

Today's Prelims Topics

Why are antivenoms not easily accessible in India?

Context

India records an estimated 58,000 snakebite deaths annually, making it the “snakebite capital” of the world.

What are Antivenoms?

- Antivenoms (or antivenins) are life-saving medicines used to treat snakebites. They work by neutralizing venom toxins in the body.

- **Production:** Animals like horses are injected with small amounts of venom to stimulate antibody production. These antibodies are then harvested and purified to create antivenoms.

- **Snake Venom Composition:**

- It is a lethal cocktail of toxic proteins evolved to immobilize prey and defend against threats.

- **Types of Toxins:**

- **Haemotoxins:**

- Destroy blood cells and disrupt clotting.

- **Neurotoxins:** Block nerve signals, causing paralysis.

- **Cytotoxins:** Dissolve tissue at the bite site.

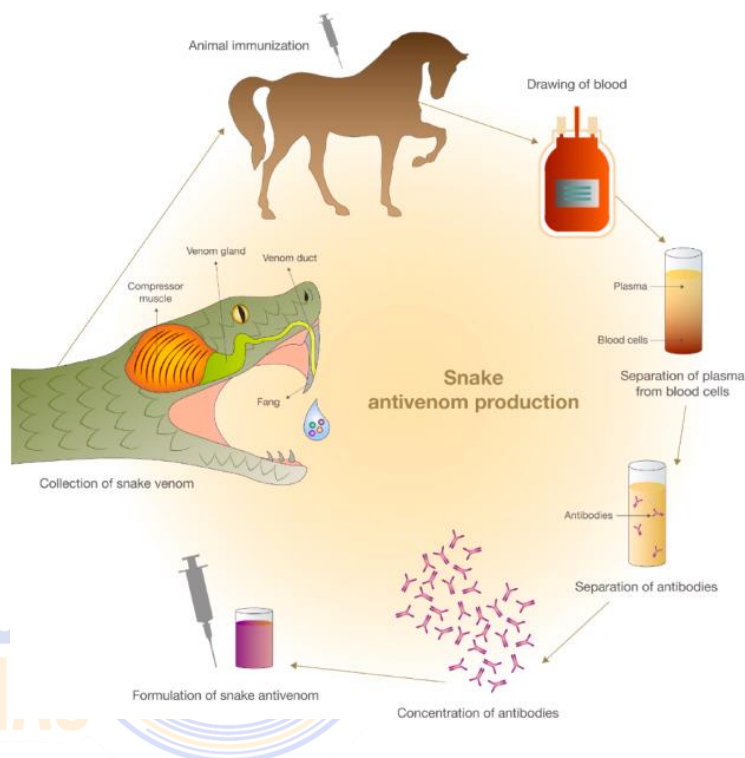
- **Function:** Antivenoms bind specifically to venom toxins, neutralizing their effects and allowing the body to clear them.

- **Challenges in accessing Anti-venoms:**

- **Access Challenges:** Remote areas lack healthcare facilities with antivenoms.
- **Infrastructure Issues:** Cold storage is critical for antivenom preservation, its non-availability in rural areas is an issue.
- **High manufacturing costs**

- **Future of Antivenoms:**

- Researchers are using **recombinant DNA technology** to produce lab-engineered, synthetic antivenoms that are free from animal-derived proteins and offer greater safety and efficacy.



Data on Snakebites in India

- India is home to **310 snake species**, of which:
 - 66 are venomous.
 - 42 are mildly venomous.
 - 23 species are medically significant due to their fatal venom.
- **'Big Four' snakes** cause 90% of bites: Indian cobra, Common krait, Russell's viper & Saw-scaled viper.

Source:

- [The Hindu - Antivenoms](#)



IWT - World Bank-appointed Neutral Expert

Context

The World Bank-appointed Neutral Expert has **backed India's stand** on the Indus Treaty against Pakistan.

About Indus Water Treaty (IWT)


The Indus Waters Treaty (IWT)

<p>■ The distribution of waters of the Indus and its tributaries between India and Pakistan is governed by the Indus Water Treaty (IWT).</p>	<p>■ Was signed on Sept 19, 1960, between India, Pakistan and a representative of World Bank after eight years of negotiations.</p>	<p>■ Partition of India cut across the Indus river basin, which has the Indus river, plus five of its main tributaries.</p>
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Western rivers

Chenab, Jhelum, Indus

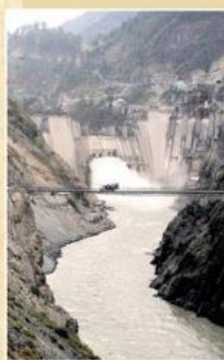
India's rights over these rivers: Limited — can set up certain irrigation, run-of-the-river power plants, very limited storage, domestic and non-consumptive use, all subject to conditions



Eastern rivers

Sutlej, Beas, Ravi


India's rights over these rivers: All exclusive rights lie with India.



Baglihar dam on Chenab

Indus Waters Commission a success story

- Once every five years, conducts a general inspection of all rivers in parts. Total inspection tours so far: Over 100
- Regularly meets once a year. Total meetings thus far, including those for taking up Pak objections: Over 100



Three-stage dispute resolution mechanism under Indus Water Treaty (1960)

- **Permanent Indus Commission (PIC):** The first level of dispute resolution, where either party informs the other of their plans for the Indus River.
- **Neutral Expert:** The **World Bank appoints a neutral expert** to resolve any differences.
- **Court of Arbitration:** If either party is not satisfied with the neutral expert's decision, or if there is a dispute over the treaty's interpretation, the matter goes to a Court of Arbitration.
 - The World Bank appoints the **chair** of the Court of Arbitration.

Neutral Expert's Decision

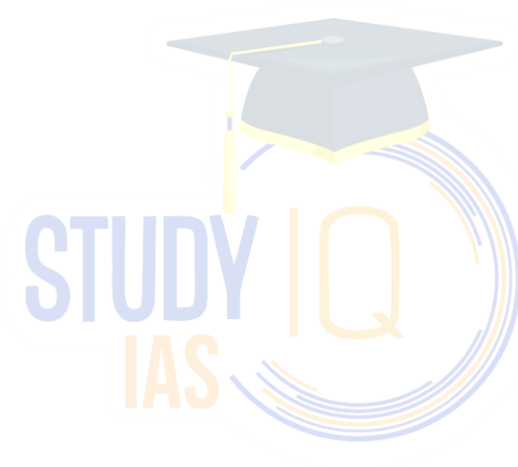
- The Neutral Expert validated India's position that the seven questions referred to him fall under his jurisdiction per Paragraph 7 of Annexure F of the treaty.
- This aligns with India's consistent claim that only the Neutral Expert has the competence to decide these issues.
- The decision marks the beginning of the merits phase, which will evaluate the specific technical differences and lead to a final decision

Hydroelectric projects objected by Pakistan

- **Kishanganga HE Project (330 MW):**
 - It is a run-of-the-river project in **Bandipora (Jammu and Kashmir)**.
 - River Kishanganga is a tributary of **Jhelum**.
 - It requires diverting water from the Kishanganga River through the tunnel to a power plant.
- **Rattle HE Project (880 MW):**
 - It is also a **run-of-river** hydroelectric power project in Kishtwar District of Jammu and Kashmir.
 - It is constructed on **Chenab river**.

Source:

- [The Hindu - Competent to judge Indus Water Treaty](#)



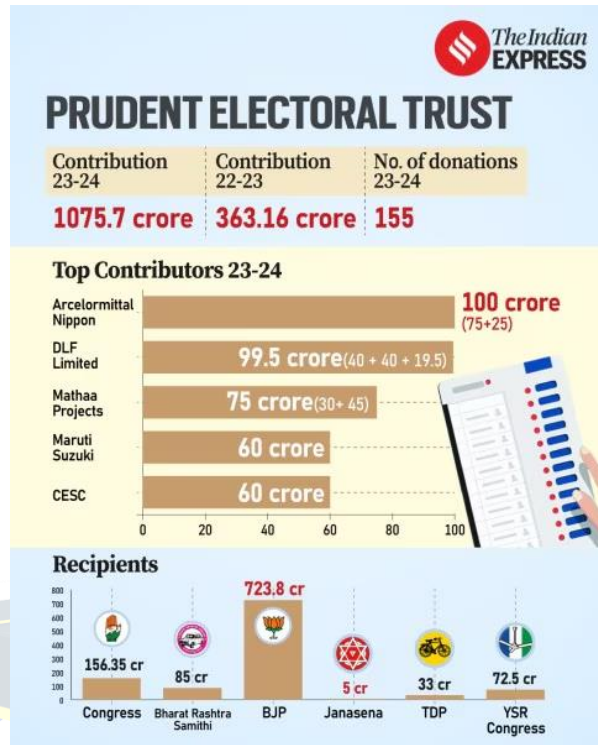
Trust route booms after electoral bond ban

Context

After SC Supreme ban on electoral bonds scheme, donations to political parties saw a significant increase through electoral trusts.

About Electoral trust

- **Formation:** Companies registered under Section 25 of the Companies Act, 1956 can establish electoral trusts.
- **Donor Eligibility:** Indian citizens, companies, firms, Hindu Undivided Families or associations of persons residing in India can donate to electoral trusts (Income tax act, 1961).
- **Renewal and Allocation:** Electoral trusts must renew every three years and allocate at least 95% of their contributions to political parties.
- **Donor Identification:** Donors must provide a PAN (residents) or passport(NRI) number when making donations.



Comparison b/w Electoral Bond and Electoral Trust

Aspect	Electoral Trusts	Electoral Bonds
Transparency in Funding	Offer transparency; public can see who is funding whom in cases of single contributor and beneficiary.	Lack transparency; only the aggregate amount received is reported to ECI.
Donor Anonymity	Contributors' identities are public, though tracing specific donations can be challenging in cases of multiple contributors.	Provide complete anonymity to donors, shielding their identities from public disclosure.
Reporting Requirements	Must submit annual contribution reports to ECI, detailing contributions and donations to parties.	Parties report only the total donations received through bonds to ECI, without specifics on individual donors.
Donation Patterns	Varied donation patterns; some trusts like Prudent Electoral Trust donate significant amounts to multiple parties.	Less transparent due to donor anonymity; specific donation patterns are unclear.

Source:

- [Indian Express - Trust route booms](#)

10th anniversary of Beti Bachao Beti Padhao initiative

Context

The Union government is organising celebrations to commemorate the **10th anniversary of the Beti Bachao Beti Padhao initiative**.

About Beti Bachao Beti Padhao (BBBP) Scheme

- It was launched by the Union Govt. in **January 2015**.
- **Aim:** To address the declining Child Sex Ratio and related issues of empowerment of Women over a lifecycle continuum.
- **Ministry:** Joint initiative of the Ministry of Women and Child Development, Ministry of Health and Family Welfare and Ministry of Education.
- **Since 2021**, the BBBP scheme has been integrated with **Mission Shakti**, a comprehensive program focusing on women's safety and empowerment.
- The scheme has **3 major components**:
 - Mass Communication Campaign on Beti Bachao Beti Padhao.
 - Multi-Sectoral interventions in **100 Gender Critical Districts** covering all States. **Later it was extended to all districts of the country.**
 - A financial incentive-linked scheme - **Sukanya Samridhi Yojna** to encourage parents to build a fund for female children.
- **Main objectives of the scheme:**



Key achievements

- Improvement in the **National Sex Ratio at Birth (SRB)** from 918 in 2014-15 to 930 in 2023-24.
- Rise in the **gross enrolment ratio of girls at the secondary level** from 75.51% in 2014-15 to 78% in 2023-24.
- Increase in institutional deliveries from 61% to 97.3%.

Source:

- [The Hindu - India's national sex ratio at birth in 2023-24](#)

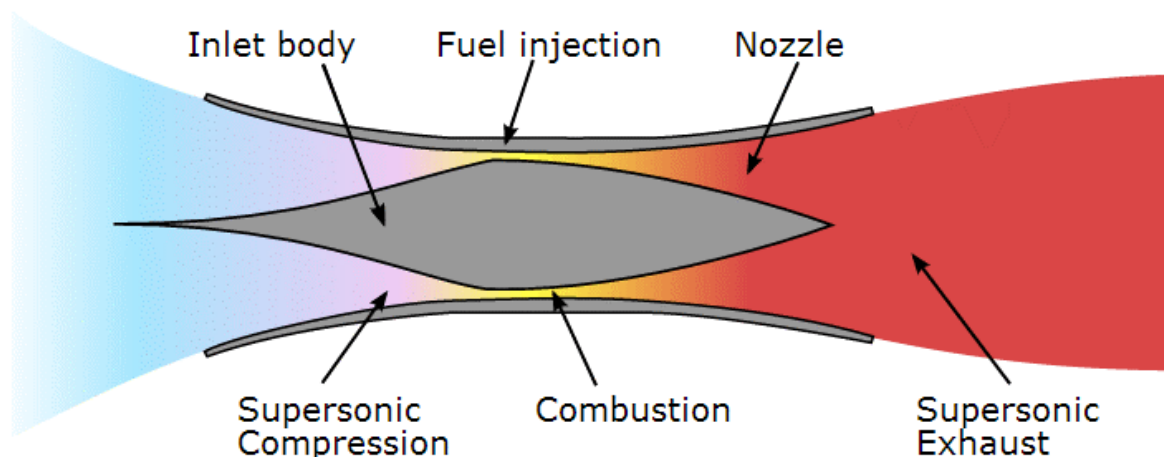
DRDO conducts Scramjet Engine Ground Test

Context

DRDO has successfully conducted the **1st Active Cooled Scramjet Combustor Ground Test in India, running for 120 seconds**

What is a Scramjet Engine?

- A Supersonic Combustion Ramjet engine is an **air-breathing propulsion system** designed for hypersonic speeds.
- **How It Works:**
 - **Air Compression:** Incoming air is compressed due to the vehicle's high speed (no turbines or compressors).
 - **Fuel Injection:** Endothermic fuel is injected into the compressed air.
 - **Supersonic Combustion:** Combustion occurs at supersonic speeds, producing thrust.
- **Advantages:**
 - **High Efficiency:** Utilizes atmospheric oxygen, reducing the need to carry oxidizers.
 - **Reduced Complexity:** No moving parts.
 - **Capability:** Enables speeds greater than Mach 5.
- **Applications:** Hypersonic missiles, spaceplanes and reusable launch vehicles.



The principle of operation of a scramjet engine

About Hypersonic Missiles

- Hypersonic missiles are advanced weapon systems capable of travelling at speeds exceeding Mach 5 (five times the speed of sound, approximately 6,125 km/h).
- **Key Characteristics:**
 - **Speed:** Hypersonic missiles travel at speeds of Mach 5 or higher, enabling them to cover vast distances in a fraction of the time compared to traditional missiles.
 - **Manoeuvrability:** Unlike ballistic missiles, which follow a predictable arc, hypersonic missiles can manoeuvre during flight, making them challenging to detect and intercept.
 - **Trajectory:** They fly within the atmosphere (at altitudes of 20-100 km), avoiding traditional ballistic arcs and complicating radar tracking.
- **Types of Hypersonic Missiles:**
 - **Hypersonic Glide Vehicles (HGVs):** HGVs are launched by rockets and glide to their targets at hypersonic speeds.
 - **Hypersonic Cruise Missiles:** They are powered by **scramjet engines**, maintaining sustained hypersonic speeds throughout their flight.

- **Mach Number:** Ratio of the speed of an object to the speed of sound in the same medium is called the Mach number.
 - Mach > 1 : Subsonic
 - Mach ≈ 1 : Transonic
 - Mach 1 -5: Supersonic
 - Mach < 6 : Hypersonic

Source:

- [PIB - Scramjet Engine Ground Test](#)



Surgical Tele-Robotic System

Context

SSI Mantra has successfully conducted two complex heart surgeries with a patient in Jaipur and the operating surgeon in Gurgaon.

About Surgical Tele Robotic System

- SSI Mantra is a robotic surgical system developed in India by SS Innovations.
- It is a multi-arm system that can be used for a variety of surgical procedures, including urology, gynecology, cardiothoracic and general surgery.
- The system has received regulatory approval from the Central Drugs Standard Control Organisation (CDSCO) in India.
- It performed the robotic beating heart Totally Endoscopic Coronary Artery Bypass (TECAB), considered one of the most complex cardiac surgical procedures.
- **Advantages:**
 - **Reduced blood loss:** Robotic surgery can reduce blood loss, postoperative pain and hospital stay.
 - **Faster recovery:** Robotic surgery can help patients recover faster
 - **Better Precision**
- **Challenges:**
 - High initial cost
 - Skill and training gap to operate intricate robotic systems
 - Ethical concerns (who will be accountable for potential errors).



Source:

- [The Hindu - Two complex heart surgeries, over a distance of 286 km](#)

Yala Glacier

Context

Yala Glacier in Nepal is predicted to disappear by the 2040s due to rapid retreat and mass loss.

About Yala glacier retreat

- **Location:** Langtang Valley, central Nepal.
- It is one of the most studied glaciers in Nepal and represents the Hindu Kush Himalayan region in the World Glacier Monitoring Service (WGMS) database.
- It is the **only glacier in the Himalayas listed on the Global Glacier Casualty List.**
- It has retreated by **680 meters between 1974 and 2021, with a 36%** reduction in area during this period.
- **The Hindu Kush Himalayan (HKH)** cryosphere is warming twice as fast as the global average, leading to rapid glacial retreat.

Global Glacier Casualty List

- It was launched in 2024 by a group of institutions including Rice University, World Glacier Monitoring Service (WGMS), World Meteorological Organization (WMO) and UNESCO.
- It documents **endangered or vanished glaciers.**
- **Glaciers Listed (15):** Pico Humboldt Glacier (Venezuela), Sarenne Glacier (France): Vanished in 2023, Dagu Glacier (China) etc.

Source:

- [Times of India: Yala glacier](#)

Indian Cryptography Research and Quantum Challenges

Context

India is increasingly investing in cryptographic research to secure communications.

About Cryptography

- Cryptography is the science of securing information so that only authorized people can access it.
- It works by converting readable information (**plain text**) into an unreadable format called **ciphertext**.
- **Encryption and Decryption:**
 - **Encryption:** Converting plain text into ciphertext using a key.
 - **Decryption:** Converting ciphertext back into plain text using the same or a different key.
- **Importance of Cryptography:**
 - Protects sensitive information like bank details, emails and medical records.
 - Enables secure communication over the internet (e.g., online shopping, video calls).
 - Prevents unauthorized access to data, ensuring privacy.

Types of Cryptography

- **Symmetric-Key Cryptography:** In this method, the same key is used for both encryption and decryption. E.g.: A door key used by both the owner and the guest to lock and unlock the door.
- **Asymmetric-Key Cryptography (Public-Key Cryptography):** Two keys are used: one for encryption (public key) and another for decryption (private key). Widely used for secure internet communication.
- **Homomorphic Encryption:** Allows calculations to be performed on encrypted data without decrypting it. It is useful for sensitive data stored in the cloud.
- **Quantum Cryptography:** Uses the principles of **quantum mechanics** to make communication highly secure.

Technological Advances in Indian Cryptography

- **National Quantum Mission:** It was approved in **2023**, it aims to:
 - Enable **satellite-based quantum communication** over 2,000 km.
 - Establish inter-city **quantum key distribution** and multi-node quantum networks.
- ISRO has also planned to launch a **quantum-secure satellite**.
- **True Random Number Generation:** A method for generating true random numbers, crucial for creating secure private keys and unhackable passwords.
 - Recently a team of scientists from India's premier institutes published a paper describing a way to generate true random numbers.

Challenges in Cryptography

- **Threat from Quantum Computers:**
 - Quantum computers can solve problems that traditional computers find difficult. This could break many current encryption systems.
 - To counter this, researchers are developing **Quantum-Resistant Cryptography (QRC)**.
- **Data Security Risks:**
 - With more data moving to the cloud, encryption techniques for data storage and transfer are becoming essential.
 - Reports show that **74% of organizations** faced data breaches due to poor encryption.

Source:

- [The Hindu - Indian cryptography research](#)

News in Shorts

Contract Farming

- India has emerged as a major exporter of French fries, largely due to companies directly procuring potatoes from farmers through **Contract Farming**.
- Contract farming is an agreement between farmers and buyers to produce and market agricultural products.
- The agreement specifies the **quantity, quality, price and delivery date of the product**.
- **Advantages for Producers/Farmers:**
 - Increased competitiveness.
 - Assured market and reduced risks.
 - Access to technology, credit, and information.
- **Advantages for Agri-processing Firms:**
 - Consistent supply of quality produce
 - Reduced costs
- **Challenges:**
 - Bias towards firms, exploiting small farmers' bargaining power.
 - Problems with quality cuts, delayed payments and low prices.
 - Lack of legal protection for informal contracts.

Source:

- [Indian Express - how contract farming is a win-win](#)

PIEZO Channels and Their Role

- **PIEZO channels** are proteins that open in response to **pressure** (mechanical force).
- Piezo channels were discovered in 2010 by Dr. Ardem Patapoutian. In 2021, he was awarded the **Nobel Prize in Physiology/Medicine** for this discovery.
- Piezo channels are cellular sensors that convert mechanical forces into electrical signals. They are transmembrane proteins that respond to mechanical stress.
- Piezo channels are **found in all multicellular organisms except fungi and brown algae**.

Recent Discoveries

- **PIEZO2 in Fat Tissue:** It helps us sense changes in fat tissue, which communicates with the brain to control metabolism. It senses mechanical changes (like stretching) in fat, and sends signals to the brain.
- **PIEZO Channels in Gut Stem Cells:** PIEZO channels are essential for the health of the gut and for controlling stem cell behavior in the intestines. They sense **tension** or **stiffness** in the gut tissue, which helps stem cells maintain the gut lining.

Source:

- [The Hindu - In breakthrough, scientists find pressure sensor](#)

Editorial Summary

Trump 2.0: The Implications of a Renewed Unilateralist Agenda on the International Order

Context

Donald Trump was sworn in as the 47th US President in the US.

Key Recent Announcements and Orders by the Trump Administration

- **Withdrawal from International Institutions:** Signed executive orders initiating the U.S.'s withdrawal from the World Health Organization (WHO) and the Paris Agreement on Climate Change.

Why Trump Rolled Back from WHO?



Alleged Mishandling of the COVID-19 Pandemic



Inability To Implement Substantial Structural Reforms



Political Influence



Unfair Financial Burden on the U.S.



- **Protectionist Trade Policies:** Proposed a 25% tariff on imports from Mexico and Canada, signaling potential violations of WTO rules.
- **Unilateralism in Territorial Ambitions:** Expressed ambitions to annex Greenland and the Panama Canal.
 - Stated intentions to include Canada as the 51st state of the U.S., invoking practices reminiscent of imperialist-era conquests.
- **End Birthright Citizenship:** An executive order was signed aiming to end birthright citizenship for children of undocumented immigrants.
- **Onslaught on Multilateral Institutions:** Continued blockage of WTO Appellate Body reforms, further impairing the global trade dispute mechanism.
 - Plans to bypass multilateral treaties and prioritize bilateral negotiations, reflecting a sovereigntist approach.
- **Alarming Statements on Force:** Statements violating norms of non-intervention under the UN Charter, such as coercive territorial ambitions, risk undermining the rule-based international order.

What are its implications?

- **Erosion of Multilateralism:** Potential exit from key institutions like the WHO and WTO would weaken their authority and legitimacy.
 - Violations of UN Charter principles, particularly non-intervention and the prohibition of the use of force, risk eroding the legitimacy of international law.

Global Implication OF US's WHO Withdrawal

- **Financial Instability:** U.S. exit cuts 20% of WHO's budget.
- **Leadership Vacuum:** U.S. withdrawal reduces global health initiative leadership.
- **Pandemic Readiness:** Global pandemic response weakens without U.S. expertise.
- **Power Shift:** China gains influence in global health governance.
- **Surveillance Impact:** WHO-CDC collaboration severed, weakening disease surveillance efforts.

- **Global Trade Instability:** The weakening of the WTO Appellate Body hampers dispute resolution, increasing uncertainty for international trade.
 - Additionally this will limit the ability of developing nations (particularly global south) to push for equitable global trade policies.
- **Revival of Power Politics:** Territorial ambitions signal a regression to 19th-century-style conquest diplomacy, which could embolden other revisionist powers like China and Russia to challenge global norms.
- **Empowering Domestic Policy Influence:** A strengthened majority in Congress may enable smoother implementation of Trump's policies, reducing internal checks on his sovereigntist approach.
- **Global Climate Action Setback:** The U.S., being the **second-largest greenhouse gas emitter**, is crucial for achieving global emission reduction targets. Its exit weakens the collective effort to combat climate change.
 - Additionally it will impact the International Climate Finance Plan and diminish contributions to global climate funds.
 - Also it will create a gap in global climate leadership.

What are the Impacts of Recent Orders and Announcements for India

- **Termination of Birthright Citizenship:** President Trump's executive order ending birthright citizenship could affect Indian families with U.S.-born children, potentially altering their legal status and future opportunities.
- **Trade and Economic Relations:** The 'America First' policy may lead to increased tariffs on Indian goods, impacting India's export economy and trade balance
 - India is expected to boost purchases of U.S. oil and gas following President Trump's initiative to maximize American energy production, affecting India's energy sourcing and trade dynamics.
- **H-1B Visa Reforms:** Potential reforms to the H-1B visa program could impact Indian IT professionals, affecting the technology sector and bilateral workforce exchange.
- **Healthcare:** US withdrawal from WHO disrupts India's health programs like immunization, increases financial strain, affects global health guidelines, but offers India an opportunity to lead global health initiatives and strengthen south-south cooperation.

Sources:

- [The Hindu: Trump 2.0 as disruptor of the global legal order](#)
- [Indian Express: Why Donald Trump's Paris Agreement pullout could have worse consequences than in 2017](#)

What is the status of the Smart Cities Mission?

Context

Smart cities mission nearly a decade later, has faced significant challenges and criticisms, leading to its perceived failure.

Introduction to Smart Cities Mission



- **Launch:** June 2015
- **Valid Till:** 31st March 2025
- **Ministry:** Ministry of Housing and Urban Affairs (MoHUA).
- **Aim:** To create 100 model cities for urban development.
- **Key Components:**
 - **Pan-city Proposals:** IT-enabled services like mobility and waste management.
 - **Area-Based Development (ABD):** Focused on retrofitting, redevelopment, and greenfield projects, confined to specific city zones.
- **Governance Structure:** Managed through **Special Purpose Vehicles (SPVs)** registered under the Companies Act, bypassing traditional city councils.
 - Assumed private company-like governance would deliver better results, excluding local governments.

Challenges and Shortcomings

- **Mismatch with India's Needs:** Framework was based on the Internet of Things (IoT), ideal for advanced economies with existing infrastructure but less suited for India's scenario of lacking basic services.

- **Governance Issues:** The governance model sidelined public involvement and local urban bodies, leading to a lack of ownership and accountability.
- **Infrastructure and Retrofitting Challenges:** Upgrading existing urban infrastructure to smart standards is complex and costly. Many cities lack comprehensive master plans, hindering effective integration of smart technologies.
- **Financial Constraints:** Securing sustainable financing for smart city projects is a significant hurdle. Dependence on public-private partnerships and limited municipal revenues often lead to funding shortfalls.
- **Governance and Coordination Issues:** The creation of Special Purpose Vehicles (SPVs) to manage projects has sometimes resulted in overlapping responsibilities and coordination challenges among various governmental agencies.

Case Study: Shimla Smart City

- **Inclusion:** Shimla was initially excluded from the smart cities list but gained inclusion following a legal challenge in the Himachal Pradesh High Court.
- **Project Proposal:**
 - **ABD Projects:**
 - **Retrofitting (244 acres):** Pedestrian crossings, mobility corridors, underground ducting, parking provisions, eco-adventure tourism, stormwater, and spring water management for water security.
 - **Redevelopment:** Focused on Lower Bazar, Middle Bazar, and Krishnanagar to replace unsafe, dilapidated buildings with modern, earthquake-resistant structures to promote tourism.
- **Budget and Funding:**
 - **Total Investment:** ₹2,906 crore.
 - ₹897.80 crore from Public-Private Partnerships (PPP).
 - ₹101.77 crore via municipal bonds.
 - ₹205.57 crore from external borrowings.
 - ₹348.49 crore from state and central government schemes.
 - Remaining amount from other sources.
- **Execution and Spending:**
 - Only ₹707 crore (24% of the original budget) spent:
 - ₹53 crore on completed projects.
 - ₹654 crore on ongoing projects.
 - **PPP Contributions:** Yet to materialise.

Outcomes and Failures

- **Unmet Goals:** Funds for redeveloping Lower Bazar, Middle Bazar, and Krishnanagar remain unused.
 - Traffic congestion has worsened, with non-motorised mobility neglected.
- **Misallocation of Resources:** ₹2 crore spent on flower pots.
 - Large, obstructive structures for escalators remain non-functional, marring Shimla's iconic valley views.
- **Dwindling Vision:** Lack of meaningful urban governance and public involvement has left the smart city vision unfulfilled.

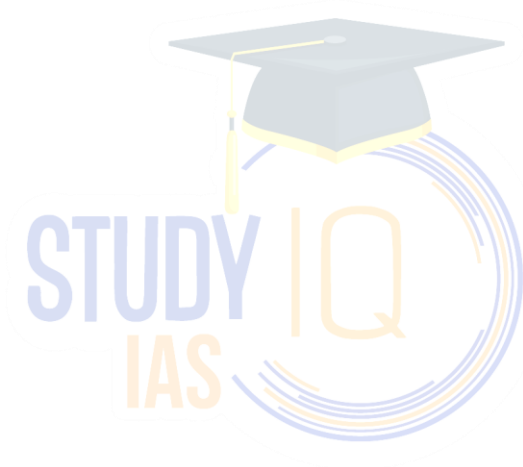
Lessons and Implications

- **Failure of Governance Model:** Projects bypassing local governments and public participation lack ownership and accountability, leading to inefficiencies.
- **Priority Alignment:** Smart cities in India should focus on delivering basic urban services before advancing to IoT-based frameworks.

Way Forward

- **Comprehensive Planning:** Develop detailed city development plans that integrate smart solutions with existing urban frameworks.
- **Innovative Financing:** Explore diverse funding sources, including municipal bonds and international collaborations, to ensure financial sustainability.
- **Strengthened Governance:** Enhance coordination between SPVs and local governments to streamline decision-making processes.
- **Capacity Building:** Invest in training urban planners and officials in the latest technologies and data management practices.
- **Public Engagement:** Implement initiatives to raise awareness and involve citizens in the planning and monitoring of smart city projects.

Source: [The Hindu: What is the status of the Smart Cities Mission?](#)



Need policy for affordable bioethanol

Context

- According to chief engineer Hiroya Ueda of Honda Motor Co Ltd., India has the advantage of achieving carbon neutrality through bioethanol and renewable energy-based electrification.
- But the government needs to create a mechanism to make prices of bioethanol fuel more affordable to make it economically viable for users

What is Bio Ethanol?

- Bioethanol is a type of ethanol (ethyl alcohol, C₂H₅OH) derived from biological sources, primarily used as an alternative fuel to petrol in road transport vehicles.

About Ethanol

- It is a clear, colourless, and flammable liquid. It is also known as Ethyl Alcohol (C₂H₅OH)
- Ethanol is produced through the fermentation of sugars by yeast or other microorganisms.
- Once blended, ethanol cannot be separated from the petrol.
- As the ethanol molecule contains oxygen, it allows the engine to more completely combust the fuel, resulting in fewer emissions and thereby reducing the occurrence of environmental pollution.
- It has a **higher octane number than gasoline**, hence improving the petrol octane number.

Production of Bioethanol

Bioethanol is mainly produced through two methods:

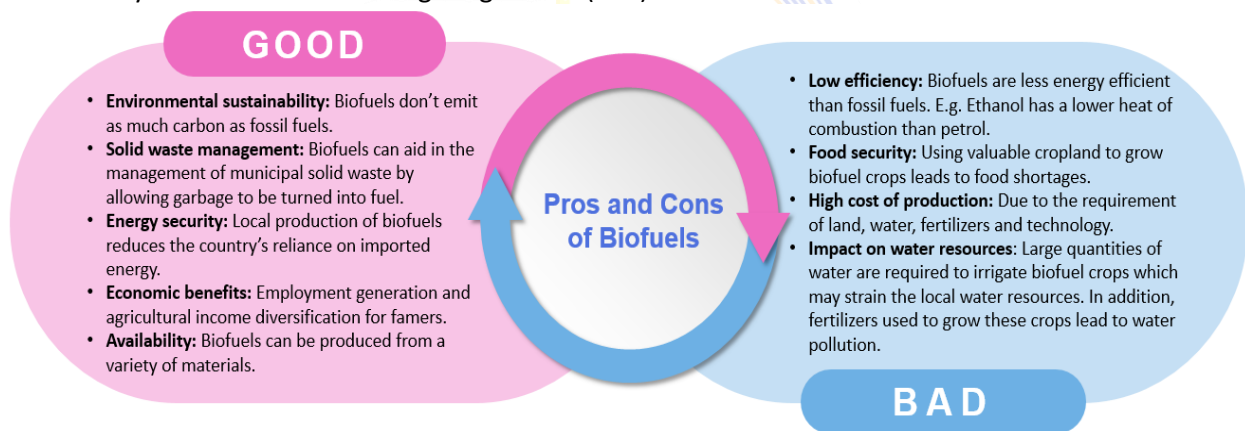
- **Fermentation Process:** The most common method involves fermenting sugars from crops such as corn, maize, wheat, sugar beet, and energy crops like sorghum and Jerusalem artichoke. The sugars from these crops are converted into ethanol by yeast fermentation.
- **Chemical Process:** Ethanol can also be produced by reacting ethylene with steam in a chemical reaction.

Advantages of Bioethanol

- **Renewable Resource:** Bioethanol is produced from crops, a renewable resource, unlike fossil fuels that are finite.
- **Reduction in Greenhouse Gas Emissions:** Grain-based ethanol cuts greenhouse gas emissions significantly by 44 to 52% compared to gasoline, according to the US Department of Energy's Argonne National Laboratory.
- **Extension of Oil Supplies:** Blending bioethanol with petrol helps conserve limited oil supplies, reducing dependence on oil-producing nations, and **contributing to fuel security**.
- **Rural Economy Benefits:** Increased demand for bioethanol leads to the growth of energy crops, thereby benefiting the rural economy.
- **Environmental Safety:** Bioethanol is biodegradable and far less toxic than fossil fuels, causing minimal environmental pollution if spilled.
- **Improved Air Quality:** Bioethanol can reduce carbon monoxide emissions, especially in older vehicle engines, improving air quality.
- **Integration with Existing Infrastructure:** Bioethanol can be blended with petrol up to 10% (E10) without requiring modifications to vehicle engines or warranties. It can also be used in flexible fuel vehicles (E85, up to 85% ethanol).
- **Oxygenation of Fuel:** Blending ethanol with petrol allows for more complete combustion, reducing pollutants and improving fuel efficiency.

What are the Challenges Associated with Ethanol Blending?

- **Production Challenges:** The government's target to achieve 20% ethanol-blended petrol by 2024-25 is facing setbacks due to restrictions on ethanol production from sugarcane juice in 2023-24.
- **Vehicle Compatibility:** Vehicles in India are currently designed for E0 and calibrated for E10 (10% ethanol blend).
 - Using E20 (20% ethanol blend) may result in a loss of fuel efficiency – approximately 6-7% for four-wheelers and 3-4% for two-wheelers.
 - Modifications in engines are required to reduce this efficiency loss.
 - Moreover, the use of E20 will necessitate changes to the fuel lines, as well as some plastic and rubber parts, due to the corrosive nature of the fuel.
 - The engines will also need to be recalibrated for the required power, efficiency, and emission-level balance due to the lower energy density of the fuel.
- **Impact on Emissions:** There are concerns regarding unregulated emissions such as acetaldehyde, which could be higher with E10 and E20 compared to normal petrol.
 - The overall impact on emissions, both regulated and unregulated, needs careful monitoring and assessment as India progresses towards higher ethanol blending.
- **Potential for food scarcity:** Diverting crops for fuel can reduce food availability, leading to higher prices and food insecurity.
- **Competition for land:** Biofuel crops can compete with food production and conservation needs, potentially leading to land-use changes and biodiversity loss.
- **Minimum Support Price:** Ethanol production costs in India are higher compared to countries like the U.S. and Brazil. This is partly due to the government-fixed cost of raw materials like sugarcane and food grains, which are set to support farmers. This policy impacts the economic viability of the Ethanol Blending Programme (EBP).



Government Efforts To Advance Ethanol Blending In India

- **Central Agency Oversight:** The **Department of Food and Public Distribution** oversees the promotion of fuel-grade ethanol distilleries in the nation.
- **Ethanol Blended Petrol Program (EBPP):** Initiated in 2003, this program aims to foster the use of renewable fuels. Originally starting with 5% blending, the goal has been set to achieve 10% blending by 2022, and 20% (E20) by 2025-26, a revision from the earlier target of 2030.
- **National Policy on Biofuels (2018):** This policy sets an indicative target of 5% biodiesel blending in diesel by 2030.
- **Differential Pricing:** To offset the reduced or nullified sugar production, the government has established higher prices for ethanol produced from B-heavy molasses and entire sugarcane syrup.
- **GST Reduction:** The Goods & Service Tax on ethanol intended for the Ethanol Blended Petrol Programme has been lowered from 18% to 5%.
- **Interest Subvention Scheme:** This scheme aims to enhance and augment ethanol production capacity, promoting year-round production.
- **Ethanol Blending Roadmap 2020-25 by Niti Aayog:** It lays out an annual plan to increase domestic ethanol production in line with target of the amended National Policy on Biofuels (2018) as well as with its Ethanol Blended Petrol (EBP) Programme to reach a blending of 20% of ethanol in petrol (E20) by 2025/26.
 - Raise pan-India ethanol production capacity from the current 700 to 1500 crore litres.
 - Phased rollout of E10 fuel by April 2022.
 - Phased rollout of E20 from April 2023, its availability by April 2025.
 - Rollout of E20 material-compliant and E10 engine-tuned vehicles from April 2023.
 - Production of E20-tuned engine vehicles from April 2025.
 - Encourage use of water-sparing crops, such as maize, to produce ethanol.
 - Promote technology for the production of ethanol from non-food feedstock.

Way Forward

- **E20 Mission for Fuel Independence:** India's aim to lessen its dependency on fuel imports through the E20 initiative is commendable, but the 2025-26 target is ambitious.
- **Competition for Resources:** Achieving this goal may lead to a clash for crop and land resources between fuel and food crops, necessitating a balanced approach.
- **Addressing Undernourishment:** With a significant undernourished population, India needs to expand the cultivation of pulses, oilseeds, and horticultural crops.
- **Focus on Agricultural Productivity:** Enhancing crop yields through advanced seeds and farming techniques is crucial, especially if these crops are used for biofuel production.
- **Land-Use Planning:** A strategic plan for land use is vital to avoid dedicating existing croplands to fuel production, considering the decline in arable land in India.
- **Utilising Fallow Land:** Prioritising the use of the increased fallow land, around 4.3 million hectares between 1978-79 and 2018-19, for biofuel crop production could be a solution.
- **Second Generation (2G) Biofuel Technologies:** These technologies, which use waste materials like wheat straw, corn cobs, wood, and agricultural residues for bioethanol production, should be further researched and developed for commercial viability.
- **Avoiding Food vs. Fuel Dilemma:** The roadmap should ensure no trade-off between achieving food and energy security, as both are equally important.

Source: [The Hindu: Need Policy For Affordable Bioethanol](#)