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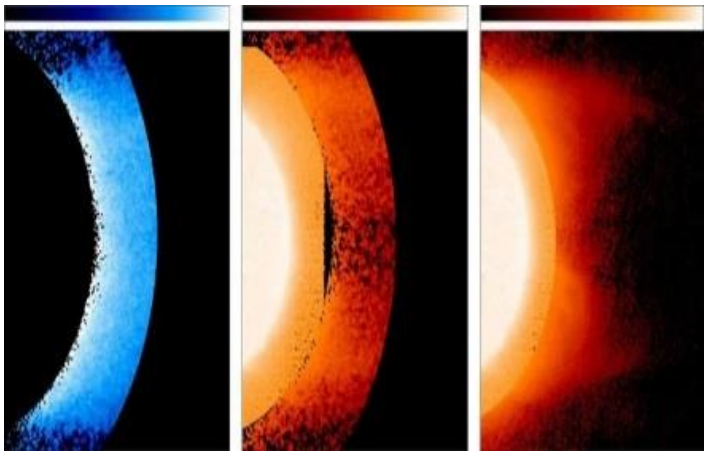
GS Paper 3 – Science & Technology

1 Revolutionary Breakthrough: New Technique to Estimate Helium Abundance in the Sun



Context: Researchers from the **Indian Institute of Astrophysics (IIA)** have pioneered a **novel method** to accurately estimate the **abundance of Helium** in the **Sun's photosphere**, overcoming a challenge that has puzzled astrophysicists for decades.

Why is Helium Hard to Detect?

Helium is the **second most abundant element** in the Sun. However, its **detection in the photosphere** is extremely difficult due to the **absence of visible spectral lines**.

Until now, scientists relied on **indirect methods** such as:

- **Solar wind and coronal data**
- **Extrapolations from hotter stars**
- **Helioseismology** (studying solar interior vibrations)

These approaches lacked precision since they did **not involve direct photospheric measurements**.

What's the New Method?

The IIA team developed an **innovative approach** using **indirect spectral analysis** of:

- **Neutral Magnesium (Mg I)** and **Neutral Carbon (C I)** lines
- **Molecular lines** of **MgH**, **CH**, and **C_2**

This method is grounded in the idea that **Helium abundance influences Hydrogen availability**, which in turn affects the **strength and formation of molecular lines** such as CH and MgH.

By analyzing **atomic and molecular abundances** of Magnesium and Carbon at various **Helium-to-Hydrogen (He/H) ratios**, the researchers found:

Only at a He/H ratio of ~0.1 do the data align — validating the commonly accepted solar helium abundance.

Quick Facts About Helium:

- **Element Type**: **Noble gas**, chemically **inert** due to its **closed-shell electronic configuration**
- **Discovery**: Identified in **1868** by **Jules Janssen** and **Norman Lockyer** during a **solar eclipse**
- **Name Origin**: Derived from the Greek word **'Helios'** meaning **'Sun'**
- **Major Global Reserves**: **United States**, **Algeria**, **Russia**
- **India's Treasure Trove**: The **Rajmahal Volcanic Basin** in **Jharkhand** houses a **significant helium reserve**, estimated to have been trapped for **billions of years**

Conclusion:

This **breakthrough by Indian scientists** marks a major step forward in **solar physics**, offering a more **reliable and direct estimation** of **helium abundance** in the Sun's **photosphere**. It not only sharpens our understanding of solar composition but also enhances models of **stellar evolution**.

GS Paper 3 – Biotechnology, Health, Human Resources

2 India's First Human Gene Therapy Trial for Haemophilia: A Medical Milestone

Context: In a groundbreaking achievement, **BRIC-inStem**, Bengaluru, in collaboration with **CMC Vellore**, has successfully completed **India's first-in-human gene therapy trial for Haemophilia**. This marks a significant advancement in the field of **genetic medicine** and offers renewed hope for patients suffering from this rare disorder.

What is Gene Therapy?

Gene therapy is a cutting-edge **biomedical technique** that modifies or replaces **faulty genes** within a person's cells to **treat or prevent diseases**. It aims to address the **root genetic causes** rather than just managing symptoms.

Key Approaches:

- **Replacing** a mutated gene with a healthy version
- **Inactivating** a malfunctioning gene
- **Introducing** an entirely new gene into the body

Unlike traditional treatments, gene therapy targets the **genetic blueprint** itself, using approaches like:

- **Ex vivo** modification of **stem cells** or **T-lymphocytes** outside the body
- **In vivo** delivery of gene-editing tools directly into the patient

Understanding Haemophilia

Haemophilia is a **rare genetic bleeding disorder** where the blood **fails to clot properly** due to mutations in genes that encode **clotting proteins**.

Quick Facts:

- The disorder is **X-linked**, making **males more prone** to it
- Affects approximately **1 in 10,000 people** globally
- **India bears a high patient burden**, highlighting the need for advanced therapies

About BRIC-inStem

BRIC-inStem is a premier institute under the **Biotechnology Research and Innovation Council (BRIC)**. It integrates **14 autonomous research institutions** across India and is a frontrunner in **translational and regenerative medicine**.

Key Innovations:

- **Gene therapy trials** for rare diseases
- **Anti-viral germicidal masks** developed during COVID-19
- **'Kisan Kavach'**, a protective pesticide shield for farmers
- **Biosafety Level III Lab** for handling **high-risk pathogens** under the **One Health Mission**

Why This Matters

This successful gene therapy trial is not just a national achievement — it represents a **new frontier in precision medicine** in India. It shows that **homegrown scientific excellence** can lead transformative healthcare initiatives that **save lives** and **set global benchmarks**.

GS Paper 1 – Geography

3 6.2 Magnitude Earthquake Strikes Istanbul – Epicenter in Sea of Marmara

Context: A **powerful earthquake** measuring **6.2 on the Richter scale** recently struck **Istanbul**, with its **epicenter located in the Sea of Marmara**. The tremors were felt widely across the city, sparking concerns over future seismic threats in this geologically active zone.

About the Sea of Marmara:

The **Sea of Marmara** is a **small inland sea** situated entirely within **Turkey**, acting as a **natural divider** between the **European and Asian parts** of the country.

Key Facts:

- **Area**: Approximately **11,350 sq.km**
- **Length**: About **280 km**
- **Widest Point**: Up to **80 km**

It forms a vital link between seas:

- **Northeast**: Connected to the **Black Sea** via the **Bosphorus Strait**
- **Southwest**: Linked to the **Aegean Sea** through the **Dardanelles Strait**

As a result, the Sea of Marmara acts as a **transitional zone** between the **Black Sea** and the **Mediterranean Sea**.

Unique Salinity and Water Layers:

Due to the inflow of **cold, fresh water** from the **Black Sea** and **warm, salty water** from the **Mediterranean**, the sea displays a **layered water structure**:

- **Surface**: Fresher water
- **Bottom**: Much **saltier** water

Climate and Conditions:

The region enjoys a **humid subtropical climate**, characterized by:

- **Hot summers**
- **Cold, wet winters**

This climate supports rich biodiversity and dense human settlements along its coasts.

Tectonic Activity and Earthquake Risk:

Beneath the Sea of Marmara runs the **North Anatolian Fault**, a **major seismic fault line** responsible for multiple devastating **earthquakes** in Turkish history — making this region highly **seismically active**.

Major Islands in the Sea:

Some of the **notable islands** include:

- **Marmara Island – Turkey's second-largest island**, rich in **marble**
- **Prince Islands**

- **Avşa**, **Imrali**, **Ekinlik**, and **Paşalimani Islands**

Key Coastal Cities:

Several major cities lie along the **Sea of Marmara**, including:

- **Istanbul**
- **Izmit**
- **Balikesir**
- **Yalova**
- **Tekirdag**
- **Bursa**
- **Çanakkale**

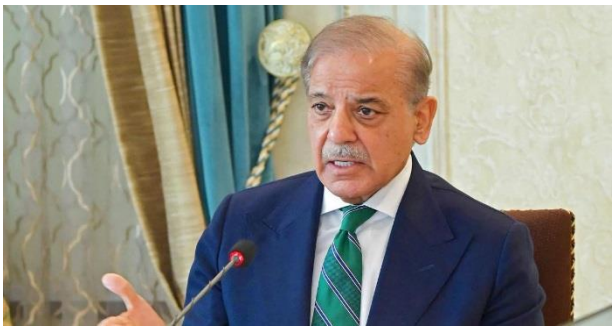
These urban areas are both culturally significant and economically vital, making earthquake preparedness even more crucial.

Conclusion:

This recent **earthquake in the Sea of Marmara** serves as a **stark reminder** of the region's **seismic vulnerability**. As urban development continues along its shores, there is a growing need for **resilient infrastructure** and **disaster preparedness** to safeguard both **lives** and **livelihoods**.

GS Paper 2 – International Relation

4 Pakistan Suspends Simla Agreement After India's Response to Terror Attack



Context: In a **dramatic diplomatic shift**, **Pakistan has announced the suspension of the 1972 Simla Agreement**, following India's strong response to the recent **terror attack in Pahalgam**, Jammu and Kashmir. This move has sparked serious concerns over **regional peace**, especially around the **Line of Control (LoC)**.

What is the Simla Agreement?

The **Simla Agreement** was a **landmark bilateral treaty** signed on **2nd July 1972** in **Shimla**, between **Indian Prime Minister Indira Gandhi** and **Pakistani President Zulfikar Ali Bhutto**. It was framed after the **1971 India-Pakistan War**, which led to the **creation of Bangladesh**.

Key Provisions:

- **Respect for Sovereignty**: Both countries agreed not to interfere in each other's **internal affairs**.
- **Bilateral Dispute Resolution**: All disputes, including **Kashmir**, were to be resolved **bilaterally**, without third-party involvement.
- **Redrawing the Ceasefire Line**: The old ceasefire line was converted into the **Line of Control (LoC)**.
- **Normalization of Ties**: Restoration of **trade, travel**, and **diplomatic channels** was encouraged.
- **Release of POWs**: India released **over 93,000 Pakistani prisoners of war**, one of the largest releases post-conflict.

Note: While the agreement laid the foundation for peaceful bilateralism, it lacked enforcement mechanisms and left **the Kashmir issue unresolved**, turning the **LoC into a de facto border**.

What Does the Suspension Mean?

From Bilateralism to Internationalization:

- Pakistan may now attempt to **internationalize the Kashmir issue**, inviting **UN**, **China**, or the **OIC** to mediate—**violating the Simla framework**.

Risks of Proxy Warfare:

- Past Pakistani actions, including the **1984 Siachen conflict** and the **1999 Kargil War**, were in breach of the agreement. Its suspension could **embolden proxy warfare** tactics once more.

Increased Military and Diplomatic Tensions:

- Though symbolic in the short term, this move could **escalate military posturing** and derail India's ongoing **developmental efforts in Jammu & Kashmir**, especially post **Article 370 abrogation**.

Impact on Regional Cooperation:

- Disruption of bilateral ties may also affect **SAARC** and other regional platforms, weakening collective action on **terrorism** and **economic development**.

How Should India Respond? Enhancing LoC Security

1. Deploy Anti-Drone Defense Systems:

- Install **AI-based drone detection** and **radar systems**

- Collaborate with **Israel's "Drone Dome"** for high-precision responses

2. Strengthen Satellite & UAV Surveillance:

- Use **Heron TP drones** and **real-time satellite imagery**
- Employ **AI analytics** to detect infiltration and tunnel construction

3. Fortify Counter-Infiltration Grids:

- Improve coordination between **Army, BSF, police, and intelligence**
- Continuously update **Standard Operating Procedures (SOPs)** based on seasonal patterns

4. Revive Village Defence Committees (VDCs):

- Especially in areas like **Anantnag**
- Provide **training, weapons**, and integrate locals into early warning networks

5. Modernize Border Fencing:

- Implement **smart fencing** with **laser walls**, **infrared sensors**, and **seismic detectors**
- Prioritize **vulnerable sectors** such as **Gurez, Uri, and Poonch**

Conclusion: A Time for Strategic Recalibration

The **suspension of the Simla Agreement** is not just a diplomatic setback but an opportunity for **India to recalibrate its security strategy**. By:

- **Strengthening border defenses**
- **Exposing Pakistan's role in terror networks**, and
- **Advocating for its re-listing in the FATF grey list**

India can turn this challenge into a **strategic advantage** on both the **security and diplomatic fronts**.

GS Paper 3 – Economic Development

5 Monsoon 2025 & Food Inflation in India: What's the Link?

Context: The **India Meteorological Department (IMD)** has projected an **above-normal monsoon** for **2025**, forecasting **rainfall at 105% of the Long Period Average (LPA)**. This is expected to **boost agricultural production** and support the government's efforts to **control food inflation**, which is closely tied to **rainfall variability** in India.

IMD's Monsoon Forecast 2025: Key Highlights

- **Rainfall Prediction**: Rainfall expected to be **105% of the LPA (87 cm)** with a ±5% margin
- Classification of rainfall:
  - **Deficient**: <90%
  - **Below Normal**: 90–95%
  - **Normal**: 96–104%
  - **Above Normal**: 105–110%
  - **Excess**: >110%

Climatic Support:

- Neutral **El Niño–Southern Oscillation (ENSO)**
- Positive **Indian Ocean Dipole (IOD)**
- **Below-normal Eurasian snow cover**, indicating stronger monsoon winds

Improved Forecast Accuracy:

Average deviation has dropped from **7.5% (2017–20)** to **2.27% (2021–25)**

Geographical Distribution:

- **Below Normal**: Jammu & Kashmir, Ladakh, Tamil Nadu, Bihar, Northeast
- **Normal to Above Normal**: Madhya Pradesh, Rajasthan, Maharashtra, Odisha, Chhattisgarh, Uttar Pradesh, West Bengal (key **rain-fed agriculture zones**)

Monsoon's Impact on Food Inflation:

Agricultural Yield & Crop Prices:

- Good rainfall usually improves **crop yields** and reduces prices.
- However, **individual crop prices** may still spike due to **localized production issues**.

Stats Snapshot (2015–24):

- **6 out of 10 years** had normal or above-average rainfall.
- Years like **FY16 & FY19** saw **low rainfall**, leading to weak agricultural growth: **0.65% in FY18**, **2.7% in FY24** (Decade average: 4.45%)

Supply Chain & Transportation Costs:

- **Heavy rainfall/floods** disrupt transport and storage, causing **logistics delays**.
- Example: **2023 floods in Assam and Bihar** delayed staple movement, leading to **temporary price hikes**.

Monsoon Deficit & Import Costs:

- Poor monsoons increase **import dependency**, especially for **pulses and edible oils**.
- **2023 Example**: Low rainfall = spike in edible oil imports from **Indonesia & Malaysia**.
- In **2022–23**, India imported **16.5 million tonnes of edible oils**, with **domestic production meeting just 40–45%** of demand.

Beyond Rainfall: What Else Drives Food Inflation?

Despite high rainfall in **FY20, FY21, FY23, and FY25**, food inflation **remained high** (6–7%). In contrast, **below-normal rainfall years** like FY18 and FY19 saw **low food inflation** (2.2% and 0.7%).

Recent Trend:

- Food inflation fell from **8% (Dec 2024)** to **below 6% (Jan 2025)**
- For the first time since **July 2023**, it dropped **below headline inflation** by **March 2025**

Other Contributing Factors:

- **Supply Shocks**: Hoarding, market disruptions, and black marketing affect prices
- **Global Commodity Prices**: Rise in **edible oil & pulse prices** directly impacts India due to high import reliance
- **Monetary Policy**: RBI's interest rate hikes raise **input costs**, especially for **processed and packaged food**
- **Government Policies**: **MSP hikes** support farmers but can raise inflation

  Export bans (e.g., on onions or rice) protect local supply but may **destabilize markets**
- **Infrastructure Gaps**: Poor **storage and transportation** result in wastage and higher consumer prices

Conclusion: Rainfall Helps, But It's Not Everything

While a **strong monsoon** is a **positive sign for agriculture**, it is **not a silver bullet** for food inflation. **Structural reforms**, **efficient logistics**, **supply chain resilience**, and **global price monitoring** are just as crucial.

GS Paper 2 – Governance, Constitution, Polity, Social Justice

6 Tamil Nadu Bans Raw Egg Mayonnaise: A Bold Move for Public Health

Context: In a significant **public health decision**, the **Tamil Nadu government** has announced a **one-year ban**—effective from **April 8, 2025**—on the **manufacture, storage, distribution, and sale** of **mayonnaise made with raw eggs**. The move is aimed at **preventing foodborne illnesses** in India's **hot and humid** climate, which heightens the risk of **bacterial contamination**.

What is Mayonnaise?

Origin and Composition:

Mayonnaise is a popular **cold emulsion sauce** believed to have originated in **France or Spain**. Today, it's a **global staple** in **fast food** and **homemade cooking**, especially as a **spread** or **dressing**.

Basic Ingredients

- **Egg yolk**
- **Vegetable oil**
- **Vinegar or lemon juice**
- **Salt and seasonings**

The **egg yolk proteins** act as **emulsifiers**, binding the **oil and acid** into a **smooth, stable mixture**.

Why Raw Eggs are Risky

Health Hazards of Raw Egg Mayonnaise:

- Raw eggs can harbor **harmful bacteria** such as **Salmonella** and **E. coli**, which are **not eliminated** unless properly cooked or pasteurized.

Fact Check: According to the **World Health Organization (WHO)**, **Salmonella** causes over **93.8 million foodborne illnesses** and **155,000 deaths** globally each year.

Why Indian Conditions Are More Dangerous:

- **High temperatures** and **poor refrigeration** increase spoilage risks.
- **Street vendors** and **unregulated kitchens** often lack **cold storage**, leading to **unsafe mayonnaise preparation**.

Know the Pathogens:

- **Salmonella**: Causes **fever, diarrhoea, vomiting, and abdominal pain**
- **E. coli**: Some strains can cause **kidney failure** (e.g., E. coli O157:H7)

High-Risk Groups:

- **Children**
- **Elderly**
- **People with weakened immune systems**

Expert Opinion: Why the Ban is Justified:

Health experts and nutritionists have welcomed the move, citing:

- **Raw egg-based mayo** as **high-risk food**
- The need for **regulations** on **temperature-sensitive food items**
- Availability of **safer alternatives** like **eggless** or **pasteurized egg mayonnaise**

Did You Know? Pasteurized eggs are **heat-treated** to eliminate bacteria without cooking the egg, making them safe for raw applications like mayonnaise.

Impact on the Food and Fast-Food Industry:

Urban Food Chains and Local Vendors:

- Many eateries use **homemade or locally-sourced mayonnaise**, which may not follow **food safety standards**.
- The ban will **encourage** a shift toward:
    - **Eggless mayonnaise** (already dominant in India)
    - **Pasteurized egg-based alternatives**

Market Trends:

- India's eggless mayo market is estimated to grow at a **CAGR of over 9%**, driven by **vegan trends**, **cost-efficiency**, and **religious dietary preferences**.

Not an Isolated Incident:

Tamil Nadu follows **Telangana**, which imposed a similar **one-year ban** in **November 2024**.

This step aligns with Tamil Nadu's history of **proactive health regulations**, such as:

- The **gutka and paan masala bans**
- Enforcement of **food labeling** norms
- Crackdown on **adulterated milk and oil**

Broader Health Policy Trend in India:

Tamil Nadu's decision reflects a **larger national shift** toward:

- **Food safety awareness**
- **Preventive health measures**
- **Child and adolescent protection**

Other Recent Bans in India:

- **Punjab** banned **caffeinated energy drinks** for children and near schools.
- **Scientific assessments** are underway to analyze **long-term effects** of these foods.

Public health experts argue that **prevention-based bans** are crucial in **reducing foodborne disease burdens**, especially in developing nations.