71st BPSC Prelims Current Affairs

Science & Technology (October 2024 to May 2025)

1st ever Gene Edited (GE) Rice varieties

- ICAR has developed the **world's first climate-smart genome-edited (GE) rice varieties** using CRISPR-Cas9 techniques (SDN1 & SDN2).
- These are **India's first-ever gene-edited food crop varieties cleared for cultivation**.
- In **March 2022**, India relaxed regulatory controls for SDN1 and SDN2 gene editing techniques, as they do not insert foreign genes.
- India's first genome-edited rice varieties are **DRR Dhan 100 (Kamla)** and **Pusa DST Rice 1**.
- These are improved versions of traditional varieties **Samba Mahsuri** and **MTU 1010**.
- SDN1 and SDN2 techniques **do not involve introduction of foreign genes**; crops remain **non-transgenic**.
- In contrast, **SDN3 and beyond introduce foreign genes**, making the crop **transgenic**.
- **DRR Dhan 100** shows a **19% higher yield**, matures **20 days earlier**, lowers methane emissions, and reduces water requirements.
- **Pusa DST Rice 1** is **tolerant to drought, salinity, and climate stresses**.

India's First Gene-Edited Sheep

Researchers from Kashmir produced India's first gene-edited sheep.

- **Institution Behind the Achievement**
  The achievement was made by **Sher-e-Kashmir University of Agricultural Science & Technology (SKUAST), Srinagar**.
- SKUAST also produced India's first cloned pashmina goat called **Noori** in 2012.
- The gene editing increased the **muscle mass of the sheep by 30%**.
- This was achieved by **disrupting the myostatin gene**, which regulates muscle growth.
- **Comparison with European Breeds**
  This mutation occurs naturally in European breeds like **Texel**, but was not present in Indian sheep.
- **Non-Transgenic Nature**
  Since no foreign gene was introduced, the gene-edited sheep is **non-transgenic** in nature.

India is developing Drone-Based QKD

Achievements in QKD:

- **India's First QKD Demonstration (2021)**
  ISRO demonstrated Quantum Key Distribution (QKD) for the first time in India in 2021 over a 300-meter communication link.
- **QKD over 100 km**
  IIT Delhi and DRDO successfully demonstrated QKD between Prayagraj and Vindhyachal, covering over 100 km distance.
- **Drone-Based QKD**
  A public-private partnership established QKD-based secure communication links between drones and drone-to-ground stations.
- **Space-Based Quantum Communication**
  ISRO is planning to build a satellite-based communication link using QKD to achieve secure communication over long distances.

Launch of EOS-09 and PSLV Failure

ISRO attempted to launch the dual-use earth observation satellite EOS-09 on PSLV C-61, but it failed to reach its intended sun-synchronous polar orbit (SSPO) due to a glitch in the rocket's third stage. This was 101st Launch of ISRO.

PSLV Failure History

This was the third PSLV failure since its debut in 1997, following earlier failures in 1993 (PSLV-D1) and 2017 (PSLV-C39).

EOS-09 as Part of RISAT Series

EOS-09 (also referred to as RISAT-1B) was part of India's plan to enhance its 52-satellite surveillance and remote sensing constellation.

Dual-Use Nature of EOS-09

EOS-09 was designed as a dual-use reconnaissance satellite, serving both military and civilian purposes.

India's First Gene Therapy Trial for Haemophilia

India successfully conducted its first human trial of gene therapy for haemophilia.

Institutions Involved

Researchers from Christian Medical College (CMC) Vellore and inSTEM (Bengaluru), an autonomous institute under the Department of Biotechnology (DBT), developed the world's first **lentivirus-based gene therapy** for haemophilia.

About Haemophilia

Haemophilia is a rare **X-linked genetic bleeding disorder**, primarily due to deficiency of clotting Factor VIII (Haemophilia A) or Factor IX (Haemophilia B).

Who it Affects and Symptoms

It commonly affects males and leads to spontaneous bleeding in joints, soft tissues, and muscles. Internal bleeding, such as brain hemorrhage, can be life-threatening.

Current Treatments

Treatment includes intravenous infusion of clotting factors, recombinant therapy, and gene therapy in advanced countries.

China's Tianwen-2 Mission

China launched the spacecraft **Tianwen-2** to a near-Earth asteroid using the **Long March 3B rocket**.

Mission Objectives

To collect and return samples from near-Earth asteroid **469219 Kamo'oalewa** (believed to be a fragment of the Moon) by **2027**.

To later orbit and study **Comet 311P** in the asteroid belt between Mars and Jupiter by **2035**.

About Kamo'oalewa

Discovered in **2016** by **Pan-STARRS 1 telescope** in Hawaii.

It is a small near-Earth object, about **15 million km** away from Earth.

It is classified as a **quasi-satellite of Earth**, meaning it orbits the Sun but remains close to Earth due to gravitational resonance.

It has maintained this orbit for over **100 years**.

Other Notable Asteroid Missions

Hyabusa 1 (JAXA, Japan) — returned minimal samples from asteroid Itokawa in **2010**.

Hyabusa 2 (JAXA, Japan) — returned samples from asteroid Ryugu in **2020**.

Osiris-Rex (NASA, USA) — returned rocks and dust from asteroid Bennu in **2023**.

Repairability Index (RI) Framework

The Department of Consumer Affairs has developed a **Repairability Index (RI)** framework for smartphones and tablets.

Manufacturers will have to declare a **repairability score** showing how easy it is to repair their devices.

What is Repairability Index?

It is a **rating system** that assesses how easily a smartphone or tablet can be repaired — either by consumers or by third-party repair shops.

Parameters of RI

Repair information — easy access to repair manuals, DIY guides, diagnostic details.

Spare parts — easy and affordable access to original spare parts.

Affordable tools — availability of safe tools and software needed for repair.

Modular design — so that one part can be repaired without damaging others.

Economic feasibility — cost of parts and labour is affordable.

Steps Taken in India

In **2022**, the government launched the **Right to Repair Portal**, where companies share repair information for automobiles, mobiles & electronics, consumer durables, and farming equipment.

Sodium-Ion Batteries

Researchers in India are developing **sodium-ion batteries (NiB)** as an alternative to lithium-ion batteries (LiB).

Comparison between Lithion Ion Batteries and Sodium Ion Batteries

Li-ion: Smaller lithium ions, graphite anode, lithium metal oxide cathode (with cobalt & nickel), high energy density, compact, fast charge/discharge, costlier, high import dependence.

Na-ion: Larger sodium ions, hard carbon anode, sodium-manganese cathode (no cobalt/nickel), lower energy density, bulkier,

cheaper, longer life, slower discharge (good for grid), low import dependence.

India's 1st Quantum Technology Park in Amravati

- India's first **Quantum Technology Valley Park** is being set up in **Amaravati, Andhra Pradesh** to support the National Quantum Mission.
- It is a partnership between the Andhra Pradesh government and IT giants **IBM, TCS, and L&T**.
- The park will be based on India's largest quantum computer — a **156-qubit Heron quantum processor** of IBM Quantum System-2.
- **TCS and IBM** will develop quantum algorithms for applications in life sciences, energy efficiency, materials science, green manufacturing, cryptology, and supply chain optimization.
- The project also aims to enable quantum-powered public services like **GST optimization**, **real-time census modelling**, and developing India's first **quantum governance framework**.

Bharat Forecasting System (BFS)

- India launched the **Bharat Forecasting System (BFS)** — the world's highest-resolution weather forecasting model.
- BFS was developed indigenously by the **Indian Institute of Tropical Meteorology (IITM), Pune**, under the **Ministry of Earth Sciences**.
- It is powered by the high-performance computing (HPC) facility **Arka**, established at IITM Pune.
- BFS provides **block-level weather forecasts for the next two hours (nowcast)** and predicts at **6×6 km resolution** (compared to earlier 12×12 km).
- It enhances forecasting of **extreme weather events** like heat waves, cold waves, cyclones, floods, thunderstorms, lightning, etc.
- BFS also provides high-resolution forecasts for the **entire tropical belt (30° S to 30° N)**, covering parts of Africa, South Asia, and Southeast Asia.

CRISPR in Cancer Diagnostics

Scientists at Tata Memorial Hospital developed a genetic testing tool called **RAPID-CRISPR** for diagnosing **Acute Promyelocytic Leukemia (APL)**. **RAPID-CRISPR** stands for **Redefined APL Identification**. It is a **CRISPR-based diagnostic system** that detects the **PML-RARA fusion gene** in a blood sample.

Genome India Project: Preliminary Findings

- The **Genome India Project** is a flagship initiative of the **Department of Biotechnology (DBT)**, launched in **2020**, to build a **reference genome of Indians**.
- Preliminary findings from sequencing ~10,000 Indians revealed about **180 million gene variants**.
- A biobank was established with **20,000 blood samples and phenotype data** (weight, height, waist-hip ratio, blood pressure).
- Participants represented **83 population groups** — 30 tribal and 53 non-tribal.
- ~10,000 genomes sequenced in the first phase created a **reference genome for India**.
- The project addresses the limitation of the **Human Genome Project (2001)**, which sequenced mainly white populations.

Fram2 Mission

- **Fram2** is the **first-ever human space flight to polar orbit**, launched by a **SpaceX Falcon 9 rocket**.
- The mission lasted about **3.5 days**.
- It carried **4 astronauts** on board the **Dragon spacecraft** to a **900 km circular polar orbit**, flying over both the North and South Poles.
- The mission aimed to study unusual **light emissions resembling auroras** at 400–500 km altitude, higher than normal auroras (100–300 km).
- It also conducted experiments on **human health in microgravity**, including capturing the **first-ever X-ray image of a human in space**.

CROP: Realtime Crop Monitoring System

- **CROP** stands for **Comprehensive Remote Sensing Observation on Crop Progress**.
- It is a **real-time crop monitoring system** jointly developed by **ISRO** and the **National Remote Sensing Centre (NRSC)**.
- CROP uses **advanced satellite remote sensing** to monitor agricultural crops across India.
- By March 31, 2025, using the CROP system, ISRO estimated India's wheat production in eight key states at **122.724 million tonnes**.

Semaglutide: Wonder Drug for Obesity & Diabetes

Semaglutide is a drug that **mimics the natural hormone GLP-1 (Glucagon-Like Peptide-1)** found in the human gut.

GLP-1 functions:

– Regulates blood sugar levels.
– Aids in digestion by breaking down food.
– Creates a feeling of satiety in the stomach.
– Helps control hunger and manage appetite.

Vehicle-to-Grid (V2G) Technology

The **Kerala State Electricity Board**, in collaboration with **IIT Bombay**, is working on implementing V2G technology in Kerala to enable **reverse charging of the grid from electric vehicles (EVs)**.

What is V2G?

V2G is based on **bi-directional energy transfer** between EVs and the electricity grid. EVs can:
– Charge from the grid (**G2V — Grid-to-Vehicle**)
– Discharge electricity back to the grid (**V2G — Vehicle-to-Grid**)
– Supply power to homes (**V2H — Vehicle-to-Home**) during peak demand or power outages.

Biomass Satellite Mission

- The **European Space Agency (ESA)** launched the **'Biomass'** forest-monitoring satellite aboard a **Vega-C rocket**.
- Biomass is part of ESA's **'Earth Explorers' series** of climate satellites under the **Living Planet Programme**, aimed at studying **changes in ecosystems** and their interaction with **climate change**.

RT-LAMP: TB Diagnostic Tool

- Researchers in India have developed and tested a **molecular diagnostic tool** called **RT-LAMP (Real-Time Loop-Mediated Amplification)** for early detection of **Tuberculosis (TB)**.
- It is faster, cheaper, more reliable, and more precise compared to conventional TB diagnostic methods.

Universal Acceptance (UA): A Movement for Multilingual Internet

- The Government of India is working to make all official websites **Universal Acceptance (UA) compliant**, ensuring that URLs and email addresses can appear in **22 scheduled Indian languages** (e.g., सरकार.भारत for gov.in).
- The goal is to make digital services **accessible in local scripts** across the governance ecosystem, promoting **digital inclusion**.
- **Universal Acceptance (UA)** is a global movement to create a **multilingual internet** by developing **Internationalised Domain Names (IDNs)** and associated email addresses.
- **Note:** March 28 is observed as **Universal Acceptance Day**, recognised by the **National Internet Exchange of India (NIXI)** under the **Ministry of Electronics and Information Technology (MeitY)**.

Vellore Declaration: Type 5 Diabetes

- The **International Diabetes Foundation (IDF)** has formally recognised **malnutrition-linked diabetes** as a distinct form of the disease, now called **Type 5 diabetes**.
- The recognition was announced at the **75th World Diabetes Congress** in **Bangkok**, but the decision was taken earlier at a forum in **Vellore, Tamil Nadu**, hence named the **Vellore Declaration**.
- **Type 5 diabetes**, previously called **J-type diabetes** (first reported in Jamaica, 1955), was observed in undernourished populations.
- In **1985**, the **WHO** classified it as **malnutrition-related diabetes**

mellitus, but this category was dropped in **1999** due to insufficient evidence linking malnutrition directly to diabetes.

ISRO Successfully Undocks SpaDeX Satellites

- ISRO successfully **undocked** the SpaDeX (Space Docking Experiment) satellites — **SDX01 (Chaser)** and **SDX02 (Target)** — after nearly two months of testing their docking capabilities.
- This achievement makes India the **fourth country**, after the **United States, Russia, and China**, to develop advanced space docking technology.
- It is a key milestone for future ISRO missions, including **human spaceflight, lunar exploration, and India's planned space station**.

About SpaDeX Mission

SpaDeX tests India's ability to autonomously **dock and undock satellites in orbit**.
– In January 2025, the two **220-kg satellites**, SDX01 and SDX02, were maneuvered into the same orbit and docked.
– They demonstrated **power sharing**, operating as a single composite unit.
– After testing, the satellites were successfully **undocked**.

Indian Firms Racing to Build Local AI Solutions

- IndiaAI Mission launched **AI Kosha**, a national dataset platform to collect **non-personal data** for AI model development.
- A **Common Compute Portal** was also launched to give startups and academia shared access to **GPUs** for AI work.
- Currently, **14,000 GPUs** are commissioned for shared use (up from 10,000 in early 2024), supplied by **10 selected companies**.
- India plans to develop **indigenous GPUs** in the next **3–5 years** to reduce import dependence and boost AI self-reliance.

Solar Flares and Aditya L1 mission

The Solar Ultraviolet Imaging Telescope (SUIT) onboard Aditya-L1 recorded the first-ever image of a solar flare 'kernel'. SUIT one of the seven scientific payloads on the Aditya-L1 spacecraft, developed by the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune

About Aditya L1 mission (Launched in 2023 aboard PSLV C-57 rocket)

- India's first dedicated space-based observatory for studying the Sun.
- Primary goal is to investigate the solar atmosphere, solar magnetic storms, and their impact on the environment around Earth.
- The spacecraft is positioned in a halo orbit around the Lagrange point 1 (L1) of the Sun-Earth system, approximately 1.5 million kilometers from Earth. This location provides a continuous, unobstructed view of the Sun.
- It was successfully placed in its halo orbit around L1 in January 2024.

Ocelot Chip

Amazon unveils first quantum chip 'Ocelot' days after Microsoft's Majorana 1 and Google's 'Willow' chips.

Blue Ghost Mission

- Firefly Aerospace's **Blue Ghost lunar lander** successfully landed at the Moon's **Mare Crisium**, a volcanic region on the northeastern near side.
- It is part of NASA's **Commercial Lunar Payload Services (CLPS)** initiative, which engages private companies to deliver scientific instruments and technology demos to the Moon.
- The mission supports NASA's **Artemis program** and the goal of establishing a **long-term human presence** on the Moon.

Bose Metal

- Scientists from Japan and China has found that niobium diselenide ($NbSe_2$) exhibits properties of a Bose metal, a long-theorized but unproven quantum state.
- A Bose metal is a **quantum state** of matter where **Cooper pairs** (electron pairs in superconductors) do not fully condense into a superconducting phase, leading to anomalous conductivity even at extremely low temperatures.

PUNCH Mission

- The National Aeronautics and Space Administration (NASA) is set to launch its solar mission, Polarimeter to Unify the Corona and Heliosphere (PUNCH) during the solar maximum phase of the Sun's cycle.
- **Objective:** To study how the Sun's corona transitions into the solar wind, the constant stream of charged particles that flows throughout the solar system. It aims to provide a comprehensive, 3D view of this region, which is crucial for understanding space weather.
- **Polarimetry for enhanced observation:** Unlike previous missions (e.g., SOHO, Parker Solar Probe), PUNCH will provide a real-time dynamic view of solar wind behavior.
- **Parker Solar Probe** (launched in 2018) studies the Sun's corona at close range, while PUNCH will complement it by providing large-scale imaging of solar wind.

Plastic Ice (The Fourth Form of Water)

- Scientists have confirmed a fourth form of water called **Plastic Ice VII**, which forms under **extreme pressures** (> 3 gigapascals, ~30,000 times Earth's atmospheric pressure).
- It exists in **deep planetary interiors** and high-pressure lab setups, with a distinct crystalline structure.
- It exhibits **plastic behavior**, meaning it deforms without fracturing because water molecules can still rotate within the lattice, allowing flow under stress.
- This explains the **plasticity of Antarctic and Greenland ice sheets**, and may also occur in the ice crusts of Jupiter's moon **Europa** and Saturn's moon **Enceladus**, potentially influencing subsurface life.

Northeast Centre for Technology Application & Reach (NECTAR)

- The central government has decided to establish **NECTAR's permanent campus in Shillong**.
- NECTAR is an **autonomous society under the Department of Science & Technology**, created in **2012** by merging the **National Mission for Bamboo Application (NMBA)** and the **Mission for Geospatial Applications (MGA)**.
- It uses modern technologies like **remote sensing, GIS, and ICT** to tackle challenges specific to the **North Eastern Region**.
- NECTAR promotes **Agri-Tech**, **bamboo industry**, and **Eri & Muga silk industries** in Assam and Meghalaya, supporting **Atmanirbhar Bharat** and **Vocal for Local** initiatives.

Birefringence

Birefringence, also called **double refraction**, is an **optical phenomenon** where a single light wave entering an **anisotropic material** splits into two rays, traveling at different speeds and refracted at different angles.
It is increasingly used in **LCD screens, medical microscopes, optical switches, waveplates, frequency converters, and high-power lasers**.

Examples of birefringent materials:

– **Natural crystals**: calcite, quartz, mica
– **Biological structures**: collagen fibers, muscle tissues
– **Engineered materials**: liquid crystals in LCDs, certain plastics

Chandrayaan-5 (ISRO-JAXA Joint Mission)

– Approved by the Centre to explore the Moon's **south pole**.
– Aims to study lunar surface, composition, and potential water resources.
– Supports India's goal of a **human landing on the Moon by 2040**.
– Will perform **on-site sampling, analysis**, and demonstrate **lunar night survival technologies**.
– Features a **larger, advanced 250 kg rover** to explore shadowed regions where water ice is suspected.

India's Second Spaceport (Kulasekarapattinam, Tamil Nadu)

– Located in **Thoothukudi district**, designed for **Small Satellite Launch Vehicle (SSLV)** launches.
– Strategically advantageous for **polar orbit**

launches via direct southward trajectory over the Indian Ocean.
– Avoids fuel-intensive maneuvers around Sri Lanka, unlike launches from Sriharikota.

White Hydrogen

– France discovered a **46-million-ton reserve** of white hydrogen in the **Moselle region**, valued at **$92 trillion**.
– Unlike **green** or **blue hydrogen**, white hydrogen occurs **naturally within the Earth**, formed by geological reactions between water and certain minerals.
– It is seen as a **clean energy source** with lower carbon footprint than conventional hydrogen production.
– Estimated production cost is around **$1 per kg**, making it highly affordable.

India Bio-Economy Report 2024

The Department of Biotechnology has released the India BioEconomy Report 2024 highlighting that India's bioeconomy crossed $165 billion, contributing 4.2% of GDP. It has doubled in last 5 years.

GAIA Mission

– ESA's **Gaia (Global Astrometric Interferometer for Astrophysics)** mission has been shut down.
– Launched in **2013**, aimed to create the most precise **3D map of the Milky Way galaxy**.
– Operated from **Lagrange Point 2 (L2)**, about 1.5 million km from Earth.
– Measured positions, distances, and motions of **over a billion stars**.
– Contributed to understanding **exoplanets, stellar physics, dark matter, and General Relativity**.
– Mapped the galaxy's past and future structure, and detected over **1,50,000 asteroids**, projecting potential Earth threats.

Small Modular Reactors (SMRs)

– Finance Minister announced a **₹20,000 crore Nuclear Energy Mission** to develop indigenous SMRs.
– In **Feb 2025**, India and France signed a partnership for SMR development.

About SMRs:

– Alternative to large nuclear plants, with capacity up to **300 MWe**, producing ~7.2 million kWh/day (vs >1000 MWe & ~24 million kWh/day for large reactors).
– Built modularly: factory-fabricated & assembled onsite, reducing cost & construction time.
– Suitable for **existing grids & remote areas**, with passive safety features relying on natural forces for shutdown during emergencies.

India's SMR Plans:

– Dept. of Atomic Energy & Tata Consulting Engineers plan **40–50 SMRs by 2032**, replacing old coal plants.
– NTPC is exploring SMRs with international firms like **Holtec International (USA)**.

Global Developments:

– Russia's **Akademik Lomonosov** (floating SMR) operational since 2020 in Arctic.
– China & Russia lead in deployed SMRs.
– Google signed an agreement with **Kairos Power** in 2024 to procure **500 MW** from SMRs for data centers & AI operations.
– **IAEA:** over **80 SMR designs** under development in **19 countries**, including advanced light-water, fast neutron, and molten salt reactors.

GARBHINI-DRISHTI

– India launched **GARBH-INi-DRISHTI**, a **data repository & information sharing hub**, along with its first **Ferret Research Facility**.
– Initiative of the **Department of Biotechnology (DBT)**.
– Established at **Translational Health Science and Technology Institute (THSTI), Faridabad, Haryana**.
– Aim: To support research and improve healthcare interventions in **maternal and neonatal health**.

Einstein Ring

– ESA's **Euclid space telescope** discovered a clear **Einstein ring** around galaxy **NGC 6505**, about **590 million light-years** away.
– The discovery helps study **mass distribution & dark matter** in NGC 6505.

About Einstein Ring:

– A result of **gravitational lensing**, where light from a distant galaxy or quasar is bent and magnified by a massive object (like a galaxy or black hole) between the source and observer.
– Predicted by **Einstein's General Theory of Relativity**, where massive objects warp spacetime, bending light like a lens.

PARAS-2 Spectrograph

– Scientists at **Physical Research Laboratory (PRL), Ahmedabad** discovered exoplanet **TOI-6038A b** (a dense sub-Saturn) using **PARAS-2 spectrograph**.
– **PARAS-2** is a **high-resolution Radial Velocity (RV) spectrograph**, the highest resolution in Asia.
– Purpose: Detects & measures mass of exoplanets, especially low-mass ones (like super-Earths), using the **radial velocity method** (detects star's wobble due to planet's gravity).
– Installed on the **2.5-meter telescope at Mount Abu Observatory**, benefiting from high altitude & clear skies for precision observations.

Indirect Prompt Injection

– Researchers flagged rising cases of **Indirect Prompt Injection attacks** on AI chatbots using **Large Language Models (LLMs)**.
– **What is it?**
– Unlike direct injection (where attacker directly inputs malicious prompts), **indirect attacks manipulate the data sources** (e.g., websites, documents) that the LLM uses for context.
– Aim: To trick the LLM into behaving in unintended or malicious ways by poisoning its input context indirectly.

International Thermonuclear Experimental Reactor (ITER)

– ITER is located in **Cadarache, Southern France**; India's PM recently visited the site.
– It is a **collaborative project of 7 parties**: China, European Union, India, Japan, Russia, South Korea, USA.
– India joined ITER in **2005** and contributed key components like the **Cryostat**, the world's largest high-vacuum chamber, built by Larsen & Toubro.
– Aim: To produce **500 MW of fusion power** from **50 MW input**, achieving a **tenfold energy gain**, creating a "burning plasma" at **>150 million°C**.
– Fusion reaction: Combines **deuterium & tritium**, releasing large amounts of energy.
– Technology: Uses **tokamak** design — a doughnut-shaped (toroidal) reactor with strong magnetic fields to confine plasma.
– ITER is part of global efforts alongside other tokamaks like China's **EAST**, which achieved **120 million°C for 100 seconds**, earning the name "artificial sun."
– Currently, over **200 tokamaks** are operational worldwide.

Advantages of fusion over fission:

– No meltdown risk (unlike Chernobyl/Fukushima).
– Produces less radioactive waste.

Majorana 1

Microsoft has announced a new quantum computing chip, called Majorana 1.

Coronal Holes

– Coronal holes are **dark regions in the Sun's corona** (outer atmosphere), visible in extreme ultraviolet (EUV) and X-ray images.
– First discovered in the **1970s** by X-ray satellites.
– They are **cooler, less dense**, and have **open, unipolar magnetic field lines**, allowing high-speed solar wind to escape into space.
– Cause enhanced **auroras** (e.g., Aurora Borealis) and can influence stratospheric ozone and global temperature patterns.
– More common and persistent during **solar minimum**, lasting weeks to months.
– Monitored by NASA's **Solar Dynamics Observatory (SDO)**, ESA's **Solar Orbiter**, and India's **Aditya-L1 Mission (2023)** to study solar activity and space weather.

Technology Adoption Fund

– Launched by **IN-SPACe (Indian National Space Promotion and Authorisation Centre)**.
– Corpus: **₹500 crore**.
– Purpose: To promote development and adoption of **cutting-edge space technologies** by **Indian private firms, startups, and academia**.

Selenium

– Recent incident: **Hair loss cases in Buldhana (Maharashtra)** linked to **high selenium content in wheat** from Punjab & Haryana (ration shops).
– **Symbol:** Se | **Atomic Number:** 34.
– **Type:** Nonmetal, properties intermediate between **sulfur** and **tellurium**.
– **Forms:** Red powder, black vitreous solid, gray metallic form.
– **Occurrence:** Found in trace amounts in Earth's crust, usually with sulfide ores.

– **Uses:** In **glassmaking**, **pigments**, and some **electronic components**.

Guillain-Barré Syndrome (GBS)

– GBS is a **rare autoimmune neurological disorder** where the immune system attacks peripheral nerves, causing muscle weakness and possibly paralysis.
– Onset: Develops over days to weeks; more common in **adults & males**.
– Incidence: ~1–2 cases per **100,000 population**.

Causes & Risk Factors:

– Exact cause unclear, but often triggered by:

- **Common triggers:** Infections, esp. *Campylobacter jejuni* (gastroenteritis).
- Other infections: Flu, CMV, Epstein-Barr, Zika.
- Rare: Vaccinations (risk very low).

Treatment:

– No cure, but treatments help recovery (most recover, some have lasting weakness).
– **Plasma Exchange (Plasmapheresis):** Removes antibodies attacking nerves.
– **IVIG Therapy:** Immunoglobulins neutralize immune attack.

Recent context:

– Outbreak reported in **Pune**, India — 73 cases investigated by Union Health Ministry.

Cubic Kilometre Neutrino Telescope (KM3NeT)

– T**wo underwater neutrino telescopes** in the Mediterranean Sea.
– Aims to observe at least **1 cubic kilometer of seawater** to detect **high-energy neutrinos (ghost particles)** using **water Cherenkov detectors**.
– Neutrinos: Neutral, fundamental particles, second-most abundant after photons.

Two Telescopes:

- **ARCA (Astroparticle Research with Cosmic in the Abyss):** Offshore Sicily, Italy — studies high-energy cosmic neutrinos from distant astrophysical sources.
- **ORCA (Oscillation Research with Cosmic in the Abyss):** Offshore Toulon, France — optimized to study neutrino properties (mass, oscillations).

Scientific Goals:

– **Astrophysics:** Trace cosmic neutrinos from extreme events (e.g., supernovae, gamma-ray bursts).
– **Particle Physics:** Explore neutrino mass & oscillations — fundamental to particle physics.
– **Oceanography:** Long-term monitoring of the deep-sea environment.

Methylcobalamin

– A **coenzyme form of vitamin B12** (water-soluble vitamin), directly usable by the body.
– Essential for **cell growth, blood formation, protein synthesis**, and production of neurotransmitters like **serotonin and dopamine** (important for mood & mental health).
– Unlike other forms of B12, it does **not require conversion** to become active in the body.
– **Sources:** Naturally found in meat, fish, eggs, and milk.
– Recently, FSSAI provided clarity on its use as a nutrient in foods and supplements.

Indigenous Paracetamol Drug

– CSIR has developed an **indigenous version of paracetamol**, ensuring self-reliance in its production.

About Paracetamol:

– Also called **N-acetyl-para-aminophenol**; rapidly absorbed in the gastrointestinal tract.
– Widely used as an **analgesic (pain reliever)** and **antipyretic (fever reducer)**.
– **Overdose risk:** Can cause severe **liver damage (hepatotoxicity)**.
– Known as **acetaminophen** in the US & Japan.
– Listed in the **WHO Model List of Essential Medicines**.
– **Working:** Inhibits prostaglandins (pain mediators) and acts on the hypothalamus to lower fever.
– Safer than aspirin (which has anticoagulant effects and is unsuitable for some people).

Tidal Tail

– A study found the longest **tidal tail** linked to galaxy **NGC 3785**, ~430 million light-years away in the **Leo constellation**, with an ultra-diffuse galaxy at its end.

What is a Tidal Tail?

– A long, thin stream of **stars, gas (mainly hydrogen), and dust** pulled out of a galaxy's main body.
– Caused by **gravitational interactions**

between galaxies during close encounters or mergers.

Firefly — India's First Private Satellite Constellation

– Developed and launched by **Pixxel**, a Bengaluru-based space tech startup (backed by Google and launched via SpaceX).
– Consists of **six hyperspectral imaging satellites**, launched from **Vandenberg Space Force Base, California, USA**.
– Purpose: To deliver **high-resolution hyperspectral imaging** for agriculture, mining, environmental monitoring, defense, and resource management.
– Plan: Expand to **24 satellites by 2029** to meet global demand.

Silver Nanowire-Based Conductive Ink Technology

– Developed under a **MeitY-funded project** and transferred to two Indian startups.
– It is a **specialized ink** that forms an electrically conductive path when applied to surfaces.

Applications:

– **Flexible Electronics & Solar Cells** — used in foldable phones, tablets, solar panels.
– **Wearable Technology & E-textiles** — smartwatches, fitness trackers, conductive fabrics.
– **Semiconductors, Photovoltaics & RFID** – enables printing of circuits on diverse surfaces, transforming manufacturing processes.

Third Launch Pad (TLP) — Satish Dhawan Space Centre, Sriharikota

— Approved by the Union Cabinet for construction at ISRO's Sriharikota spaceport, Andhra Pradesh.

Purpose:

— To support ISRO's upcoming Next Generation Launch Vehicles (NGLVs).
— Will also serve as a backup to the existing Second Launch Pad (SLP).

Existing Launch Pads:

— **First Launch Pad (FLP):** Used for Polar Satellite Launch Vehicle (PSLV) and Small Satellite Launch Vehicle (SSLV).
— **Second Launch Pad (SLP):** Used for Geosynchronous Satellite Launch Vehicle (GSLV) and Launch Vehicle Mark-3 (LVM3).
— The TLP will enhance ISRO's capacity to handle higher launch frequency and newer missions.

Planet Parade

— A celestial phenomenon where multiple planets appear to align or cluster closely in the night sky as seen from Earth.
— The alignment is not perfectly straight but visually striking.
— **Recent Event:** Venus, Saturn, Jupiter, and Mars aligned to form a medium planet parade.
— **Types of Planet Parades:**
— *Mini Parade:* Alignment of 3 planets.
— *Medium Parade:* Alignment of 4–5 planets.
— *Grand Parade:* Alignment of 6 or more planets (rare).

LID 568

— NASA's James Webb Space Telescope and Chandra X-ray Observatory has discovered LID-568, a low-mass supermassive black hole from 1.5 billion years after the Big Bang.

Mission SCOT

— The Prime Minister of India lauded the Indian space startup Digantara at the success of Mission SCOT, a significant milestone in the realm of space situational awareness (SSA).

About Mission SCOT (Space Camera for Object Tracking)

— It is one of the world's first commercial satellites dedicated to tracking objects in space. This marks a shift towards private sector involvement in critical space infrastructure.
— Launch Vehicle: SpaceX's Transporter-12 mission.
— Placed in a sun-synchronous orbit, allowing it to efficiently track objects in LEO.
— The primary objective is to track Resident Space Objects (RSOs), which include defunct satellites, rocket parts, and other debris orbiting Earth.
— It can monitor smaller RSOs (as small as 5 cm), filling a crucial gap in current tracking systems that often struggle with such small objects.

Rhodamine B (RhB)

— Rhodamine B is under intense scrutiny including global ban by the Food and Drug Administration (FDA) and various Indian states for its harmful carcinogenic effects.

— In 2024, the Karnataka government prohibited usage of Rhodamine B artificial colour in *gobi manchurian* and *cotton candy*.

About Rhodamine B (RhB)

— It is a synthetic organic compound belonging to the rhodamine family of dyes.
— Appearance: a reddish-violet powder and dissolves readily in water to produce a bright pink or reddish-purple fluorescent solution.

NVS-02 Satellite

— In its 100th launch, ISRO sent off the 2250 kg **NVS-02 navigation satellite** on-board **GSLV-F15**.
— NVS-01 was launched on-board **GSLV-F12** in 2023 and carried India's first indigenous atomic clock.

About NVS-02 Satellite (Power: ~3 kW)

— Second of five second-generation satellites to replace the existing Indian Regional Navigation Satellite System (NavIC) constellation (replacing IRNSS-1E).
— NavIC offers:
— **Standard Positioning Service (SPS):** for general users
— **Restricted Service (RS):** for strategic users
— Position accuracy: better than 20 meters; timing accuracy: within 40 nanoseconds.
— Orbit: Geosynchronous Transfer Orbit.
— Lifespan: 12 years; equipped with indigenous **Rubidium Atomic Frequency Standard (RAFS)** clocks.
— Configured with navigation payload in **three frequency bands** — L1, L5, and S — plus a ranging payload in C-band (like NVS-01).
— Supports compatibility with a wider range of devices, including smaller gadgets like fitness trackers and wearables.

WASP-127b

Jet-stream winds reaching 33,000 km/h have been observed on the exoplanet WASP-127b, making them the fastest planetary winds ever recorded.

Organophosphates (OPs)

Organophosphate, used in pesticides, likely behind 17 deaths that spread panic in J&K village.

Nafithromycin

— India formally launched its first indigenous antibiotic **Nafithromycin**, aimed at tackling **Antimicrobial Resistance (AMR)** — a condition where bacteria, viruses, fungi, and parasites no longer respond to antimicrobial medicines (antibiotics, antivirals, antifungals, antiparasitics).

About Nafithromycin (trade name: Miqnaf)

— An antibiotic developed to combat drug-resistant bacteria, particularly those causing **community-acquired bacterial pneumonia (CABP)** — one of the most common infectious diseases and a major cause of mortality and morbidity worldwide.
— Developed by **Wockhardt** with support from **Biotechnology Industry Research Assistance Council (BIRAC)** under the Department of Biotechnology.

Key Features

— **Enhanced Efficacy:** Around 10 times more potent than azithromycin, with 8 times higher lung exposure and minimal side effects.
— **Shorter Treatment Course:** Requires only 3 days of treatment compared to longer courses of conventional antibiotics.

Hyperloop

— India's first **hyperloop test track** was inaugurated through a collaboration between **Indian Railways, IIT-Madras, and TuTr Hyperloop**.
— Proposed routes under exploration include **Mumbai–Pune** and **Bengaluru–Chennai**.

About Hyperloop (proposed by Elon Musk in 2013)

— A high-speed (1,100–1,300 km/h or higher) transportation system where pods travel through **low-pressure tubes** with minimal air resistance.

Concept and Working

— **Low-Pressure Tubes:** Pods move through sealed, near-vacuum tubes, which reduces drag and improves energy efficiency.
— **Pod Design:** Passenger/cargo pods levitate and move using **magnetic or air-based levitation**, ensuring minimal friction.
— **Magnetic Levitation:** Enables the pods to float above the track, eliminating contact and reducing resistance.
— **Energy Source:** Often designed to integrate solar panels along the tube, making it a

potential **zero-emission transport mode** if powered by renewable energy.
— Pods are designed to provide comfort and safety similar to modern aircraft while achieving much higher speeds.

Willow Chip

Google has unveiled its next-generation quantum computing chip called 'Willow'.

Expansion of Universe

NASA's James Webb Space Telescope has confirmed that the universe is expanding faster than expected, corroborating observations made by the Hubble Space Telescope. The expansion rate of the universe is known as the Hubble constant (H_0), and it's a fundamental parameter for understanding the evolution and ultimate fate of the cosmos.
✓ **Hubble's Law:** The velocity of a galaxy moving away is proportional to its distance from Earth.
Here is a concise and factual summary of the **Carbon-14 Diamond Battery** — suitable for notes:

Carbon-14 Diamond Battery

— Scientists have developed the world's first **carbon-14 diamond battery**, which converts radioactive decay into electricity.

Features & Working

— Harnesses energy from the radioactive decay of **carbon-14 (C-14)**, an isotope with a **half-life of ~5,700 years**.
— **Diamond Encapsulation:** C-14 is embedded within a diamond structure, ensuring safety and durability by preventing radiation leakage.
— **Use of Nuclear Waste:** C-14 is sourced from graphite blocks used in nuclear reactors, offering a sustainable use of radioactive waste and helping with its disposal.
— Aims to provide a long-lasting, safe, and innovative energy source by turning nuclear waste into electricity.

Diamond Cooling Technology

— **Developed by Akash Systems**, which partnered with India's NxtGen Datacenter in a $27 million deal.

What it is:

— A cooling technology that utilizes the exceptional **thermal conductivity of diamond** to dissipate heat from high-power electronic components.

Applications:

— Laser diodes, electric vehicles, high-power transistors & amplifiers, CPUs, GPUs — where heat management is critical.

Key Principles & Features:

— Diamond has the **highest thermal conductivity** of any natural material — several times better than copper — enabling superior heat transfer.
— Diamond's hardness also ensures durability in demanding, high-stress environments.

IRIS² Project (Infrastructure for Resilience, Interconnectivity and Security by Satellite)

— Launched by the **European Union** as a €10 billion space programme to compete with private systems like **Elon Musk's Starlink**.

Purpose:

— To deliver **secure satellite-based communication, location tracking, and surveillance** for EU governmental agencies.
— Also aims to provide **broadband internet access** to citizens and businesses across Europe.
— Strengthens EU's **strategic autonomy** in space and bridges digital divides, while enhancing security capabilities.

SpaDeX (Space Docking Experiment)

— **Launched by ISRO** on **PSLV-C60** from Satish Dhawan Space Centre, along with 24 **POEM-4** payloads.
— **Objective:** To master **indigenous technology** for autonomous **in-space docking and undocking**, vital for future space stations, crewed missions, and deep space exploration.
— India aims to become the **4th country** (after US, Russia, China) to achieve space docking capability.

Background:

— Space docking was first demonstrated by the Soviet Union in 1967 (Kosmos-186 & Kosmos-188).
— India's system is fully developed in-house, similar in principle to NASA's Apollo and SpaceX Crew Dragon.

Key Technologies Demonstrated:

— Proximity Operations Sensors — for guidance.
— Automated Rendezvous & Docking (AR&D)

— for precision maneuvers.
— Low-Thrust Propulsion — for fine control.

Working:

— Two small Indian satellites, **SDX01 (chaser)** and **SDX02 (target)**, launched into **470 km Low-Earth Orbit (LEO) at 55° inclination**.
— They autonomously dock, remain attached, then undock and separate — validating India's indigenous docking system.

Parker Solar Probe

— Launched in **2018** by **NASA** under the *Living with a Star* program.

Mission Objective:

— Study the Sun's outer atmosphere (**corona**) and answer two key questions:
— Why is the corona much hotter than the Sun's surface? (*Coronal Heating Problem*)
— How is the **solar wind** accelerated?

Achievements:

— In **December 2021**, it became the first spacecraft to enter the Sun's atmosphere (corona).
— Continues looping closer to the Sun with each orbit, sending critical data.

Key Features:

— **Proximity:** Closest-ever approach to the Sun, flying into the outer corona.
— **Heat Shield:** Special Thermal Protection System (TPS) withstands temperatures exceeding **1,377°C**.

Indian Context:

— *Aditya-L1 Mission* — India's first solar mission — complements Parker Solar Probe by observing the Sun from Lagrange Point 1 (L1).

Ultra-Enforcement Concrete (UEC)

— The Government is working to reduce the cost of the construction of public infrastructure by 25% with the use of ultra-enforcement concrete.

About Ultra-Enforcement Concrete (UEC — adapted from Malaysian technology)

— It is a specialized type of concrete that exhibits exceptional mechanical properties, such as high strength, durability, and resistance to cracking.

V404 Cygni: Black Hole Triple System

- Scientists have discovered First ever "black hole triple" system named V404 Cygni located around 8,000 light years away in the constellation of Cygnus.

About Black Hole Triple System

- It is a rare astronomical phenomenon where three celestial bodies, including at least one black hole, are gravitationally bound and orbit each other.
- Two black holes orbit each other closely in the inner region **(Kozai-Lidov cycles)**, creating a binary black hole system. The third black hole orbits the inner binary at a larger distance.

Luminescent Nanomaterials

– Scientists at the Institute of Nano Science and Technology (INST) have developed a novel security ink based on luminescent nanomaterials.

– About Luminescent Nanomaterials:

– Nanoscale materials that emit light (luminescence) when excited by an external energy source, such as light, chemical reactions, or an electric field.
– They possess unique optical properties, making them useful for a wide range of applications like security inks, bioimaging, displays, and sensors.

Analog Space Mission

– **ISRO** has launched **India's first analog space mission** in **Leh, Ladakh**.

About Analog Space Missions:

– Simulated missions conducted on Earth in environments that closely resemble **extraterrestrial conditions**.
– Aim to prepare astronauts for the challenges of space exploration by testing human endurance, technologies, and equipment in realistic scenarios.
– A **joint effort** involving: Human Spaceflight Centre of ISRO, AAKA Space Studio, University of Ladakh, IIT Bombay, Supported by the Ladakh Autonomous Hill Development Council.

Titanium

– India and Kazakhstan have signed an agreement to establish a **joint venture company** for the production of **titanium slag** in India.

About Titanium:

– A strong, lightweight, and corrosion-resistant metal.
– Present in **meteorites** and the **sun**.

– 9th most abundant element on Earth.
– **Primary ores:** Rutile (TiO_2) and Ilmenite ($FeTiO_3$).

Titanium Slag:

– Byproduct obtained during the production of titanium dioxide pigment from ilmenite ore.
– A complex mixture of titanium oxides, iron oxides, and other minerals.

Uses of Titanium:

– Aerospace components (aircraft engines, frames).
– Medical implants (due to biocompatibility).
– Automotive parts, electronics, and sports equipment.

Allulose

– **Allulose**, also known as **D-psicose**, belongs to the **monosaccharide** category.
– A rare **low-calorie sugar** (about 70% as sweet as regular sugar with similar taste), naturally found in **figs, raisins, and maple syrup**.
– Commercially produced from **beet sugar** or **corn** using specific enzymes.
– Approved in the **U.S.** and **South Korea**, but classified as a "novel food" in the **EU** and **Canada**, with limited regulatory approval elsewhere.

Key Properties:

– **Minimal impact on blood sugar:** Little to no effect, making it suitable for diabetics.
– **Low glycemic index:** Does not cause significant spikes in blood sugar.
– **Non-cariogenic:** Does not promote tooth decay.
– **Digestive health:** Not fully absorbed, minimally fermented, and excreted in urine, which may support better digestion.

Millimeter Wave Transceiver

– The **Centre for Development of Telematics (C-DOT)** and **IIT Roorkee** are jointly developing a millimeter wave transceiver under the **Telecom Technology Development Fund (TTDF)** to improve **5G connectivity in rural areas**.

About Millimeter Wave Transceiver Technology (30–300 GHz):

– **High-Speed Data Rates:**
– Millimeter waves provide much higher bandwidth compared to lower-frequency bands, enabling **extremely fast data transfer rates**, suitable for high-speed applications.
– **Short Range:**
– Due to the high frequency, the signal has a **limited range** and is more susceptible to obstacles.
– To ensure coverage, a **dense network of small cells** is typically required.
– **Beamforming:**
– Uses advanced antenna technologies such as **beamforming** to direct the signal precisely, improving the **signal-to-noise ratio** and efficiency.

Nickel Toxicity and Sterols

– Researchers have observed that **exposure to nickel** in mammalian and fungal cells leads to a **deficiency of sterols**, which are crucial for cell membrane integrity and function.

Sterols (subgroup of steroids):

– Essential components of cell membranes in **plants, animals, and fungi**, maintaining membrane structure and regulating fluidity.

Common Examples of Sterols:

– **Cholesterol:** Key sterol in animal cell membranes.
– **Ergosterol:** Major sterol in fungi, also a precursor to **vitamin D** when exposed to UV light.
– **Sitosterol:** A plant sterol (phytosterol) known for its ability to lower human blood cholesterol levels.

Gravity Energy Storage

– **Gravity energy storage** is emerging as a viable solution to tackle the **intermittency of solar and wind power**.

About Gravity Energy Storage:

– It works by using **gravity and potential energy** to store and release electricity.
– Excess electricity (e.g., from solar or wind) is used to lift a heavy mass (like concrete blocks) to a higher position.
– When energy is needed, the mass is allowed to descend, and the potential energy is converted back into electricity (typically through generators).
– It is considered a **promising, sustainable, and scalable grid-level energy storage technology**, complementing renewable energy sources.

Operation Dronagiri

– **Launched by:** Ministry of Science and Technology

– **Type:** Public-Private Partnership

About:

– A **pilot project** under the **National Geospatial Policy 2022**.
– Showcases how **geospatial technologies** (drones, satellite imagery, GIS) can improve quality of life and ease of doing business.
– Uses the **Integrated Geospatial Data Sharing Interface (GDI)** for seamless data sharing and analysis.

Implementation:

– Piloted in **Uttar Pradesh, Haryana, Assam, Andhra Pradesh, and Maharashtra**.

GSAT-20

– **Launch:** SpaceX's Falcon-9 from Cape Canaveral, USA.
– **Also Known As:** GSAT N-2
– **Mission Life:** 14 years

About:

– A **high-throughput communication satellite** launched by **New Space India Ltd (NSIL)**, ISRO's commercial arm.
– Placed in a **geosynchronous transfer orbit (GTO)**.
– It is **NSIL's second demand-driven satellite**, after **GSAT-24 (GSAT N-1)** launched in 2022 (leased to Tata Play).

Specifications:

– Weight: **4,700 kg** — too heavy for India's LVM-3 (which can lift ~4 tonnes to GTO).
– Structure: Based on **Carbon Fiber Reinforced Polymer (CFRP)** based **I4K bus**.

One Day One Genome Initiative

– **Launched By:** Department of Biotechnology (DBT) & Biotechnology Research and Innovation Council (BRIC).

About:

– A significant initiative aimed at exploring and documenting **India's microbial diversity**.
– Focuses on sequencing at least **one microbial genome per day**, showcasing India's capacity in genomics research.
– Aims to uncover the potential applications of microbes in areas such as **healthcare, agriculture, environment, and industry**.

PACE Programme (Patent Acquisition and Collaborative Research and Technology Development)

– **Launched By:** Department of Scientific & Industrial Research (DSIR).

About:

– Supports **innovative work, entrepreneurial activities, and development of new technologies** to address unmet industrial needs.
– Encourages **projects demonstrating proof-of-concept**, aimed at commercialization of products and processes.
– Typical **project duration:** 1 to 3 years.

Objectives:

– Facilitate **collaborative research and technology development** between industry and academia.
– Provide **financial support for patent acquisition and intellectual property rights (IPR)**.

Union Cabinet Approves ₹1,000-Crore Fund to Boost Indian Space Start-Ups

– The Union Cabinet approved a **₹1,000-crore venture capital (VC) fund** to support around **40 space start-ups over five years**.
– Launched under **IN-SPACe**, the fund aims to attract private investment and foster innovation in India's space sector.

Supporting India's Emerging Space Entrepreneurs

Key Initiatives:

– **Pre-Incubation Entrepreneurship (PIE) Development Program:** Helps startups move from ideation to prototype with support from IN-SPACe.

Financial & Regulatory Support:

– GST exemptions for satellite launches.
– Income tax breaks for R&D.
– Funding through **Startup India Seed Fund**, **DRDO's Technology Development Fund**, and **Atal Innovation Mission**.

World-Class Infrastructure:

– **GIFT City**, Gujarat, is positioned as a global hub for space technology with regulatory and infrastructure advantages.

Collaborations:

– **AWS Space Accelerator**, in partnership with ISRO and IN-SPACe, supports 24 startups with mentorship and up to $100,000 in credits.

Incubation & Mentorship:

– **Space Technology Incubation Centre (STIC)** provides access to advanced labs, funding, and expert guidance.

India's AI Mission

– Announced by the PM of India at the **GPAI Summit 2023** in New Delhi.
– To be implemented by the 'IndiaAI' Independent Business Division (IBD) under **Digital India Corporation (DIC)**.
– Led by the **Ministry of Electronics and IT (MeitY)**.

Key Objectives:

– Establish a **computing capacity of over 10,000 GPUs** to accelerate AI development.
– Develop **foundational models** trained on Indian datasets for priority sectors like **healthcare, agriculture, and governance**.
– Set up **AI Curation Units (ACUs)** in ministries and create an **AI marketplace** to offer AI services and pre-trained models.

Implementation:

– Carried out via a **Public-Private Partnership (PPP)** model with 50% viability gap funding.
– Of the total outlay of **₹10,372 crore**, ₹4,564 crore earmarked for building computing infrastructure.
– **Union Budget 2024** allocated ₹551 crore for IndiaAI Mission for 2024–25.
– IT Ministry to release a **tender to procure 300–500 GPUs**.

7 Key Features of the IndiaAI Mission:

1. **India AI Compute Capacity:** Build a high-end scalable AI computing ecosystem with over 10,000 GPUs.
2. **India AI Innovation Centre:** Develop and deploy indigenous Large Multimodal Models (LMMs) and foundational models.
3. **India AI Datasets Platform:** Provide streamlined access to quality non-personal datasets.
4. **India AI Application Development Initiative:** Promote AI solutions in critical sectors using real-world problem statements.
5. **India AI Future Skills:** Expand AI-related education at undergraduate, masters, and PhD levels.
6. **India AI Startup Financing:** Support deep-tech AI startups with funding for futuristic projects.
7. **Safe & Trusted AI:** Ensure responsible AI through indigenous tools and frameworks.

Thermobaric Weapons (also known as vacuum bombs or enhanced blast weapons)

– Russia used against Ukraine
– Thermobaric weapons, or **fuel-air explosives (FAEs)**, use **oxygen from the surrounding air** to produce a high-temperature explosion.
– Unlike conventional explosives (which carry both fuel and oxidizer), these release a **fuel cloud**, which is then ignited to create a powerful blast.
– The explosion produces a **blast wave of immense pressure**, followed by a **vacuum effect** as surrounding oxygen is consumed.
– The intense overpressure and vacuum cause extreme destruction, especially in confined spaces like tunnels or buildings.

Notable Examples:

– **Russian FOAB (Father of All Bombs):** Claimed to be the most powerful thermobaric bomb, with a blast yield ~4× stronger than the U.S. MOAB.
– **U.S. MOAB (Mother of All Bombs):** GBU-43/B Massive Ordnance Air Blast, a large fuel-air explosive in the U.S. arsenal.

Legal Status:

– No specific international ban exists on thermobaric weapons.
– However, targeting **civilians** or **civilian infrastructure** with such weapons can constitute a **war crime** under the **Hague Conventions (1899 & 1907)**.

Charon — Pluto's Largest Moon

– **Recent Discovery:** Gases *carbon dioxide* and *hydrogen peroxide* detected on Charon's surface.
– **Size:** About half the size of Pluto; some astronomers consider Pluto–Charon as a *double planet system* rather than a planet–moon system.
– **Orbit:** Charon orbits Pluto with *synchronous rotation*, meaning the same side of Charon always faces Pluto (mutual tidal locking).
– **Surface:** Features mountains, plains, craters, and possibly *cryovolcanoes* (volcanoes that erupt icy material).
– Charon lacks a significant atmosphere, while Pluto has a thin one.
– **New Horizons Mission (2015):** NASA's New Horizons provided the first detailed images and data of the Pluto–Charon system.

Pluto

– Once the ninth planet, reclassified in **2006** as a *dwarf planet* after similar Kuiper Belt objects were discovered beyond Neptune.

Nobel Prize in Chemistry

2024 Nobel Prize for chemistry shared by (American scientist) **David Baker "for computational protein design"** along with (British scientist) **Demis Hassabis and** (American scientist) **John Jumper "for protein structure prediction."**

MicroRNAs

The 2024 Nobel Prize in Physiology or Medicine was awarded to **Victor Ambros & Gary Ruvkun** for the discovery of microRNA and its role in post-transcriptional gene regulation.

About microRNAs (miRNAs)

- miRNAs are small, non-coding RNA molecules (do not code for proteins) that play a crucial role in regulating gene expression in organisms.
- CRISPR/Cas9: Genome-editing technologies that can be used to manipulate miRNA genes to study their functions in detail.
- They are single-stranded RNA molecules, and their small size distinguishes them from other types of RNAs like messenger RNA (mRNA) and ribosomal RNA (rRNA).

Artificial Neural Networks (ANNs)

– John Hopfield and Geoffrey Hinton won the 2024 Nobel Prize for Physics for their foundational work enabling machine learning with ANNs.

– **Definition:** ANNs are a subset of *machine learning* and a key part of *artificial intelligence (AI)*, designed to mimic how the human brain processes information.

– **Structure:** Computational models inspired by the brain's structure and function, consisting of interconnected units called *neurons* that process and transmit information.

– **Functionality:** ANNs learn patterns and relationships from large datasets, enabling them to make predictions or decisions without explicit programming.

– **Adaptability:** Once trained, ANNs can generalize and adapt to new tasks and data efficiently.

Major Atmospheric Cherenkov Experiment (MACE) Observatory

– It is an **indigenous, largest imaging Cherenkov telescope project in Asia**, built by **BARC** (Bhabha Atomic Research Centre) with support from **ECIL** (Electronics Corporation of India Limited) and other Indian industry partners.

– Located at **Hanle, Ladakh**, which provides an ideal environment due to clear skies, low light pollution, and dry air — crucial for detecting Cherenkov radiation.

– It is the **highest Cherenkov telescope in the world**, situated at an altitude of ~4,300 m, and is part of India's **TIFR (Tata Institute of Fundamental Research)** High Energy Gamma-Ray Observatory (HAGAR) initiative.

– One of the largest Cherenkov telescopes operating in the northern hemisphere.

– **Objective:** To detect Cherenkov radiation produced by very high-energy (VHE) gamma rays from cosmic sources such as supernova remnants, active galactic nuclei, and pulsars when they interact with Earth's atmosphere.

– **Cherenkov radiation:** Occurs when charged particles move through a dielectric medium at a speed faster than light in that medium, emitting electromagnetic radiation visible as a bluish glow.

Biopolymers

India's first demonstration facility for Biopolymers inaugurated near Pune.

X-band Radar

– The Union Ministry of Earth Sciences approved the installation of an X-band radar in **Wayanad** to improve monitoring and prediction of weather conditions.

– **X-band radar** operates in the **X-band of the electromagnetic spectrum**, which covers frequencies between **8 and 12 gigahertz (GHz)**.

– **Radar** stands for *Radio Detection and Ranging* — it uses radio waves to determine the distance, velocity, and physical characteristics of objects.

Characteristics of X-band Radar:

– **High Resolution:** Can detect and track small objects with high accuracy due to its higher frequency.

– **Short Range:** Its high frequency limits its

range, making it suitable for applications like air traffic control and weather monitoring over smaller areas.
– **Less Affected by Rain:** Performs better than lower frequency radars in rainy or adverse weather conditions, ensuring reliable observations.

Smart Insulin: NNC2215

Scientists have developed real time responding smart insulin, named NNC2215.

About NNC2215: It is the insulin that auto-adjusts its activity based on blood sugar levels, reducing the risk of hypoglycemia.

Mechazilla

– **Mechazilla** is SpaceX's tower-based rocket-catching system, designed to recover the reusable stages of its rockets, especially the **Super Heavy booster** and potentially the **Starship**, during landing.
– It eliminates the need for landing legs by **catching the rocket mid-air**, enabling quicker turnaround and reducing launch costs.
– The name "Mechazilla" was coined by Elon Musk, likening the robotic structure to a giant mechanical **Godzilla**.

Key Features:

– A **400-ft tall structure** located at SpaceX's **Starbase, South Texas**.
– Equipped with two large mechanical arms, nicknamed **"chopsticks"**, to catch the descending rocket stages.
– Designed to handle the **heaviest flying object ever made**, weighing about **250 tons**.
– By facilitating rapid refurbishment and reuse, **Mechazilla** enhances the sustainability and cost-effectiveness of SpaceX's space missions.

Moonlight Programme

– The **European Space Agency (ESA)** launched the **Moonlight Lunar Communications and Navigation Services (LCNS)** programme at the **International Astronautical Congress**.
– **Objective:** To provide reliable communication and navigation services for future lunar missions, both robotic and manned.

Key Features:

– Constellation of **five lunar satellites**:
– **Four** for communication.
– **One** for navigation.
– Enables data transfer over **~400,000 km** between the Earth and the Moon.
– Functions like **GPS on Earth**, but for the lunar environment.
– Supports coordination of lunar missions, moon bases, and resource exploration.
– Coverage focused on the **lunar south pole**, which is a priority area for exploration.

Collaboration Potential:

– ISRO, after the success of **Chandrayaan-3**, has shown interest in future lunar missions.
– India could collaborate with ESA's Moonlight Programme for communication and navigation support in its upcoming missions.

E. coli

– **E. coli (Escherichia coli)** is a **Gram-negative, rod-shaped bacterium** commonly found in the lower intestine of warm-blooded organisms, including humans and animals.

Key Points:

– Most strains are harmless and even beneficial, but some can cause **serious foodborne illnesses**.
– Certain harmful strains produce a toxin called **Shiga toxin**, which can lead to severe diarrhoea and kidney damage.
– Widely used in the **pharmaceutical industry** for producing **insulin, growth hormones, and vaccines**, due to its simple genetics and fast growth.
– Acts as an indicator organism in **river cleaning projects** (like Ganga Action Plan) to measure **pollution and water quality**.

Recent Events:

– An outbreak in the **U.S.** caused 1 death and several hospitalizations.
– In **India (2023)**, over 500 diarrhoeal disease outbreaks linked to E. coli were reported (NCDC data).