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## Today's Prelims Topics

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### Cosmic Particle Acceleration Near Earth

#### Context

Scientists are exploring how tiny space particles, like electrons, gain extreme energy and speed. According to a recent study published in *Nature Communications* suggests that **shock waves in space** may function as powerful particle accelerators.

#### Findings of the Study

- **Scientists Found an Unusual Event Near Earth:**
  - In 2017, three NASA space missions (**MMS, THEMIS, and ARTEMIS**) recorded something surprising.
  - They noticed that electrons in the **foreshock region** suddenly gained a **huge amount of energy**—up to **500 keV** (kiloelectronvolts).
  - These electrons were moving at **86% of the speed of light**. Normally, electrons in this region only have **1 keV** of energy.
- **How Did These Electrons Gain So Much Energy?**
  - Scientists believe that **multiple processes** were working together:
    - **Plasma waves** (waves of energy moving through space plasma).
    - **Magnetic structures** in the bow shock and foreshock.
    - **Electromagnetic forces** pushing the electrons forward.
- **Electron Injection Problem:**
  - The **Electron Injection Problem** is a long-standing mystery in astrophysics related to how electrons in space gain their **initial boost of energy** before undergoing further acceleration.
  - Scientists know that **diffusive shock acceleration** (a key process for accelerating electrons) requires electrons to already be moving at **50% of the speed of light** before they can be accelerated further.
  - The problem is: **What gives electrons this first push to reach such high speeds?**
  - In space, particles don't collide like they do in air or water. Instead, they interact through **electromagnetic forces**, making it unclear how electrons get this energy boost.

**Related Concepts**

- **What is Plasma?**
  - Plasma is a special state of matter made up of **charged particles** (electrons and ions).
  - It is found **all over space**, including in the Sun, stars, and even in the Earth's magnetosphere (the protective bubble around our planet).
  - Unlike solids, liquids, and gases, plasma particles don't collide much; instead, they move and interact using **electromagnetic forces** (forces caused by electric and magnetic fields).
- **What are Shock Waves?**
  - A shock wave is a sudden change in pressure and energy in a moving substance.
  - On Earth, you see shock waves in **sonic booms** (when a plane flies faster than sound) or **explosions**.
  - In space, **shock waves happen in plasma** and carry a huge amount of energy.
- **What is the Solar Wind?**
  - The **Sun constantly throws out charged particles** into space. This fast-moving stream is called the **solar wind**.
  - It carries energy and **interacts with planets**, especially their magnetic fields.
- **Earth's Magnetosphere:**
  - Earth has an invisible protective shield made of **magnetic fields** called **magnetosphere**, it **protects us from harmful solar wind and cosmic rays**.
- **Bow Shock and Foreshock:**
  - When the solar wind **hits Earth's magnetosphere**, it slows down and creates a shock wave. This shock wave is called the **bow shock** (because it looks like a bow in front of Earth).
  - The **area ahead of the bow shock is called the foreshock**, where electrons were found gaining massive amounts of energy.

**Source:**

- [The Hindu - Cosmic particle accelerator](#)

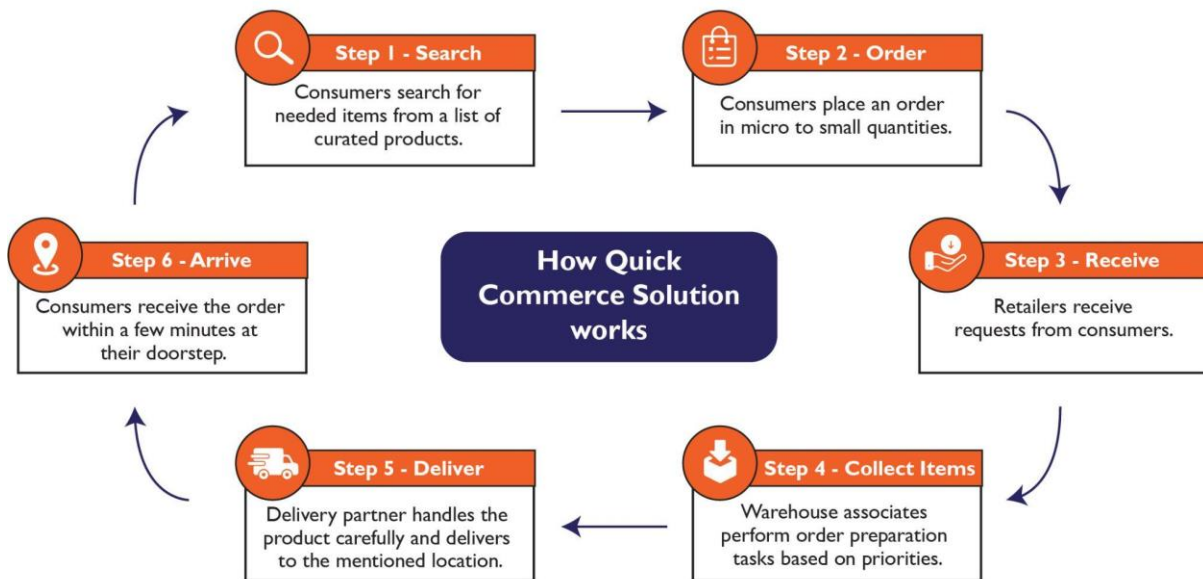
## Rise of Quick Commerce

### Context

According to a recent report by Bernstein, Quick commerce in India is set to grow at an impressive rate of 75-100 per cent year-on-year, significantly outpacing traditional retail.

### What is Quick- Commerce?

- It is a unique business model where the **delivery of goods and services is done within 10-30 minutes of ordering.**
  - E.g. Blinkit, Zepto, Swiggy Instamart etc.
- **Components of Q-Commerce:**
  - **Technology:** Uses **AI and machine learning** for predicting demand, real-time inventory tracking, and route optimization for fast deliveries.
  - **Logistics:** Requires Dark stores and a network of couriers for speedy delivery.
  - **Supply Chain Management:** Needs reliable suppliers, efficient inventory restocking, and smooth coordination to prevent delays.
  - **Customer Interface:** User-friendly apps and websites which allows customers to place orders quickly and track their deliveries in real-time.



### What Are Dark Stores?

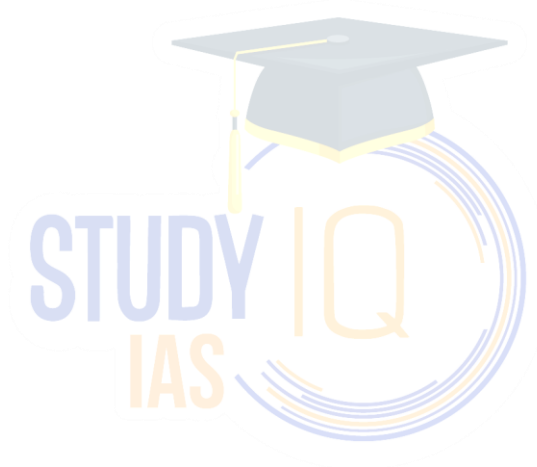
- **Dark stores are small, local warehouses used exclusively for online orders**—customers cannot physically shop there.
- Their **primary goal is to reduce delivery time** by being **closer to residential and commercial areas.**
- **How Dark Stores Work ?**
  - **Stock Selection:** Each dark store stocks **high-demand, fast-moving products** like groceries, snacks, dairy, beverages, personal care, and household essentials.
  - **Order Processing:** The moment a customer places an order on an app, the system **assigns it to the nearest dark store for fast picking and packing.**
  - **Delivery Logistics:** A **delivery partner (rider)** picks up the order and delivers it **within minutes, typically traveling 1-3 km** from the dark store.

**Related Terms**

- **E-commerce:** It refers to the online purchase or sale of a good or service, which can take 3-4 or longer days to deliver.
- **Dark factory:** A fully automated manufacturing facility that operates with minimal or no human intervention. It uses AI, Robotics, Automation and IoT to handle production processes.

**Source:**

- [The Hindu - Q Commerce](#)



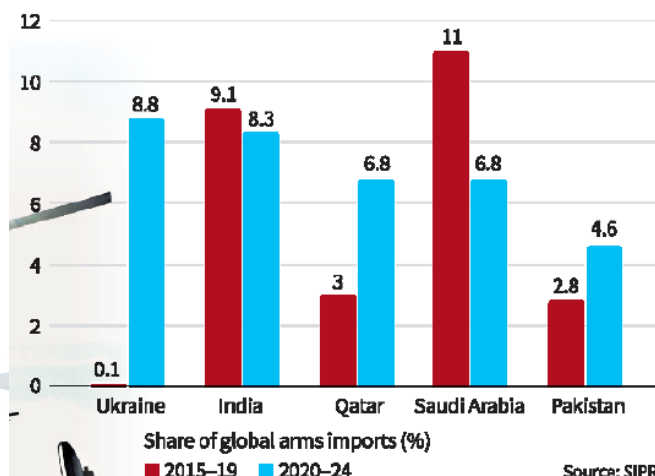
## SIPRI Report on Global Arms Transfers (2020-24)

### Context

Recently Stockholm International Peace Research Institute (SIPRI) has released new data on international arms transfers.

### Global Arms Import Trends

- **Ukraine** became the **largest arms importer** globally in **2020-24**, witnessing a **nearly 100-fold increase** in imports compared to **2015-19**, primarily due to its ongoing war with Russia.
- **India** ranked as the **second-largest arms importer**, though its imports declined **by 9.3%** compared to **2015-19**.
- **China** dropped out of the **top 10 arms importers** for the first time since **1990-94**, reflecting its strengthened domestic defense industry.
- **Pakistan's** arms imports increased by **61%** from **2015-19** to **2020-24**.
  - **China** dominated as Pakistan's main supplier, contributing **81%** of total imports.
- **European arms imports** grew by **155%**, driven by concerns over Russian aggression.



### Global Arms Export Trends

- **Russia's Declining Arms Exports:** Russia's **global arms exports fell by 64%**, now making up just **7.8%** of the global market.
- **France's Rising Arms Exports:** France overtook Russia as the **second-largest arms exporter** in **2020-24**, accounting for **9.6%** of **global exports**.
  - **Major buyers of French arms:** India (28%) (largest recipient) & Qatar (9.7%).
- **U.S.A. has expanded its dominance**, increasing its share to **43%** of **global arms exports**.

### India's Arms Imports

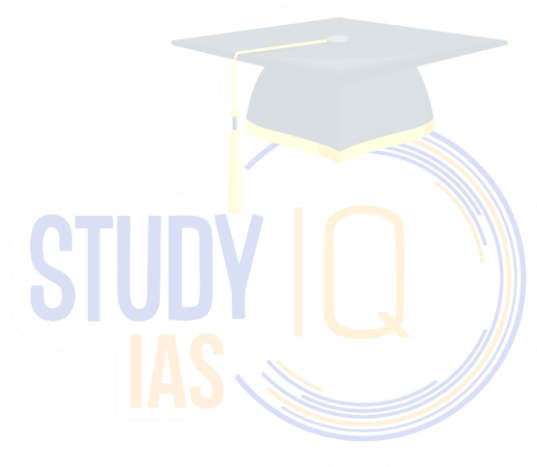
- India's **largest supplier** remained **Russia**, but its share **declined to 36%** (from **55%** in **2015-19** and **72%** in **2010-14**).
- India was the **biggest export destination** for both **Russia** and **France** in **2020-24**.
- **France** emerged as a key supplier, with **India accounting for 28%** of **French arms exports**.
- **Major Indian arms deals with France:**
  - 36 Rafale fighter jets
  - 6 Scorpene-class submarines
  - Upcoming deals: 26 Rafale-M jets and 3 more submarines.

**Stockholm International Peace Research Institute (SIPRI)**

- It is a globally renowned institute dedicated to research on conflict, armaments, arms control and disarmament.
- It was founded in **1966**. It is based in **Stockholm**.
- SIPRI provides critical data and analysis on global security issues, particularly related to military expenditures and the arms trade in its **Yearly Book**.

Source:

- [The Hindu- SIPRI Report](#)



## Athena Lander Mission Failure

### Context

Intuitive Machines has declared its **second lunar mission, Athena, a failure** after it missed its intended landing site on the Moon.

### Landing Failure and Mission Termination

- Athena **missed its intended landing site by over 250 meters**, landing **sideways in a crater** near the **Moon's south pole**.
- The lander sent back images confirming its position and activated a few experiments before losing power.
- **Extreme cold and poor solar panel alignment** made it unlikely to recharge, leading to mission termination.
- The **Moon's south pole** is difficult to explore due to:
  - **Harsh sun angles** affecting solar power.
  - **Limited communication** with Earth.
  - **Rugged, uncharted terrain**.
- Athena's landing (**160 km from the South Pole**) was the **closest any spacecraft has reached this region**.
- This was **Intuitive Machines' second lunar landing attempt**:
  - **First attempt (2024)** also resulted in a **sideways landing** but remained operational for longer.
- In **both Athena missions**, **last-minute failures** in the **primary laser navigation system** caused problems during landing.

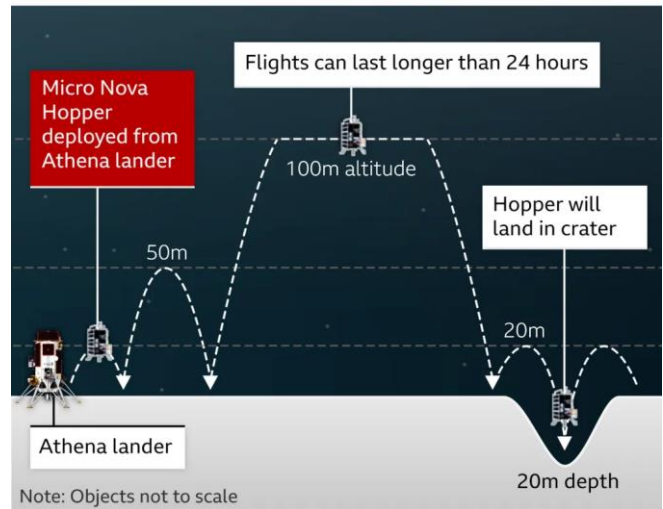
### About Athena Lander

- It is developed by **Intuitive Machines** under **NASA's Commercial Lunar Payload Services (CLPS) program**.
  - CLPS program is designed to facilitate private sector lunar exploration.
- **Location: Mons Mouton**, approximately **160 km from the Moon's South Pole**—the **closest landing to the South Pole ever achieved**.
- NASA's **Lunar Reconnaissance Orbiter** will soon capture images of Athena to determine its exact position.
- **Scientific Goals**:
  - **Primary Objective: Search for subsurface water ice**—a crucial resource for **future lunar missions**.
  - Conduct studies to support **NASA's Artemis program** for **long-term human exploration**.
  - Test **advanced technologies** that could be used for **future lunar and Mars missions**.

### Scientific Instruments

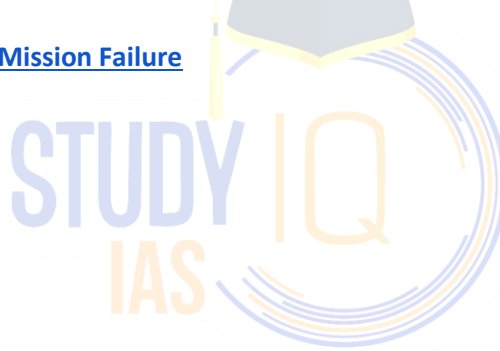
- **Micro Nova Hopper (Grace) – A Jumping Robot:**
  - Designed to **hop across the Moon's surface** instead of rolling like traditional rovers.
  - It can **leap 100 meters high** and travel up to **2 km (1.2 miles)**.
  - Planned to **make five jumps** to land inside a **permanently shadowed crater** to capture **the first-ever images of its interior**.
  - Permanently shaded areas are **ideal locations for finding ice**, as they remain at **extremely low temperatures**.
- **NASA's Scientific Instruments:**
  - **Trident Drill:** Designed to **churn up lunar rocks and soil**.
    - Its goal is to determine **if ice exists beneath the Moon's surface**.
  - **Mass Spectrometer:** It will analyze **gases released** from the lunar surface.
  - **Lunar Mobile Communications Antenna (4G Technology by Nokia):** Aims to establish a mobile communication network on the Moon.

### How Micro Nova Hopper will explore Moon



### Source:

- [The Hindu - Athena Mission Failure](#)





## Appoint process of IRDAI chairman

### Context

The Union Government has recently issued an advertisement for the post of Chairman of the Insurance Regulatory and Development Authority of India.

### Appointment Process & Eligibility Criteria

- The **Financial Sector Regulatory Appointment Search Committee (FSRASC)**, headed by the **Cabinet Secretary**, is responsible for selecting regulatory body heads.
  - It consists of Cabinet Secretary, current RBI Governor, Financial Services Secretary and two independent members.
- The **FSRASC can recommend candidates** based on merit, including those who have not applied.
- For exceptional candidates, the committee **can relax eligibility criteria**.
- No chairman can hold office **beyond 65 years of age**.
- **Eligibility Criteria for Applicants:**
  - Must have **at least two years of residual service** as of **March 14, 2025**.
  - Should not be older than **63 years** on the date of vacancy.
  - Should have a **minimum of 30 years of relevant work experience**.
  - Must have served as **Secretary to the Government of India** or at an **equivalent level** in government or large institutions.
  - Private sector applicants must have been a **CEO or equivalent of a large financial institution**.

### Insurance Regulatory and Development Authority of India (IRDAI)

- It is a **statutory body** under IRDA Act, 1999 that regulates the insurance industry in India.
- **Composition:** Chairman and a maximum of 10 members. All are appointed by the Central Government.
- **Nodal Ministry:** Union Ministry of Finance.
- Its main function is to regulate and supervise the Insurance Industry. (**HQ - Hyderabad**)
- **Major Initiatives by IRDAI**
  - **Bima Sugam** – A **one-stop digital insurance platform** for buying, comparing, and claiming policies.
  - **Bima Trinity** – A plan to **simplify insurance products and increase penetration**.
  - **Increasing FDI in Insurance to 100%** – Encouraging foreign investment and boosting competition.
  - **Sandbox Regulations** – Allowing insurers to test **new insurance products and technology** in a controlled environment.

Source:

- [Indian Express - IRDAI](#)

## News in short

### Badagas

- Badagas are an **indigenous** tribe of the **Nilgiri Hills** in **Tamil Nadu** and **Kerala**. They are the largest community in the Nilgiris.
- They were **once a warrior community** and later became settled agriculturists.
- **Religion:** Most Badagas follow **Hinduism**, worshipping deities like **Hethai Amman**, their principal goddess.
  - They practice **hypergamy**, a system in which women can marry into a caste that is higher than the one they were born into, and also marry into a lower caste.
- **Hethai Habba Festival:** The biggest festival of the Badagas, celebrated annually in honor of **Hethai Amman**.
- **Language and Culture:**
  - They speak **Badaga**, a **Dravidian language** with similarities to **Kannada**.
  - **Hatti (village) system:** Badagas traditionally live in **clan-based villages** known as **Hattis**.
  - **Dressing:** Men wear **white dhotis and turbans**, while women wear **white sarees**.



Source:

- [The Hindu - Badagas](#)

### Genetically-Engineered Non-Browning Banana

- Scientists have developed a genetically-engineered banana with a longer shelf-life to reduce food waste.

#### Why Do Bananas Turn Brown?

- Bananas undergo a natural ripening process due to the hormone **ethylene**, which they produce in large amounts, even after being harvested.
- Ethylene triggers genes responsible for producing **polyphenol oxidase (PPO)**—an enzyme that causes browning when it reacts with oxygen.
  - **PPO breaks down yellow pigments**, causing the fruit to turn brown.
- Scientists **disabled the gene responsible for PPO production** without affecting the ripening process.
- The technique has also been applied to tomatoes, melons, kiwifruits, and mushrooms.
- **Significance of the Development:**
  - **Reducing Food Waste:** **Up to 50% of bananas** go to waste annually.
  - **Environmental Benefits:** Food waste is a major contributor to **greenhouse gas (GHG) emissions**.



**Source:**

- [Indian Express - Gene edited banana](#)

**India's Wheat Production Estimated at a Record High in 2024-25**

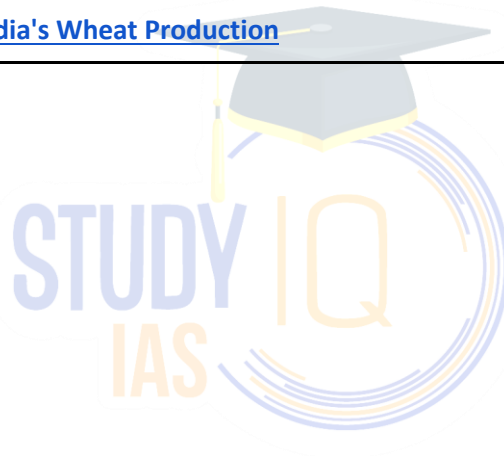
- India's wheat production is estimated to reach **115.3 million metric tonnes (MMT) in 2024-25**, marking a **2% increase** from **113.3 MMT in 2023-24**.

**Wheat Cultivation**

- **Wheat is India's second-largest crop** (after paddy) in terms of area coverage.
- In **2023-24**, wheat was cultivated on **318.33 lakh hectares**.
- It is a **rabi crop** that requires a cool growing season and bright sunshine at the time of ripening.
- **Soil:** Well-drained loamy soils rich in organic matter are ideal for wheat cultivation.
- **Temperature:** Ideal temperature range between 10°C and 24°C.
  - A **frost-free period** of about **100 days** is required for its cultivation.
- **Top Producers India:** (1) Uttar Pradesh (2) Madhya Pradesh (3) Punjab (4) Haryana (5) Rajasthan.
- **Top Producers Worldwide:** (1) China (2) India (3) Russia (4) USA.

**Source:**

- [Indian Express - India's Wheat Production](#)



## Places in News

### Darvaza Gas Crater

- **How Did It Form?**

- In **1971**, **Soviet geologists** were conducting **drilling operations** in search of **natural gas reserves**.
- The ground beneath their drilling rig **collapsed**, creating a **huge sinkhole** about **69 meters**.
- To prevent the release of **poisonous methane gas**, scientists **set the crater on fire**, expecting it to burn out in a few weeks.
- However, **it has continued burning for over 50 years** due to **abundant natural gas reserves** underground.



- **Location:** Karakum Desert, Turkmenistan, near the village of Darvaza (Derweze).
- It is also known as the "**Door to Hell**".
- It has been burning for over **five decades**, emitting flames and heat
- The crater is **one of Turkmenistan's most famous landmarks**.
- Tourists visit the site for **camping and photography**, especially at night.

**Source:**

- [The Hindu - Door to Hell](#)

### North Sea

- Recently, a massive fire broke out in the North Sea due to a collision between a U.S. military-chartered tanker and a cargo ship.



- **Location:** between the British Isles and the mainland of northwestern Europe. It is an **arm of the Atlantic Ocean**.
- **Bordering Countries:** Norway, Scotland, England, France, Belgium, Netherlands, Germany and Denmark.
- It connects to the Atlantic Ocean via the English Channel and to the Baltic Sea through the **Kattegat and Skagerrak Straits**.
- **Major Rivers draining in North Sea:** Forth, Elbe, Scheldt, Thames, Humber.
- **Major Ports:** **Rotterdam** (busiest port in Europe), Antwerp, Hamburg etc.

**Source:**

- [The Hindu - North Sea](#)

## Editorial Summary

### An India-U.S. trade agreement and the test of WTO laws

#### Context

- India and the U.S. have initiated negotiations for a multi-sector Bilateral Trade Agreement (BTA) targeting \$500 billion in bilateral trade by 2030, with the first tranche expected by fall 2025.
  - This agreement faces critical scrutiny under WTO law, particularly regarding compliance with GATT provisions and MFN principles.

#### Scrutiny Under WTO Law: Compliance with GATT and MFN Principles

- **MFN Principle and Preferential Access:** Under **Article I of GATT**, the **MFN principle** mandates that WTO members must extend any trade advantage, such as lower tariffs or reduced trade barriers, to **all other WTO members** equally.
  - If India and the U.S. reduce tariffs or trade barriers **exclusively** for each other under the BTA, without extending similar treatment to other WTO members, it would amount to discrimination and violate the MFN rule.
  - **Example:** If India lowers tariffs on specific American products (e.g., agricultural goods or technology products) without lowering tariffs for other WTO members, it breaches the MFN principle.
- **Article XXIV of GATT – Conditions for FTAs and Interim Agreements:** WTO law allows exceptions to the MFN principle under **Article XXIV** of GATT, which permits countries to form:
  - **Free Trade Agreements (FTAs)**
  - **Customs Unions**

For the BTA to qualify as an FTA or a stepping stone toward one, it must meet two key conditions:

#### 1. Substantially All Trade Requirement (Article XXIV.8(b))

- FTAs must cover “**substantially all trade**” between the member countries.
- The term is not precisely defined but is generally interpreted to mean a **very high percentage** of trade.
- If the BTA covers only select products or limited sectors, it **fails** to meet this requirement.
- **Example:** If India and the U.S. negotiate tariff reductions only on select products like **pharmaceuticals** and **automobiles**, but exclude other major sectors like **agriculture** and **services**, the BTA would not qualify as an FTA under GATT.

#### 2. Interim Agreement Exception (Article XXIV.5)

- Countries can sign an **interim agreement** leading to an FTA if:
  - It is a necessary step toward an FTA.
  - It includes a clear plan and timeline for forming the FTA, typically within **10 years**.
- If the BTA is presented as an interim agreement without a credible plan for a future FTA, it will violate WTO rules.
- **Example:** If India and the U.S. use the interim agreement mechanism solely to secure temporary benefits without intending to form a comprehensive FTA, it would be legally indefensible under WTO law.



- **Enabling Clause and Market Access for Developing Countries:** The **enabling clause** under WTO allows developing countries to receive preferential treatment in trade agreements.
  - However, this clause applies only when:
    - Developing countries are granted market access.
    - Developed countries (like the U.S.) provide trade concessions to developing nations (like India).
  - The proposed BTA is unlikely to qualify under this clause because:
    - India is providing better market access to American products (as noted in the Joint Statement).
    - This contradicts the enabling clause’s objective of improving trade conditions for developing countries.
  - **Example:** If India lowers tariffs on American electronic goods or medical equipment, it benefits the U.S., not India — making the arrangement inconsistent with the enabling clause.
- **Violation of Special and Differential Treatment (S&DT):** WTO recognizes the **Special and Differential Treatment (S&DT)** principle, which allows developing countries to:
  - Offer less than full reciprocity in tariff commitments.
  - Retain higher tariffs than developed countries.
  - If India is pressured to match U.S. tariffs under a “**reciprocal tariff**” arrangement, it would violate the S&DT principle.
  - **Example:** If India is forced to reduce tariffs on American agricultural products to match U.S. tariff levels on Indian exports, it would undermine the S&DT framework.
- **Notification and Transparency Requirement:**
  - GATT requires that:
    - All FTAs and interim agreements must be **notified to the WTO**.
    - The agreement must be evaluated to confirm compliance with GATT provisions.
  - If India and the U.S. fail to notify the BTA or withhold key details, it would face WTO scrutiny.
  - **Example:** If India and the U.S. reduce tariffs through a limited-sector agreement but label it as a full FTA without notification, other WTO members could challenge its legality.
- **Risk of Trade Retaliation and Dispute Settlement:** WTO members can challenge any BTA that violates MFN or other GATT provisions.
  - Affected members can:
    - Initiate a **dispute settlement process**.
    - Impose retaliatory measures if the agreement is found to be WTO-inconsistent.
  - **Example:** If the European Union or China feels disadvantaged by the India-U.S. BTA, they could file a dispute at the WTO, leading to trade retaliation.

## Conclusion

The proposed BTA between India and the U.S. represents a significant development in bilateral trade relations. However, India faces legal and strategic challenges in aligning the agreement with WTO rules while ensuring favorable economic outcomes. The decision to pursue an interim agreement or full FTA will have long-term trade and geopolitical consequences.

**Source:** [The Hindu: An India-U.S. trade agreement and the test of WTO laws](#)