

## BIO-TECH

PRE-CONTEXT

### CRISPR CAS9

THE HINDU, PG.NO: 11.

**News:** "Putting the gene editing tool to use."

#### About CRISPR CAS9:

- A revolutionary **gene-editing tool** that allows for precise, directed changes to genomic DNA. It **capitalises on the innate defense mechanism employed by bacteria against viruses**.
- **CRISPR:** Stands for *Clustered Regularly Interspaced Short Palindromic Repeats*.
- **Cas9:** An enzyme (*CRISPR-associated protein 9*) that acts as molecular scissors to cut DNA at specific locations, facilitating gene editing.
- It is an **patented technology**, so any commercial use requires a license.
- **Applications:**
  - **Medicine:**
    - **Correct genetic defects** causing diseases like sickle cell anemia, cystic fibrosis.
    - Engineering immune cells to better **target cancer cells**.
  - **Agriculture:**
    - Creating **disease-resistant, pest-resistant, and climate-resilient crops**.
    - **Livestock Enhancement:** Improving **traits** in animals, such as growth rates and disease resistance.
  - **Biotechnology:**
    - Engineering microbes for **biofuel production, waste management**.
  - **Environment Conservation:**
    - Controlling invasive species, managing vector-borne diseases like **malaria** by targeting mosquito populations.

#### Ethical Concerns:

- **Germline Editing:** Potential to make heritable changes raises moral questions about **designer babies** and long-term impacts on the gene pool.
  - **South Africa** becomes **first country to allow HHGE** (Heritable Human Genome Editing).
- **In India**, Human germline editing and reproductive cloning are **banned** by the **National Guidelines for Stem Cell Research**

#### RNA Editing vs DNA Editing:

- **DNA editing makes permanent changes** to a person's genome, and sometimes this can lead to irreversible errors.
- **RNA editing makes temporary changes**, allowing the effects of the edits to fade over time.
  - This means a **doctor can stop the therapy if a problem arises** and mitigate long-term risk.
- **CRISPR-Cas9 and other DNA editing tools require proteins acquired from certain bacteria** to perform the cutting function, these proteins can create undesirable immune reactions in some cases.
- **RNA editing relies on ADAR enzymes, which already occur in the human body** and thus present a lower risk of allergic reactions.

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### PLASTICIZERS

THE HINDU, PG.NO: 11.

**News:** "IIT Roorkee uses bacterial enzymes to degrade plasticizers."

#### About Plasticizers:

- Plasticizers are **chemicals added to plastics and personal care products to enhance flexibility and shine** and are commonly found in items such as **baby toys, shampoos, soaps, and food containers**.
- **Plasticizers can be absorbed through the skin**, making them a direct threat to human health.
- **An enzyme — esterase enzyme — produced by soil bacteria** to break down diethyl hexyl phthalate (DEHP) plasticiser.
- Developed by **IIT Roorkee**.

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## ENVIRONMENT

PRE-CONTEXT

### GROUNDWATER POLLUTION

THE HINDU, PG.NO: 12.

**News:** "Is groundwater contamination high in India?"

#### Findings reported by Central Groundwater Board:

- **Excessive nitrates have been found in groundwater** in 440 districts as of 2023.
  - **Largely due to the use of subsidised synthetic nitrogenous fertilizer**, a key input for farming.
- Rajasthan, Karnataka, and Tamil Nadu reported the **highest nitrate contamination problem**.
  - **Leads to Blue-baby syndrome in infants** (a reduced ability of red blood cells to carry oxygen).
  - Once nitrates in groundwater rise to the surface and become part of lakes and ponds, **algal blooms harm aquatic ecosystems**.
- Rajasthan and Punjab reported the **highest number of samples with uranium concentration**.
- Other major chemical contaminants affecting groundwater **quality are fluoride and uranium**.
  - Fluoride pollution causes **Knock Knee syndrome**.

#### About Central Groundwater Board:

- **Statutory body** constituted under the **Environment (Protection) Act, 1986**.
- **Nodal agency** for ground water development and management in the country.

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## IR

PRE-CONTEXT

### GREENLAND

THE HINDU, PG.NO: 13.

**News:** "The island of interest."

**Context:** U.S. President-elect Donald Trump says he won't rule out use of military force or coercion to annex or buy the world's largest island (**Greenland**), Mr. Trump has also issued calls to buy/annex the **Panama Canal and Canada**.

#### About Greenland:

- Greenland, the **world's largest island** with a population of 57,000, **is an autonomous territory controlled by Denmark**.
- The island is surrounded by the Atlantic** on one side and the **Arctic** waters on the other.
- The Greenland, colonized by the Danes in the 18th century, is **geographically part of North America and closer to the U.S. than Copenhagen**.
- Island is also rich in minerals**. As per a 2025 survey, 25 of 34 critical raw materials, which are used in EVs and batteries, were found in Greenland.
- Due to climate change and global warming, glaciers and ice sheets in the Arctic Sea are melting, leading to potentially new shipping routes**, which could greatly enhance trade.
- Greenland's Prime Minister in his New Year address talked about taking the "next step" and removing the "shackles of colonialism".

#### Implications:

- Such calls to buy/annex violates:**
  - First and fundamental rule of the UN Charter:** recognising the sovereignty of nations.
  - With respect to Greenland, the U.S. is going **against the NATO agreement as well**.
  - Similarly, the Arctic waters are a global common under the **UN Convention on the Law of the Sea**.

#### Note:

- Both **China and Russia developed a sub-committee for cooperation on the northern sea route, which spans 5,600 km from the Barents Sea (near Scandinavia) to the Bering Strait (near Alaska)**.
- With Russia-China cooperation in the region, **annexing Greenland could give the U.S. significant control over the area**, deciding who controls it and operates in these strategic waters.

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## TECHNOLOGY

PRE-CONTEXT

### LITHIUM BATTERIES

THE HINDU, PG.NO: 12.

**News:** "Are lithium batteries on flights dangerous?"

#### About Lithium Batteries:

- Lithium batteries are **rechargeable or non-rechargeable power sources** that **utilize lithium as a key component of their electrochemistry**.
- Known for their **high energy density** (Stores more energy per unit weight), **lightweight, and long cycle life**.
- Types:**
  - Lithium-Ion (Li-ion) Batteries:** Consumer electronics (smartphones, laptops), electric vehicles (EVs), renewable energy storage.
  - Lithium Polymer (Li-Po) Batteries:** Flexible form factors; used in Drones, wearable devices, smartphones.
- Disadvantages:**
  - High cost, Safety concerns (over heating, fires if stressed).
  - Resource intensive:** Extraction of lithium and other materials (cobalt).

#### Battery Waste Management Rules 2022:

- Issued by **Central Pollution Control Board (CPCB)**.
- In case of noncompliance of the rules, CPCB empowered **impose and collect Environment Compensation** from producers and entities involved in refurbishment and recycling of waste battery.

#### Lithium Reserves:

- Chile** had the **largest lithium reserves worldwide**, by a large margin **followed by Australia, Argentina, China**.
- However, **Australia was the top country in Production** in 2023.
- In India:**
  - In 2021, **India's first lithium deposit** was found in the **Mandya district of Karnataka**.
  - In early 2023, the **Geological Survey of India** reported the discovery of **5.9 million MT of the lithium reserves in Jammu and Kashmir**.

#### Khanij Bidesh India Ltd:

- Objective:** to ensure **consistent supply of critical minerals and strategic minerals** to Indian domestic market.
- KABIL signed a MoU with Australia** for a critical mineral (**cobalt and Lithium**) investment partnership.
- KABIL signed pacts with Latin America's Lithium Triangle (Argentina, Chile, and Bolivia)**.
- India and Kazakhstan** formed a joint venture, to produce **titanium slag** in India.

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**Thank you!**