, Testing, Marking & Packaging)**
 - **OSAT (Outsourced Semiconductor Assembly & Test)**
 - **Display Manufacturing**
 - **Compound Semiconductors**
- **ISM 2.0** shifts focus from only fabrication to **upstream supply-chain industries**, including:

- Semiconductor-grade gases
- Specialty chemicals
- Silicon wafers
- Photomasks
- Capital equipment
- Advanced packaging materials

43. Specified Non-Financial Assets (SNFA)

- **Recently**, RBI introduced the concept of **Specified Non-Financial Assets (SNFAs)** under the **Commercial Banks (Resolution of Stressed Assets) Directions, 2025** (Third Amendment Directions, 2026) to regulate the acquisition, valuation and disposal of non-financial assets acquired from defaulting borrowers.
- SNFAs are **non-financial assets**, primarily **immovable properties**, acquired by banks during the resolution of stressed loans.
- They include: Residential properties + Commercial buildings + Industrial land + Other real estate accepted in loan settlement.
- An SNFA can be acquired **only after the loan is classified as a Non-Performing Asset (NPA)**.
- Acquisition should involve **full or partial settlement** of outstanding dues.
- Disposal should preferably be through **transparent public auction** following **SARFAESI Act principles**.
- **Banks cannot sell SNFAs back to:** Original borrower + Related parties + Connected entities.
- RBI has mandated **independent valuation by at least two external valuers**.
- Asset shall be recorded at the **lower of Net Book Value (NBV) or Distress Sale Value (DSV)** to avoid overvaluation.
- **Securitisation and Reconstruction of Financial Assets and Enforcement of Security Interest (SARFAESI) Act, 2002.**
- ❑ Enables banks to **enforce security interests and auction secured assets without prior court intervention**.
- ❑ Applicable mainly to **secured loans**.

44. Corporate Average Fuel Economy (CAFE) Norms

- **Recently**, the Government released the **Draft CAFE-III Norms** for stakeholder consultation. The norms will apply to **M1 category passenger vehicles** manufactured or imported during **2027–28 to 2031–32** and introduce **Carbon Neutrality Factors (CNFs)** for low-carbon fuels.
- CAFE stands for **Corporate Average Fuel Economy**.

- They prescribe the **average fuel efficiency / CO₂ emission target** for the **entire fleet of passenger vehicles sold by a manufacturer, not for an individual vehicle**.
- Applicable to **M1 Category Passenger Vehicles**.
- Covers **vehicles manufactured or imported for sale in India**.
- Compliance is measured at the **manufacturer (corporate) level**, not vehicle-wise.
- **CAFE III – Major Changes**
- ❑ Introduces **Carbon Neutrality Factors (CNFs)**.
- ❑ Recognises **life-cycle carbon emissions**, not merely tailpipe emissions.
- Renewable fuels eligible for CNF benefits include: **Ethanol + Compressed Biogas (CBG) + Other approved biofuels**.
- Manufacturers can claim **reduction in declared CO₂ emissions** for using such fuels before compliance assessment.
- Compliance will be assessed in **two blocks** instead of annually: **2027–28 to 2029–30 & 2030–31 to 2031–32**

45. HPV (Human Papillomavirus)

- **Recently**, Delhi intensified its HPV vaccination drive under the **National HPV Vaccination Programme (2026)** targeting **14-year-old girls** to prevent cervical cancer.
- **HPV (Human Papillomavirus)** is a **double-stranded DNA, non-enveloped virus** belonging to the **Papillomaviridae** family.
- **Persistent** infection with **high-risk HPV** is responsible for more than **95% of cervical cancer** cases.
- **Transmission:** Primarily through **sexual contact**; most infections are **asymptomatic and self-limiting**.
- **CERVAVAC** is India's **first indigenous quadrivalent HPV vaccine**, developed by **Serum Institute of India (SII)** with **DBT & BIRAC** support.
- **WHO** recommends routine vaccination of **girls aged 9–14 years**, preferably **before sexual debut**; many countries also vaccinate boys.
- The HPV vaccine is a series of shots that can protect you from an HPV infection.
- It prevents HPV infections that can progress to cancer or genital warts.
- Once a person gets HPV, the vaccine may not be as effective.
- The HPV vaccine isn't given during pregnancy.
- **Cervical cancer** is the **4th most common cancer among women globally** and among the **leading causes of cancer deaths in Indian women**.

46. Polymer Currency Notes

- The Reserve Bank of India (RBI) has initiated trials for **polymer-based currency notes** by floating a tender through its subsidiary **Bharatiya Reserve Bank Note Mudran Private Limited (BRBNMPL)** for procurement of polymer substrates.
- Polymer notes are banknotes printed on **Biaxially Oriented Polypropylene (BOPP)** substrate instead of cotton-based paper.
- **BOPP** is a **thermoplastic polymer** produced from **polypropylene**, offering high strength, flexibility and moisture resistance.
- They possess advanced security features and have a significantly longer circulation life than conventional paper notes.
- Polymer banknotes were **first introduced by Australia in 1988**.
- **BRBNMPL (Bharatiya Reserve Bank Note Mudran Pvt. Ltd.)**
- ❑ Wholly owned subsidiary of the **Reserve Bank of India (RBI)**.
- ❑ Operates currency printing presses at **Mysuru (Karnataka)** and **Salboni (West Bengal)**.
- India currently uses **cotton-based banknote paper**, composed mainly of **cotton and cotton rag fibres**, not wood pulp.
- Under **Section 22 of the RBI Act, 1934**, the **Reserve Bank of India has the sole right to issue banknotes** in India.

47. Mansbal Lake

- Recently, **Mansbal Lake** in **Ganderbal district, Jammu & Kashmir**, witnessed the return of **migratory birds** after years of ecological degradation.
- Restoration measures such as **dredging, de-weeding, channel restoration and water budgeting** have improved the lake's ecological health.
- **Mansbal Lake** is the **deepest freshwater lake in Kashmir Valley**.
- Located in **Ganderbal district**, about **30 km north of Srinagar**.
- It is primarily **fed by underground springs** and drains into the **Jhelum River** through the **Sindh Nallah**.
- The lake is famous for its extensive **lotus (Nelumbo nucifera)** growth.
- It is an important habitat for **resident and migratory waterbirds** along the **Central Asian Flyway (CAF)**.
- Common migratory birds recorded include **Mallard, White-headed Duck, Eurasian Hoopoe, Grey-backed Shrike, Horned Grebe and Long-eared Owl**.
- The **Central Asian Flyway (CAF)** covers **30 countries** and supports the migration of over **280**

species of waterbirds; India lies on this major migratory route.

48. Indus Waters Treaty (IWT)

- Recently, the **Indus Waters Treaty (1960)** has again come into focus following India's decision to keep the Treaty in **abeyance** after the **Pahalgam** terrorist attack.
- The **Indus Waters Treaty (IWT)** was signed between **India and Pakistan** on **19 September 1960** at **Karachi**, with the **World Bank** as a signatory and facilitator.
- Signed by **Prime Minister Jawaharlal Nehru (India)** and **President Ayub Khan (Pakistan)**.
- Allocates the **Eastern Rivers (Ravi, Beas and Sutlej)** to **India** and the **Western Rivers (Indus, Jhelum and Chenab)** to **Pakistan**.
- India has **exclusive rights** over Eastern rivers, subject to certain Treaty obligations.
- India is permitted **non-consumptive use, domestic use, irrigation and run-of-the-river hydropower projects** on the Western Rivers, subject to treaty provisions.
- Established the **Permanent Indus Commission (PIC)** with one Commissioner from each country to facilitate cooperation and resolve technical issues.
- Provides a **graded dispute resolution mechanism**—Permanent Indus Commission → Neutral Expert → Court of Arbitration.
- The **Indus Basin** extends across **China, India, Pakistan and Afghanistan**, although the Treaty is **only between India and Pakistan**.
- **Major Indian Projects under IWT**
- **Kishanganga Hydroelectric Project** – Jhelum basin.
- **Ratle Hydroelectric Project** – Chenab.
- **Baglihar Hydroelectric Project** – Chenab.
- **Pakal Dul Project** – Marusudar (Chenab tributary).

49. National Maritime Heritage Complex (NMHC), Lothal

- Recently, the **National Maritime Heritage Complex (NMHC)** at **Lothal, Gujarat** is nearing inauguration. The first phase includes a **life-size recreation of the Harappan town of Lothal**, showcasing its dockyard, markets and maritime legacy to highlight India's **4,500-year-old seafaring tradition**.
- **National Maritime Heritage Complex (NMHC)** is being developed at **Lothal, Gujarat** under the **Ministry of Ports, Shipping & Waterways (MoPSW)**. It aims to become the **world's largest maritime museum**.
- The centerpiece of the museum is an **80 m × 80 m life-size reconstruction of the Harappan town of Lothal**.

- Lothal is famous for the **world's earliest known man-made dockyard**, located on the banks of **Bhogavo River**.
- Excavations at Lothal were carried out by the **Archaeological Survey of India (ASI)** between **1955–62** under **S. R. Rao**.
- Important discoveries at Lothal include: **Dockyard + Bead-making factory + Warehouse + Fire altars + Standardized weights and measures + Seals with Indus script**.
- The museum traces India's maritime history from the **Harappan period to the modern era**, including ancient trade with **Mesopotamia, Egypt and West Asia**.
- **Lothal** is one of the important sites included in India's **UNESCO Tentative List**.
- Lothal maintained maritime trade with **Mesopotamia (Sumer), Bahrain (Dilmun) and Oman (Magan)**.
- The city followed a **grid-pattern layout** with a **citadel** and **lower town**, typical of mature Harappan urban planning. Like other Harappan sites, it had an **advanced drainage and sanitation system**.

50. Electronic Gold Receipts (EGRs)

- Recently, **SEBI** introduced the **Electronic Gold Receipts (EGRs)** segment on stock exchanges, **Electronic Gold Receipt (EGR)** is a **SEBI-regulated security** representing ownership of **physical gold** deposited in **SEBI-accredited vaults**.
- EGRs are traded on recognised stock exchanges such as **NSE** and **BSE**, similar to equity shares.
- They are held in **demat accounts** and settled through the **depository system**.
- Every EGR is backed by **995 purity gold** stored in accredited vaults.
- Standard denominations include **995 mg, 5 g, 10 g, 100 g and 1 kg**.
- Investors can **convert EGRs into physical gold** by surrendering the receipt and paying applicable vaulting and delivery charges.
- EGRs facilitate **transparent price discovery**, nationwide trading and assured purity.
- Trading follows the normal stock market timings with **T+1 settlement**.
- The framework for EGRs was introduced through the **SEBI (Vault Managers) Regulations, 2021**.
- **Vault Managers** are SEBI-registered entities responsible for storage, assaying and issuance/redemption of EGRs.
- The **India International Bullion Exchange (IIBX)** at **GIFT City** facilitates international bullion trading, while **EGRs are traded on domestic stock exchanges**.
- **EGR ≠ Sovereign Gold Bond (SGB):**

- ❑ **EGR:** Backed by physical gold stored in vaults.
- ❑ **SGB:** Government security issued by RBI, linked to gold prices and carries interest.
- **EGR ≠ Gold ETF:**
- ❑ **EGR:** Direct claim on specific physical gold with redemption option.
- ❑ **Gold ETF:** Mutual fund investing in gold; redemption is generally in cash.

51. Vikram-1 Launch Vehicle

- Recently, **Skyroot Aerospace** successfully launched **Vikram-1** under the '**Aagaman**' mission, making **India the third country** after the **USA and China** whose **private sector** has independently placed a payload into orbit.
- **Vikram-1** is India's **first privately developed orbital launch vehicle**.
- Vikram-1 is a **four-stage, all-solid-fuel Small Satellite Launch Vehicle (SSLV class)** in **first 3 stages and fourth stage is liquid** designed to place **small satellites into Low Earth Orbit (LEO)**.
- The rocket extensively uses **Carbon Fibre Reinforced Polymer (CFRP)**, making it significantly lighter than conventional metallic structures.
- The **Raman engine** incorporates **3D-printed components** manufactured through **additive manufacturing**, reducing component count, weight and production time.
- **3D Printing (Additive Manufacturing)** builds components layer-by-layer, unlike conventional subtractive manufacturing.
- **Polar Satellite Launch Vehicle (PSLV)** uses **solid + liquid stages**.
- **Solid propellant rockets** are mechanically simpler, easier to store and provide high initial thrust but **cannot be throttled or restarted** after ignition.
- It is the **second mission** of Skyroot after the successful **Vikram-S** suborbital flight on **18 November 2022**, which became the **first private Indian rocket to reach space**.
- All stages of the launch vehicle have been **integrated and stacked** at the launch pad.
- **Vikram-1** is designed to place **small satellites into Low Earth Orbit (LEO)**.
- **Low Earth Orbit (LEO):** Extends from about **160 km to 2,000 km** above Earth; commonly used for Earth observation, communication constellations and scientific satellites.

52. Long Duration Energy Storage (LDES)

- **Long Duration Energy Storage (LDES)** refers to technologies capable of supplying electricity for **8 hours or more** after charging.

- It addresses **daily, weekly and even seasonal** mismatch between renewable generation and electricity demand.
- **LDES is a functional classification, not a single technology.**
- **Why is LDES Needed?**
- ❑ Solar generation falls after sunset (**Duck Curve** problem).
- ❑ Wind generation is intermittent and weather-dependent.
- ❑ Helps achieve **Round-the-Clock (RTC)** renewable power.
- ❑ Reduces renewable energy curtailment.
- ❑ Provides **firm and dispatchable renewable energy.**

Technology	Working
Pumped Hydro Energy Storage (PHES)	World's most mature LDES technology; stores energy as gravitational potential energy of water.
Compressed Air Energy Storage (CAES)	Requires underground geological formations such as salt caverns or depleted gas reservoirs.
Flow Batteries	Electrolyte stored in external tanks; power and energy capacity can be scaled independently.
Thermal Energy Storage	Uses molten salts, rocks or phase-change materials; common in Concentrated Solar Power (CSP) plants.
Hydrogen Storage	Surplus renewable electricity → Electrolysis → Green Hydrogen → Electricity through fuel cells/turbines.
Gravity Storage	Uses lifted concrete blocks/mineshafes instead of water reservoirs.

53. Magnetic Levitation (Maglev) train

- Maglev trains operate using **levitation, guidance and propulsion** generated through magnetic fields.
- Two principal technologies are **Electromagnetic Suspension (EMS)** and **Electrodynamic Suspension (EDS)**.
- EMS employs **electromagnetic attraction**, whereas EDS uses **repulsive force generated by superconducting magnets.**
- EDS generally requires the train to attain minimum speed before **stable levitation.**
- Propulsion is provided through a **Linear Synchronous Motor (LSM)** that creates a travelling magnetic field.
- Maglev requires **dedicated guideways** and cannot operate on conventional railway tracks.
- Absence of wheel-rail contact eliminates **rolling friction**; aerodynamic drag remains the primary resistance.

- Shanghai Maglev is the world's first commercial high-speed maglev line, while Japan's **SCMaglev** holds the world speed record (603 km/h).
- Superconducting magnets used in EDS exhibit **zero electrical resistance below the critical temperature** and **Meissner Effect.**
- Applications include **magnetic bearings, MRI systems, flywheel energy storage and semiconductor manufacturing.**

54. Qdenga (TAK-003)

- The **Drugs Controller General of India (DCGI)** has approved **Qdenga (TAK-003)**, developed by **Takeda Biopharmaceuticals (Japan)**, making it **India's first approved dengue vaccine.** The vaccine is indicated against **all four dengue virus serotypes (DENV-1, DENV-2, DENV-3 and DENV-4)** and will be manufactured in India through a partnership with **Biological E Ltd., Hyderabad.**
- Administered as a **2-dose schedule**, with doses given **3 months apart.**
- Can be administered **irrespective of prior dengue infection; pre-vaccination serological testing is not required.**
- India accounts for nearly **one-third of the global dengue burden**, making universal protection against all serotypes particularly significant.
- Dengue is caused by the **Dengue virus (DENV)**, a **Flavivirus** belonging to the **Flaviviridae** family.
- Transmitted primarily by the **female Aedes aegypti** mosquito; **Aedes albopictus** is also a vector.
- Mosquitoes are **day-biting**, with peak activity during **early morning and late afternoon.**
- Infection with one serotype provides **lifelong immunity to that serotype**, but only **temporary cross-immunity** to the other serotypes.
- **Secondary infection with a different serotype** increases the risk of **Severe Dengue (Dengue Haemorrhagic Fever/Dengue Shock Syndrome)** due to **Antibody-Dependent Enhancement (ADE).**
- Incubation period is generally **4–10 days** after the infective mosquito bite.
- There is **no specific antiviral treatment**; management is primarily supportive.

55. Beta Pictoris d

- Astronomers have discovered **Beta Pictoris d**, orbiting the young star **Beta Pictoris**, about **63 light-years** away.
- The planet was independently detected by two research teams using the **ESO's Very Large Telescope (VLT)** and **NASA's James Webb Space Telescope (JWST),**

with findings published in **The Astrophysical Journal Letters**.

- **Beta Pictoris d** is a **gas giant exoplanet** and the **third known planet** in the Beta Pictoris planetary system.
- It is the **faintest exoplanet ever directly imaged** from Earth, nearly **100 times fainter** than Beta Pictoris b
- The planet orbits **Beta Pictoris**, a **young (~20 million years old) A-type star** located in the **southern constellation Pictor**, about **63 light-years** from Earth.
- It is **slightly larger than Jupiter** and completes one orbit in about **91 years**.
- The discovery was made using the **direct imaging** technique, one of the most challenging methods of exoplanet detection because the host star outshines the planet.
- The European team confirmed the planet after analysing **11 years of archival observations** from the **Very Large Telescope (Chile)**.
- The second team independently detected the planet using **NASA's James Webb Space Telescope (JWST)**.
- The Beta Pictoris system is one of the **few planetary systems with more than two directly imaged exoplanets**, making it an important laboratory for studying planetary system evolution.
- The young age of the system provides astronomers with insights into the **early stages of giant planet formation** and the evolution of planetary systems.
- More than **6,000 exoplanets** have been confirmed so far, but **fewer than 100** have been discovered through **direct imaging**

56. White-bellied Heron (*Ardea insignis*)

- The proposed **1,200 MW Lohit Hydroelectric Project** in Arunachal Pradesh has raised concerns over the survival of the **White-bellied Heron**, one of the world's rarest herons.
- The **White-bellied Heron (*Ardea insignis*)** is one of the **world's rarest and largest heron species**.
- It is classified as **Critically Endangered** on the **IUCN Red List** (since 2007), **Schedule 1 of WPA, 1972 and Appendix I of CITES**
- The species is found in **Bhutan, India, Myanmar and possibly China**, with India supporting a very small remnant population.
- In India, it is currently restricted to **three river systems**:
 - **Namdapha–Noa Dihing River** (Arunachal Pradesh)
 - **Lohit River** (Arunachal Pradesh)
 - **Kamlang River Basin** (Arunachal Pradesh)
- The **Lohit River Basin** is estimated to support nearly **70% of India's White-bellied Heron population**, making it the species' most important habitat in the country.

- It inhabits **fast-flowing, clear rivers** bordered by **undisturbed old-growth forests**, unlike most herons that prefer wetlands and marshes.
- It is an **apex freshwater predator**, feeding mainly on **fish**, along with amphibians and aquatic invertebrates.
- The species is highly sensitive to **changes in river flow, turbidity, sand/gravel extraction and human disturbance**, making it a strong indicator of **healthy river ecosystems**.
- Major threats include **hydroelectric projects, river regulation, habitat fragmentation, illegal fishing practices, mining and climate change**.
- The species was **first scientifically described in 1878** from specimens collected in the **Teesta River basin**, where it is now locally extinct.

57. Prevention of Insults to National Honour (Amendment) Bill, 2026

- The Union Government has introduced the **Prevention of Insults to National Honour (Amendment) Bill, 2026** to bring the **National Song – Vande Mataram** within the ambit of the **Prevention of Insults to National Honour Act, 1971**, in addition to the **National Flag and National Anthem**.
- **Intentional prevention** of singing **Vande Mataram** at any assembly engaged in its rendition would constitute an offence under the proposed amendment.
- The offence is punishable with **imprisonment up to 3 years, fine, or both**, similar to the existing penalty under the Act.
- The amendment is based on the recommendation of the **Committee on Petitions (Rajya Sabha)**.
- **Vande Mataram** was composed by **Bankim Chandra Chattopadhyay** and was first published in the novel **Anandamath (1882)**.
- The **first two stanzas of Vande Mataram** were adopted as the **National Song** by the **Constituent Assembly on 24 January 1950**.
- **Jana Gana Mana** was adopted as the **National Anthem** by the **Constituent Assembly on 24 January 1950**.
- **Article 51A(a)** of the Constitution makes it a **Fundamental Duty** to abide by the Constitution and respect its ideals and institutions, the **National Flag and the National Anthem**; the **National Song is not mentioned** under Fundamental Duties.
- In **Bijoe Emmanuel v. State of Kerala (1986)**, the **Supreme Court** held that **respectful silence** during the National Anthem is protected under **Article 19(1)(a)** and **Article 25(1)**, and citizens cannot be compelled to sing it if it conflicts with their sincerely held religious beliefs.

- **No law at present mandates singing of the National Anthem or the National Song;** existing law penalises only acts amounting to **intentional insult**, not mere non-participation.

58. Internet Shutdowns in India – Legal

Framework

- Following the temporary internet shutdown in parts of Delhi during the CJP protest, the legal framework governing internet shutdowns has again come into focus. Since the **Telecommunications Act, 2023** and the **Telecommunications (Temporary Suspension of Services) Rules, 2024** are now in force, shutdown orders are governed by this updated framework.
- An **internet shutdown** refers to the **intentional disruption of internet or electronic communication services**, rendering them inaccessible or effectively unusable for a specific population or location.
- Internet shutdowns are presently governed by: **Section 20(2) of the Telecommunications Act, 2023**, and **Telecommunications (Temporary Suspension of Services) Rules, 2024**.
- The **Indian Telegraph Act, 1885** and the **Temporary Suspension of Telecom Services (Public Emergency or Public Safety) Rules, 2017** have been replaced by the new legal framework.
- Under **Section 20(2)**, telecommunication services may be suspended **only during a public emergency or in the interest of public safety**, subject to the conditions prescribed under the Rules.
- The **2024 Rules** require that a suspension order:
 - ☐ be issued by the competent authority,
 - ☐ be reasoned in writing,
 - ☐ specify the **geographical area and duration**,
 - ☐ be reviewed by the designated Review Committee,
 - ☐ and consider whether **less restrictive alternatives** would suffice.
- Under the **2024 Rules**, a suspension order **cannot remain in force for more than 15 days**.
- In **Anuradha Bhasin v. Union of India (2020)**, the Supreme Court held that:
 - ☐ **Indefinite internet shutdowns are impermissible**,
 - ☐ shutdown orders must satisfy the **tests of legality, necessity and proportionality**,
- The Supreme Court further observed that **freedom of speech and expression through the internet** is protected under **Article 19(1)(a)**, while restrictions must satisfy **Article 19(2)** of the Constitution.

59. First Oral PCSK9 Inhibitor – Lipfendra

(Enlucitide)

- **Lipfendra (enlucitide)** is the **first FDA-approved oral PCSK9 inhibitor**; previously, all approved PCSK9 inhibitors were **injectable**.
- It is indicated for **adults with hypercholesterolemia**, including **heterozygous familial hypercholesterolemia (HeFH)**, as an adjunct to **diet and exercise**.
- **PCSK9 (Proprotein Convertase Subtilisin/Kexin Type 9)** is a protein produced mainly by the **liver** that binds to **LDL receptors** and promotes their degradation. **Inhibiting PCSK9 increases the number of LDL receptors on liver cells**, thereby enhancing clearance of **LDL cholesterol from blood**.
- **LDL (Low-Density Lipoprotein)** transports cholesterol **from the liver to peripheral tissues**. Excess LDL deposits cholesterol in arterial walls, promoting **atherosclerosis**, and is therefore called **"bad cholesterol."**
- **HDL (High-Density Lipoprotein)** carries excess cholesterol **from peripheral tissues back to the liver** for disposal (**reverse cholesterol transport**) and is commonly termed **"good cholesterol."**
- **Familial Hypercholesterolemia (FH)** is an **autosomal dominant genetic disorder** characterised by markedly elevated LDL cholesterol and an increased risk of **premature cardiovascular disease**. HeFH results from inheritance of one defective allele.
- Elevated **LDL cholesterol** is a major **modifiable risk factor** for **atherosclerotic cardiovascular disease (ASCVD)**, including **coronary artery disease, myocardial infarction and ischemic stroke**.

60. Places in News: Around Bab-el-Mandeb

- **Bab-el-Mandeb Strait** is a strategic chokepoint connecting the **Red Sea** with the **Gulf of Aden**, and ultimately the **Arabian Sea**.
- It separates **Yemen (Asia)** from **Djibouti and Eritrea (Africa)**.
- The strait is divided by **Perim (Mayyun) Island** into **Eastern (Bab Iskender)** and **Western (Dact-el-Mayun)** channels.
- **Djibouti** hosts military bases of several countries, including the **US, France, China and Japan**, owing to its strategic location.
- **Hanish Islands** lie in the southern Red Sea between **Yemen and Eritrea**.
- **Socotra Island (Yemen)**, located east of the Gulf of Aden, is a **UNESCO World Heritage Site** known for its high endemism.
- **Port of Aden (Yemen)** and **Port of Djibouti** are major ports located near the Bab-el-Mandeb shipping route.

61. Project Kusha (Long-Range Surface-to-Air Missile)

- DRDO successfully conducted the **maiden flight test** of the **Long-Range Surface-to-Air Missile (LR-SAM) 'Kusha'** from **Dr APJ Abdul Kalam Island, Odisha**.
- **Project Kusha** is an **indigenous long-range surface-to-air missile (LR-SAM)** programme developed by **DRDO** to provide **area air defence** against aircraft, cruise missiles, UAVs and selected ballistic missile threats.
- The programme seeks to bridge the capability gap between **MRSAM (~70–80 km class)** and the **S-400 Triumf (~400 km class)**, creating an indigenous long-range air-defence layer.
- The programme is expected to comprise **multiple interceptor variants** with progressively increasing engagement ranges (commonly referred to as **M1 with about 150km, M2 with 250 km and M3 with 350-400km**) to create a **layered interception envelope**.
- **Indian Air Force (IAF)** is the **lead user/service** for Project Kusha, while **DRDO** is the development agency.
- The project received **Acceptance of Necessity (AoN)** from the **Defence Acquisition Council (DAC)**.
- **Bharat Electronics Limited (BEL)** is one of the principal industry partners for system integration and production, supporting the **Aatmanirbhar Bharat** initiative.
- Project Kusha is designed as a **network-centric air-defence system**, integrating **long-range surveillance radars, multifunction fire-control radars, command-and-control systems and interceptor missiles** for simultaneous engagement of multiple aerial threats.
- The programme complements—not replaces—existing indigenous air-defence systems such as **Akash, Akash-NG, QRSAM, MRSAM, and VSHORADS**, forming different layers of India's integrated air-defence architecture.

62. Kutki (Picrorhiza kurroa)

- A sustainable cultivation model developed in **Mandi (Himachal Pradesh)** has enabled farmers to cultivate **Kutki (Picrorhiza kurroa)**, an **endangered Himalayan medicinal herb**, using **stolon-based harvesting** instead of uprooting the entire plant. The initiative, led by the **Himalayan Research Group (HRG)** under the **Department of Biotechnology (DBT)**, aims to conserve wild populations while enhancing farmers' incomes.
- **Kutki (Picrorhiza kurroa)** is a **perennial Himalayan medicinal herb** belonging to the **Plantaginaceae** family (formerly placed under **Scrophulariaceae**).
- It is **native to the alpine and sub-alpine Himalayas** and occurs at elevations of **2,700–4,500 m** in **India, Nepal, Bhutan, Pakistan and China (Tibet)**.

- **Medicinally important part: Rhizome/Stolon (underground stem)**, which contains bioactive compounds such as **Picrosides** used in Ayurvedic formulations.
- **Destructive harvesting** by uprooting the entire plant for its underground stem, resulting in severe depletion of wild populations.
- **Sustainable harvesting technique:** Harvest only the **side stolons** while leaving the **mother plant intact**, allowing regeneration and repeated harvesting over several years.
- **Stolon** is a **horizontal creeping stem** that grows along or just below the soil surface, develops **nodes**, and gives rise to new shoots and roots—an important mode of **vegetative propagation**.
- Kutki (*Picrorhiza kurroa*) is officially categorized as **Endangered** on the IUCN Red List, listed under **Appendix II** of CITES

63. INS Malvan

- INS Malvan, the **second Mahe-class ASW Shallow Water Craft built by Cochin Shipyard Limited (CSL), Kochi**, is **also the sixth of 16** such vessels to join the Indian Navy.
- The ship was commissioned on **July 22, 2026**, at the **Karwar Naval Base Built by Cochin Shipyard Limited (CSL), Kochi**.
- **Primary Role:** Detect, track and neutralise **enemy submarines operating in shallow coastal waters (littoral zones)**.
- Besides Anti-Submarine Warfare (ASW), the ships are capable of: **Underwater surveillance + Search & Rescue (SAR) + Low-intensity maritime operations**.
- **Shallow Water Crafts** have a **low draught**, enabling operations in **coastal waters, harbours, estuaries and near-shore zones** where larger warships cannot operate effectively.
- The **16-vessel ASW-SWC Project** was approved by the **Defence Acquisition Council (DAC)** in **2019** to replace the ageing **Abhay-class ASW Corvettes**.
- Of the **16 vessels**:
- **8** are being built by **Cochin Shipyard Ltd (CSL)**
- **8** by **Garden Reach Shipbuilders & Engineers (GRSE)**
- **INS Malvan** is named after **Malvan**, a historic coastal town in **Sindhudurg district, Maharashtra**, associated with **Chhatrapati Shivaji Maharaj's naval legacy**.
- The ship's crest bears the **"Bagh Nakh" (Tiger Claws)**, symbolising **courage, agility, stealth and offensive capability**.
- Over **80% indigenous content**, it is powered by diesel engines with waterjet propulsion, providing high manoeuvrability in shallow coastal waters.

64 . Qdenga (TAK-003): India's First Approved

Dengue Vaccine

- Qdenga (TAK-003) is a **live-attenuated tetravalent dengue vaccine** developed by **Takeda Pharmaceuticals (Japan)**.
- It is designed to provide protection against **all four dengue virus serotypes (DENV-1, DENV-2, DENV-3 and DENV-4)**.
- The vaccine is approved in India for individuals aged **4–60 years**.
- Unlike the earlier **Dengvaxia**, **Qdenga does not require pre-vaccination serological screening** under WHO recommendations.
- Dengue has **four antigenically distinct serotypes**; infection with one serotype provides **lifelong immunity only to that serotype**, while protection against the others is temporary.
- A second infection with a different serotype can lead to **Antibody-Dependent Enhancement (ADE)**, increasing the risk of **severe dengue**.
- Because dengue vaccines mimic natural infection, **vaccine efficacy and safety are closely linked to an individual's prior dengue exposure (serostatus)**.
- India has **all four dengue serotypes** in circulation, making **tetravalent vaccines** particularly important for long-term disease control.
- **Seropositive**: A person who has **detectable antibodies** against the dengue virus, indicating **previous infection or exposure**.
- **Seronegative**: A person with **no detectable dengue antibodies**, indicating **no prior infection** and hence immunologically naïve to dengue.
- A **live-attenuated vaccine** contains a **weakened (attenuated) form of the live pathogen** that can replicate but **does not normally cause disease in healthy individuals**.
- It induces a **strong, long-lasting humoral and cellular immune response**, often with fewer doses.

65. UNESCO World Heritage Committee – New

Inscriptions

- During the **47th Session of the UNESCO World Heritage Committee** held in **Busan (Republic of Korea)**, several new sites were inscribed on the **UNESCO World Heritage List**, including:
 - ❑ **D-Day Landing Beaches (France)**
 - ❑ **Mount Olympus (Greece)**
 - ❑ **Ancient Capitals of Asuka & Fujiwara (Japan)**
 - ❑ **Boma–Badingilo Migratory Landscape (South Sudan)**
- The **World Heritage Committee** is responsible for:

- ❑ Inscribing new World Heritage Sites.
- ❑ Monitoring the conservation status of existing sites.
- ❑ Managing the **List of World Heritage in Danger**.
- ❑ The Committee functions under the **1972 UNESCO World Heritage Convention**.
- It consists of **21 States Parties**, elected by the **General Assembly of States Parties** for a **4-year term**.
- UNESCO classifies World Heritage Sites into: **Cultural + Natural + Mixed**
- A property must satisfy **at least one of the ten Outstanding Universal Value (OUV) criteria** for inscription.
- A site can be placed on the **List of World Heritage in Danger** if threatened by: **Armed conflict + Natural disasters + Uncontrolled urbanisation + Climate change + Pollution**

66. Black Sea Region: Places in News

- A **marginal sea of the Atlantic Ocean**, connected to the **Mediterranean Sea** via the **Turkish Straits**.
- **Bounded by**: **Ukraine, Russia, Georgia, Turkiye, Bulgaria and Romania**.
- Connected to:
 - ❑ **Sea of Marmara → Bosphorus Strait**
 - ❑ **Aegean Sea → Dardanelles Strait**
- **Cretan Sea**: Acts as the open southern marine boundary where the Aegean transitions directly into the main Mediterranean basin.
- Major rivers draining into it include the **Danube, Dniester, Dnieper and Southern Bug..**
- **Odesa** is **Ukraine's largest port on the north-western Black Sea**. A key hub for **grain exports** under the Black Sea maritime trade routes.

67 . National Investment Policy for Urea (NIPU)-2026

- The **Union Cabinet** approved the **National Investment Policy for Urea (NIPU)-2026** to promote **self-reliance in urea production** by encouraging investment in new **gas-based urea plants**.
- **NIPU-2026** aims to increase **domestic urea production** and reduce **import dependence**.
- The policy encourages investment in **new natural gas-based urea manufacturing units**.
- Major features include:
 - **Separate fixed and variable cost components**.
 - **Return on Equity (RoE)** with a **floor of 12% and ceiling of 16%**.
 - Mechanism to mitigate **foreign exchange risk**.
 - Urea is the **most widely used nitrogenous fertilizer** in India.

- It contains **46% Nitrogen (N)**—the highest nitrogen content among solid nitrogenous fertilizers
- To ensure affordability for farmers, urea is heavily subsidized by the Government of India. **Unlike non-urea fertilizers (which fall under the Nutrient Based Subsidy Scheme), the Maximum Retail Price (MRP) of urea is statutorily fixed by the government.**

68. CBDT issues Crypto Asset Reporting Guidance aligned with OECD's CARE

- The CBDT has issued a **198-page Guidance Note** on the **Crypto-Asset Reporting Framework (CARF)** to help **Reporting Crypto-Asset Service Providers (RCASPs)** comply with the reporting obligations under the **Income-tax Act**.
- The framework will facilitate the **Automatic Exchange of Information (AEOI)** on crypto-assets with partner jurisdictions.
- The Guidance Note operationalises India's **Crypto-Asset Reporting Framework (CARF)**.
- It is aligned with the **OECD's CARE**, enabling **automatic exchange of crypto-asset information** with partner jurisdictions.
- The reporting obligation is applicable to **Reporting Crypto-Asset Service Providers (RCASPs)**.
- Information reported by RCASPs will be exchanged through **Automatic Exchange of Information (AEOI)** under applicable international agreements.
- The Guidance Note clarifies that it **does not legalise or regulate crypto-assets**; it only prescribes the **tax reporting framework**.
- Taxpayers are **not required to file an additional return**, but must maintain proper records of purchases, sales, transfers and wallet movements.

69. Places in News – Sudan

- **Khartoum: Capital of Sudan.**
- ❑ Located at the **confluence of the Blue Nile and White Nile**, where they form the **River Nile**.
- ❑ Forms the **Khartoum metropolitan area** along with **Omdurman and Bahri (Khartoum North)**.
- **El-Obeid: Capital of North Kordofan State.**
- ❑ Located about **360 km southwest of Khartoum**.
- ❑ A **major transport and commercial hub** connecting **Khartoum, Kordofan, Darfur and southern Sudan**, making it strategically important in the ongoing conflict.
- **Kordofan Region: A historical region of central Sudan**, comprising: **North Kordofan + South Kordofan + West Kordofan**
- ❑ Acts as a **land bridge between central Sudan and Darfur**.

- **Port Sudan** → On the **Red Sea** (current seat of the Sudanese government during the conflict)
- **Darfur: Known for the Darfur conflict (since 2003) and ongoing humanitarian crisis.**

70. Western Ghats Ecologically Sensitive Area (ESA)

- The **Ministry of Environment, Forest and Climate Change (MoEFCC)** has issued a fresh **draft notification** proposing an **Ecologically Sensitive Area (ESA)** of **56,825.7 sq. km** across the **Western Ghats**.
- The draft proposes restrictions on **mining, quarrying, new thermal power plants and Red Category industries**, while permitting agriculture, plantations and other sustainable livelihood activities.
- **Ecologically Sensitive Areas (ESAs)** are notified under the **Environment (Protection) Act, 1986** to regulate activities in ecologically fragile regions.
- The proposed ESA covers **six States: Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu**.
- The proposal is based on the recommendations of the **High-Level Working Group (HLWG)** headed by **Dr. K. Kasturirangan (2013)**, which recommended protection of about **37% (~59,940 sq. km)** of the Western Ghats.
- The earlier **Western Ghats Ecology Expert Panel (WGEEP)** headed by **Prof. Madhav Gadgil (2011)** had recommended declaring the **entire Western Ghats (~1,29,037 sq. km)** as an Ecologically Sensitive Area.
- The **Western Ghats** were inscribed as a **UNESCO World Heritage Site (2012)** with **39 serial sites** across four States.
- The mountain chain is recognised as one of the world's **36 Biodiversity Hotspots** due to its exceptional **endemism** and species richness.
- It is the origin of major peninsular rivers including the **Godavari, Krishna, Kaveri, Tungabhadra and Periyar**.
- The region supports several endemic and threatened species such as the **Lion-tailed Macaque, Nilgiri Tahr, Malabar Civet and Purple Frog**.
- Major protected areas include **Silent Valley National Park, Periyar Tiger Reserve, Bandipur National Park, Nagarhole National Park, Kudremukh National Park and Anamalai Tiger Reserve**.

71. SHeat2: Oral Therapy for Cervical Cancer

- **ICMR** has developed **SHeat2**, an experimental **oral small-molecule therapy** for cervical cancer, which

targets the **cancer-causing proteins of Human Papillomavirus (HPV)**.

- **Cervical cancer** is caused by **persistent infection with high-risk Human Papillomavirus (HPV)**, with **HPV-16 and HPV-18** accounting for nearly **70% of cases** worldwide.
- **HPV** is a **double-stranded DNA virus** belonging to the **Papillomaviridae** family and is primarily transmitted through **sexual contact**.
- The therapy is intended for **high-grade Cervical Intraepithelial Neoplasia (CIN)** and **early cervical cancer**, and **does not prevent HPV infection** like a vaccine.
- In India, the **indigenously developed Cervavac** (by **Serum Institute of India & DBT**) is a **quadrivalent HPV vaccine** providing protection against **HPV-6, 11, 16 and 18**.
- The **Universal Immunisation Programme (UIP)** currently **does not include HPV vaccination**; however, several States have introduced HPV vaccination programmes for adolescent girls.

72. Nominal Effective Exchange Rate (NEER) & Real Effective Exchange Rate (REER)

- The **Reserve Bank of India (RBI)** uses the **Nominal Effective Exchange Rate (NEER)** and **Real Effective Exchange Rate (REER)** as broad indicators of the external competitiveness of the rupee.
- **NEER (Nominal Effective Exchange Rate)** is the **trade-weighted average** of the rupee's exchange rate against a **basket of currencies** of India's major trading partners **without adjusting for inflation**.
- **REER (Real Effective Exchange Rate)** is the **inflation-adjusted NEER**, reflecting the rupee's competitiveness after accounting for inflation differentials between India and its trading partners.
- The **RBI publishes NEER and REER** using both the **40-currency and 6-currency baskets**, with **2015–16 = 100** as the base year.
- **REER > 100** generally indicates the currency is **relatively overvalued**, while **REER < 100** indicates it is **relatively undervalued**, compared with the base year.
- A **depreciation** of the rupee makes **exports relatively cheaper** and **imports costlier**, whereas **appreciation** has the opposite effect.
- **NEER alone does not measure competitiveness**, as it ignores inflation; **REER is considered a better indicator** of export competitiveness.
- The **Consumer Price Index (CPI)** is used to adjust NEER while computing the **REER**.
- Exchange rate movements are influenced by factors such as **capital flows, crude oil prices, inflation**

differentials, interest rate differentials, current account balance and RBI interventions.

- The RBI follows a **market-determined exchange rate system** with intervention only to **contain excessive volatility**, not to target a fixed exchange rate

73. Prevention of Insults to National Honour Act,

1971

- The **Rajya Sabha** passed the **Prevention of Insults to National Honour (Amendment) Bill, 2026**, which seeks to extend the statutory protection available to the **National Anthem (Jana Gana Mana)** to the **National Song (Vande Mataram)** by amending the **Prevention of Insults to National Honour Act, 1971**.
- The Bill substitutes Section 3 of the **Prevention of Insults to National Honour Act, 1971**, making it an offence to **intentionally prevent the singing of Vande Mataram or cause disturbance to an assembly engaged in its singing**, on the same lines as the **National Anthem**.
- The **Prevention of Insults to National Honour Act, 1971** protects the **National Flag**, the **Constitution of India**, and the **National Anthem** against intentional insult or disrespect; the amendment extends similar protection to the **National Song**.
- **Vande Mataram** was composed by **Bankim Chandra Chattopadhyay** in 1875 and was later included in his novel **Anandamath (1882)**.
- On **24 January 1950**, **Dr. Rajendra Prasad**, President of the Constituent Assembly, declared that **Jana Gana Mana** would be the **National Anthem**, while **Vande Mataram** would enjoy **equal honour as the National Song**.
- **Only the first two stanzas of Vande Mataram** enjoy official recognition as the **National Song**.
- **Jana Gana Mana** was composed by **Rabindranath Tagore** and was adopted as the **National Anthem** on **24 January 1950**. Its full rendition takes **approximately 52 seconds**.
- The **State Emblem of India** is adopted from the **Lion Capital of Ashoka at Sarnath**, while the **National Flag** is governed by the **Flag Code of India, 2002**.
- The **Emblems and Names (Prevention of Improper Use) Act, 1950** prohibits the improper commercial use of specified national emblems, names and official insignia.
- **Article 51A(a)** of the Constitution makes it a **Fundamental Duty** of every citizen to **abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem**. (*The Constitution does not specifically mention the National Song.*)

74. Retrospective Environmental Clearance

(Supreme Court Judgment)

- The **Supreme Court** struck down the **2021 Office Memorandum (OM)** that allowed **retrospective (post facto) environmental clearances** through an administrative mechanism. However, the Court held that **post facto environmental clearance may still be granted in exceptional cases through a notification issued under the Environment (Protection) Act, 1986**, provided it satisfies the tests of **public interest, proportionality and reasonableness**.
- **Environmental Clearance (EC)** is the prior approval required for specified development projects before commencement of construction or operation, to assess and mitigate environmental impacts.
- **Post facto (Retrospective) Environmental Clearance** refers to granting environmental approval **after** a project has already started construction or operations without obtaining prior EC.
- The Court struck down the **2021 Office Memorandum**, holding that such an administrative order **cannot create a permanent mechanism** for retrospective environmental clearances.
- The Court clarified that the **Central Government** may issue **exceptional notifications** under the **Environment (Protection) Act, 1986** in cases involving **overriding public interest**, but **blanket amnesty schemes are impermissible**.
- The ruling preserves the principle that **prior environmental clearance is the norm**, while **post facto approval remains a rare exception**.
- Environmental Clearance in India is governed by the **EIA Notification, 2006**, issued under the **Environment (Protection) Act, 1986**, which classifies projects into **Category A** (MoEFCC appraisal) and **Category B** (State Environment Impact Assessment Authority – SEIAA).
- The **Expert Appraisal Committee (EAC)** (Central level) and **State Expert Appraisal Committee (SEAC)** evaluate projects before recommending grant of Environmental Clearance.
- The judgment reinforces key environmental law principles such as the **Precautionary Principle, Sustainable Development, Polluter Pays Principle, and Inter-generational Equity**, all recognised as part of Indian environmental jurisprudence.

75. IRDAI Reforms for the Insurance Sector

(2026)

- The **Insurance Regulatory and Development Authority of India (IRDAI)** has approved a

comprehensive set of reforms to modernise the insurance sector by improving **ease of doing business, governance, policyholder protection and insurance penetration**, in line with the **Insurance Laws (Amendment) Act, 2025 (Sabka Bima Sabki Raksha Act)**.

- **IRDAI** is a **statutory regulatory body** established under the **IRDA Act, 1999** to regulate, promote and ensure the orderly growth of the insurance and reinsurance industry in India.
- The reforms liberalise norms relating to **investment, capital infusion, transfer of shares and amalgamation of insurers**, while strengthening governance and financial resilience.
- A key reform is the **mandatory tagging of the authorised insurance salesperson** to every insurance proposal, policy and certificate, improving **accountability, transparency and traceability**.
- **IRDAI (Policyholders' Education and Protection Fund) Regulations, 2026** operationalise the **Policyholders' Education and Protection Fund (PEPF)** under **Section 16A of the IRDA Act, 1999**.
- **PEPF** aims to promote **insurance awareness, financial literacy, grievance redressal**, and facilitate the **identification and settlement of unclaimed insurance amounts**.
- The regulator has also introduced **perpetual registration** for insurance intermediaries through an **annual fee mechanism**, replacing periodic renewal to improve ease of doing business.
- **Insurance intermediaries** include **insurance brokers, insurance agents, web aggregators, corporate agents, third-party administrators (TPAs), surveyors & loss assessors, insurance marketing firms (IMFs)** and other entities facilitating insurance distribution.

76. Chandrayaan-5 (LUPEX – Lunar Polar

Exploration Mission)

- **ISRO** and the **Japan Aerospace Exploration Agency (JAXA)** reviewed preparations for **Chandrayaan-5 (LUPEX)**, India's first joint lunar mission, targeted for launch in **2028**.
- The mission will explore the **Moon's south polar region** to study **water ice and subsurface volatiles**.
- **ISRO** is developing the **lander**, while **JAXA** is developing the **rover**. The mission is proposed to be launched aboard **Japan's H3 Launch Vehicle**.
- The rover will carry **seven scientific instruments** to study **lunar water ice, subsurface volatiles, lunar soil (regolith), geology and topography**.

- The mission is designed for a **long-duration surface operation (~100 days)**, significantly longer than Chandrayaan-3.
- Payload participation under discussion with NASA and the **European Space Agency (ESA)** highlighting potential for global collaboration in lunar exploration.
- The mission builds upon the success of **Chandrayaan-3 (2023)**, which made India the **first country to achieve a soft landing near the Moon's south polar region**.
- **Chandrayaan Programme:**
- ❑ **Chandrayaan-1 (2008):** First Indian lunar mission; confirmed the presence of **water/hydroxyl molecules** on the Moon.
- ❑ **Chandrayaan-2 (2019):** Orbiter remains operational and continues scientific observations.
- ❑ **Chandrayaan-3 (2023):** Successful soft landing and rover operations near the lunar south pole.
- ❑ **Chandrayaan-4:** Chandrayaan-4 is India's proposed lunar sample-return mission.
- The **lunar south pole** is of immense scientific interest because it contains **permanently shadowed craters (PSRs)** that may preserve **water ice**, an important resource for future **human habitation and deep-space missions**.

77. Cloudbursts in India

- According to the **India Meteorological Department (IMD)**, a **cloudburst** is an event where **100 mm or more rainfall occurs within one hour** over a **localized area of about 20–30 sq. km**, often triggering **flash floods and landslides**.
- Cloudbursts are most common in the **Himalayan region** (Jammu & Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim) and parts of the **Western Ghats**, where **orographic lifting** forces moisture-laden winds to rise rapidly.
- Formation involves **strong convection**, rapid condensation into **cumulonimbus clouds**, intense updrafts, and sudden collapse of water droplets, resulting in extremely intense rainfall over a small area.
- **Seasonal Pattern:** Most occur between **June & August** under the **southwest monsoon**.
- Cloudbursts are **highly localized and short-lived**, making them difficult to forecast using conventional weather models. Mountainous terrain also creates **radar blind spots** and limits the coverage of **Automatic Weather Stations (AWSs)**.
- **Cloudburst ≠ Heavy Rainfall:** Every heavy rainfall event is **not** a cloudburst. The IMD definition is based on **rainfall intensity and spatial extent**, not merely the damage caused.

78. NavIC (Navigation with Indian Constellation)

- The Government informed Parliament that **NavIC is currently operating in a multi-constellation mode**, as the existing constellation does not have the minimum number of operational satellites required for standalone Positioning, Navigation and Timing (PNT) services.
- ISRO is developing **NVS-03** and additional satellites to restore full independent capability.
- **NavIC (Navigation with Indian Constellation)**, earlier known as the **Indian Regional Navigation Satellite System (IRNSS)**, is India's **indigenous regional satellite navigation system**, developed by ISRO.
- It is designed to provide **accurate Positioning, Navigation and Timing (PNT)** services over **India and up to 1,500 km beyond its borders**, with wider coverage extending into the Indian Ocean Region.
- **NavIC constellation** was originally planned with **7 satellites**:
 - ❑ **3 Geostationary (GEO)** satellites.
 - ❑ **4 Geosynchronous (GSO)** satellites placed in inclined geosynchronous orbits.
- It provides two services:
 - ❑ **Standard Positioning Service (SPS)** – Open for civilian users.
 - ❑ **Restricted Service (RS)** – Encrypted service for authorised users such as defence and strategic agencies.
- It operates primarily in the **L5 and S-band**, while the **second-generation NVS satellites** also support the **L1 band**, improving compatibility with smartphones and commercial GNSS receivers.
- **NVS-01 (2023)** is the first **second-generation NavIC satellite**, carrying an **indigenous Rubidium Atomic Clock** developed by ISRO.
- **Global Navigation Satellite Systems (GNSS)**
 - ❑ **GPS** – United States
 - ❑ **GLONASS** – Russia
 - ❑ **Galileo** – European Union
 - ❑ **BeiDou (BDS)** – China
 - ❑ **QZSS** – Japan (Regional augmentation system)