UPSC Daily Current Affairs| Prelimbits 19-06-2025

India Demonstrates Quantum Entanglement

Prelims: Science and technology| Current events of National Importance

Why in news?

Recently, Defence Research and Development Organisation (DRDO) and Indian Institute of Technology (IIT) Delhi successfully demonstrated quantum secure communication in India.

- India achieved **entanglement-based free-space quantum communication** over **a distance exceeding 1 kilometre**, marking a significant milestone in secure communication.
- **Quantum Entanglement** – It is a **quantum phenomenon** where two particles (like photons) become linked such that **any change in one instantly reflects in the other**, regardless of distance.

Communication through quantum entanglement

    - A pair of **entangled photons** is generated.
    - One photon is sent to the **sender**, the other to the **receiver**.
    - Characteristics of photons are **correlated**, allowing the generation of a **shared secre**t **key** forming a state of quantum entanglement.
    - If an outsider tries to intercept one photon, then the quantum state is disturbed and **intrusion is immediately detected**.
- **Free-Space communication –** The **transmission of photons through open air**, not through optical fiber or cable.
- It enables secure links over short urban distances, remote areas, and satellite-ground communication.
- **Security –** Based on the **laws of quantum physics**, any attempt to observe or intercept, changes the whole system's state.
- This makes the system **tamper-proof** and ensures that eavesdropping cannot go undetected.
- **Strategic Importance for India** – It helps to secure military, financial, and governmental communications.
- It reduces dependence on foreign encryption technologies.
- It contributes to **Atmanirbhar Bharat** in the field of cyber and data security.
- **Global context –** India now joins a list of elite countries like the **USA, China, and members of the EU** to demonstrate quantum communication and encryption technologies.
- It enhances India’s position in the emerging quantum technology race.
- **Future applications –** Forms the basis for Quantum Key Distribution (QKD)

networks.
- Opens avenues for satellite-based secure links and quantum internet.
- Potential use in banking, defence, space, and critical infrastructure.

Reference

India Today| India Demonstrates Quantum Entanglement

Fossilized Leaves Discovered in Assam

Prelims: Current events of National Importance

Why in news?

Recently, 24-million-year-old fossilized leaves were found in Assam's Makum Coalfield, which revealed insights into ancient plant life and ecosystems.

- **Discovery of fossils** – The study was led by scientists from the **Birbal Sahni Institute of Palaeosciences (BSIP)**, Lucknow which is an autonomous body under the **Department of Science and Technology**.

  The team used herbarium comparisons, cluster analysis, and CLAMP (Climate Leaf Analysis Multivariate Program) to reconstruct the past environment.

- **Plant species identified –** Fossils were identified as the **oldest known record of the Nothopegia genus**, which no longer exists in Northeast India today.
- **Modern comparison –** They are closely related to modern Nothopegia species found in the **Western Ghats**, located thousands of kilometres away.
- **Dating period –** The fossils date back to the **late Oligocene epoch (24–23 million years ago)**, a period of significant climatic and geological change.
- **Ancient climatic conditions –** Ancient Northeast India had a warm and humid climate, suitable for tropical species like Nothopegia — similar to today's Western Ghats.
- **Geological impact –** The **rise of the Himalayas** due to tectonic movements drastically changed Northeast India's climate, making it **inhospitable** for tropical plants which led to the disappearance of species.
- **Species migration –** Nothopegia disappeared from Assam but survived in the Western Ghats, a climatically stable region that became its refuge.
- **Ecological significance –** This shows how **climate and geological forces** can force species to **migrate or vanish**, affecting biodiversity over long periods.
- It also depicts that current climate change is much faster and human-driven, unlike slow ancient shifts.
- It also emphasizes the need to protect biodiversity hotspots like the Western Ghats, which act as climate refuges for ancient and rare species.

Reference

DD News| Fossil Leaves Unearthed in Assam

SIPRI Report 2025

Prelims: Current events of National Importance

Why in new?

Recently the SIRPI Yearbook was release which is a comprehensive resource on world armaments and global security.

- **SIPRI –** Stockholm International Peace Research Institute
- **Established** – 19b66
- **Headquarters** – Stockholm, Sweden
- It provides data, analysis, and recommendations on armed conflict, military expenditure, arms trade, disarmament, and nuclear forces.

Key Global Findings (2025 Yearbook)

- **Global Nuclear Arsenal –** Total **global nuclear warheads** is approximately 12,121 (including retired stock).
- **Countries with nuclear weapons –** 9 countries (USA, Russia, UK, France, China, India, Pakistan, Israel, North Korea).
- Russia & USA hold over 90% of global nuclear weapons.
- Russia - 5,459 warheads
- USA - 5,177 warheads
- **Deployment trends –** Many countries are **modernising** their nuclear arsenals.
- **Dual-capable missiles** (conventional + nuclear) being developed or upgraded by Russia, China, India, Pakistan, North Korea.
- **MIRV Capability –** MIRV means Multiple Independently Targetable Reentry Vehicles that allows a missile to carry several warheads.
- It is already deployed by USA, Russia, UK, France, China
- It is in development in India, Pakistan, North Korea.

India-Specific findings

- **Nuclear warhead count –** India has **180 nuclear warheads** (as of January 2025)
  - Pakistan - 170
  - China - 600
- **Expansion & modernisation –** India slightly **expanded its nuclear arsenal** in 2024.
- It continued to focus on developing new types of nuclear delivery systems.
- **Canisterised missiles –** India is developing canister-based missiles which,
  - Allow quick deployment.
  - Likely to carry multiple warheads in the future.
  - May shift India toward peacetime warhead-missile mating.
- **Mature nuclear triad –** India possesses a nuclear triad,
  - Air-based – Fighter aircraft

    - Land-based – Ballistic missiles
    - Sea-based – Nuclear submarines (SSBNs)
- **Strategic posture –** India's nuclear policy primarily aimed at Pakistan, but growing emphasis on long-range deterrence against China.
- Increase in submarine patrols and operational readiness.
- India is increasingly seen as a **responsible nuclear power**, yet rapidly adapting to a **changing threat environment**.

Reference

The Indian Express| SIPRI report

DNA Identification Techniques

Prelims: Current events of National Importance

Why in News?

After the Air India Boeing 787 Dreamliner crash in Ahmedabad, authorities are using DNA analysis to identify the remains of those killed in the accident.

- **DNA Identification -** Every person ***has a unique DNA*** that is present in nearly every cell of their body except identical twins.
- DNA identification is the gold standard for identifying human remains, especially after mass fatality events in which bodies might not be easy to identify otherwise.
- As soon as an individual dies, their DNA begins to degrade.
- Over time, this degradation can make it difficult, even impossible, for the DNA to be analysed.
- The extent of degradation depends on the kind of tissue DNA is extracted from and the conditions in which the body is kept, among other factors.
- **Sample Collection & Storage** - DNA survives much better in cold and dry conditions than in hot and humid conditions.
- So, samples must be collected as soon as possible, and once collected, stored in as cool and dry an environment as possible.
- They should ideally be ***frozen at minus 20 degrees Celsius***, or, in the case of soft tissues (skin, muscles, etc.), they may be stored in 95% ethanol.
- DNA from soft tissues degrades much faster than that from hard tissues (bones and teeth).
- This is because cells in hard tissues are largely protected from the effects of putrefaction and decomposition, forensic investigators usually collect DNA from hard tissue.
- **Reference Matching** - To identify who the collected DNA belongs to, reference samples are collected from biological relatives.
- Parents and children of the victim are ideal candidates for providing these samples, given that they share 50% of each other's' DNA.
- **Analysis Methods -** After the samples are collected, the next step is to extract DNA

from them.

- Subsequently, depending on the quality of the collected DNA, scientists can choose between a number of different methods of analysis.
- **Short tandem repeat (STR) analysis** - The method evaluates short tandem repeats, which are essentially short repeating sequences of DNA.
- STRs are used for DNA identification as they widely vary between individuals.
- **Mitochondrial DNA (mtDNA) analysis -** This method is used when nuclear DNA is degraded or unavailable.
- Mitochondrial DNA is found within the cell's energy-producing organelles known as mitochondria.
- As mtDNA is present in multiple copies within the cell, it is easier to recover from human remains that are not well preserved.
- **Y chromosome analysis -** Humans have two types of sex chromosomes, X and Y - biological males typically have one X and one Y chromosome, and biological females typically have two X chromosomes.
- **Single nucleotide polymorphisms (SNPs) analysis** - The method is typically used when the DNA to be analysed is highly degraded.
- A SNP is a variation in the DNA sequence where a single base — A, C, G, or T — at a specific location differs among people.
- Given that SNPs are unique to each person, they can be used for identification purposes with the help of reference samples taken from the victim's personal belongings such as a toothbrush and hairbrush.

Reference

The Indian Express | How DNA identification works

Portulaca bharat

Prelims: Current events of National Importance | Conservation

Why in News?

New plant species discovered in Aravali hills landscape near Jaipur.

- It is a ***new species of flowering plant*** named after Bharat serves as a symbolic reminder of India's rich and still-unfolding natural heritage.
- **Genus** - **Portulaca** currently comprises about 153 species worldwide, primarily found in tropical and subtropical regions.
- These succulent plants are known for their toughness, water-storing tissues, and adaptation to extreme environments.
- In India, 11 species are currently known, including four endemics, mostly distributed in dry and semi-arid habitats.
- **Habitat** - Discovered in the rocky and semi-arid landscape of Aravali hills.
- **Appearance** – It has opposite and slightly conclave leaves and pale-yellow flowers becoming creamish-white towards apex, with the presence of glandular hairs on

stamen filaments and thick roots.

- It added to the list of India's endemics.
- The plant's narrow endemism and specific habitat requirements make it *highly vulnerable* to habitat degradation and climate change.
- It has been provisionally assessed as ***"data deficient"*** under the International Union for Conservation of Nature Red List guidelines.

Reference

The Hindu | Portulaca bharat