

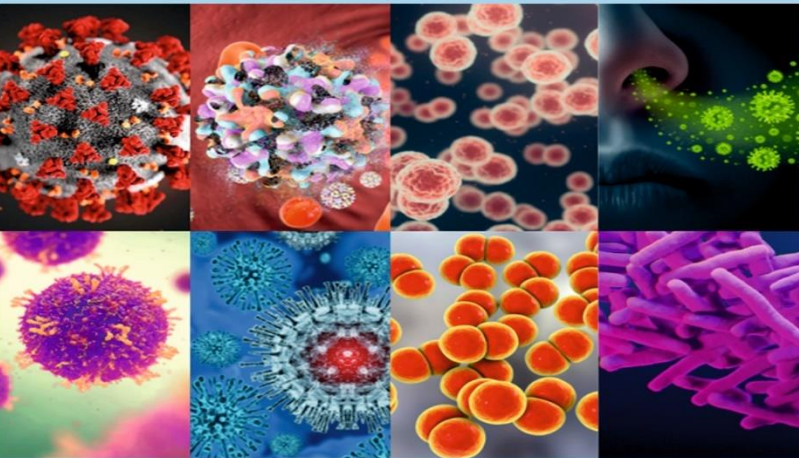
**SCIENCE & TECH.
DISEASES
PRELIMS SPECIAL**

KSG

An Institute For **IAS** Exam...

2024

STEM



**BOOKLET
4/8**

YEARLY COMPILATION

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GENERAL SCIENCE

Nobel Prize for Chemistry 2023

News Excerpt:

The 2023 Nobel Prize in Chemistry has been awarded to **Moungi G. Bawendi, Louis E. Brus** and **Alexei I. Ekimov** for the discovery and synthesis of **quantum dots**.

Quantum dots:

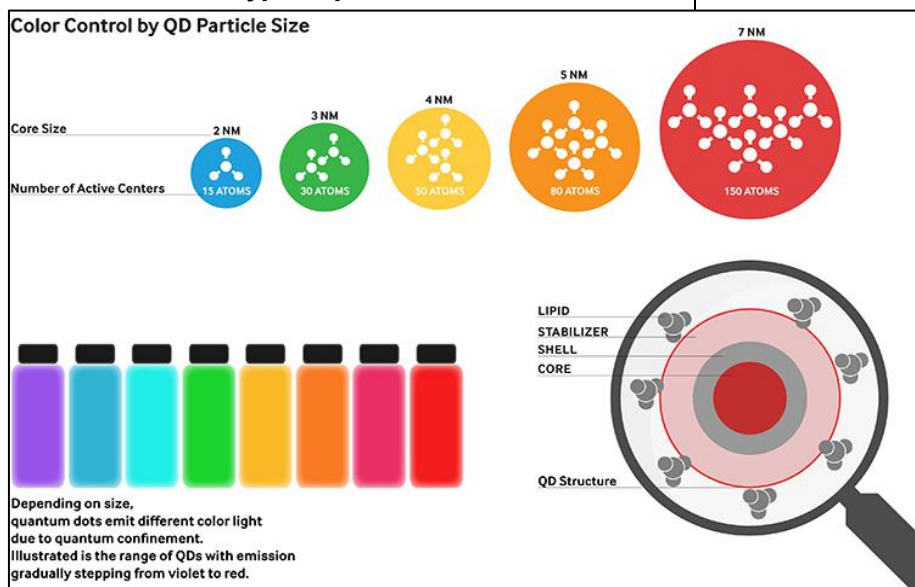
- Quantum dots (QDs) are **man-made nanoscale crystals** that exhibit unique optical and electronic properties, including the ability to transport electrons and emit light of various colours when exposed to UV light.
- It is a really small assembly of atoms (just a few thousand) around a few nanometres wide. The 'quantum' in its name comes from the fact that the electrons in these atoms have very little space to move around, so the crystal as a whole displays the quirky effects of quantum mechanics - effects that otherwise would be hard to 'see' without more sophisticated instruments.
- Quantum dots have also been called '**artificial atoms**' because the dot as a whole behaves like an atom in some circumstances.
- Quantum dots have unique properties and spread their light from television screens and LED lamps. They catalyze chemical reactions, and their clear light can illuminate tumour tissue for a surgeon.
- Researchers have primarily utilized quantum dots to create coloured light. They believe that in the future, quantum dots can contribute to **flexible electronics, miniscule sensors, slimmer solar cells, and encrypted quantum communication**.

Reasons for interest in quantum dots:

- There are two broad types of materials: atomic and bulk.
 - Atomic refers to individual atoms and their specific properties.
 - Bulk refers to large assemblies of atoms and molecules.
- Quantum dots lie somewhere in between and behave in ways that neither atoms nor bulk materials do. One particular behaviour distinguishes them: the properties of a quantum dot change based on how big it is.
- Just by tweaking its size, scientists can change, say, the quantum dot's melting point or how readily it participates in a chemical reaction.
- When light is shined on a quantum dot, it absorbs and then re-emits it at a different frequency. Smaller dots emit blueish light and larger dots, emit redder light. This happens because light shone on the dot energizes some electrons to jump from one energy level to a higher one, before jumping back down and releasing the energy at a different frequency.
- So, quantum dots can be easily adapted for a variety of applications, **including surgical oncology, advanced electronics, and quantum computing**.

Applications of quantum dots:

- An array of quantum dots can be a TV screen by receiving electric signals and emitting light of different colours.
- Scientists can control the path of a chemical reaction by placing some quantum dots in the mix and making them release electrons by shining light on them.



- If one of the energy levels an electron jumps between in a quantum-dot atom is the conduction band, the dot can operate like a semiconductor.

- Solar cells made with quantum dots are expected to have a thermodynamic efficiency as **high as 66%**.

- A quantum dot can also highlight a tumour that a surgeon needs to remove,

- It can hasten chemical reactions that extract hydrogen from water, and as a multiplexer in telecommunications.

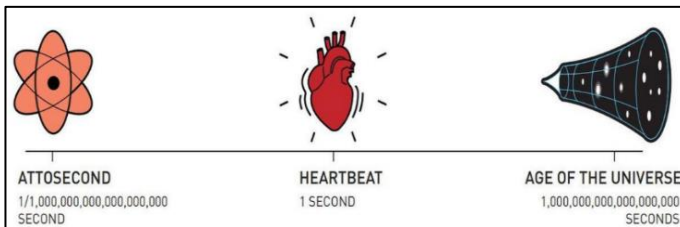
Nobel Prize for Physics 2023

News Excerpt:

The 2023 Nobel Prize for Physics was shared by three scientists - **Pierre Agostini, Ferenc Krausz and Anne L’Huillier** - for their experimental methods that generate **attosecond pulses** for the study of **electron dynamics** in matter, potentially leading to better detection of disease and developing electronic machinery.

About their experiment:

- An atom, a tiny unit into which matter can be divided, is composed of a nucleus of protons and neutrons and electrons that travel around this nucleus. Electrons move so fast that it is impossible to observe them in real-time.
- Their work has brought humanity closer to observing and studying the movement of electrons by producing pulses of light that last only **attoseconds**, which is 1×10^{-18} of a second.
- Roughly, this can be compared to a high-shutter-speed camera. If a regular camera is used to capture a moving train, the image will be blurred. But a high shutter-speed camera can freeze motion and capture a clear image of the train.



Electron dynamics:

- Electrons are the negatively charged particles of an atom. They zoom around the denser nucleus. Before being able to study them directly, scientists understood their properties through averages.
- The movement of an atom in a molecule can be studied with the very shortest pulses produced by a laser. These movements and changes in the atoms occur on the order of femtoseconds—a millionth of a billionth of a second. But electrons are lighter and interact faster in the attosecond realm. An attosecond is a billionth of a billionth of a second.

Significance of attosecond physics:

- For medical diagnostics, attosecond pulses can be used to check for the presence of certain molecules based on their fleeting signatures and find therapies for cancer care.

- These pulses could also be used to develop faster electronic devices and better telecommunications, imaging, and spectroscopy.
- It also holds promise in areas such as a new **in-vitro diagnostic technique** to detect characteristic molecular traces of diseases in blood samples.

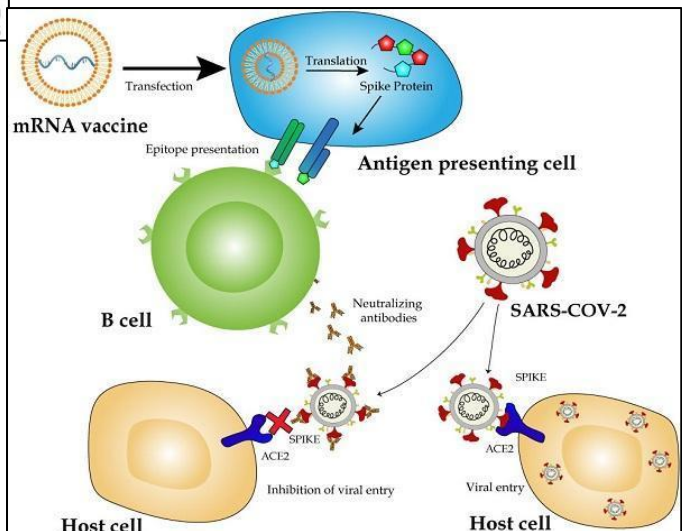
Nobel Prize in Medicine 2023

News Excerpt:

The 2023 Nobel Prize in Physiology or Medicine has been awarded to **Katalin Karikó and Drew Weissman** for their “discoveries concerning **nucleoside base modifications** that enabled the development of effective **mRNA vaccines** against COVID-19”.

Findings of their discovery:

- Kariko and Weissman realized that the immune system was able to recognize the lab-developed mRNA molecules as foreign substances, leading to inflammatory reactions.
- However, this did not happen when mRNA derived from animal cell assays were used. This led them to look for properties in the lab-developed mRNA molecules that were tripping off the immune system.
- They found that the mRNA derived from the animal cell assays frequently contained modifications not seen in the lab-developed uniform mRNA molecules.



Vaccines available before the pandemic:

- **The first one** includes a **live, attenuated vaccine**, which has a weakened version of the pathogen, like the oral polio vaccine.

- **The second type** involves an **inactivated vaccine** that uses killed pathogens to elicit an immune response, such as the rabies vaccine.
- With the progress of molecular biology and techniques to edit genetic codes, vaccines using small, non-lethal parts of the pathogen have been developed. These are called **sub-unit vaccines**.
- Some vaccines also encode these non-lethal parts to another pathogen that carries and distributes it through the body - an example of this was the AstraZeneca vaccine available in India as Covishield that used parts of the COVID-19 virus attached to an adenovirus. These are called **vector vaccines**.

Challenges to mRNA technology before the pandemic:

- The lab-based mRNA molecules were considered unstable and challenging to deliver into the body in addition to the inflammatory responses.
- Developing efficient fat molecules to carry the mRNA inside the body was the key to the development of the vaccines.

mRNA Vaccines:

- mRNA, which stands for messenger RNA, is a form of nucleic acid that **carries genetic information**.
- Like other vaccines, the mRNA vaccine also attempts to activate the immune system to produce antibodies that help counter an infection from a live virus.
- However, while most vaccines use weakened or dead bacteria or viruses to evoke a response from the immune system, mRNA vaccines only introduce a piece of the genetic material that corresponds to a viral protein.
- This protein is usually found on the virus's membrane and is called **spike protein**. Therefore, the mRNA vaccine does not expose individuals to the virus itself.

White Phosphorus Bombs

News Excerpt:

Global human rights organizations Amnesty International and Human Rights Watch have accused the Israel Defence Forces (IDF) of using white phosphorus munitions in Gaza and Lebanon.

About:

- White phosphorus is a pyrophoric that ignites when exposed to oxygen, producing thick, light smoke as well as intense 815-degree Celsius heat.

- Pyrophoric substances are those that ignite spontaneously or very quickly (under five minutes) when in contact with air.
- It is among the most unstable of pyrophoric substances.
- Under the **Globally Harmonized System of Classification and Labeling of Chemicals**, it falls under **"Pyrophoric solids, category 1"**.
- **Military uses of white phosphorus:**
 - It is dispersed in artillery shells, bombs, and rockets.
 - It can also be delivered via felt (textile) wedges soaked in the chemical.
 - Its primary military use is as a **smokescreen** - used to hide troop movement on the ground. The smoke acts as a visual obscurant.
 - It is also known to mess with infrared optics and weapons tracking systems, thus protecting forces from guided missiles.
- **The harmful impact of white phosphorus:**
 - It can cause severe burns, often down to the bone. The burns are excruciatingly painful, difficult to heal, and susceptible to infections.
- **Legal status of white phosphorus munitions:**
 - White phosphorus munitions are not under a blanket ban, though their use is regulated under the IHL.
 - It is not considered a chemical weapon because its operational utility is primarily due to heat and smoke rather than toxicity.
 - Thus, its use is governed by the Convention on Conventional Weapons (CCW), specifically Protocol III.

Safety Measures taken by Government against Gas leaks:

- **The Bhopal Gas Leak (Processing of Claims) Act of 1985** empowered the central government to secure claims resulting from or associated with the Bhopal gas tragedy.
- **The Environment Protection Act (EPA) of 1986** empowers the central government to take actions to improve the environment, set standards, and inspect industrial units.
- **The Public Liability Insurance Act of 1991** is a type of insurance designed to help people who have been injured while working with hazardous substances.
- Under the **Hazardous Waste (Management, Handling, and Trans-boundary Movement) Rules, 1989**, industries are expected to identify main accident hazards, implement preventative

measures, and submit a report to the appropriate authorities.

- **The Chemical Accidents (Emergency, Planning, Preparedness, and Response) Rules, 1996** mandate the central government to form a central crisis group for chemical accident management and to build up a rapid response mechanism known as the crisis alert system.

The National Environment Appellate Authority Act, 1997: Under this, the National Environment Appellate Authority can hear appeals concerning the restriction of areas in which any industries, operations, processes, or class of industries shall not be carried out or shall be carried out subject to certain safeguards under the EPA 1986.

Biodegradable paper supercapacitor

News Excerpt:

Recently, Scientists at **Gujarat Energy Research and Management Institute (GERMI)** have developed the **thinnest, lightweight, and biodegradable paper-based supercapacitor.**

Pre-Connect

About Supercapacitor

- A supercapacitor is an electrochemical charge storage device with a fast charging/discharging cycle, high power density and a longer lifecycle.
- A supercapacitor, also called an ultracapacitor, is a high-capacity capacitor, with a capacitance value much higher than other capacitors but with lower voltage limits.
- It **bridges the gap between electrolytic capacitors and rechargeable batteries.**
- Supercapacitors are constructed with **two metal foils (current collectors)**, each coated with an electrode material such as activated carbon, which

serve as the power connection between the electrode material and the external terminals of the capacitor.

About research

- The cellulose nanofibers were extracted **from green seaweed *Cheatomorpha antennia* which was collected from Porbandar, Gujarat in India.**
- The fibers underwent bleaching treatment and were shaped into architectural structure like that of a spider web.
- Cellulose is **found to be as most suitable biopolymer material for manufacturing paper-based electrode materials** such as paper supercapacitors or batteries for energy storage applications.
 - Cellulose itself is **an insulating material that requires to be coated with conductive material to make a paper-based energy storage device.**
- The product can be used in electronics, memory backup systems, airbags, heavy machines, electric vehicles, etc.; hence, it holds a huge business prospect.

Deep Sea Mining

News Excerpt:

The International Seabed Authority which is the **United Nations body** that regulates the world's ocean floor is preparing to resume negotiations that could open the international seabed for mining, including for

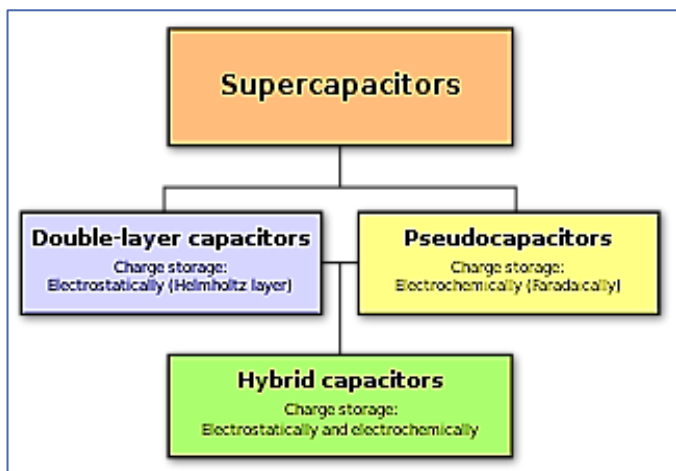
Marine Seaweed or macroalgae

- **Seaweeds** are macroalgae attached to rock or other substrata and are found in coastal areas, said Bhutiya. They are classified as chlorophyta (green), rhodophyta (red) and phaeophyta (brown) based on their pigmentation.
- Among them, chlorophyta holds more potential components — carbohydrates, lipids, proteins and bioactive compounds — in the cell wall. Green seaweed has a high amount of a particular type of cellulose in its cell wall.
- The marine cellulose-based material used in developing the flexible and thinnest paper supercapacitor can be used in almost all smart electronic devices.

materials critical for the green energy transition.

What Is Deep Sea Mining?

- Deep sea mining involves removing mineral deposits and metals from the **ocean's seabed.**



- There are three types of such mining:
 - Taking deposit-rich **polymetallic nodules** off the ocean floor.
 - Mining **massive seafloor sulphide** deposits.
 - Stripping cobalt crusts from rock.
- These nodules, deposits and crusts contain materials, such as nickel, rare earths, cobalt etc that are needed for everyday technology like cellphones, batteries and computers.

Regulation of Deep-Sea Mining

- Countries manage their own maritime territory and exclusive economic zones.
- The high seas and the international ocean floor are governed by **the United Nations Convention on the Law of the Seas (UNCLOS)**.
- UNCLOS is considered to apply to states regardless of whether or not they have signed or ratified it.
- Under the treaty, **the seabed and its mineral resources are considered the common heritage** of mankind that must be managed in a way that protects the interests of humanity.
- Such measures include the sharing of economic benefits, support for marine scientific research, and protecting marine environments.
- Mining companies interested in deep sea exploitation are partnering with countries to help them get exploration licenses and around 30 exploration licenses have been issued so far.

- The **Deep Ocean Mission** was launched in September 2021 as the **Central Sector Scheme of the Ministry of Earth Sciences (MoES)** with the approval of the Cabinet.
- With this step India joined the **elite club of nations such as USA, Russia, Japan, France and China** in having such underwater vehicles for carrying out subsea activities.
- It will facilitate MoES in carrying out **deep ocean exploration of the non-living resources such as polymetallic manganese nodules, gas hydrates, hydro-thermal sulphides, and cobalt crusts**, located at a depth between 1000 and 5500 metres.

DEEP OCEAN MISSION - 'SAMUDRAYAAN'

News Excerpt:

India's first and unique manned Deep Ocean Mission 'Samudrayaan' plans to send 3 humans to 6000m (6 km) ocean depth in a submersible, to study the deep-sea resources and biodiversity assessment while ensuring minimal disruption to the ecosystem.

Pre-Connect

- **Estimated Ocean Resources:** India has been allotted a site of 75,000 sq. km. in the **Central Indian Ocean Basin (CIOB)** by the UN International Seabed Authority for the exploitation of **polymetallic nodules (PMN)**.

About Samudrayaan:

- Samudrayaan is a project under the **Deep Ocean Mission**.



MATSYA 6000

- Preliminary design of the **manned submersible MATSYA 6000** is completed, and realization of the vehicle has been started with various organizations including the Indian Space Research Organisation (ISRO), Indian Institute of Tropical Meteorology (IITM) and Defence Research and Development Organisation (DRDO) roped-in to support the development.
- MATSYA 6000 is expected to have an endurance of 12 hours of operational period and 96 hours in case of emergency.

Major objectives:

- Address issues arising from long-term changes in the ocean due to climate change.
- Develop technologies for deep-sea missions of living (biodiversity) and non-living (minerals) resources.
- Develop underwater vehicles and underwater robotics.
- Provide ocean climate change advisory services.
- Identify technological innovations and conservation methods for sustainable utilization of marine bioresources.
- Develop offshore-based desalination techniques.
- Develop renewable energy generation techniques.
- Provide clean drinking water and explore the avenues of desalination of water as well as extracting minerals from the ocean belt.

Components:

- Development of Technologies for Deep Sea Mining, and Manned Submersible.
- Development of Ocean Climate Change Advisory Services.
- Technological innovations for exploration and conservation of deep-sea biodiversity.
- Deep Ocean Survey and Exploration.
- Energy and freshwater from the Ocean:
- Advanced Marine Station for Ocean Biology.

Sodium-ion batteries

News Excerpt:

In recent years, considerable attention has been focused on the development of **sodium-ion batteries**.

About Sodium Battery

- Sodium batteries are a **burgeoning field in energy storage research, aiming to supplant conventional lithium-ion batteries by leveraging**

sodium ions for electrochemical energy storage and retrieval.

- These batteries employ sodium as a viable alternative to **lithium, capitalizing on its greater abundance, enhanced cost-effectiveness, and reduced environmental impact.**
- Sodium is widely available and less expensive compared to lithium. Sodium batteries utilize sodium ions, making them a cost-effective option for large-scale energy storage.
- Sodium batteries offer a greener alternative as they don't deplete scarce resources or pose significant environmental concerns.
- Sodium batteries are considered safer than traditional lithium-ion batteries. They have higher thermal stability, reducing the risk of thermal runaway or fire hazards, which improves overall battery safety.

Difference between Sodium Batteries and Lithium Batteries

<ul style="list-style-type: none"> • Sodium is more than 500 times more abundant than lithium. It can also be extracted from seawater at a low cost. 	<ul style="list-style-type: none"> • Lithium availability is limited to a few countries, which is why prices have risen more than seven-fold since 2021.
<ul style="list-style-type: none"> • Sodium is more environmentally friendly and can be transported at zero volt, making it safer. 	<ul style="list-style-type: none"> • Lithium is less environmentally friendly than sodium and must be always stored with a minimum charge, increasing fire risks.
<ul style="list-style-type: none"> • Uses aluminium which is cheaper than copper. 	<ul style="list-style-type: none"> • Uses copper, which is three or four times more expensive than aluminium.
<ul style="list-style-type: none"> • Higher operating temperature range. This means these can be used in more extreme temperatures without the risk of thermal runaway. 	<ul style="list-style-type: none"> • Lower operating temperature range and can cause fire if operated in higher temperatures.
<ul style="list-style-type: none"> • Charges faster than lithium-ion variants and have a three times higher lifecycle. 	<ul style="list-style-type: none"> • Slow charge rate and smaller lifecycle compared to sodium-based batteries.

Possible Advantages:

The successful development and commercialization of sodium batteries have **the potential to revolutionize the energy storage landscape, enabling sustainable and scalable solutions for renewable energy integration, electric vehicles, and grid-level storage.**

- **Electric Vehicle Adoption:** Boost India's EV adoption by providing a viable alternative to traditional lithium-ion batteries. The abundance and lower cost of sodium make it a promising choice.
- **Enhanced Energy Storage:** Offer significant energy storage capabilities, which can support the integration of renewable energy sources like solar and wind power.
- **Improved Energy Access:** Provide reliable and sustainable energy access to remote and off-grid areas in India.
- By storing electricity from renewable sources, sodium batteries can **power off-grid communities, improving their quality of life and supporting economic development.**

Limitations:

- **Lower energy density: Store less energy per unit of weight or volume,** which may result in shorter operating times or reduced driving ranges in electric vehicles.
- **Limited cycle life: May degrade and lose their capacity to store and deliver energy after a certain number of charge and discharge cycles.**
- **In the early stages of development and commercialization:** The infrastructure to support their widespread adoption, including manufacturing facilities, recycling systems, and charging networks, is not as well-established as it is for lithium-ion batteries.

How can gravity solve green power's problem?

News Excerpt:

Gravity batteries are emerging as the best bet in solving renewable energy's biggest problem –**intermittency**. After the **USA & China**, an energy company is in talks with **Indian firms** offering to deploy **gravity-based storage** that could be installed alongside green power generation to balance out the variability in demand and supply of electricity generated through renewable power.

What is Gravity-based energy storage?

It depends on the vertical movement of a heavy object in a gravitational field to store or release electricity. This

technology accomplishes energy storage by converting the **electrical energy in the power system** to the gravitational potential energy of the weight through electromechanical equipment.

1. Mechanical Elevator Storage System:

- It is a type of electricity storage device that involves lifting (charging) and lowering (discharging) a heavy weight.
- The platform **utilizes gravity** and a **mechanical elevator system** to stack **25-tonne blocks** made of composite material at the top of a **towering structure**.
- It mimics the broad attributes of a pumped hydroelectric plant, which uses moving water to store and discharge power.
- When the electricity **demand** is **low**, the elevator uses **surplus electricity** from the grid or electricity generated by renewable plants to raise these blocks and line them up at the **top** of the structure.
- When electricity demand picks up, the blocks are lowered one by one, **releasing kinetic energy** used to rotate a motor and generate electricity, which can then be pumped back to the grid.

2. Water-Based Gravity Systems:

- Pumped hydro is an established technology responsible for about **96%** of the world's high-capacity **energy storage**, according to the **International Hydropower Association**.
- In this, **excess energy** on the grid is used to **pump water uphill** to a **high-elevation reservoir**. When there is **energy demand**, the water is released, driving a **turbine** as it flows into a reservoir below.
- However, these facilities are **expensive** to build and are **restricted by geography**, as the technology requires hills and access to water.

Indian Perspective:

- India's push for deployment of large-scale renewable power makes storage a **prerequisite** to support this expansion.
- As per the updated India's Nationally Determined Contribution (**INDC**), India is committed to reducing the emissions intensity of its **GDP by 45% by 2030** from the 2005 level and achieving about **50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030**.
- India, in its **PANCHAMRIT PLEDGES** (Five Nectar Elements), is **determined to become net zero by 2070**.

- The Indian government now plans to accept bids for a **100MW** round-the-clock clean **energy system with storage**. **National Hydrogen policy** was already cleared by the cabinet last year to increase green hydrogen production.
- The **World Economic Forum** founded the **Global Battery Alliance (GBA)** in 2017 to establish a sustainable battery **supply chain** by 2030.
 - GBA is a body of over 100 leading international organizations, NGOs, industry actors, academics, and multiple governments.

It became independent in 2021, and its membership is collectively working towards the goals set out in the **GBA 2030 Vision**.

VAIBHAV Fellowship Programme

About:

The Government has launched a new fellowship programme to connect the Indian STEM diaspora with Indian academic and R&D institutions for collaborative research work leading to sharing of knowledge, wisdom, and best practices in the frontier areas of science & technology.

Vaibhav Fellowship programme

The VAIBHAV Fellowship aims at improving the research ecosystem of India's Higher Educational and Scientific Institutions by facilitating academic and research collaborations between Indian Institutions and the best institutions in the world through mobility of faculty/researcher from overseas institutions to India.

The Vaishvik Bhartiya Vaigyanik (VAIBHAV) fellowships programme to be implemented by the Department of Science and Technology (DST), Ministry of Science and Technology, would be awarded to outstanding scientist/technologists of Indian origin (NRI/OCI/PIO) who are engaged in research activities in their respective countries.

The VAIBHAV Fellow would identify an Indian Institution for collaboration and may spend up to two months in a year for a maximum of 3 years.

Fellowship would include fellowship grant (INR 4,00,000 per month), international and domestic travel, accommodation and contingencies.

The VAIBHAV fellows are expected to collaborate with their Indian counterparts and help initiate research activities in the host institution in the cutting-edge areas of Science and Technology.

The 75 selected fellows would be invited to work in 18 identified knowledge verticals including quantum technology, health, pharma, electronics, agriculture, energy, computer sciences, and material sciences amongst others.

Vaibhav Fellowship programme

- The fellowship programme launched as a step to further those efforts by shaping and implementing the VAIBHAV programme, envisages collaboration between scientists of Indian Diaspora with Indian Higher Educational Institutions (HEIs), Universities, and/ or public funded Scientific Institutions.

Rashtriya Vigyan Puraskar

News Excerpt:

The Government of India has come out with new awards known as "Rashtriya Vigyan Puraskar".

About the Award:

Objective: To recognize the notable and inspiring contribution made by the scientists, technologists, and innovators individually or in teams in various fields of science, technology and technology led innovation.

- People of Indian Origin staying abroad** with exceptional contributions benefiting the Indian communities or society shall **also be eligible** for the awards.
- The awards shall be given in the following **four** categories:
 - Vigyan Ratna (VR)**- recognize lifetime achievements & contributions.
 - Vigyan Shri (VS)**- recognize distinguished contributions.
 - Vigyan Yuva-Shanti Swarup Bhatnagar (VY-SSB)**- recognize & encourage young scientists up to the age of 45 years who made an exceptional contribution.
 - Vigyan Team (VT)**- given to a team comprising of 3 or more scientists/researchers/innovators who have made an exceptional contribution.
- These awards shall be given in the **13 domains**, namely Physics, Chemistry, Biological Sciences, Mathematics & Computer Science, Earth Science, Medicine, Engineering Sciences, Agricultural Science, Environmental Science, Technology & Innovation, Atomic Energy, Space Science and Technology, and Others.
- The representation from each domain/field, including **gender parity**, will be ensured.
- The nominations will be invited every year on 14th January, which would remain open till **28th February (National Science Day)** every year.
- These awards shall be announced on **11th May (National Technology Day)** every year.
- The Award Ceremony for all categories will be held on **23rd August (National Space Day)**.

Luminescence dating

News Excerpt:

A new research confirms the antiquity of fossilized footprints at White Sands National Park in New Mexico, based on radiocarbon and optically stimulated luminescence dating techniques.

About:

- Luminescence dating is a form of geochronology that measures the energy of photons being released.
- In natural settings, ionizing radiation (U, Th, Rb, & K) is absorbed and stored by sediments in the crystal lattice.
- This stored radiation dose can be evicted with stimulation and released as luminescence.
- The calculated age is the time since the last exposure to sunlight or intense heat.
- The sunlight bleaches away the luminescence signal and resets the time 'clock'.
- As time passes, the luminescence signal increases through exposure to ionizing radiation and cosmic rays.
- It is based on quantifying both the radiation dose received by a sample since its zeroing event and the dose rate that it has experienced during the accumulation period.
- The principal minerals used are quartz and potassium feldspar.

Radiometric dating**News Excerpt:**

A new study shows a way to use calcium-41 the same way carbon-14 has been used in carbon dating.

About

- Carbon dating has revolutionised many fields of science by allowing scientists to estimate the age of an organic material based on how much carbon-14 it contains.
- However, carbon-14 has a half-life of 5,700 years, so the technique can't determine the age of objects older than around 50,000 years.
- Scientists suggested to use calcium-41, with a half-life of 99,400 years.

About Calcium-41

- Calcium-41 is a stable isotope, meaning it is non-radioactive and does not pose any health risks during its use in research or measurements.
- Calcium-41 can be used in conjunction with other isotopic systems, such as carbon-14 and stable carbon isotopes (e.g., carbon-12, carbon-13), to provide a more comprehensive understanding of carbon cycling and processes.

Radiometric dating

- It is a method used to determine the age of rocks and other geological materials by analyzing the relative abundance of certain isotopes within them.
- It relies on the fact that certain isotopes of elements are unstable and decay over time into more stable forms at a predictable rate called a **half-life**. The process involves measuring the ratio of parent isotopes (unstable isotopes) to daughter isotopes (the isotopes formed by the decay process) in a sample.

Ball Lightning**About:**

- It is a rare and **mysterious** form of lightning that appears as a **luminous ball** near the spot where lightning strikes.
- It usually occurs **near the ground** during thunderstorms, in close association with cloud-to-ground lightning.
- It may be **red, orange, yellow, white, or blue** and is often accompanied by a **hissing sound and distinct odour**.
- It normally **lasts only a few seconds**, usually moving about and then vanishing suddenly, either silently or explosively.
- It moves **horizontally** at a speed of a few centimetres per second and explodes at the end but is **not** usually **destructive**.
- It is also known as **Globe lightning** and occurs during **intense electrical activity** in the atmosphere, but scientists have not been able to satisfactorily explain it.

Fluorine**News Excerpt**

Scientists from Oxford University have come up with a new way to obtain Fluorine atoms.

About

- Fluorine, is a **highly reactive** element that comes from a calcium salt called **calcium fluoride (fluorspar)**.
- Fluorspar is mined and treated with **sulphuric acid** at a high temperature to **release** hydrogen fluoride (**HF**).
- HF is then made to react with other compounds to create **fluorochemicals**.

- A major downside of this process is that HF is an **extremely poisonous and corrosive liquid** that irritates the eyes and respiratory tract. It requires special transportation and storage requirements.
- Moreover, **HF spills** cause fatal accidents and detrimental **environmental effects**.

New method:

- To avoid HF and to make the extraction process require less energy, the researchers took inspiration from **calcium phosphate biomineralization**, the process by which human body makes bones and teeth.
- **Fluorspar** is grounded in a ball mill with **potassium phosphate**. While fluorine is very reactive, calcium atoms prefer phosphorus even more, so the milling created calcium phosphate and another compound with fluorine atoms. They called the latter **Fluoromix**.
- When Fluoromix was reacted with organic compounds, it could create around **50 fluorochemicals** with up to **98% yield**.

Uses of Fluorine:

- It is used to make fluorochemicals, which in turn are used to produce **plastics, agrochemicals, lithium-ion batteries**, and **drugs**.

Thallium

News Excerpt:

A case of Thallium poisoning has been reported in Maharashtra.

About:

- It is a soft, silvery-white, **heavy metal found in trace amounts in the earth's crust**. It is tasteless and odourless and has been historically used as a rodenticide.
- It is found in pyrites, mainly as a **by-product of copper, zinc, and lead refining**, and in manganese nodules on the ocean floor.
- Thallium is used in **electronics, low-temperature thermometers, optical lenses, and imitation precious jewels**. It is used to produce special glass with a high index of refraction and low melting point.
- **Thallium has no known biological role and is highly toxic**, with evidence of teratogenic (disturbs the development of an embryo or foetus) and carcinogenic effects.

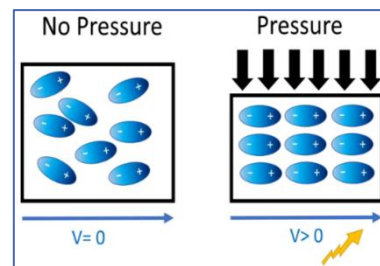
Piezoelectricity

News Excerpt:

In the future, piezoelectricity might be used for energy harvesting.

About Piezoelectricity:

- **Jacques and Pierre Curie**, two French physicist brothers, discovered piezoelectricity in 1880.
- The process of utilizing crystals to transform mechanical energy into electrical energy or vice versa is known as piezoelectricity.
- When mechanical stress is applied to some materials, those materials tend to accumulate electric charges.
 - The fact that a piezoelectric material will produce a voltage when pressure is applied to it is known as the piezoelectric effect.
- The inverse piezoelectric effect is used in many transducers to produce ultrasonic sound waves.



How does piezoelectricity appear under pressure in ceramic or crystal materials?

- When the material is in a free state (without any pressure), those molecules will be arranged in a certain way, which corresponds to an equilibrium of the material and in which the charges of the molecules cancel themselves if we look at the whole.
- When pressure is applied, however, those molecules change position and align into a dipolar state where the global charge isn't null anymore, and 2 sides of the materials become polarized.

Applications of piezoelectricity:

- Piezoelectricity is being used in electronic applications these days: Speakers & buzzers, Actuators, Drivers, Sensors, Motors, Quartz watches.

China to build the world's largest 'ghost particle' detector

News Excerpt:

China is building an enormous telescope **underwater** named the **Trident** in the **Western Pacific Ocean**.

About the news:

- Trident will be located in the **South China Sea**, a major marginal sea of the Western Pacific Ocean. It will span 7.5 cubic kilometres.

- Its job will be to detect “ghost particles”, also known as **Neutrinos**.
- The largest neutrino-detecting telescope right now is the University of Madison-Wisconsin’s (US) “**IceCube**” **telescope**. Situated deep in the **Antarctic**, the telescope’s sensors span around 1 cubic kilometre.

About the ‘Ghost particle’:

- Neutrinos are a type of electron but, like neutrons, they do not have any charge.
- They can only be “seen” when they interact with other particles. **The rarity of interactions with other particles makes them almost impossible to track.** That’s why they’re called **ghost particles**.
- They are among the most abundant particles in our universe, with trillions of neutrinos passing through us at any given second, and are also among the tiniest.
- Neutrinos’ weak charge and almost nonexistent mass have left them undetected for years.

China starts up the world's first fourth-generation nuclear reactor

News Excerpt:

China has started commercial operations at a new-generation nuclear reactor that is the first of its kind in the world.

About:

- This **fourth-generation Shidaowan plant** is **designed to use fuel more efficiently** and improve economics and safety.
- It will also reduce China's environmental footprint as it turns to nuclear power to meet carbon emission goals.
- It uses a **modular design**. (Modular plants refer to those nuclear plants of less than 300MW and can be constructed off-site.)
- **China aims to produce 10% of its electricity** from nuclear by 2035 and 18% by 2060.

History of Reactor Generations:

Three generations of nuclear power systems -

- **Generation I:**
 - It refers to the prototype and power reactors that launched **civil nuclear power**.
 - This generation consists of **early prototype reactors** from the 1950s and 1960s.
- **Generation II:**

- It refers to a class of **commercial reactors** designed to be economical and reliable.
- They are designed for a typical **operational lifetime of 40 years**.
- These reactors are typically referred to as **light water reactors (LWRs)**.

- **Generation III:**

- Gen III nuclear reactors are essentially Gen II reactors with evolutionary, **state-of-the-art design improvements**.
- These **improvements** include **fuel technology, thermal efficiency, modularized construction, safety systems, and standardized design**.

Electricity generation in the nuclear reactor:

- A nuclear reactor is driven by the **splitting of atoms**, a process called **fission**, where a **particle (a ‘neutron’) is fired at an atom**, which then **fissions into two smaller atoms** and some additional neutrons.
- Some of the released neutrons then hit other atoms, causing them to fission and release more neutrons. This is called a **chain reaction**.
- The fissioning of atoms in the chain reaction also **releases much energy as heat**.
- A circulating fluid, typically water, removes the generated heat from the reactor.
- This heat can then be used to generate steam, which drives **turbines for electricity production**.

Nuclear reactors in India:

- NPCIL presently **operates 23 reactors** with a total capacity of 7480 MW and **has nine units** (including KAPP-4) with a capacity of 7500 MW **under construction**.
- In addition, 10 more reactors with a total capacity of 7000 MW are in **pre-project activities**. These are expected to be completed progressively **by 2031-32**.

Small Modular Reactors (SMR’s)

News Excerpt:

India is considering steps for the development of SMR’s.

About

- Small modular reactors (SMRs) are **advanced nuclear reactors** that have a power capacity of **up to 300 MW(e) per unit**, which is about one-third of the generating capacity of traditional nuclear power reactors.
- Provisions of **Atomic Energy Act, 1962** are being examined to allow participation of the **private**

sector and start-ups to promote SMR's technology in the country.

Advantages of SMR's:

- Sited on locations not suitable for larger nuclear power plants.
- Prefabricated units of SMRs can be manufactured and then shipped and installed on-site, making them more affordable to build than large power reactors.
- They can be deployed incrementally to match increasing energy demand.
- It eliminates or significantly lower the potential for unsafe releases of radioactivity to the environment and the public in case of an accident.
- SMRs have reduced fuel requirements.
- Promising technology in industrial decarbonization especially where reliable and continuous power supply required.
- It can help fulfil India, its commitment to Clean Energy transition, SDG 7 and Net zero by 2070.

Alpha Keratin and Beta Keratin

News Excerpt:

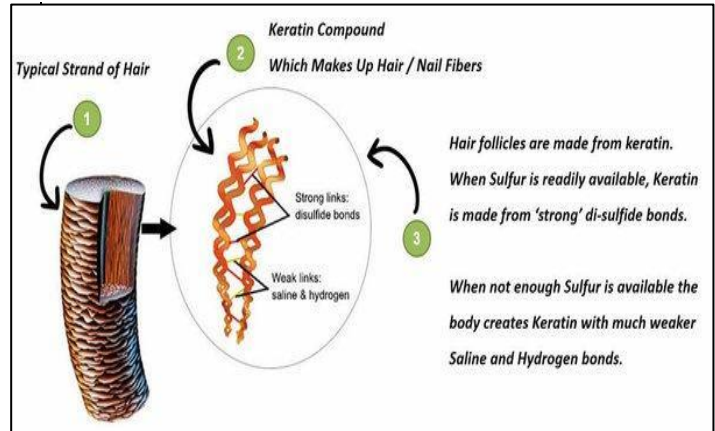
Recently, Keratin present in the silk of spiders and the horns of rhinos was discussed by scientists.

What is Keratin?

- A **broad group of proteins**, defined as a fibrous protein that forms the main structural constituents of hair, feathers, claws, horns, etc.
- The **alpha keratin** and **beta keratin** are two forms of keratin, that occurs in animals.

Difference between Alpha and beta keratin:

	Alpha keratin	Beta keratin
Presence	A type of protein found in Mammals.	A structural protein that mainly occurs in the epidermis of reptiles.
Occurrence	Occurs in hair, horns, nails, and the epidermal layer of their skin.	Occurs in the epidermal stratum corneum of their skin, rich in stacked beta-pleated sheets.
Function	Provides the mammal with structural Stability	Provides rigidity to skin, waterproofing and prevention of desiccation in reptiles.



Function of Keratin:

- Provides support and protection in your body.
- Human hair, nails and skin rely on the amount of keratin in your body for their overall health. Moreover, human glands and organs also contain keratin.
- Keratin is strong, so **won't dissolve** in diluted acids, alkaline, solvents or water.
- Even though the human body has many toxic chemicals in it due to increasing pollution levels, none of them affect keratin.

Cryptozoology

News Excerpt:

On August 26-27, 'Monster Hunters' converged on Loch Ness Lake in the Scottish Highlands to understand the biggest search in 50 years for a legendary monster named 'Nessie'.

About Cryptid:

Nessie is also known as a 'cryptid', a creature that is unknown, legendary, or extinct and whose present existence is disputed or unsubstantiated.

What is Cryptozoology?

- It is a field of study and subculture that searches for and studies cryptids.
- **Cryptids** have been reported on every continent and several cultures.
- Some famous include –
 - Mokele Mbembe (dinosaur-like creature of the **Congo**).
 - Chupacabra of Latin America and the **Caribbean**.
 - Bigfoot or Sasquatch of **North America**.

Yeti of **Himalayas**.

Perovskite- Solar Panel Technology

News Excerpt:

The National Centre for Photovoltaic Research and Education (NCPRE) at the Indian Institute of Technology Bombay (IITB) has developed a perovskite solar cell (PSC). The cell has demonstrated an efficiency of over 26 per cent.

About Perovskite- Solar Panel Technology:

- In material science, the word 'perovskite' refers to a certain crystal structure in which the atoms are arranged.
- It is in the form of ABX₃. For example, Calcium titanium oxide, or CaTiO₃, is a perovskite.
- Solar cells made with perovskite material are highly efficient at converting light into electricity.
- However, they are unstable and degrade when exposed to light.

LAN Radio

News Excerpt:

The Indian Army has sealed a deal with a Bengaluru-based company to procure the indigenously developed tactical LAN radio.

Tactical LAN Radio

- It is a state-of-the-art high-bandwidth backhaul wireless radio equipment for the provisioning of reliable communication.
- It is the second contract that the Army has firmed up under the framework of Innovations for Defence Excellence (iDEX).
- The LAN radio solution offers an enhanced range of communication and embedded frequency hopping mechanism to preclude chances of interception.
- The system also incorporates enhanced safety features and can operate continuously for 48 hours on a single-set basis, without any breakdown.

Innovations for Defence Excellence (iDEX)

- iDEX aims at creation of an ecosystem to foster innovation and technology development in Defence and Aerospace by engaging Industries including MSMEs, start-ups, individual innovators, R&D institutes & academia.
- It will be funded and managed by a 'Defence Innovation Organization (DIO)' which has been formed as a 'not for profit' company for this purpose.
- iDEX will function as the executive arm of DIO, carrying out all the required activities while DIO will provide high level policy guidance to iDEX.

Electromagnetic Ion Cyclotron (EMIC) waves

News Excerpt:

Recently, Scientists have discovered Electromagnetic Ion Cyclotron (EMIC) waves. These are plasma waves which were observed at the **Maitri station on Antarctic**.

About EMIC waves:

- The discrete electromagnetic emissions detected in the magnetosphere of the Earth are known as **Electromagnetic Ion Cyclotron (EMIC) waves**.
- The loss mechanisms of extremely energetic electrons (**in the MeV range or "killer electrons"**) in the inner magnetosphere of the Earth are significantly influenced by the EMIC waves.
- These waves originate at equatorial latitudes (11 degree), travel along magnetic field lines, and leave their mark in the ionosphere at high latitudes.
- **Both space and ground-based magnetometers can detect their traces.**
- These waves are **crucial in the precipitation of killer electrons**, which pose a threat to our space-based equipment and instruments.
 - Killer electrons are electrons with a speed similar to that of light that create the radiation belt of planet Earth.
- The work can aid in understanding how energetic particles in the radiation belts affect low-orbit spacecraft.

Digital Highways

News Excerpt:

Recently, The National Highways Authority of India (NHA) has announced a plan to build over **10,000 km of Optic Fiber Cable (OFC) infrastructure across the country by fiscal year 2025**.

About Digital Highways:

- Digital Highways or Roads are **digital platforms that provide shared public and private services**.
- They use data, technology, and connection to improve the **Strategic Road Network (SRN)** in terms of **design, construction, operation, and utilisation**.
- This will result in **safer travel, faster deliveries, and overall better experiences for all**.

Optic Fiber Cable (OFC)

- Fiber-optic cables resemble tubes that contain small glass or plastic wires.

- They use light to deliver data considerably faster than traditional lines that use power.
- Metal wires are preferable for transmission in optical fiber communication because they cause less damage to the signals.
- The optical fiber operates on the **total internal reflection (TIR) concept**.
- TIR is the total reflection of a beam of light from the surrounding surfaces back into a medium such as water or glass.
- For Telecom/Internet Services, the OFC network will enable direct **plug-and-play** or '**Fiber-on-demand**' models.
- The network will be leased to eligible users on an '**Open for All**' basis via a web portal using a Fixed Price Allotment process.

Universal Dynamic Crosslinker (UDC)

News Excerpt:

Researchers at IIT Madras, Columbia University and Colorado State University in the U.S. have developed a **technique to merge diverse plastics into strong and recyclable materials**.



Key findings:

- The technique **combines** different types of plastics to create **new composite plastics** that are **strong, processable, and recyclable**.
- The team employed a **specially designed** universal dynamic crosslinker (**UDC**) to successfully blend usually incompatible plastics.

Universal Dynamic Crosslinker (UDC):

- The design and development of several UDCs enable an optimal **closed-loop upcycling path** for immiscible multicomponent plastics.
- UDCs **reactivate dead chains** in the mixed plastics to dynamically **crosslink** them into compatibilized,

grafted multiblock copolymers with superior properties and **without** the need for **deconstruction** or **reconstruction**.

- The resulting upcycled materials can be used and reprocessed through **multiple cycles** and have enhanced performance over **virgin plastics**.
- The **key barrier** in the technique is **cost**.

HEALTH

GM Insects

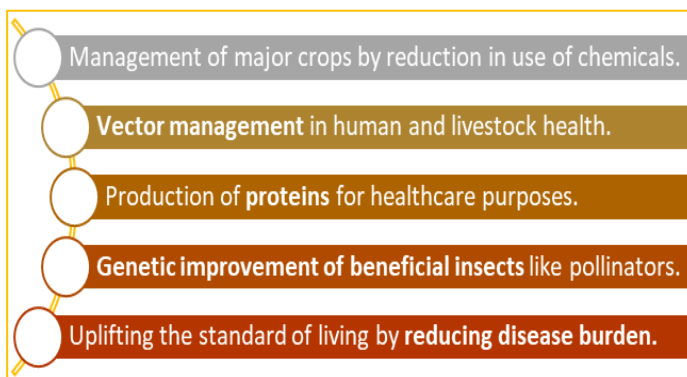
News Excerpt:

The Department of Biotechnology (DBT) has issued the '**Guidelines for Genetically Engineered (GE) Insects**'.

Prospects of India's Bioeconomy:

- The sector accounts for **2.6% of India's GDP**.
- According to the "Bioeconomy Report 2022", this contribution in GDP **should come closer to 5% by 2030**.
- The current budgetary allocation for DBT is only 0.0001% of India's GDP.

Advantages of GE insects: The development and release of GE insects offers applications in various fields such as:



India's own CAR-T Cell Therapy

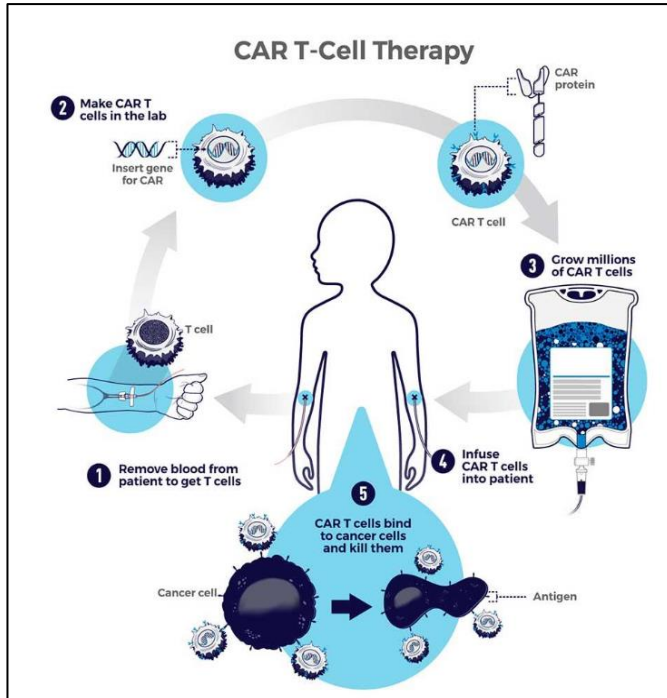
News Excerpt:

The **Central Drugs Standard Control Organization (CDSCO)** has granted market authorization to India's breakthrough **Chimeric Antigen Receptor (CAR) T-cell** therapy for patients with B-cell lymphomas who didn't respond to standard treatments like chemotherapy.

About CAR-T Cell Therapy:

- CAR-T is a revolutionary therapy that **modifies immune cells**, specifically T-cells, by turning them into potent cancer fighters.

- **(CAR)- T cell therapy** involves genetic modification of a patient's autologous T-cells in a laboratory so that they will bind to specific proteins (Antigens) on cancer cells and kill them.



NexCar19: A type of CAR-T therapy indigenously made in India:

- The Food and Drug Administration (FDA) has approved **six CAR-T-cell treatments since 2017**. All are licensed for the treatment of blood cancers such as **lymphomas, leukaemia**, and, most recently, **multiple myeloma**.
- **NexCar19** is a type of **CAR-T and gene therapy** developed indigenously in India by **ImmunoACT and Tata Memorial Centre (TMC)**. ImmunoACT is a company incubated at IIT Bombay.
- **Immunoadoptive Cell Therapy Private Limited (ImmunoACT)** obtained **CDSDO** approval for NexCAR19, a CAR-T treatment, to treat relapsed or refractory **B-cell lymphoblastic leukaemia**.
- The approval came after a Phase I/II trial of 60 patients showed a **70% overall response rate** and significant delay in cancer progression.

About Central Drugs Standard Control Organisation (CDSCO):

- It comes under the Directorate General of Health Services, **Ministry of Health & Family Welfare**.
- It is the **National Regulatory Authority of India** for cosmetics, pharmaceuticals, and medical devices, headquartered at New Delhi.

- **Under the Drugs & Cosmetics Act, 1940 and rules 1945**, CDSCO is responsible for **approval of Drugs**, Conduct of **Clinical Trials**, laying down the **standards for Drugs**, control over the quality of imported Drugs in the country and coordination of the **activities of State Drug Control Organizations** by providing expert advice.

- **B-cell acute lymphoblastic leukaemia** is a disease that affects your "B lymphocytes" – white blood cells that form in the soft centre of your bones, known as marrow. **B-cell leukaemia is most common among children**.
- **B lymphocytes** are meant to develop into cells that can help in the fight against infections. However, with this disease, they transform into "leukaemia" cells, which live longer than normal cells and proliferate rapidly. They accumulate in your bone marrow and then enter your bloodstream. They can then spread to other organs in your body.

Anthrobots

News Excerpt:

In a groundbreaking study, researchers created small robots from human cells that can **move and heal neurons in a laboratory setting**.

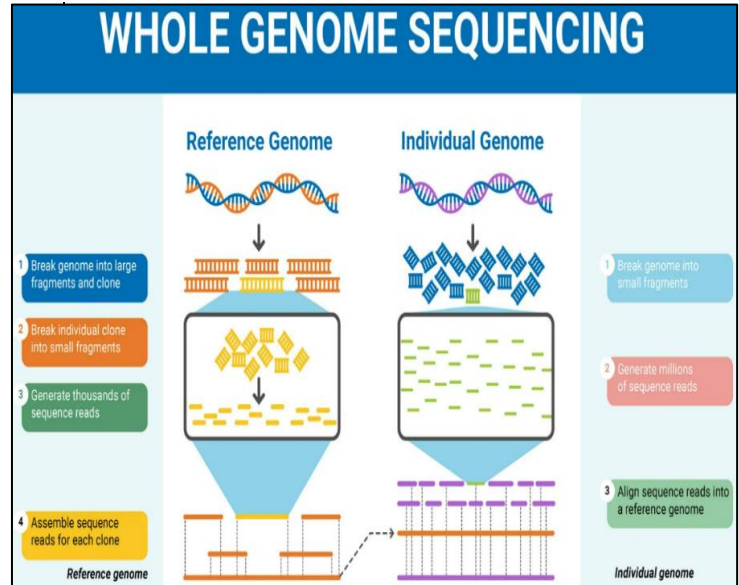
Genome (IndiGen) from India:

- A pilot programme for **population genomes in India named IndiGen** provided an early view of more than a thousand genomes of individuals from cosmopolitan areas in India.
- It yielded some clues to the **landscape of many treatable genetic diseases** and variants of clinical significance, including the efficacy and toxicity of drugs and the prevalence of rare disorders.
- A larger programme to **sequence 10,000 whole genomes** from diverse population groups is being worked on under the GenomeIndia initiative.

About Anthrobots:

- These are **bio-engineered entities consisting of human tracheal cells** and possess the ability to configure themselves into various forms and dimensions autonomously.

- The scientists anticipate employing these **bio-bots** (robots built of biological material) as innovative instruments for **regeneration, recovery, and the management of diseases**.
- It can mend damaged tissues.
- These **self-assembling creations**, which **measure between the width of a human hair and the tip of a sharpened pencil**, have the potential to be used in **regenerative medicine, wound healing, and disease therapy**.
- It may also be possible to make bio-bots with potential **uses in sustainable construction and outer-space exploration by mixing multiple cell types and exploring other stimuli**.
- They **can be created from adult human cells without genetic modifications**, making them a potential patient-specific therapeutic tool.



Newborn genome-sequencing

News Excerpt:

Recently, Newborn screening programmes (NBS) have been deployed in some states in India.

Pre-Connect

Genome India: 'Cataloguing the Genetic Variation in Indians' project has been sanctioned by **Department of Biotechnology (DBT) in, 2020** for a period of 3 years to 20 institutions from varied disciplines across the country.

About Genomes Sequencing

All organisms have a unique genetic code that is composed of nucleotide bases (A, T, C, and G). **Determining the order of bases is called sequencing.**

- There are two types of genome sequencing:
 - (i) **Targeted sequencing:** Where only specific genes are sequenced and analysed.
 - (ii) **whole exome or whole genome sequencing:** Where all the DNA (whole genome) or all of the coding segments of all genes (whole exome) are sequenced and analysed.

Bronchial/Tracheal cells:

- These cells are from the lining of the bronchi/trachea, the network of tubes used to convey air to the lungs.
- These cells are responsible for producing lubricating mucus to keep the airways functional, and they are a type of epithelial cell, a term used generally to refer to cells lining the inside or outside of the body.

About Genes and Genomes

- **Gene:** They are segments of DNA that contain instructions for building the molecules that make the body work. Most of the molecules are proteins. Parents pass their genes to their offspring.
- **Genomes:** It is all of the genetic material in an organism. It is made of DNA (or RNA in some viruses) and includes genes and other elements that control the activity of those genes.

Newborn genome sequencing

It is an early diagnosis which allow to use effective treatments and management of conditions and save an infant from death or disability.

- It is the practice of collecting and analysing large portions of a newborn's DNA, revealing certain genetic disorders including rare inborn errors of metabolism that the newborn might be at risk of developing in infancy, childhood, or later in life.

deCODE Initiative

News Excerpt:

Recently, the **United Kingdom** has announced the completion of half a million whole-genome sequences, almost **0.7% of its population**.

The deCODE initiative:

- An early effort to use large-scale population genetic studies was **initiated in Iceland by deCODE genomics in 1996**, with most of the Icelandic population enrolling for genetic studies in around a decade.

- The initiative and the **democratization of sequencing technologies** provided the initial impetus for programmes that wished to use population-scale genomic data for precision medicine and public health.
- The deCODE effort considerably **improved our understanding of the genetics of diseases** and the utility of such data in risk assessment.
 - It also contributed **significantly to the methods, infrastructure, and standards** with which researchers handle large-scale genomic data and set up discussions on their bioethics.
- The project laid the groundwork to **integrate medical records** and people’s **genealogies**, resulting in **new drugs** and **therapeutics**.
- deCODE’s success, plus the **wider availability of sequencing technologies**, gave rise to several population-scale genome initiatives around the world, including many pilot programmes initiated in the last decade.
 - At first, several projects worked with **hundreds to thousands of genomes**, but in the last half a decade, such endeavours have leapfrogged to lakhs of genomes.

Ketamine

News Excerpt:

Recently, as per the autopsy report, Mathew Perry (“Friends” series & American-Canadian actor) **died from the “acute effects” of ketamine.**

What is Ketamine?

- Ketamine is an anaesthetic that has been listed as a **hallucinogen**.
- It’s referred to as a “**dissociative anaesthetic hallucinogen**” because it creates a feeling of detachment from pain and the environment.
- Its effects include **pain control, forgetfulness, intoxication, dissociation, and euphoria.**

Uses of Ketamine

MEDICAL USES

- It has been used more widely due to its **approval for treatment-resistant depression (TRD)** — that is, severe depression that has not improved via other therapies, including for people who

RECREATIONAL USES

- Ketamine is also used as a recreational drug, popularly known as **K** or **Special K** among clubgoers.
- It garnered popularity as it affects brain

are experiencing suicidal thoughts.

- **Relief from TRD with ketamine happens rapidly.** Instead of waiting for an SSRI (Selective serotonin reuptake inhibitor) to provide relief over weeks, people who are suffering from depression can start to feel the benefits of ketamine **within about 40 minutes.**

receptors that traditional antidepressants do not target.

- It can make a user feel like they are having an “**out of body**” **experience and hallucinations** for a short time.

DRESS Syndrome

News Excerpt:

The **Indian Pharmacopoeia Commission (IPC)** issued an advisory about the side effects of Meftal - a commonly consumed painkiller - as it could be a reaction known as **Drug Rash with Eosinophilia and Systemic Symptoms (DRESS) syndrome.**

DRESS Syndrome

- DRESS syndrome (**Drug Rash with Eosinophilia and Systemic Symptoms**) is an adverse reaction term that is currently used to describe a hypersensitivity reaction.
- DRESS syndrome is a **type 4 hypersensitivity reaction.**
- It is a serious drug reaction affecting the skin and other organs, with a **mortality rate of up to 10%.**
 - **Sometimes referred to as DIHS (Drug-Induced Hypersensitivity Syndrome).**

Symptoms of DRESS syndrome:

The symptoms can vary, but they typically develop over several days, with the typical onset being 2–6 weeks after starting the responsible medicine.

Typical signs of DRESS syndrome include fever, skin rashes or eruption, eosinophilia, atypical lymphocytosis, swollen lymph nodes and inflammation of internal organs.

Treatment

- The most important treatment for DRESS Syndrome is **Early recognition and immediate withdrawal of the medication** in treating the disease.
- **Corticosteroids** are often used and sometimes **immunosuppressants such as cyclosporine** are frequently used for the treatment.

Mangroves' Genomic

About

- Scientists have achieved a breakthrough by sequencing the entire **genome of Avicennia marina, a highly salt-tolerant and salt-secreting true-mangrove species.**
- Avicennia marina is a prominent mangrove species in India, thriving in all mangrove formations.
- It exhibits exceptional salt tolerance, secreting 40% of salt through specialized glands in its leaves and preventing salt entry into the roots.
- This genomic data will enable researchers to explore the potential of identified genes in developing drought and salinity-tolerant varieties of important coastal crops in India, which is home to vast coastlines and island systems.
- Mangroves, unique species inhabiting estuarine regions, possess adaptive mechanisms to survive high salinity, providing ecological, economic, and protective benefits by connecting marine and terrestrial ecosystems and serving as habitats for diverse organisms.

Class D Biomedical Device

News Excerpt:

Recently, Indian Drugs Controller approved **the first indigenously developed animal-derived tissue engineering scaffold for healing skin wounds with minimum scarring.**

Class D Biomedical Device

- **The Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) became the first institution in the country to develop Class D medical devices** that satisfy all statutory requirements of the Central Drugs Standard Control Organisation.
- **Healing Capabilities:** Membrane forms of the scaffold, identified as **Cholederm**, healed different types of skin wounds including burn and diabetic wounds in rat, rabbit, or dog faster than similar products currently available in the market with minimal scarring as proved by several in-depth laboratory investigations **focusing Type I and Type III collagen.**
- **Cost reduction & Income generation:** It is expected that with the introduction of **Cholederm** to the Indian market, the treatment cost can be reduced from Rs **10,000/- to Rs 2,000/-** making it more affordable to the common man.

- The technology for recovering extracellular matrix from the gall bladder is not available to others and it gives a fair chance for competition in the international market. It will create an additional income-generating opportunity.

About Meftal- Spas Meftal-Spas is a commonly prescribed drug for various conditions such as **rheumatoid arthritis, osteoarthritis, dysmenorrhoea, mild to moderate pain, inflammation, fever, and dental pain.**

- **Future development:** Researchers are developing injectable gel formulations of the scaffold that permits transvenous on-site delivery of the scaffold and for surface modification of polymeric medical devices.

C.T. scans associated with increased risk of blood cancers

News Excerpt:

Recently, researchers formed the International Agency for Research on Cancer (IARC) and stated that **the C.T. (Computerized Tomography) Scan** can potentially increase cancer risks. The high cumulative doses from multiple scans have raised concerns among the medical and scientific community.

Key highlights of the findings:

- Researchers monitored a group of people for at least two years after their initial C.T. scan.
 - They discovered **790 cases of haematological malignancies**, including 578 cases of **lymphoid malignancies** and 203 cases of **myeloid malignancies** and acute **leukaemia (A.L.)**.
- They found a clear association between cumulative dose and risk of all haematological malignancies, with an excess relative risk of 1.96 per 100 mGy.
- Researchers estimated that **"for every 10,000 children examined today (mean dose 8 mGy), one to two persons** are expected to **develop a haematological malignancy** attributable to radiation exposure **in the subsequent 12 years."**
- The results showed a **clear dose response between cumulative ABM (active bone marrow) dose and lymphoid and myeloid haematological malignancies risk, with increased risk at doses as low as 10-15 mGy.**

About Indian Pharmacopoeia Commission (IPC)

- Indian Pharmacopoeia Commission (IPC) is an **Autonomous Institution** of the **Ministry of Health and Family Welfare**.
- Indian Pharmacopoeia Commission (IPC) to deal with matters relating to the official book of standards for drugs included therein, in terms of the **Second Schedule to the Drugs and Cosmetics Act, 1940**.
- The Commission became fully **operational on January 1, 2009**, as an Autonomous Body fully **financed by the Central Government**.
- Its basic function is **regularly updating the standards of drugs commonly** required for treating diseases prevailing in this region.

Working of C.T. Scan:

- A CT scanner **emits a series of narrow beams** through the human body as it moves through an arc.
- This **differs from an X-ray machine**, which sends just one radiation beam.
- The **CT scan produces a more detailed final picture than an X-ray image**.
- The CT scanner's X-ray detector can see hundreds of different density levels. It can see tissues within a solid organ.
- This data is transmitted to a computer, which builds up a 3-D cross-sectional picture of the part of the body and displays it on the screen.
- Sometimes, a contrast dye is used because it can help show certain structures more clearly.
 - For instance, **if a 3-D image of the abdomen is required**, the **patient may have to drink a barium meal**. The barium appears white on the scan as it travels through the digestive system.

Mitochondrial Donation Treatment**News Excerpt:**

The recent news of a kid born in the United Kingdom having three parents' DNA.

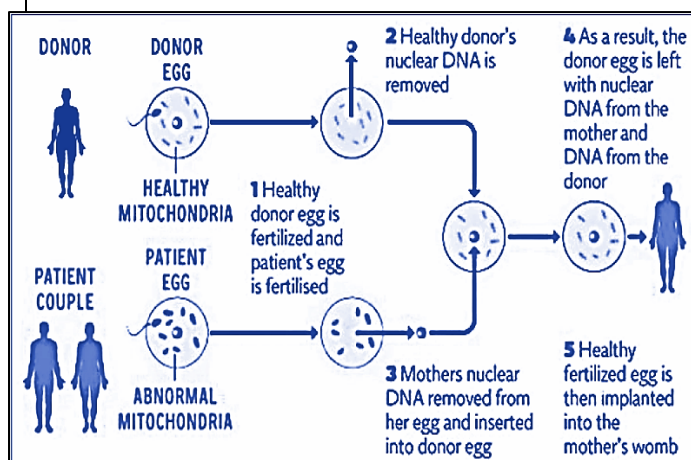
Pre-Connect

- Mitochondria are the energy-producing powerhouses of the cell in the form of **Adenosine triphosphate (ATP)**.
- Their function is dependent on proteins transcribed from nuclear and mitochondrial DNA (mtDNA). **Mitochondrial DNA** is circular in structure and contains **37 genes**.

- Unlike nuclear DNA, which we inherit from both parents, mitochondrial DNA (mtDNA) is passed exclusively from mother to child.

About Mitochondrial Disorders

- Mitochondrial disorders are a group of rare genetic conditions caused by mutations in the DNA of mitochondria, the energy-producing structures within cells.



- These disorders can lead to a wide range of debilitating symptoms, including muscle weakness, organ dysfunction, neurological issues, and impaired growth.
- Furthermore, since mitochondria are passed down exclusively from the mother, affected individuals can transmit these disorders to their offspring.

About Mitochondrial Donation Treatment

- Mitochondrial donation treatment, also referred to as **mitochondrial replacement therapy (MRT)** or **three-parent IVF**, involves the transfer of healthy mitochondrial DNA from a donor to an embryo or egg with defective mitochondria.
- This procedure aims to prevent the transmission of mitochondrial diseases to future generations by replacing the faulty mitochondria responsible for the condition.

The Three-Parent Technique

The procedure involves two main techniques:

- Pronuclear transfer** involves transferring the nucleus of a fertilized egg from the affected mother to a donor egg with healthy mitochondria, which is then implanted into the mother's womb.
- Maternal spindle transfer**, on the other hand, involves transferring the nucleus of the mother's egg to a donor egg before fertilization.

Neurotoxins

News Excerpt:

Recently, a gas leak in the Giaspura neighborhood of Ludhiana, Punjab, resulted in 11 fatalities and four hospitalizations for illness.

Pre-Connect

- **Bhopal Gas leak 1984** - Over 500,000 people were exposed to **methyl isocyanate (MIC)** gas and other chemicals in a pesticide plant resulted in the deaths of thousands of people.
- **2017 Delhi Gas leak:** Around 470 school children were hospitalized after inhaling poisonous fumes that spread due to a chemical leak at a container depot near two schools in the customs area of Tughlaqabad depot.
- **2020 Vizag Gas Leak-** A gas leak at a chemical plant killed least 12 people in the **styrene plant** owned by South Korean electronics giant LG at Visakhapatnam, in the state of Andhra Pradesh.

Ludhiana Gas Tragedy

- According to the police preliminary investigation, **Hydrogen Sulphide**, a neurotoxic gas, has been speculated as the cause of the catastrophe by forensic professionals.
- Expert view: It's likely that some acidic garbage was dumped into the sewer, where it mixed with other sewer gases like methane and carbon monoxide to create hydrogen sulphide.

About Neurotoxins

- Neurotoxins are harmful compounds that have a direct impact on the neurological system.
- **Neurotoxicity** occurs when the nervous system's normal activity is disrupted by exposure to hazardous substances, whether natural or man-made.
- These compounds have the potential to damage or even kill neurons or nerve cells, which are essential for signal transmission and processing in the brain and other sections of the nervous system.

Neurotoxic gases

- Neurotoxic gases include methane, hydrogen sulphide, carbon monoxide, and carbon dioxide.
- While methane and carbon monoxide are odourless gases, hydrogen sulphide has a strong odour and can be lethal in large concentrations.
- Chemical oxidation is used to remove gases such as hydrogen sulphide from wastewater. Oxidants such as hydrogen peroxide are applied to the wastewater.

DNA Nanoball (DNB) Technology

About:

DNA nanoball (DNB) technology combines single-stranded circular (ssCir) library construction, generation and loading of DNBs onto patterned nanoarrays, and combinatorial probe anchor synthesis (cPAS) sequencing.

- It helps increase our understanding of human health, from improving diagnostic testing accuracy to developing precision-based medicines for cancer and infectious diseases.
- It can be used for complete genome association studies and to identify rare variants and somatic mutations important in clinical settings.

Aspartame: an artificial sweetener

News Excerpt

Recent reports stated that Artificial sweetener Aspartame **may increase cancer risk in human** and WHO is gearing up to declare it as 'possibly carcinogenic to humans'.

Pre-Connect

- Report stated that Sugar alternatives had undesirable effects like increased **risk of type 2 diabetes, cardiovascular diseases, and mortality in adults**.
- As per **JECFA (the Joint WHO and Food and Agriculture Organization's Expert Committee on Food Additives)**, which is the WHO's expert committee on food additives, an adult weighing 60 kilos has to drink more than 12 cans of diet soda everyday to be at risk.

About Aspartame

- Aspartame, a popular artificial sweetener found in **Diet Coke, chewing gum, yoghurt and other food products**.
- Aspartame is about 200 times sweeter than the regular table sugar.

Significance of Aspartame

- Despite its intense sweetness, aspartame has an almost zero calorific value and no bitter aftertaste like saccharin and grew in popularity as a more diet-conscious consumer emerged.
- According to The European Food Safety Authority, aspartame is made of the two naturally occurring amino acids, phenylalanine and aspartic acid. They are also components of proteins in our body and in food.

- The phenylalanine in aspartame gets slightly modified by adding a methyl group which gives aspartame its sweet taste.
- Aspartame also doesn't leave a bitter aftertaste like saccharine, which is 400 times sweeter than sugar but has to be mixed with other artificial sweeteners to curb its unpleasant side.

Concern with Aspartame:

- Aspartame has been linked to **behavioural and cognitive problems including learning problems, headache, seizure, migraines, irritable moods, anxiety, depression, and insomnia and is likely to be declared a possible carcinogen.**
- Several studies link aspartame to weight gain, increased appetite, diabetes, metabolic derangement and obesity-related diseases.

Other foods that can cause cancer:

- Certain ways of cooking like heating food in plastic utensils, overuse of microwave and certain processed foods such as **frozen sausages, preserved food, pickle preserved by nitrate, can be a cause of cancer.**
- **Ajinomoto, artificial sweeteners, artificial colouring agents all are possible carcinogenic food items.**
 - These foods can cause **Oesophagus cancer, liver cancer, gall bladder cancer, stomach, colon, rectal cancers are on rise due to carcinogenic in our food.**



Regulations

- Different countries have implemented regulations and policies regarding the use of aspartame. In the United States, the Food and Drug Administration (FDA) oversees the regulation of aspartame as a food additive.
 - The FDA has established an Acceptable Daily Intake (ADI) limit for aspartame, which is set at 50 milligrams per kilogram of body weight.
- The **European Food Safety Authority (EFSA)** has recommended a slightly lower ADI for aspartame, specifically 40 milligrams per kilogram of body weight per day.
- The Indian government will set its own standards on artificial sweeteners such as aspartame.

Antimicrobial resistance

News Excerpt

Antimicrobial resistance (AMR) has become a Global issue, which is not confined by political boundaries, and is a threat to all humanity.

Pre-Connect

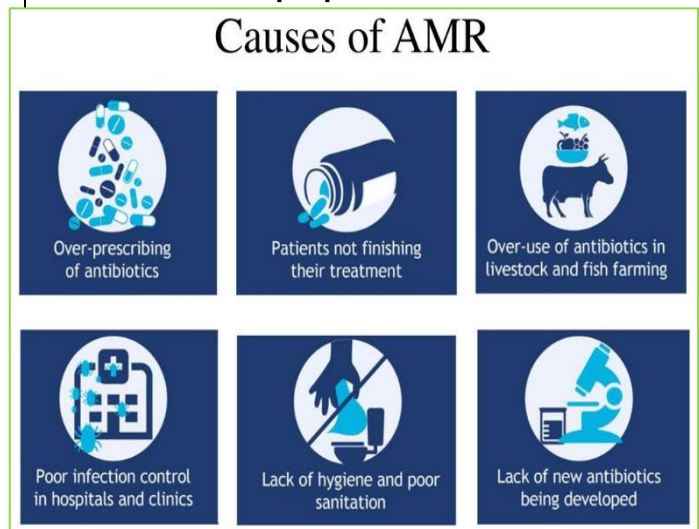
- Over the last ten years, the prevention, control, and response to AMR has been a high priority for most national governments, international organisations (such as the WHO, FAO, OIE), healthcare communities, and civil society, etc.

About Antimicrobial Resistance (AMR):

- AMR occurs when bacteria, viruses, fungi, and parasites evolve over time and no longer **respond to medicines**, making infections more challenging to treat and increasing the risk of disease spread, severe illness, and death.
- As a result, the medicines become **ineffective, and infections persist** in the body, increasing the risk of spreading to others.
- AMR threatens the effective prevention and treatment of an ever-increasing range of infections.
- Antimicrobials - including **antibiotics, antivirals, antifungals, and antiparasitic** - are medicines used to prevent and treat human, animal, and plant infections. Microorganisms that develop AMR are sometimes referred to as "**superbugs**".

Status of AMR in India:

- India has one of the highest age-standardized infectious disease mortalities in South Asia, and the rates of antibiotic resistance **are alarming.**
- India has one of the highest uses of human antibiotics, a prime driver of antimicrobial resistance, at **10.7 units per person.**



- Over the past four years, the number of isolates reported has gradually increased from 25,833 to 1,19,686.
 - Similar to the previous five years, Escherichia coli (33%) remained the most commonly isolated pathogen in the **AMR Surveillance data 2022**.

Antimicrobial Resistance: A global multifaceted phenomenon

- Antimicrobial resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses, and fungi no longer susceptible to the common medicines used to treat them.
 - The problem of AMR is especially urgent regarding antibiotic resistance in bacteria.
- Following the indication of a primary role for surveillance, in April 2014, WHO published **the first global report on surveillance of AMR** collecting experiences from national and international surveillance networks.
- It has emerged public health problems threatening the effective prevention and treatment of an increasing range of infections caused by bacteria, parasites, viruses and fungi no longer susceptible to the common medicines used to treat them.
- Bacteria causing common or severe infections have developed resistance to each new antibiotic coming to market.

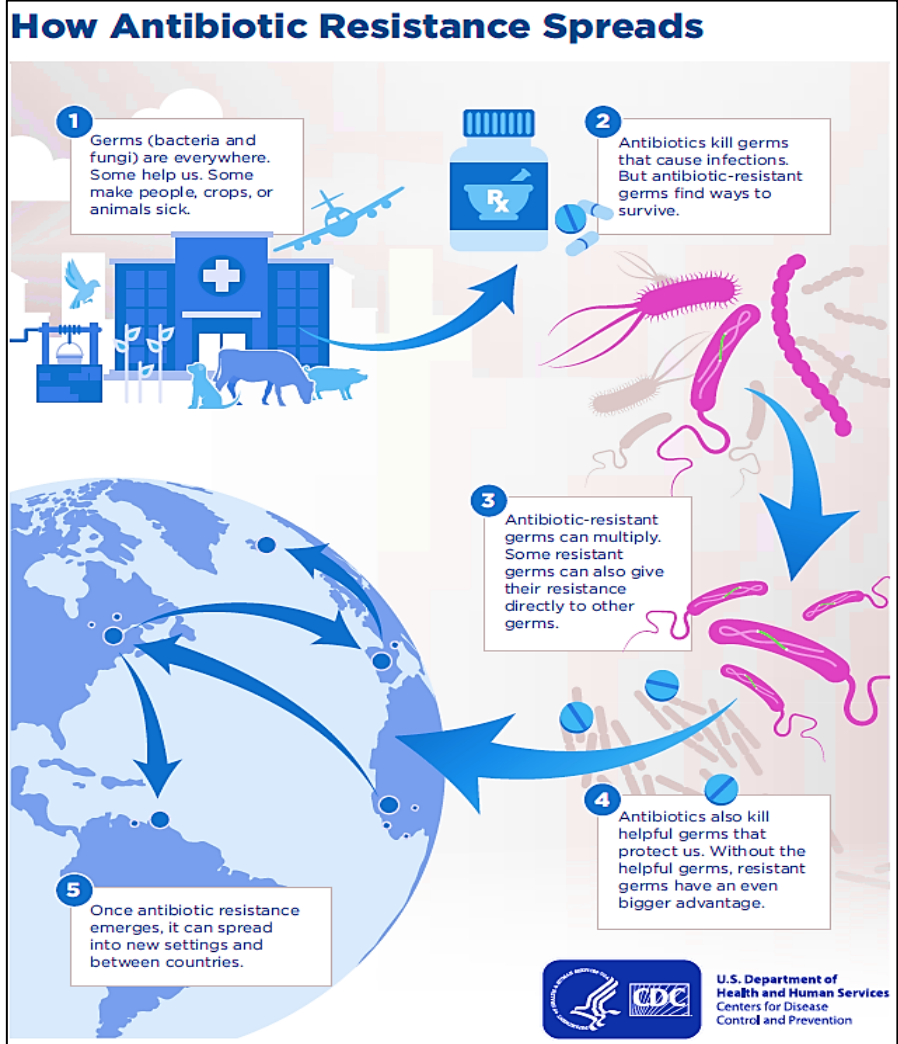
How Antimicrobial Resistance Happens?

- It is a naturally occurring process happens when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them.

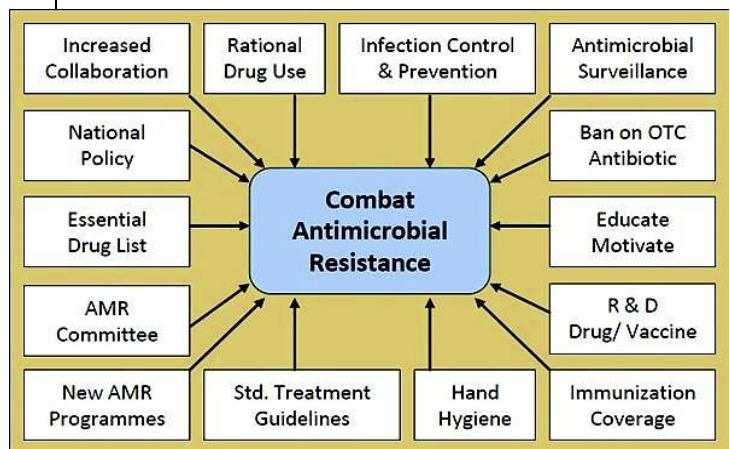
Antimicrobial Resistance Challenge in India:

The current magnitude of the problem in India is as follows:

- The high burden of communicable diseases.
- Overburdened public health system.
- Limited laboratory capacity for etiology-based diagnosis.



- Inexpensive and widely available antibiotics without prescriptions.
- Inconsistent infection prevention control (IPC) practices.
- Lack of standardized effective surveillance platforms that monitor healthcare-associated infections (HAI).



Various Programmes initiated by Govt. of India

- **National action plan on containment of Antimicrobial Resistance (NAP-AMR)**- It is focused on One Health with the objectives including **improving awareness, enhancing surveillance measures, and strengthening infection prevention and control.**
- **AMR Surveillance Network**- comprised of 30 tertiary care hospitals, both private and government to generate evidence and capture trends and patterns of drug-resistant infections in the country.
- **AMR Research & International Collaboration**- Initiatives to develop new drugs /medicines through international collaborations in order to strengthen medical research in AMR.

Global Measures on AMR:

- **Global Action Plan to tackle AMR:** The goal of GAP-AMR is to ensure continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them.
- **WHO launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS):** The first global collaborative effort to standardize AMR surveillance.
- **It is a standardized approach** to the collection, analysis, interpretation and sharing of data by countries and seeks to actively support capacity building and monitor the status of existing and new national surveillance systems.

Initiatives: To increase awareness about antibiotics misuse

- **The Indian Council of Medical Research (ICMR)** has initiated **antibiotic stewardship program (AMSP)** on a pilot project basis in **20 tertiary care hospitals across India** to control misuse and overuse of antibiotics in hospital wards and ICUs.
- **Drugs Controller General of India** has banned **40 fixed dose combinations (FDCs) which were found inappropriate.**

Calixcoca Vaccine

News Excerpt:

Researchers in Brazil have created a vaccine "**Calixcoca**" as a new cure for cocaine and crack.

Working of the vaccine:

- It triggers an immune response that blocks the high from cocaine and its derivatives and stops it from

reaching the brain by producing antibodies that bind cocaine molecules to the bloodstream.

- The enlarged molecules will be rendered too large to pass into the **brain's "reward center"** or the mesolimbic system that is stimulated by cocaine to produce **dopamine** - the pleasure-inducing reward chemical.
- Once vaccinated, the drug will potentially help people break the cycle of addiction.
- This drug, however, would be a **supplementary treatment in addition to rehab.**
- **It is meant for recovering addicts who are off cocaine and want to stay that way and not for everyone.**

Efficiency of the vaccine:

- The vaccine has produced significant antibodies against cocaine in animal tests conducted by scientists, which have shown encouraging results.
- In addition to having few side effects, the vaccine helped shield rat fetuses against cocaine.
- As per scientists, it would help prevent addiction from getting passed on to the unborn babies of pregnant addicted people.

Captagon pills

News Excerpt:

The reports of the rising prominence of Captagon shows that the drug was being widely consumed by the Islamic State (IS) and Syrian fighters to increase alertness and suppress appetite during their gruelling battles.

What is Captagon?

- **Captagon is a highly addictive amphetamine-type drug**, which is produced mainly in Syria and widely smuggled across West Asia.
- Amphetamine-based drugs stimulate the central nervous system and provide a boost of energy, enhance someone's focus, let someone stay awake for longer periods of time, and produce a feeling of excitement.
- The currently prominently used Captagon is actually a counterfeit version of a medicine with the same brand name which was first produced in the 1960s by the German pharma company.
- It can cause loss of appetite, heart problems, high body temperature, skin flushing, memory loss, problems thinking clearly, and stroke.
- Nazi Germany supplied crystal meth to its soldiers while the Allied forces gave their troops amphetamine sulfate to help them stay awake and alert during World War 2.

Chikungunya Vaccine

News Excerpt:

U.S. health authorities have approved the **world's first vaccine for Chikungunya**.

About the vaccine:

- It is being **developed by the European company Valneva**.
- **IXCHIQ** becomes the world's first licensed chikungunya vaccine available to address this unmet medical need.
- The vaccine is **injected in one dose** and **contains a live, weakened version of the chikungunya virus**, as is standard with other vaccines.

About Chikungunya:

- It is a **mosquito-borne viral disease** that causes **fever and severe joint pain**.
- It is a **ribonucleic acid (RNA) virus that was first recognized in 1952** during an outbreak in southern **Tanzania**.
- In 2018, the chikungunya virus was listed as a priority pathogen for vaccine development by the World Health Organization.
- Chikungunya is transmitted to humans by the bites of **infected female Aedes aegypti and Aedes albopictus mosquitoes** which **bite throughout daylight hours**.
- There is **currently no vaccine to prevent or medicine available to treat chikungunya** virus infection.
- It is **generally seen in tropical and subtropical regions of Africa, southeast Asia, and parts of the Americas**.
- It can be **passed from a pregnant person to their unborn child**, and the virus can be fatal to newborns.
- People with **chronic illnesses such as diabetes and heart disease**, as well as those **over the age of 65**, are more **prone to** develop severe **chikungunya** symptoms.

Helicobacter pylori (H. pylori) bacteria

News Excerpt:

Researchers from the National Institute of Cholera and Enteric Diseases (ICMR-NICED), Kolkata, have developed a **new two-step PCR test** of the **Helicobacter pylori (H. pylori) bacteria** which is a common cause for peptic ulcers.

Helicobacter pylori (H. pylori) infection:

- It occurs when **H. pylori bacteria** infects the stomach.
- About two-thirds of the world's population has it in their bodies although for most people, it **never causes any symptoms**.
- In **India**, it affects almost **60-70% of the population**.
- This usually happens **during childhood** and remains in the stomach throughout life if not treated with antibiotics effectively.
- **Symptoms**

Why is it a concern?

- As it takes **three weeks to culture the bacteria** and carry out tests and thus, the antibiotic is **used without knowing the drug's sensitivity**.
- The growing incidence of **clarithromycin-resistant bacteria** is a big concern and has to be addressed as it is the **most important reason for treatment failure**.
- The new test bypasses this time barrier and is **found to have 100% sensitivity, thus creating a milestone in this medical journey**.

Bed aquiline: Drug for Tuberculosis

News Excerpt:

The Indian Patent Office rejected the application of **J&J's secondary patent** on bed aquiline.

About

- Bed aquiline is used to treat drug resistant tuberculosis (**DR-TB**).
- Tuberculosis is an **infectious** disease. It affects the lungs and other parts of the body known as **Pulmonary TB** and **extra Pulmonary TB** respectively. DR-TB is resistant to at least **isoniazid** and **rifampin**, the two most potent TB drugs. It is a major contributor to antimicrobial resistance (**AMR**).
- AMR occurs when **bacteria, viruses, fungi**, and parasites change over time and **no longer respond** to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death.
- Each year, nearly half a million people develop drug-resistant TB. Nearly 2.8 million patients, the most in the world, live in India.
- J&J has filed secondary patents over bed aquiline till **2027**, which were **granted in 66** low-and middle-income countries. A deal between J&J and

the Global Drug Facility (**GDF**), a non-profit distribution agency housed in the WHO is signed which will lower the price of drug procured through GDF in respective countries.

Snake Venom and its Effect on the Human Body

News Excerpt:

An incident of the sale of Snake Venom at rave parties in the National Capital Region has come to light.

Consumption and its effect on the Human Body:

- Snakes were deliberately made to bite on the **consumer’s feet or tongue**.
- Snakes like **Cobras** and **Indian Kraits** are most commonly used for this purpose.
- Consumers often associated the snake bite with jerky movements of the body, blurring of vision, and unresponsiveness, i.e. ‘blackout’ for 1 hour.
- Once the effect of the bite wore off, they began to experience irritation and lethargy and craved drugs.
- In the reported cases, consumers described the experience of a snake bite to be associated with **“happiness, grandiosity, and excessive sleepiness**.
- Consumers didn’t report any withdrawal symptoms, however, in some cases, they became more tolerant and started to indulge “in more frequent snake bite trips.”

Why the generation of Psychotropic effects?

- It may have to do with the **neurotoxin nature of Snake venom** that causes analgesia, or the inability to feel pain.
- According to the study, forms of a neurotoxin found in Cobra venom, particularly, bind on **nicotinic acetylcholine receptors (nAChRs)** that are widely distributed in the human brain area and are involved in the euphoric or rewarding experience.
- Once the venom enters human blood, it releases active metabolites like **serotonin**. It has different psychotropic effects such as hypnotic and sedative.
- Recreational use of snake venom can lead to **not only addiction but also death**.

The market of Snake Venom:

- The **"Snake Anti-venom Market"** research report 2023 provides an in-depth study of the

industry's segmentation based on Types, Applications, and Regions.

- The global Snake Antivenom market size was valued at USD 2405.0 million in 2022 and is expected to reach USD 3500.73 million by 2028.
- **Snake anti-venom** is a medication made up of antibodies **used to treat venomous snake bites** as it is often used as a **recreational drug**.

Gene therapies for Sickle Cell Disease

News Excerpt:

The U.S. Food and Drug Administration (FDA) has approved two gene therapies for Sickle Cell disease.

About the Gene Therapies:

- **CASGEVY™ (exagamglogene autotemcel) and LYFGENIA™ (lovotibeglogene autotemcel) are the first two gene therapies** for the treatment of sickle cell disease in patients 12 years and older with **recurrent vaso-occlusive crises (VOCs)**.
 - A VOC occurs when sickled red blood cells block blood flow to the point that tissues become deprived of oxygen. This, in turn, sets in motion an inflammatory response as the body tries to rectify the problem.

CASGEVY	LYFGENIA
<ul style="list-style-type: none"> • It is based on CRISPR, which uses molecular "scissors" to trim faulty parts of genes that can be disabled or replaced with new strands of normal DNA. • Patients must have stem cells harvested from their bone marrow for this therapy. • The cells are then sent to manufacturing facilities and edited using CRISPR/Cas9 technology. • Once the cells are incubated, they are infused back into the patient. 	<ul style="list-style-type: none"> • It uses a more conventional form of gene therapy that uses a virus to ferry a gene into cells. • It uses a lentiviral vector (gene delivery vehicle) for genetic modification. • The patient's blood stem cells are genetically modified to produce haemoglobin that functions similarly to the normal adult haemoglobin produced in persons unaffected by sickle cell disease. These modified stem cells are then delivered to the patient.

- Both therapies, pitched as **one-time treatments**, will be available in early 2024.

What is Sickle Cell Disease?

- Sickle cell disease is an **inherited red blood cell disorder that affects haemoglobin**, the protein that carries oxygen through the body.
- Red blood cells are generally **disc-shaped** and flexible enough to move easily through the blood vessels.
 - In sickle cell disease, **red blood cells become crescent- or "sickle"-shaped due to a genetic mutation**. These sickled red blood cells do not bend or move easily and can **block blood flow to the rest of the body**.
- The blocked blood flow can lead to serious problems, including stroke, eye problems, infections, and episodes of pain called pain crises.
- Sickle cell disease is a lifelong illness. A **bone marrow transplant is currently the only cure** for sickle cell disease.
- **Every year, between 30,000 and 40,000 babies in India** are thought to be born with **this disorder**.
- Those who receive a **pair of faulty genes from both parents** have the symptoms.
 - One can lead a normal life even if they only have one copy of the gene from one parent.

What is CRISPR Technology?

- **CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)** are short DNA sequences found in the genome of prokaryotic organisms such as bacteria, which are reminders of the previous bacteriophage (viruses) attacks that the bacteria successfully defended against.
 - **Cas9 (CRISPR-associated protein 9)** enzyme (part of bacteria's defence mechanism) uses these flags to **target and cut any foreign DNA precisely**, thus protecting the bacteria from future attacks by similar bacteriophages.
 - The unprecedented precision of targeting the DNA sequences and then efficiently cutting them is the basis for CRISPR-Cas9 technology, as demonstrated in editing genes in cells and organisms.

Indian pharma companies under international scrutiny

News Excerpt:

Indian pharma companies have been under constant international scrutiny for exporting allegedly

contaminated drugs, which have led to deaths of children.

About CDSCO

- Central Drug Authority and is responsible for carrying out duties entrusted to it by the **1940 Drugs and Cosmetics Act**.
- The **National Regulatory Authority (NRA)** of India, which answers to the **Ministry of Health and Family Welfare**, is in charge of overseeing it.

About the Issue

- Nigeria raised the alarm about two oral medications, and Cameroon did the same when many children died from a cough syrup that was allegedly produced in India.
- Two medications made in India were singled out by Sri Lanka after numerous patients reported experiencing negative side effects.
- In Uzbekistan, diethylene glycol-containing cough medication caused the deaths of 18 kids. Following the deaths of children in the Gambia and Uzbekistan, the **Central Drugs Standard Control Organization (CDSCO) cancelled Marion Biotech's licence**.

The **World Health Organization (WHO)** issued an alert in October:

- It is the ciating four Indian-made cough syrups with child deaths in Gambia. While India maintained that the medicines met the required standards during domestic testing, the WHO upheld its actions.
- These controversies have overshadowed India's pharmaceutical industry, which is responsible for one-third of the world's medications.

New Drugs and Clinical Trial Rules (2023)

News Excerpt

Recently the Indian government has approved an update to the **New Drugs and Clinical Trial Rules (2023)** that will result in a dramatic change in how drugs are developed and tested.

Key highlights

- The approval of non-animal, human-relevant procedures in drug testing advances **animal-free testing**.
- The **precision and effectiveness of medication development** are expected to be improved by this modification, which will also address concerns about animal suffering.
- These novel methods have significant potential advantages and hold out hope for a **more**

trustworthy and moral drug development process.

- India wants to use these techniques to **lessen its dependency on animal experimentation** and set the standard in this forward-thinking field.

Advancements in Testing Methods

- Technologies that use **human cells or stem cells** for drug testing have made amazing strides in recent decades.
- **Organoids**, which are three-dimensional cellular constructs that resemble particular organs, offer a viable route for the creation of new drugs.
- Using human **cell-lined chips, organs-on-chip mimics the physiological circumstances** and interactions seen in the human body.
- Using patient-specific cells as "**bio-ink**," 3D bioprinting also enables the development of human tissues or organ systems.
- These innovations hold the promise of reshaping medication research, personalising drug evaluations, and reducing the need for animal testing.

Picolinic Acid

News Excerpt:

According to IISc study Picolinic acid can block viruses causing SARS-CoV-2 and influenza A.

About

Picolinic acid, a natural compound produced by mammalian cells.

- The compound has remarkable ability to disrupt the entry of enveloped viruses into the host's cell and prevent infection.

Terms - Endocytosis- A cellular process often co-opted by viruses and bacteria to enter our cells.

How it works- There is a protein coat found in all viruses, these enveloped viruses also have an extra outer membrane made of lipids derived from the host.

- During their entry into host cells, the virus envelope and the host cell membrane fuse, creating a pore through which the virus's genetic material enters the host cell, and starts replicating.
- Research showed that picolinic acid specifically blocks this fusion, which explains its effectiveness against a variety of enveloped viruses, including **flaviviruses** like the **Zika** virus and the **Japanese encephalitis** virus.

- The compound **did not have much effect on non-enveloped viruses, like rotavirus and coxsackievirus.**

Other benefits - picolinic acid led to an increase in the number of immune cells in the animals.

Single-pill strategy for cardiovascular diseases- WHO

News Excerpt;

The WHO included **three** fixed dose combinations of cardiovascular medicines (**polypills**) on its revised Model Lists of Essential Medicines (**EML**) **2023**.

About

- A polypill usually combines two or more **blood pressure lowering drugs** plus a **statin** and **aspirin**.
- One of the polypills that has been included in the EML is **Polycap** (manufactured by Cadila in India). It is a **four-drug combination** (simvastatin + ramipril + atenolol + hydrochlorothiazide), along with acetylsalicylic acid or aspirin.
- Fixed Dose Combination (**FDC**): FDC or Combination products, refer to products containing one or more active ingredients in a single dosage form.

Significance

- It is a **simple** treatment that can be administered with very **little monitoring** to most people, with backup from physicians.
- The polypill is not a new drug but a drug delivery mechanism, which improves medication adherence (because it is a single pill) and saves money by preventing hospitalisations.

Israel was among the first countries to legalize medical marijuana – it remains illegal for recreational use and is one of just three countries with a government-sponsored cannabis program, along with Canada and the Netherlands.

- It could reduce the risk of future heart attacks and strokes by about 40% to 50%.

India's First Cannabis Project

News Excerpt:

Recently, Union Minister of State (Independent Charge) Science & Technology announced that Jammu will pioneer India's first Cannabis Medicine Project.

About the Cannabis Project

- Cannabis Research Project' of CSIR-IIIJ Jammu is a first of its kind in India initiated under the leadership of Prime Minister Narendra Modi, in Private Public Partnership with a Canadian firm which has a great potential to put substance of abuse for the good of mankind especially for patients suffering from neuropathies, cancer and epilepsy.

Cannabis:

- Cannabis is a generic term used to denote the several psychoactive preparations of the plant Cannabis sativa.
- The major psychoactive constituent in cannabis is Δ -9 tetrahydrocannabinol (THC). Compounds which are structurally similar to THC are referred to as cannabinoids.
- Cannabis in India is known by many names and exists in various forms. The most popular names are weed, charas, ganja, marijuana, etc.
- **Spread:** Cannabis is by far the most widely cultivated, trafficked and abused illicit drug. Half of all drug seizures worldwide are cannabis seizures. The geographical spread of those seizures is also global, covering practically every country of the world. About 147 million people, 2.5% of the world population, consume cannabis (annual prevalence) compared with 0.2% consuming cocaine and 0.2% consuming opiates.

Legal provisions in India for Cannabis

- The NDPS Act 1985, forbids the sale and manufacturing of cannabis resin and flowers, but the use of cannabis plant leaves and seeds is legal, with states having the authority to regulate and implement state rules.
- The States derive this authority from Section 10 of the NDPS Act, 1985. Anyone caught in possession of any of these cannabis plant parts could be arrested.
- There is **no complete ban** on cannabis under NDPS Act and it can be used for medical, scientific, industrial, horticultural purposes by taking requisite permissions from respective state governments.

Regulations in Different States:

- **Odisha** is one such State in India where marijuana is legal, and residents typically use 'chillums' to enjoy it within the State's borders.
- **Uttarakhand** is the first Indian State to legalise commercial hemp farming. Many other hilly states are considering allowing regulated production of

hemp and marijuana because it is a rich crop that requires less water.

- In **Assam**, the sale, possession, purchase, and consumption of ganja and bhang are all prohibited under the Assam Ganja and Bhang Prohibition Act, 1958.
- In **Maharashtra**, the Bombay Prohibition Act of 1949 makes it illegal to manufacture, possess, or consume bhang and bhang-containing substances without a licence.

Cell-Free DNA

News Excerpt

Recently, Cell-free DNA has been in news as it promises to transform how we find diseases.

About Cell-Free DNA

- Cell-free DNA are short fragments of DNA released into the bloodstream through a natural process of cell death.
- During pregnancy, the mother's blood contains **cell-free DNA (cfDNA)**, both from her own tissue and from the fetus via the placenta. Approximately 2-20% of total cfDNA in maternal blood is placental.
- It was first discovered by **Mandel and Métais in 1948**.
- **cfDNA can be found in plasma and other body fluids** such as, Cerebral Spinal fluid, Pleural Fluid, urine, saliva and others.

c-f DNA in blood

- cfDNA can be generated and released from a cell in a number of possible situations, including when a cell is dying and the nucleic acids become degraded. Since an array of processes modulates the degradation, the amount, size, and source of the cfDNA can vary across a range as well.
- The release of cfDNA could occur together with a variety of processes, including those required for normal development, those related to the development of certain cancers, and those associated with several other diseases.

Applications of cfDNA.

- **It helps in keeping a check on baby's health:** It helps in **screening foetuses for specific chromosomal abnormalities**, an application known as **non-invasive prenatal testing**.
 - They can then use it **to understand specific chromosomal abnormalities** that involve changes in the chromosomal copy number. Such

changes can lead to conditions like Down's syndrome.

- **In Early Cancer Detection:** Another emerging application of cfDNA is in the early detection, diagnosis, and treatment of cancers. In **Genome-wide Mutational Incidence for Non-Invasive detection of cancer', or 'GEMINI'**. They adopted a whole-genome-sequencing approach to cfDNA extracted from patients.
- **In Organ Donation and Transplantation:** It helps in understanding why a body is rejecting a transplanted organ. Here, some cfDNA obtained from the donor who is donating the organ – **called donor-derived cfDNA, dd-cfDNA – could provide an early yet accurate estimate of how well the organ is being taken up.**
 - This is an attractive proposition because changes in the levels of cfDNA in the blood would precede any biochemical or molecular markers that researchers currently use as a proxy for organ acceptance.
 - That is, the cfDNA could send a signal earlier than other markers if something is going to go wrong.
- **As a Biomarker:** cfDNA could be used as a biomarker for neurological **disorders like Alzheimer's disease, neuronal tumours, stroke, traumatic brain injury, and even metabolic disorders like type-2 diabetes and non-alcoholic fatty liver disease.**

World Health Organization (WHO) reported double Cholera cases in 2023 as in 2022

News Excerpt:

Since the beginning of the year and as of 15 September 2023, at least 29 countries have reported cholera, according to the World Health Organization (WHO).

About the Report:

- According to the 2022 global cholera annual report published on 22 September 2023, Globally, the number of cholera cases reported to WHO more than doubled, from 22,33,70 cases reported in 2021 to 47,26,97 cases in 2022.
- In terms of mortality, 2349 **cholera-associated deaths** were reported to WHO globally in 2022 with a **case-fatality rate (CFR)** of 0.5% (**1.9% in Africa**).
- In 2022, several countries that had **not reported cholera** in many years reported large outbreaks, including Lebanon and Syria.

About Cholera:

- Cholera is an **acute intestinal infection** caused by the bacterium *Vibrio cholerae*, which spreads through food and water contaminated with faeces.
- **Primary causes of the 2023 cholera outbreak:**
 - The recent outbreak or the cholera upsurge is a result mainly due to **extreme weather events linked to climate change, conflict, population displacement, and weakened healthcare systems.**
 - The WHO has also said that the increased demand for cholera materials has forced cholera outbreak programs to **use a single-dose vaccination regimen as opposed to the standard two-dose regimen.**

ICMR Conducts the Truenat Test

News Excerpt:

Recently, the Indian Council for Medical Research (ICMR) allowed the Kerala government to detect Nipah with the help of the TrueNat Test.

About the TrueNat Test

- Truenat is a chip-based, point-of-care, rapid molecular test for **diagnosis of infectious diseases.**
- The technology is based on the Taqman **RT-PCR (Real Time Reverse Transcription Polymerase Chain Reaction)** chemistry, which can be performed on the portable, battery-operated Truelab Real Time micro-PCR platform.
- TrueNat tests showed 99% specificity against sputum microscopy.

- **RT-PCR** is the mRNA (messenger RNA) detection and quantification technique to produce or multiply copies of DNA in a chain form.

Applications:

- To quantify mRNA levels in smaller samples.
- Used during the coronavirus outbreak.
- To enable quantization of RNA from a single cell.

About Nipah: It is a **zoonotic virus** that can be transmitted through contaminated food or directly between people. In infected people, it causes a range of illnesses, from asymptomatic infection to acute respiratory diseases, even leading to fatalities in some cases.

About ICMR: The Indian Council of Medical Research (ICMR) is the apex body in India for the formulation, coordination, and promotion of biomedical research and is one of the oldest medical research bodies in the world.

Disease X- is 20 times deadlier than Covid

News Excerpt:

UK healthcare professionals are preparing for a potential new pandemic known as 'Disease X,' which could be more deadly than COVID-19, with the capacity to result in 20 times more fatalities.

What is Disease X?

- According to the WHO, Disease X could be a new agent, a virus, a bacterium, or a fungus without any known treatment.
- It is included to indicate an unknown pathogen that could cause a serious international epidemic.
- WHO mentioned Disease X history, for the **first time in 2018**, as an unknown disease that has epidemic potential.
- **Major Concern:** The number of potential pathogens is very large, while the resource for disease research and development (R&D) is limited.

What are Priority Diseases?

- **Priority Diseases are those** which pose the greatest public health risk due to their epidemic potential and/or whether there are no or insufficient countermeasures. The **WHO** has included Disease X in the list of its "**priority diseases.**"
- **The Priority List of Diseases for WHO are:**
 - COVID-19
 - Crimean-Congo Haemorrhagic fever
 - Ebola Virus disease and Marburg Virus Disease
 - Lassa fever
 - Middle East respiratory syndrome
 - Coronavirus (MERS-CoV) and severe acute respiratory syndrome (SARS)
 - Nipah and Henipaviral diseases
 - Rift Valley fever
 - Zika Virus
 - Disease X

Myelin Basic Protein

News Excerpt:

Recently, A research group from physical sciences division of the Institute of Advanced Study in Science and Technology, Guwahati have fabricated **monolayers of pure myelin basic protein (MBP).**

Myelin Basic protein

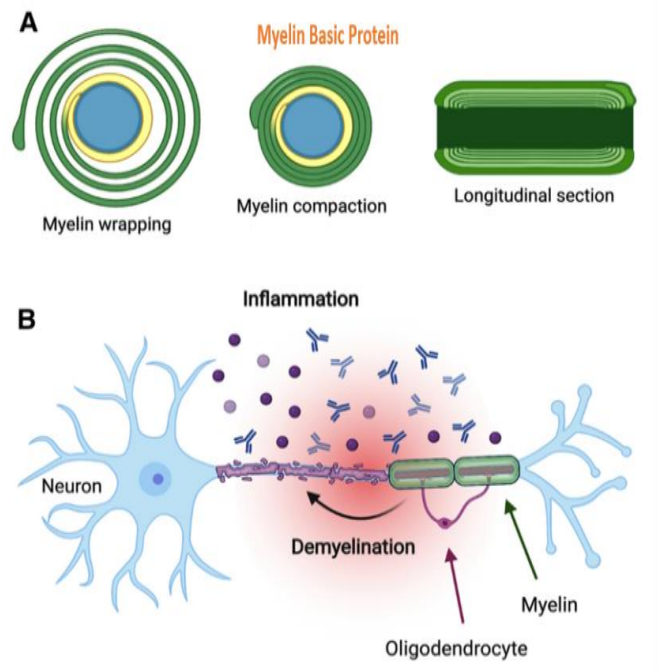
- It is a **major protein component of myelin sheath, which is a protective membrane that wraps**

around the axon of nerve cells and acts as a model protein in studying diseases like multiple sclerosis (MS).

- MBP helps in compactification of the myelin sheath, and the fabricated tailored monolayers can give an in-depth understanding of the role of MBP in forming multi-lamellar myelin sheath structure as well as preserving the integrity, stability, and compactness of the sheath.

About research

- Researchers used a technique called the **Langmuir-Blodgett (LB) technique** to form monolayers of pure myelin basic protein at the air-water and air-solid interfaces.
- They explained the mechanism of formation of MBP while tracking the stability and rigidity of the protein films by tuning the subphase pH conditions.
 - The reversible nature of the molecules confirms the flexibility of the films with respect to the pH conditions.



- The behaviour of the protein under variable pH conditions were investigated from different areas of the monolayer formed at the air-water interface.
 - The rigidity of the monolayers was correlated with the specific domains formed and the area occupied by the domains on the water surface.

IT / NANOTECH/ BIOTECH

Generative AI

News Excerpt:

The use of **Generative Artificial Intelligence (GAI)** is currently in its early phases, but its impact is expected to rise as technology evolves and improves.

Pre-Connect

- GAI is a fast-emerging branch of AI that refers to the use of algorithms and models that can generate new content that resembles human-created data.
- The aim is to develop algorithms that can capture the essence of human creativity and produce content that is indistinguishable from what humans create.
- While GAI is frequently connected with ChatGPT and deep fakes, the technology was originally developed to automate the repetitious processes needed in digital image and audio rectification.
- The **Global Partnership on Artificial Intelligence (GPAI)** is an international initiative aimed at fostering collaboration and promoting responsible development and use of artificial intelligence (AI) globally.
- It was launched in 2020 and currently consists of a group of like-minded countries and organizations that are committed to addressing challenges and opportunities related to AI.

Generative Models

- Several types of generative models have been developed, each with its own unique approach to content generation. Three prominent models are Variational Auto Encoders (VAEs), Generative Adversarial Networks (GANs), and Autoregressive models.

Variational Auto Encoders (VAEs):

- VAEs are encoder-decoder models that learn the underlying probability distribution of a given dataset.
- They consist of an encoder network that maps input data to a latent space representation and a decoder network that reconstructs the original data from the latent space.
- By training VAEs to maximize the likelihood of the input data, they can generate new samples by sampling from the learned latent space distribution.

Generative Adversarial Networks (GANs)

- GANs employ a two-component system: a generator and a discriminator. The generator aims

to create realistic content, while the discriminator tries to distinguish between real and generated samples.

- Through an adversarial training process, GANs improve their ability to generate increasingly realistic samples. GANs have been widely used to create lifelike images, videos, and even text.

Autoregressive Models

- Autoregressive models, such as the Transformer model, generate content by sequentially predicting the next element based on previously generated elements.
- These models have been particularly successful in **natural language processing tasks**, enabling the generation of coherent and contextually relevant text.

Applications of Generative AI

Generative AI has found applications across various domains, significantly transforming industries and creative processes.

ARTIFICIAL INTELLIGENCE			
👍	PROS	👎	CONS
	Efficiency and Accuracy		Uncontrollability
	Effective Data Acquisition and Analysis		AI Machines Don't (Currently) Have Any Emotion
	Reducing Costs (Cheaper Products & Services)		Degradation (unable to self-repair)
	Improving Human Decision Making		A Reduced Number of Jobs For Humans
	Improving Human Workflows		High Costs
	The Mechanical Advantage		Lacking Creativity and Out-of-the-Box Thinking
	Understanding High-Dimensional Data		Ethical Considerations

- **Visual Arts**
 - Field of computer vision, enabling the creation of realistic images and videos.
 - Assist with image synthesis, style transfer, and even inpainting, seamlessly filling in missing parts of an image.
- **Music Composition**
 - By training models on vast collections of music, generative algorithms can create original compositions, imitating various styles and genres.
- **Content Creation and Text Generation**
 - Natural language processing, and generative models have been employed for text generation, translation, summarization, and even chatbots.
 - Generate engaging stories, generate realistic dialogue, and assist with language-related tasks.
- **Data Augmentation and Synthesis**
 - Generate synthetic data to augment limited datasets for training machine learning models.
 - Helps overcome data scarcity challenges and improves the performance of AI systems.
- **Drug Discovery and Material Science**
 - By generating molecular structures and simulating chemical interactions, these models accelerate the research and development process in pharmaceuticals and materials science.

Ethical Considerations

- Bias and Discrimination
- Intellectual Property and Plagiarism
- Misinformation and Deep-fakes
- Privacy and Data Protection

AI as a Doctor

News Excerpt:

Recently, AI has been in the news for discussions regarding when AI can really work as a doctor.

How is AI being used in the medical field?

- AI algorithms and other applications powered by AI are being used to support medical professionals in clinical settings and in ongoing research.
- Currently, the most common roles for AI in medical settings are clinical decision support and imaging analysis.
- There are already several research studies suggesting that AI can perform as well as or better than humans at key healthcare tasks, such as diagnosing disease.

- Today, algorithms are already outperforming radiologists at spotting malignant tumours, and guiding researchers in how to construct cohorts for costly clinical trials.

Types of AI relevant to healthcare

- **Machine learning** – It is a statistical technique for fitting models to data and to 'learn' by training models with data. Machine learning is one of the most common forms of AI.
- **It is basically of two types:** 1. Neural networks and 2. Deep learning.

Neural Networks

- A more complex form of machine learning is the neural network – a technology that has been available since the 1960s has been well-established in healthcare research for several decades and has been used for categorization.
- It views problems in terms of inputs, outputs and weights of variables or 'features' that associate inputs with outputs.
- It has been likened to the way that neurons process signals, but the analogy to the brain's function is relatively weak.

Deep Learning

- A common application of deep learning in healthcare is recognition of potentially cancerous lesions in radiology,
- Deep learning is increasingly being applied to radiomics, or the detection of clinically relevant features in imaging data beyond what can be perceived by the human eye.
- Both radiomics and deep learning are most commonly found in oncology-oriented image analysis.
- Their combination appears to promise greater accuracy in diagnosis than the previous generation of automated tools for image analysis, known as computer-aided detection or CAD.

Natural language processing (NLP)

- **In healthcare**, the dominant applications of NLP involve the creation, understanding and classification of clinical documentation and published research.
- NLP systems can analyse unstructured clinical notes on patients, prepare reports (eg on radiology examinations), transcribe patient interactions, and conduct conversational AI.

Rule-based expert systems

- In **healthcare**, they were widely employed for 'clinical decision support' purposes over the last couple of decades and are still in wide use today.
- Many **electronic health record (EHR)** providers furnish a set of rules with their systems today.

Physical robots

- Surgical robots, initially approved **in the USA in 2000**, provide '**superpowers**' to surgeons, improving their ability to see, create precise and minimally invasive incisions, stitch wounds and so forth.
- Important decisions are still made by human surgeons.
- However. **Common surgical procedures using robotic surgery include gynaecologic surgery, prostate surgery and head and neck surgery.**

Robotic process automation

- **Robotic process automation (RPA)** doesn't really involve robots – only computer programs on servers.
- It relies on a combination of workflow, business rules and 'presentation layer' integration with information systems to act like a semi-intelligent user of the systems.
- **In healthcare, they are used for repetitive tasks like prior authorisation, updating patient records or billing.**

Diagnosis and treatment applications:

Patient engagement and adherence applications

- Patient engagement and adherence has long been seen as **the 'last mile' problem of healthcare** – the final barrier between ineffective and good health outcomes.
- The more patients proactively participate in their own well-being and care, the better the outcomes – utilisation, financial outcomes and member experience.
- These factors are increasingly being addressed by big data and AI.

Laws/Regulations in India for AI

- **It does not have any specific law regarding application of AI.**
- The **Ministry of Electronics and Information Technology (MeiTY)** is the **regulatory body of AI in India.**
- There are certain provisions mentioned under Intellectual Property Law and several provisions as **Section 43A & 72A of Information Technology Act, 2000** which implies that if anyone commits crime by using AI, then he will be liable under IT Act, criminal law and other cyber law.

Use of AI Technology by UIDAI

News Excerpt

Recently, UIDAI has been using Artificial Technology to tackle the issue of Payment frauds.

Pre-Connect

- To prevent **AePS frauds (Aadhaar-enabled payment frauds)** using **spoofed fingerprints** during Aadhaar authentication, the UIDAI has rolled out an in-house Artificial Intelligence/Machine Learning technology-based **Finger Minutiae Record – Finger Image Record (FMR-FIR)** modality which is able to check the liveness of a fingerprint to detect the use of cloned fingerprint during the authentication process.
- The technology uses a combination of both **finger minutiae** and **finger image** to check the liveness of the fingerprint captured.
- The measure was implemented after instances of people creating fake fingerprints using silicone to syphon off money from unsuspecting individuals' bank accounts were reported.

What are Fingerprint images and Fingerprint minutiae?

- The **fingerprint image contains** minutiae points, core points, ridges and valleys, background area, foreground areas, local features and global features. In a fingerprint image, the ridges appear as dark lines while the valleys are the light areas between the ridges.
- **Finger Minutiae points are the locations where a ridge becomes discontinuous.** A ridge can either come to an end, which is called as **termination** or it can split into two ridges, which is called as **bifurcation**.

What is AePS?

- The AePS is a **bank-led model that allows online interoperable financial transactions at Point of Sale (PoS) or micro-ATMs through the Business Correspondent (BC)** of any bank using the Aadhaar authentication.
- It was taken up by the **National Payments Corporation of India (NPCI)** - a joint initiative of the **Reserve Bank of India (RBI)** and the **Indian Banks' Association (IBA)**.

What is the need for this technology?

- As more frauds related to the **Aadhaar-enabled Payment System (AePS)** come to the fore, the Unique Identification Authority of India (UIDAI), has turned to artificial intelligence-based systems in a bid to limit the cases — this includes developing technologies around fingerprinting and facial recognition.

- To prevent AePS frauds using spoofed fingerprints during Aadhaar authentication, the UIDAI has rolled out an in-house Artificial Intelligence/Machine Learning technology-based Finger Minutiae Record – **Finger Image Record (FMR-FIR)** modality which can check the liveness of a fingerprint to detect the use of cloned fingerprint during the authentication process.

Global Partnership on A.I.

News Excerpt:

The Global Partnership on AI has unanimously adopted the **New Delhi Declaration**, pledging their commitment to a collaborative approach for A.I. applications.

About Global Partnership on Artificial Intelligence (GPAI):

- The GPAI is an attempt to **adopt a global risk-based approach to A.I.** largely led by the democratic world, including India.
- It is an alliance of 29 members (28 countries and the European Union) established in June 2020.
- Today, **GPAI's 29 members are** Australia, Argentina, Belgium, Brazil, Canada, Czech Republic, Denmark, France, Germany, India, Ireland, Israel, Italy, Japan, Mexico, the Netherlands, New Zealand, Poland, the Republic of Korea, Singapore, Slovenia, Spain, Sweden, Senegal, Serbia, Turkey, the United Kingdom, the United States and the European Union.
 - **Notably, China**, a major tech superpower, is **not part of the multilateral grouping.**
- **GPAI endeavours to bridge the gap between theoretical understanding and practical implementation** of A.I. by endorsing cutting-edge research and applied endeavours in AI-related priorities.
- GPAI structures its working groups around **four core themes:**
 - Responsible A.I.
 - Data Governance
 - Future of Work
 - Innovation and Commercialization

New Delhi Declaration by GPAI:

- This summit aims to finalize a comprehensive framework encompassing shared principles for **Safe and Trusted AI.**
- **Flagged Concerns:** The declaration flagged concerns emanating from such systems, including **misinformation, unemployment, lack of transparency and fairness, protection of intellectual property and personal data, and threats to human rights and democratic values.**

- **Win for India:** This is a significant win for India, which will push its **Digital Public Infrastructure (DPI)** model worldwide. Besides, access to computing capabilities from member nations will also boost New Delhi's plans of building a sovereign A.I. system,
- **Available to all countries:** The declaration seeks to ensure that A.I. and its benefits are inclusive and open to all the countries of the world, including the Global South.
- **Agriculture Sector:** GPAI members also agreed to support A.I. innovation in the agriculture sector as a new "thematic priority". India was pushing for the inclusion of agriculture as a priority sector in A.I. innovation.

World's First Law on Regulating A.I.

News Excerpt:

The E.U. has become the **first continent** to set **clear rules for the use of A.I.** European Union lawmakers have passed the world's first comprehensive regulation for artificial intelligence called the **A.I. Act.**

Key highlights in E.U. Framework:

- **Restrictions on Usage:** The deal includes substantial restrictions on facial recognition technology and on using A.I. to manipulate human behaviour, alongside provisions for tough penalties for companies breaking the rules.
 - **Governments can only use real-time biometric surveillance in public areas** when serious threats are involved, such as terrorist attacks.
- **Grievance system:** Consumers have been empowered to launch complaints against any perceived violations.
- **E.U. legal framework broadly divides A.I. applications into various risk classes:**
 - Some applications will be largely banned, including the deployment of facial recognition on a mass scale, with some exemptions for law enforcement.
 - A.I. applications focused on behavioural control will also be banned.
 - **High-risk applications** such as the use of A.I. tools for self-driving cars will be allowed but subject to certification and an explicit provision for the backend techniques to be made open to public scrutiny.
 - Those applications in the **"medium risk" category** can be deployed without restrictions, such as generative A.I. chatbots.

- Developers will need to comply with transparency obligations before they release chatbots into the markets, including details about the contents used for training the algorithm.

Global A.I. regulations: The policy response has been different across jurisdictions. The **concerns** being flagged **fall into three broad heads: Privacy, System Bias, and Violation of Intellectual Property Rights.**

- The **E.U.** has taken a **tougher stance** that segregates A.I. as per **use case scenarios**, based on the degree of invasiveness and risk.
- The **UK** follows a **'light-touch' approach** that aims to **foster innovation in the field of A.I.**
- The **U.S.** has attempted to take the lead by way of the **White House Executive Order on A.I.**
 - Washington released a blueprint for an AI Bill of Rights – seen as a building block for the subsequent executive order.
 - The U.S. approach slots somewhere in between the UK and the EU.
- **China** has released its own set of measures to regulate A.I.

India's approach to A.I.:

- India emphasizes developing its **sovereign A.I.**
- India hopes to focus on **real-life tech applications in healthcare, agriculture, governance, language translation, etc.,** to catalyze economic development
- New Delhi has also pitched itself, especially to nations in the Global South, as a country that can effectively use technology to develop and deliver governance solutions at a mass scale.

World's first Artificial Intelligence (AI) Safety Summit

News Excerpt:

28 major countries including India met at Bletchley Park in the UK and have agreed to collaborate to minimize risks from **'frontier AI'**.

About 'Frontier AI':

- **Developments in frontier AI are transforming productivity and software services,** which will multiply the productivity of many industries and sectors.
- The progress in frontier AI in recent years has been rapid, and the most advanced systems can write **text fluently and at length, write well-functioning code** from natural language instructions, **make new apps, score highly on school exams, generate convincing news articles, translate between**

many languages, summarise lengthy documents, amongst other capabilities.

The Bletchley Park Declaration in 'Frontier AI' Summit:

- It was the **world's first-ever Artificial Intelligence (AI) Safety Summit on 'Frontier AI'.**
- The declaration was also endorsed by **Brazil, Ireland, Kenya, Saudi Arabia, Nigeria, and the United Arab Emirates.**
- The declaration noted the **"potential for serious, even catastrophic, harm, stemming from the most significant capabilities of these AI models"**, as well as risks beyond frontier AI, including those of **bias and privacy.**
- The declaration encouraged entities **creating cutting-edge AI technology** to be transparent and accountable about their intentions to measure, monitor, and reduce any dangerous capabilities.
- It outlined a two-pronged approach centered on **identifying risks of common concern and developing scientific knowledge of them.**

7th India Mobile Congress

News Excerpt:

The Prime Minister announced India's ambitious advancements in 6G technology while inaugurating the **7th India Mobile Congress (IMC).**

About IMC:

- It is the largest telecom, media, and technology forum in Asia, jointly organized by the **Department of Telecommunications (DoT)** and the **Cellular Operators Association of India (COAI).**
- Since its **inception in 2017,** IMC has promoted India's positioning and serves as a key forum for global thought leaders to design the **next wave of digital innovation.**

About 6G technology	
Benefits <ul style="list-style-type: none"> • 100 times faster than 5G • Reduced Latency • Reduced worldwide emissions. • Aims to accomplish SDG 9 which talks about internet access to all 	Uses: <ul style="list-style-type: none"> • Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) • Mobile Holograms • Digital Replica

Theme: Global Digital Innovation

Aim of 7th IMC: It aims to strengthen India's position as a developer, manufacturer, and exporter of key cutting-edge technologies.

100 5G Labs Initiative:

- It is an endeavour to realize the opportunities associated with 5G technology by encouraging the development of its applications that cater, both to India's unique needs as well as the global demands.
- It aims to foster innovation across various socioeconomic sectors like education, agriculture, health, power, transportation, etc.
- It will play a pivotal role in building a 6G-ready academic and start-up ecosystem in the country.
- The Prime Minister will award 100 '5G Use Case Labs' to educational institutions across the country. These labs are being developed under the '100 5G labs initiative'.

Dark pattern sales deemed "Cybercrime"

News Excerpt:

The Consumer Affairs Secretary has called **online malpractices by airlines** and travel portals "cybercrime".

What is a 'Dark pattern'?

A dark pattern is one where an **entity nudges consumers to buy products** they didn't intend to, which is an unfair trading practice and can constitute a cybercrime.

Key grievances of the consumers:

- **Manipulating seat selection:**
 - Despite having free seats available, they show all of them to be unavailable and charge an extra fee to buy a seat to complete the purchase of the air ticket.
 - It employs both "False Urgency" and "Interface Interference" on its website.
- **Extra fees:**
 - The booking websites poke passengers into buying travel insurance by using phrases such as, "I will risk my trip" if they choose to decline the purchase, inducing fear that doing so could be harmful.
 - **Basket Sneaking:** A convenience fee is added when the consumer reaches the payment gateway after completing their booking but does not display the information upfront.
- **Refunds and compensation:**
 - There are also concerns about being denied boarding and delayed refunds.

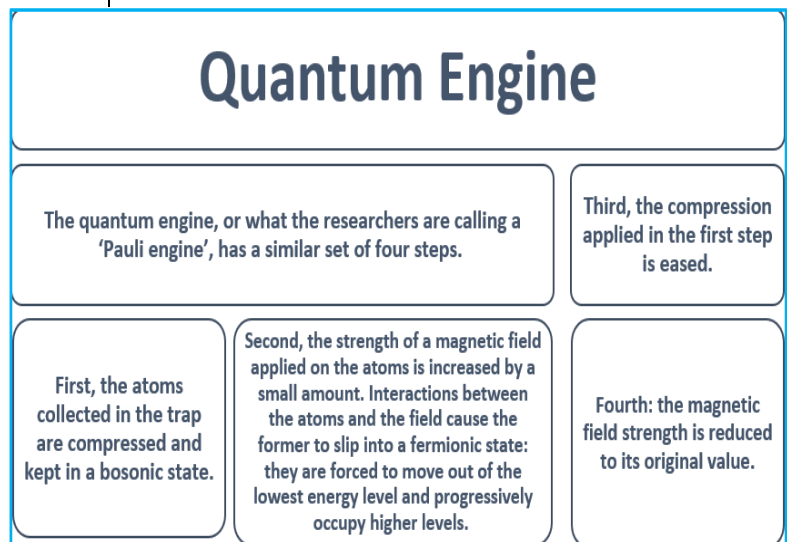
Provisions regarding airfares:

- In 2015, the **Directorate General of Civil Aviation (DGCA)** issued a circular allowing airlines to "unbundle" airfares for certain items, which can be charged separately.
- These include preferential seating, meals, access to lounges, and check-in baggage above 15 kg.
- These can be offered only on an "Opt-in" basis.
- **According to the Ministry of Civil Aviation's "Passenger Charter" of 2019:**
 - In case of a flight cancellation, an airline must accommodate a passenger on an alternate flight.
 - If it fails to inform the passenger at least 24 hours before departure, it has to pay an additional compensation of ₹5,000 to ₹10,000.
 - Similarly, for denied boarding, there is a compensation of ₹10,000 to ₹20,000 in certain situations.
 - Refunds must happen immediately if payment is in cash or within seven days if payment is made through a credit card.

Quantum Engine

News Excerpt

Recently, German physicists have **developed a method to transform the energy difference between two quantum states of an atom group into work.** The tool allows physicists to thoroughly study the developing field of quantum thermodynamics and, potentially, develop more effective quantum computers by applying the principles of the well-known classical engine to the subatomic world.



Pauli's principle

- According to Pauli's principle, all subatomic particles can be classified as either fermions or bosons.

Quantum Thermodynamics

Quantum thermodynamics is a branch of physics that focuses on how thermodynamics "emerges" in quantum-physical systems.

Pauli's Principle- In a single atom, two electrons will not have a similar quantum number.

Quantum number- It defines the position and energy of an electron in an atom.

Efficiency of Quantum Engine

- The quantum engine's effectiveness is determined by how much more energy is released in the third step compared to the energy added to the system in the first.
- The third step increases atomic energy, which can be used to create work.
- Currently, according to the researchers' paper published in Nature, the quantum engine is 25% efficient.
- The researchers expect to increase this to 50% or more in the future.
- The fundamental units of matter are fermions, while bosons are the particles that carry the forces that interact with them. They would all like to have the lowest energy possible, but they can't when a group of particles is cooled to nearly absolute zero, revealing their quantum nature.
- Four quantum numbers, which resemble an individual particle's Aadhaar number, are used to identify all particles in a system.
 - The sum of the four numbers provides information on the energy level of a particle.
 - According to the exclusion principle, no two particles in a given system can have the same four quantum numbers, meaning they can't be at the same energy level.
 - This law applies to fermions specifically. As a result, they repeatedly occupy the lowest one until all potential energy levels are occupied.
- The exclusion principle does not apply to bosons, which can all occupy the same lowest energy level at a specific low temperature. This explains how phenomena like superconductivity are feasible.
- The fundamental idea is that a system of fermions will have more energy than a system of bosons at a specific temperature.

Fermionic energy:

- At a low temperature, a system of fermions will have more energy than a system of bosons.
- Physics needed a straightforward method to change some particles from being bosons to fermions for this to serve as the foundation of an engine.
 - A solution was discovered in the early 2000s when researchers discovered via numerous investigations that a group of fermions could be made to behave like bosons by cooling them almost to absolute zero and then stimulating their interaction with one another using a magnetic field.
- In a recent study, scientists used a gas of lithium-6 atoms to accomplish this. If certain conditions are met, whole atoms can act as fermions or bosons. The team trapped them in a trap of oscillating electric and magnetic fields after cooling them to only millionths of a degree above absolute zero.

Quantum engine as proof of concept

- The quantum engine is still a proof-of-concept.
- By switching between **bosonic and fermionic states**, the researchers have shown that their design can be used to force a group of atoms to release energy in cycles.
- The scientists must determine how to transfer this energy from the interior of the trap to a device outside.

National Quantum Mission

News Excerpt

Recently, National Quantum Mission received cabinet approval at a total cost of Rs. 6003.65 crores, to scale up scientific and industrial R&D, for accelerating Quantum Technology-led economic growth.

About:

National Quantum Mission

- NQM is an eight-year (2023-24 to 2030-31) mission that will focus on everything quantum-related, from its initial development to its use in industries.
- This mission is to **be implemented by the Department of science and technology** in partnership with other departments.
- The NQM will focus on **four verticals of quantum technology** –
 - **Quantum computing, quantum communication, quantum sensing and metrology, and quantum materials and devices.**

- **The National Mission on Quantum Technologies and Applications (NM-QTA) was launched in 2020** with the goal of creating a strong quantum technology ecosystem in India.

Important Features of the Mission

- It is aiming to seed, nurture and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in Quantum Technology (QT).
- This will accelerate QT-led economic growth, nurture the ecosystem in the country and make India one of the leading nations in the development of Quantum Technologies & Applications (QTA).
- The new mission targets developing intermediate-scale quantum computers with 50-1000 physical qubits in 8 years in various platforms like superconducting and photonic technology.
 - Satellite-based secure quantum communications between ground stations over a range of 2000 kilometers within India, long-distance secure quantum communications with other countries, inter-city quantum key distribution over 2000 km as well as multi-node Quantum networks with quantum memories are also some of the deliverables of the Mission.
- The mission will help develop **magnetometers with high sensitivity in atomic systems and Atomic Clocks for precision timing, communications, and navigation.**
- It will also support design and synthesis of quantum materials such as superconductors, novel semiconductor structures, and topological materials for the fabrication of quantum devices. Single photon sources/detectors, and entangled photon sources will also be developed for quantum communication, sensing, and metrological applications.
- Mission Implementation includes setting up **four Thematic Hubs (T-Hubs) in top academic and National R&D institutes in the domains - Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices.**
 - The hubs will focus on the generation of new knowledge through basic and applied research as well as promote R&D in areas that are mandated to them.

Quantum supercomputer

News Excerpt:

Recently, Microsoft publicised a plan for creating the **first true quantum supercomputer.**

Quantum Computing

- It is a multidisciplinary field comprising aspects of **computer science, physics, and mathematics** that utilizes quantum mechanics to solve complex problems faster than classical computers.
- It is an emerging field that **harnesses the laws of quantum mechanics** to build powerful tools to process information.
- It has the potential to solve computational problems beyond the reach of classical computers. This approach to computing can transform areas such as **chemical engineering, material science, drug discovery, financial portfolio optimization, and machine learning.**

Characteristics

- They are capable of sifting through huge numbers of possibilities and extract potential solutions to complex problems and challenges.
- They use qubits to store information which carries information in a quantum state that engages 0 and 1 in a multidimensional way.



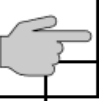
Need of Quantum Supercomputers

- Revolutionize computation by making certain types of classically intractable problems solvable.
- Major frontier in cybersecurity.
- Embrace effortless Machine Learning.
- New opportunities in artificial intelligence.
- Solve complex problems like identifying subtle patterns of fraud in financial which cannot be solved by classical computers.
- Applications in **secure communication, disaster management, computing, simulation, chemistry, healthcare, cryptography and imaging among others.**

Government Initiatives on Quantum computing:

- **National Quantum Mission** - for accelerating Quantum Technology led economic growth and leverage India into a leading nation in the area
- **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** -to make India a leading player in Cyber-Physical System.
- **The Quantum Frontier mission of the PM-STIAC:** aims to initiate work in the understanding and control of quantum mechanical systems.

Beam-splitter & Quantum Computer

 <p>Quantum Computing</p> <ul style="list-style-type: none"> Quantum computers use qubits as their basic units of information. A qubit can be a particle – like an electron; a collection of particles; or a quantum system engineered to behave like a particle. Other forms of quantum computing use other units of information. For example, linear optical quantum computing (LOQC) uses photons, the particles of light, as qubits. 	 <p>Phonons</p> <ul style="list-style-type: none"> Photons are packets of light energy; similarly, phonons are packets of vibrational energy. 	 <p>Beam-splitter</p> <ul style="list-style-type: none"> Beam-splitters are used widely in optics research. Imagine a torchlight shining light along a straight line. This is basically a stream of photons. When a beam-splitter is placed in the light's path, it will split the beam into two: i.e. it will reflect 50% of the photons to one side and let the other 50% pass straight through.
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News Excerpt:

Recently, IBM published a paper in which it claimed to have demonstrated that a quantum computer could solve a useful problem that today's conventional computers can't.

Key points

- In the new study, the researchers developed an **acoustic beam-splitter – a tiny device resembling a comb, with 16 metal bars jutting out of it.**
- It was placed in the middle of a 2-mm-long channel of lithium niobate. Each end of the channel had a superconducting qubit – a qubit whose circuit components were superconducting – that could both emit and detect individual phonons. The whole setup was maintained at an ultra-low temperature.
- If these phonons were converted to sound, their frequency would be too high for humans to hear. Each phonon in the study represented, according to the paper, the “collective” vibration of around one quadrillion atoms.
- The team found that these phonons interacted with the comb just like photons interact with an optical beam-splitter.
- When a phonon was emitted from the left side of the channel, it was reflected half of the time and transmitted to the right side the other half. When phonons were emitted simultaneously from the left and the right sides, they both ended up on one side (as expected).

- The team found that these phonons interacted with the comb just like photons interact with an optical beam-splitter.

- Beam-splitters are used widely in optics research. Imagine a torchlight shining light along a straight line. This is basically a stream of photons. When a beam-splitter is placed in the light's path, it will split the beam into two: i.e., it will reflect 50% of the photons to one side

and let the other 50% pass straight through.

Nano Technology - Modified Nano Sheets

News Excerpt

Recent observations of IISC stated that chemically modified Nano-sheets are highly effective for biomedical applications.

Pre-Connect

- Nanotechnology, often known as nanotech, is the manipulation of matter on atomic, molecular, and supramolecular scales ranging from **1 to 100 nanometers**. A nanometer (nm) is one billionth of a metre (10^{-9}).
- It takes a multidisciplinary approach that includes **applied physics, materials science, chemistry, biology, surface science, robotics, engineering, electrical engineering, and biomedical engineering.**
- Over the last few decades, physics fields such as **nanoelectronics, nano-mechanics, nano-photonics, and nanoionics** have grown to provide a fundamental scientific foundation for nanotechnology.

About Chemically Modified Nano Sheets:

- Chemically modified nano sheets are atomically thin, two-dimensional materials that undergo chemical modifications to enhance their properties and functionality.
- These materials can be derived from diverse substances such as **graphene, transition metal**

dichalcogenides (TMDs), and other layered compounds.

- By altering their chemical composition, researchers can tailor their physical, electrical, optical, and mechanical properties to suit specific applications.

Chemical Modification Techniques:

- Chemical functionalization involves altering the surface properties of nano sheets by attaching various chemical groups or molecules.

Potential Applications:

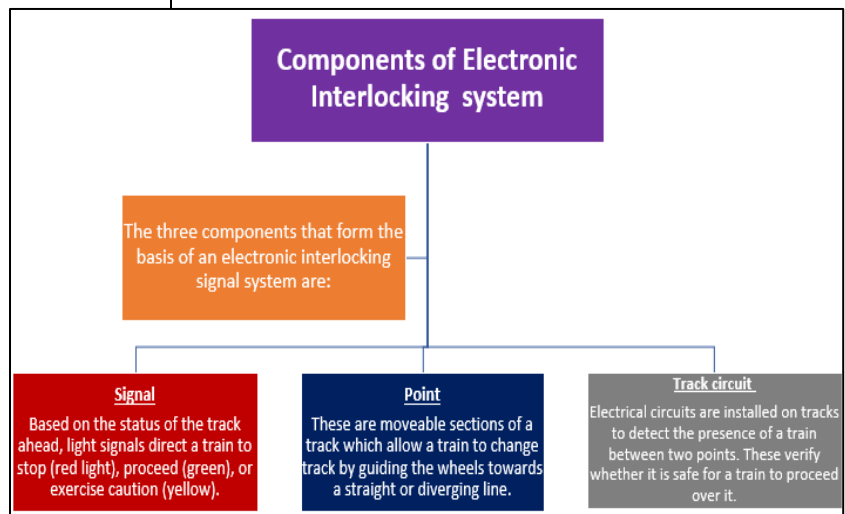
- **Electronics and Optoelectronics:**
 - Chemically modified nano sheets exhibit exceptional electrical conductivity, high carrier mobility, and tuneable band gaps. These properties make them ideal for next-generation electronic devices, ultrafast transistors, and flexible, transparent displays.
 - Additionally, their unique optical properties enable their integration into optoelectronic devices like photo detectors and sensors.
- **Energy Storage and Conversion:**
 - Nano sheets offer opportunities for significant advancements in energy storage and conversion technologies. Their high surface-to-volume ratio and mechanical flexibility make them suitable for super capacitors, batteries, and fuel cells.
 - Furthermore, their efficient catalytic activity enhances energy conversion in solar cells and hydrogen production systems.
- **Biomedical Applications:**
 - Chemically modified nano sheets hold promise in biomedical applications due to their biocompatibility, large surface area, and tunable drug delivery capabilities.
 - They can be utilized for targeted drug delivery systems, biosensors, tissue engineering scaffolds, and diagnostic tools for early disease detection. Ex: Cancer detection and treatment: **Gold nanoparticles, Smart pills, Nanobots**
- **Tissue Engineering and Regenerative Medicine:**
 - By mimicking the extracellular matrix and providing a scaffold for cell growth and tissue formation, nanosheets can promote tissue regeneration.

- Surface functionalization of nanosheets can enhance their biocompatibility, cellular adhesion, and integration with host tissues, facilitating the regeneration of damaged or diseased tissues.
- **Drug Delivery Systems:**
 - By modifying their surface with specific ligands or polymers, nanosheets can encapsulate therapeutic agents and transport them to the desired site within the body.
 - The controlled release of drugs from nano sheets offers several advantages, including enhanced drug efficacy, reduced side effects, and improved patient compliance.
- **Environmental Remediation:**
 - Nanosheets can be engineered to remove pollutants from air and water due to their large surface area and adsorption capacity.
 - These materials show potential for water purification, air filtration, and the remediation of toxic contaminants.

Electronic interlocking system

News Excerpt

An electronic track management system used by the railways has become the focus of investigations after horrific train crash involving two express trains and a goods train in Odisha’s Balasore district.



Pre-Connect KAVACH:

- The KAVACH is an **indigenously developed Automatic Train Protection (ATP) system** by the **Research Design and Standards Organisation (RDSO) in collaboration with the Indian industry.**

- It is a **state-of-the-art electronic system with Safety Integrity Level-4 (SIL-4) standards.**
- It is meant to provide protection by **preventing trains to pass the signal at Red (which marks danger) and avoid collision.**
- It activates the train's braking system automatically if the driver fails to control the train as per speed restrictions.
- It prevents the collision between two locomotives equipped with functional Kavach systems. The system also relays SoS messages during emergency situations.
- An added feature is the centralised live monitoring of train movements through the Network Monitor System.
- **The South-Central Railway (SCR) Zone is a pioneer in the implementation of the KAVACH – (TACS).**

About Interlocking system:

- **It prevents conflicting movements as a train gets a signal** to proceed ahead only when its route is set, locked, and detected as safe.
- The signal apparatus in an interlocking system may be interconnected mechanically or electrically with the tracks or both.

Electronic interlocking (EI):

- **It is an advanced version of signalling that uses computer-based systems and electronic equipment to control signals, points and level-crossing gates.**
 - The Indian Railways defines it as a **"microprocessor-based interlocking equipment to read the yard and panel inputs; process them in a 'fail-safe' manner and generate required output."**
 - Unlike the conventional relay interlocking system, the **"interlocking logic"** in an EI system is managed via software and electronic components.
 - It ensures all elements work together in proper sequence so that trains can move without coming in the way of one another.
- Electronic systems, communication devices that control signalling equipment and other components are kept in relay rooms with dual-lock access control. **All system activities are recorded in a 'data logger', which is similar to the black box of an aircraft.**

Telegram Bots

News Excerpt:

Recently, reports came out which alleged that a Telegram bot had access to Citizen's documents.

Pre-Connect

- In 2021, security researchers reportedly found a network of deep fake bots on the platform that were generating non-consensual images of people submitted by users, some of which involved children.

What are bots?

- A bot is an automated software application that performs repetitive tasks over a network. It follows specific instructions to imitate human behaviour but is faster and more accurate.
- It can also run independently without human intervention.

What are Telegram bots?

- **Bots** are computer programs that act as agents of a user or another computer program.
- Bots on Telegram are small applications that run entirely within the platform and can be designed to support any kind of task or service.
- They can **host full Web Apps.**
- They can be designed to support everything from online stores to arcade games.
- They can also be designed to make it easier for users to access information held within large databases they are connected to.

Threats from Malicious bots:

They perform activities that create security risks for organizations. For example, create disrupt operations, unfair disadvantages, send out unwanted emails, or attempt unauthorized access to sensitive data.

Major Privacy concerns about Chatbots:

- One of the main concerns about chatbots and privacy is the collection of personal information (such as PI, PII, PHI, SPDIs).
- They are often connected to the internet, which means that they are vulnerable to hacking and cyberattack.
- Chatbot data may be shared with third parties without the user's knowledge or concern.
- The lack of transparency around how chatbot data could be collected, stored, and accessed.

Type of Bots:

- Chatbots
- Web crawlers
- Monitoring bots

- Shopping bots
- Transaction bots

Protection measures

- Using anti-malware programs and run regular scans to detect and isolate bots in computer systems.
- Install a firewall to prevent bots from accessing your computer.
- Enforcing strong endpoint security policies
- Regulate sharing of portable storage drives.
- Training employees to avoid clicking on unknown or suspicious links in emails.

Open Digital Ecosystems (ODEs)

News Excerpt:

Alphabet's Google, Meta Platforms, Qualcomm, and seven other tech companies have teamed up to push for open digital ecosystems.

About the importance of the Coalition for Open Digital Ecosystem (CODE):

- CODE has emerged with a mission to champion more transparent and open platforms and systems, envisioning these changes as catalysts for growth and innovation within Europe's tech landscape.
- The coalition expressed its intent to collaborate with academics, policymakers, and corporations to promote digital openness, specifically addressing the implementation of the **Digital Markets Act (DMA) and potential future E.U. regulatory frameworks.**
 - Under the DMA, gatekeepers in the tech domain are mandated to facilitate third-party interoperability with their services.
- It aims to open up digital ecosystems through **cross-industry collaboration and promote seamless connectivity and interoperable systems**, among other strategic endeavours.

About Open Digital Ecosystem:

- ODEs are open and secure Digital Platforms that enable a community of actors to unlock transformative solutions for society based on a robust governance framework.
- Several public and private institutions have started to build ODEs in various sectors, **such as health, urban governance, e-commerce, mobility and education.**
- A few examples of digital public infrastructure that exhibit a large number of ODE characteristics and are gradually evolving into full-fledged ODEs **include:**

- **India Stack:** Enables governments and businesses to deliver presenceless (Aadhaar Authentication), paperless (eKYC, eSign, DigiLocker) and cashless (UPI) services.
- **National Digital Education Architecture (NDEAR):** A set of principles, standards, specifications, building blocks and guidelines that enable multiple entities to create parts of the digital education ecosystem - independently but interoperably.

Other A.I. models in the news:

- **Krutrim:** Meaning Artificial in Sanskrit, is an Indian Large Language Model developed by Ola.
- **Phi-2:** Microsoft's Small Language Model
 - **National Urban Digital Mission (NUDM):** Foundational digital building blocks, ready-to-use platforms, standards, specifications, and frameworks to build a shared digital infrastructure for the urban ecosystem to solve complex problems at scale and speed.
 - **Ayushman Bharat Digital Mission:** A modular and interoperable stack aimed at the seamless and safe exchange of health information among various stakeholders and across the ecosystem to provide personalized and citizen-centric health services and improve outcomes.
 - **National data and analytics platform (NDAP):** A platform to **standardize data across multiple government sources**, provide flexible analytics, and make it easily accessible in formats conducive to research, innovation, policy-making and public consumption.

Bhashini - an A.I. tool

News Excerpt:

At the **Kashi-Tamil Sangamam event** in Varanasi, the A.I. tool '**Bhashini**' was used for the first time to **live-translate the Indian Prime Minister's Hindi speech into Tamil.**



About Bhashini:

- It is an **AI-driven language translation system or tool**.
- It is also known as the BHASa Interface for India.
- It allows **translation and conversation in multiple Indian languages**.
- It allows people to communicate in their native language to **break language barriers**.
- It shall act as an orchestrator to **unify and align a large, diverse network across Government, industry, academia, research groups, and startups** to bring all their contributions into an open repository.
 - The Union government has outlined **four tracks defining Bhashini's roadmap: Foundation, Contribution, Innovation, and Grand Challenge**.
- The **platform also has a separate 'Bhasha Daan' section**, which enables individuals to contribute to various **crowdsourcing initiatives**.
- The Union Finance Minister Sitharaman announced the **National Language Translation Mission (NLTM) in the 2021-22 budget**.
 - The initiative was introduced following a survey that found that 53% of Indians who do not use the Internet will access the web if the content is available in their native language.

What's Bhasha Daan?

- Under Bhasha Daan, the Government plans to **gather language inputs across myriad local languages**.
- There are several **categories within Bhasha Daan: Suno India, Likho India, Bolo India and Dekho India**.
- **Suno India** allows people to **type audio content or validate text** transcribed by others.
- Under **Bolo India**, individuals can **record sentences in their voices** and validate the audio recorded by other people.
- Under **Likho India**, people can **translate the provided text into their local language** and validate translations submitted by others.
- In **Dekho India**, individuals can **contribute by typing the visible text** or labelling images. They can also validate the images labelled by others.

Gemini - A powerful A.I. model by Google

News Excerpt:

Recently, Google launched **Gemini**, touted as its most **powerful artificial intelligence (A.I.) model, trained to behave in human-like ways**.

About:

- It is a large language model (LM) developed by Google DeepMind division.
- It is designed to compete with other AI systems like open AI's ChatGPT.
- Gemini is designed from the ground up to be multimed, Integrating text, images and other data types.
- **Gemini comes in three versions:**
 - **Gemini Nano** ("for device tasks"), the lighter version, is meant to run natively and offline on Android devices.
 - **Gemini Pro** ("for scaling across wide range of tasks") the heavier version, will soon power several Google AI services and is the backbone of Google's chat-based AI tool, Bard.
 - **Gemini Ultra** ("for highly complex tasks") is the most powerful large language model (LLM).
- It is currently available only in **English**, but support for other languages is expected to come soon.
- It will eventually be integrated into Google's search engine, its ad products, the Chrome browser, and others globally.
- As Gemini, integrates into more Google products and services, its power and potential to solve real-world applications and problems will gradually become clearer.

BharatNet Project

News Excerpt:

Recently, Union Cabinet approved Rs 1.39 lakh crore for modernising the BharatNet Project, which involves changing its execution strategy and providing fiber connections to the last mile through Village Level Entrepreneurs.

About

- **Bharat Net Project-** The world's largest rural broadband project, to provide broadband connectivity to all the 2.5 lakhs gram panchayats across India. It is funded through universal service obligation fund. It's under Ministry of Communications.
- **Launched in 2011-** The project was executed by a Special Purpose Vehicle-Bharat Broadband Network

Limited -now merged with BSNL. Since 2017 under PhaseII it tried multiple implementing models like State-led Model, Private Sector Model and CPSU Model.

- **Under the revamped model**, will involve village level entrepreneurs or Udyamis to take the fiber connections to the homes on a 50:50 revenue-sharing basis.
- The cost for taking the infrastructure to the home will be borne by the government; the rural entrepreneur will only need to be involved in maintenance and operations of home connections, including addressing consumer complaints.
- **Under the BharatNet project**, the home broadband package will start from Rs 399 a month, giving 30 Mbps unlimited data, bundled with OTT offering, etc.
- There will be an automated network operation centre for handling complaints.

Robo Mapper

News Excerpt:

Robots develop new semiconductor materials in tests that are 10 times faster & greener.

About Robomapper:

- RobMapper, is a robot proficient in efficient and eco-friendly identification of novel semiconductor materials.
 - It can rapidly identify **new perovskite materials** with improved stability and solar cell efficiency.
 - Rob Mapper automates the procedure by miniaturizing and placing multiple samples on each chip using modern printing techniques.
 - This allows simultaneous data collection for various materials, saving time and energy.
 - The approach greatly enhances the efficiency, cost-effectiveness, and sustainability in material search, reducing the carbon footprint.
 - It's nearly 10 times faster than earlier automated methods.
- Perovskite is a calcium titanium oxide mineral composed of calcium titanate.
 - Its name is also applied to the class of compounds which have the same type of crystal structure as CaTiO_3 , known as the perovskite structure.

World coin - Biometric Project

News Excerpt:

OpenAI CEO Sam Altman has formally re-introduced Worldcoin, a project of his that was eclipsed by the popularity of ChatGPT.

Pre-Connect

- Altman previously introduced the beta version of World coin in October 2021, but the project met with criticism and concerns, while there was little to no information about the WLD crypto.
- In December 2022, Altman launched OpenAI's chatbot ChatGPT. This project captured global attention and Altman has since become a person of note in the booming artificial intelligence industry.

World coin scan irises

- World Coin explained that they are using biometric information to avoid duplication.
- The company claimed that India had "proven the effectiveness of biometrics" through its Aadhaar system.
- it uses a technology known as zero-knowledge proofs (ZKPs) to maintain users' privacy.

About World coin

- World coin is an initiative to create a digital network in which everyone can claim some kind of stake, and join the digital economy.
- Using a device called "Orb," World coin volunteers known as 'Orb operators' scan a person's iris pattern to collect their biometric data and help them get a World ID through the World app.
- With the app, scanned participants can collect a cryptocurrency called World coin [WLD] at regular intervals or make transactions with their World ID where possible.
- This process is called "**proof of personhood**" and makes sure that people do not sign themselves up multiple times in exchange for crypto.

Presence of World coin in India

- World coin lists **18 locations — largely in Delhi, Noida, and Bangalore** — where Orb operators are scanning people's eyes.
- Some locations include popular malls and metro stations in these cities.

Superconductive properties

News Excerpt:

Researchers have **demonstrated the ability to grow high-quality thin films of a recently discovered superconductor material.**

About Superconductivity

- Superconductivity refers to a **state in which a material offers zero, or near-zero, resistance to electric current**. A current is the movement of charged particles, electrons in most cases, in a particular direction.
- Superconducting materials show very interesting behaviour under magnetic field which allows the functioning of systems like the **MRI scan machine** and the **superfast Maglev trains** that float above the tracks.

Current status of superconductors

- As of now, superconductivity can be achieved only at very low temperatures, more than 250 degrees Celsius below zero.
- The first material to have been discovered to show super conductive properties was Mercury, which becomes a **superconductor at close to 270 degrees Celsius below zero**.
- Most of the other materials commonly used as superconductors – **Lead, Aluminium, Tin, Niobium, and several others** – also become **superconducting at comparable temperatures, called critical temperature**.
- In some cases, materials can exhibit superconductivity at slightly higher temperatures as well, but under increased pressure conditions.

Types of Superconductors	
Type 1 Superconductor	Type 2 Superconductor
These Superconductors are called soft superconductors.	These superconductors are called hard superconductors .
Only one critical field exists for these superconductors	Two critical fields H_{c1} (lower critical field) and H_{c2} (upper critical field) exist for these superconductors.
The critical field value is very low.	The critical field is very high.
These superconductors exhibit a perfect and complete Meissner effect.	These do not exhibit a perfect and complete Meissner effect.
These materials have limited technical applications because of their very low field strength value.	These materials have wider technological applications because of their very high field strength value.
Example: Pb, Hg, Zn, etc.	Example: Nb ₃ Ge, Nb ₃ Si, Y ₁ Ba ₂ Cu ₃ O ₇ , etc.

Properties of Superconductors

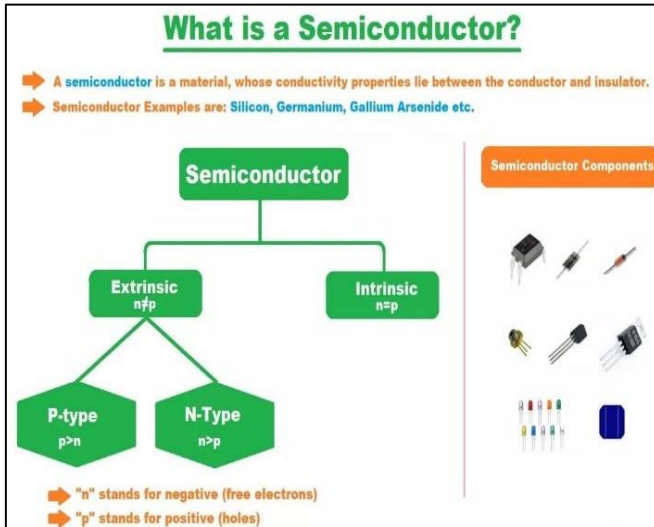
- **Meissner Effect:** In 1933 Meissner discovered that not only did superconductors **exhibit zero resistance** but also spontaneously **expel all magnetic flux** when cooled through the superconducting transition, that is, that is they are also perfect diamagnets. We call this the Meissner effect.
- **Effect of Magnetic Field:** Removal of the superconducting state does not only occur by raising the temperature but also by subjecting the material to a magnetic field.
- **Frequency effect:** Superconductivity is observed for direct current (D.C.) and up to radio frequencies. It is not observed for higher frequencies. For a superconductor, the resistance is zero only when the current is steady or varies slowly.
- **Entropy:** Entropy increases on going from a superconducting state to a normal state.
- **Thermal Conductivity:** In an ideal superconductor, there is a marked drop in thermal conductivity when superconductivity sets in.
- **Isotope Effect:** It has been observed that the critical temperature of superconductors varies with isotopic mass.

Semiconductor Tech

News Excerpt

- **The AtmaNirbharta vision** (self-reliance) in electronics and semiconductors received a boost with the Union Cabinet's approval of the **Semicon India program**, allocating **INR 76,000 crore**.
- **Semicon India aims to financially support companies investing in semiconductor, display manufacturing, and design.** The goal is to establish India's presence in the global electronics value chain.
- **The India Semiconductor Mission (ISM)**, an autonomous division of **Digital India Corporation**, aims to develop semiconductor and display facilities. It introduces **four schemes: supporting semiconductor and display fab setup, creating compound semiconductor/sensors fabs, and a design incentive scheme**.
- Scheme for setting up of **Semiconductor Fabs** in India **provides fiscal support to eligible applicants** for setting up of Semiconductor Fabs which is aimed at attracting large investments for setting up semiconductor wafer fabrication facilities in the country. Following fiscal support has been approved under the scheme:
 - 28nm or Lower - Up to 50% of the Project Cost

- Above 28 nm to 45nm - Up to 40% of the Project Cost
- Above 45 nm to 65nm - Up to 30% of the Project Cost
- Additionally, the government has also approved **modernisation of Semi-Conductor Laboratory, Mohali** as a brownfield Fab.



About Semiconductor

- A semiconductor is a substance that has **specific electrical properties** that enable it to serve as a foundation for computers and other electronic devices.
- It is typically a **solid chemical element or compound that conducts electricity under certain conditions** but not others. This makes it an ideal medium to control electrical current and everyday electrical appliances.
- **Conductor and insulator** are substances that **conduct and repel electricity**, respectively, in semiconductors.
- **A diode, integrated circuit (IC) and transistor** are all made from semiconductors.
- The conductance can vary depending on the current or voltage applied to a control electrode or on the intensity of irradiation by **infrared (IR), visible light, ultraviolet or X-rays**. The specific properties of a semiconductor depend on the impurities "known as dopants" added to it.

Significance of Semiconductors technology

- Semiconductors hold immense significance across various sectors, including **aerospace, automotive, communications, clean energy, information technology, and medical devices**, among others.

- Their critical role has led to a global chip shortage due to **demand surpassing supply**, resulting in economic setbacks and job losses.
- These semiconductors, along with displays, serve as the foundation for modern electronics, driving the ongoing digital transformation in **Industry 4.0**.

NavIC-based IST traceable Primary Reference Time Clock

News Excerpt:

The **Centre for Development of Telematics (C-DOT)** and **CSIR-National Physical Laboratory (NPL)** signed an agreement for the 'Development of NavIC-based IST traceable Primary Reference Time Clock (PRTC) for Telecom Sector'.

Aim: To achieve the objective of **"One nation, One time"**.

Purpose:

- It will provide direct Indian Standard Time (IST) traceability to all the Telecom Service Providers (TSPs) and Internet Service Providers (ISPs) within ± 20 nanoseconds.
- This shall benefit India in multiple ways, like –
 - Reducing the dependency on GPS,
 - Shifting to IRNSS/NavIC,
 - Digital forensic analysis of transactions,
 - Cyber secure networks,
 - Reduce call drops,
 - Synchronize all the telecom services with one reference time source IST, developed by CSIR-NPL.

Centre for Development of Telematics (C-DOT): It was established in 1984 as an autonomous Telecom R&D centre of DoT, India. It is a registered society under the Societies Regulation Act of 1860. It is a registered 'public funded research institution'.

Nanophotonic electron accelerator (NEA)

News Excerpt:

A team of laser physicists at the University of Erlangen-Nuremberg, Germany recently fired up the **world's smallest particle accelerator**, the **Nanophotonic electron accelerator (NEA)**.

About:

- The NEA consists of a small **microchip** that houses tiny **vacuum tubes**, which are made up of thousands of **individuals "pillars."**
- The main acceleration tube of the NEA is approximately 0.02 inches long, which is much shorter than the 27-kilometer ring that makes up **CERN's Large Hadron Collider (LHC)** in Switzerland. LHC is the world's largest and most powerful particle accelerator.
- Particles are accelerated by **ultrashort laser pulses** illuminating the nanostructures.

Carbon Nanoflorets**News Excerpt:**

Recently IIT Bombay has created a tiny flower like structure made up of carbon that can convert sunlight to heat with 87% efficiency. It is also known as material carbon nanoflorets having resemblance of small marigold flower.

Properties:

- It absorbs sunlight and converts the **light energy into thermal energy** through solar-thermal conversion with a remarkable efficiency of 87%.
- It is **extremely black**, which means it is an excellent light absorber.
- This high efficiency comes from **three properties**:
 - The nanoflorets absorb three frequencies from the sunlight – infrared, visible light, and ultraviolet. Whereas normal photovoltaic materials in solar panels absorb only visible and ultraviolet light.
 - Infrared radiation makes up more than half of the energy that sunlight carries to Earth. Consequently, the nanoflorets can absorb far more solar energy and don't lose heat to their environment. As a result, heat waves in the material aren't carried over long distances, reducing the amount of heat dissipated.

Move over VoLTE, it's VoNR**News Excerpt:**

Voice calling over VoLTE (Voice over Long term Evolution) was a game-changer. Now it's time for this feature to showcase itself in 5G-enabled VoNR (Voice over New Radio).

About the technology:

The introduction of VoLTE in India and its significant improvements to voice calling quality is remarkable. With the advent of 5G, there's anticipation surrounding the evolution to **Vo5G or Voice over New Radio (VoNR)**, seen as the future standard for voice calls on 5G networks.

OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer):

- NASA launched it in 2016. Two years later, scientists worked to place it into orbit around Bennu at an altitude of just 2 km.
- In 2020, OSIRIS-REx landed just long enough to grab a sample of the asteroid from a pre-identified spot before flying back up.
- In May 2021, it began its long journey back to Earth.

VoLTE in India (2016): VoLTE revolutionized voice calling with its **clear quality**, contrasting the previous muffled 3G/2G call experiences. It marked a significant upgrade, ensuring WhatsApp-like voice clarity without constant repetitions.

How Vo5G Works:

- **Packet-Switched Architecture:** Vo5G operates on a packet-switched network, where voice data is broken into packets and transmitted over the 5G network. This approach allows for more efficient use of network resources, optimizing voice data delivery.
- **Low Latency and Quality of Service (QoS):** The ultra-low latency of 5G networks contributes to faster call setup times, reduced delays, and improved service quality. Vo5G is designed to prioritize voice traffic, ensuring a seamless and reliable communication experience.
- **Vo5G-Compatible Devices:** To take advantage of Vo5G, users will need devices that support 5G connectivity and Vo5G technology. Modern smartphones are increasingly equipped with these capabilities, enabling users to experience the benefits of Vo5G.
- **Introduction of Vo5G (Voice over 5G):** Vo5G, also known as VoNR (Voice over New Radio), represents the future standard for voice calls on 5G networks. It utilizes 5G network advancements—**speed, capacity, responsiveness**—to enhance voice calling experiences.
- **Advantages of VoNR over VoLTE:** VoNR offers superior call quality due to advanced audio codecs leveraging 5G's increased data capacity. Faster call connection times are attributed to **reduced network latency of 5G, enhanced reliability and**

continuity in calls with lower packet loss, and reduced voice cutouts.

- **Improvements over Drop Issues in India:** VoNR aims to resolve drop issues experienced during network switches from 5G to 4G for VoLTE calls. With VoNR, 4G should remain dormant on 5G-supported phones, eliminating delays or drops during calls.
- **VoNR's Status in India:** VoNR is yet to arrive in India, despite ongoing 5G rollout by major carriers. Reports suggest Reliance Jio has been testing VoNR to ensure seamless integration with existing 4G VoLTE and new 5G networks.

SPACE

Artemis Mission

News Excerpt:

During his visit to the USA, Prime Minister of India signed the Artemis Accords and **NASA and ISRO** have also agreed to launch a joint mission to the International Space Station in 2024.

Pre-Connect

Artemis Accords

- Through the Artemis program, NASA will land the **first woman and first person of color** on the Moon, make new scientific discoveries, and explore more of the lunar surface than ever before for the benefit of all.
- While NASA is leading Artemis, international partnerships will play a key role in achieving a sustainable and robust presence at the Moon where the agency will prepare for the **first human mission to Mars**.
- NASA, in coordination with the U.S. Department of State, established the Artemis Accords in 2020 together with seven other founding member nations.
- The accords reinforce the commitment by the United States and signatory nations to the **Registration Convention, the Rescue and Return Agreement**, as well as best practices and norms of responsible behaviour that NASA and its partners support, including the public release of scientific data.
- **Member Countries- Australia, Bahrain, Brazil, Canada, Colombia, Czech Republic, Ecuador, France, India, Israel, Italy, Japan, Luxembourg, Mexico, New Zealand, Nigeria, Poland, South Korea, Romania, Rwanda, Singapore, Spain,**

Saudi Arabia, Ukraine, United Arab Emirates, United Kingdom, United States.

Principles of Artemis Accord

- **Peaceful Purposes**
- **Transparency**
- **Interoperability**
- **Emergency Assistance**
- **Registration of Space Objects**
- **Others:**
 - Release of Scientific Data
 - Protecting Heritage
 - Space Resources
 - Deconfliction of Activities
 - Orbital Debris and Spacecraft Disposal

Significance

- It would facilitate **increased collaboration** between ISRO, NASA and other international space agencies involved in the Artemis program.
- The Artemis Accords address the **utilization of lunar resources**, including water ice, minerals, and other materials and India can participate in discussions on their extraction and utilization.
- **Technological Advancement:** The program involves advanced space technologies, **including human spaceflight, robotic missions, and lunar surface infrastructure** and India could gain access to expertise, technologies, and resources related to these areas.
- Joining the Artemis Accords strengthens India's position in the international space community, and it demonstrates India's commitment to **responsible and cooperative space exploration**.

Chandrayaan-3

News Excerpt

Recently, ISRO's Chandrayaan-3 takes off for the Moon.

Pre-Connect

Chandrayaan-1: It was the first space mission launched to orbit the Moon and to dispatch an impactor to the surface.

- Its scientific goals **included the study of the chemical, mineralogical and photo-geologic mapping of the Moon**.
- One of the most important findings of Chandrayaan-1's was related to the question of **water on the Moon**.

Chandrayaan-2: It was a highly complex mission, which represents a significant technological leap compared to the previous missions of ISRO.

- The mission was designed to expand the lunar scientific knowledge through a detailed study of Topography, seismography, surface chemical composition and mineral identification etc, which would have led to a new understanding of the origin and evolution of the Moon.

- Rover:** It was equipped with payloads that provided valuable data to the scientific community regarding the properties of lunar soil and rocks including their chemical and elemental compositions.

- Propulsion Module:** It was the one that took the lander and the rover to the moon. This module
- The mission objectives of Chandrayaan-3 mission.**

- To demonstrate a safe and Soft Landing on Lunar Surface.
- Observing and demonstrating the rover's loitering capabilities on the Moon.
- To conduct in-situ scientific experiments on the materials available on the lunar surface to better understand composition of the Moon.

Exploring the Lunar South Pole

- Chandrayaan-3 would be the first to land at the Lunar South Pole** to carry in situ experiments, analysis, and observations to gain insights into the moon's composition.

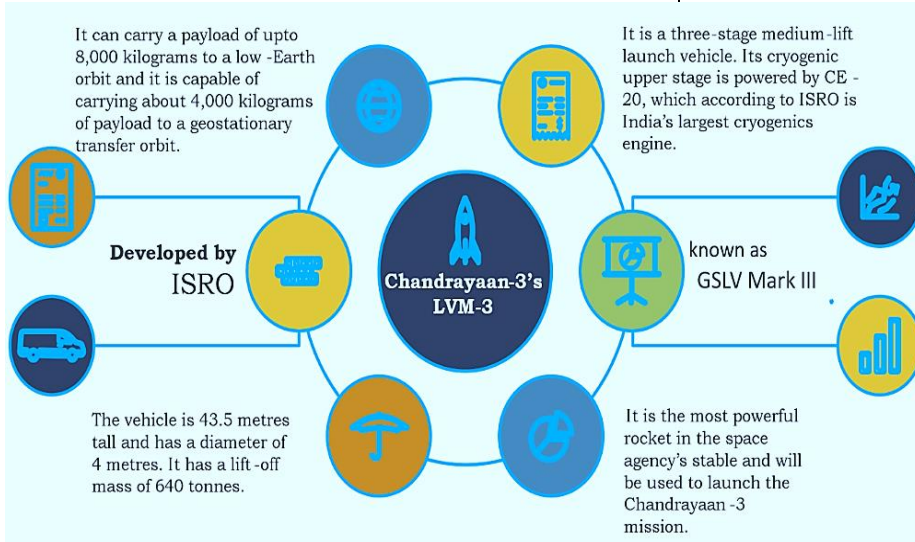
- The success of India's mission in this crucial location is a groundbreaking development and brings about significant changes in field of deep space exploration.

AI-Powered Moon Mission

The **Pragyan rover** is equipped with advanced AI technology, enabling it to communicate with the Vikram lander. This technology also assists the rover in various tasks and operations.

Key capabilities of the Pragyan Rover:

- It utilises **motion technology** to navigate the challenging terrain and successfully reach its designated landing site.
- Its AI algorithm plays a crucial role in identifying traces of water and minerals on the lunar surface.



About Chandrayaan-3

Chandrayaan-3 is a Moon mission featuring a lunar lander and a rover that carried out scientific activities on moon surface.

- It demonstrated new technologies required for interplanetary spaceflight achieved **India's first soft landing on moon.**
- In addition to ISRO's own deep space communication antenna, the mission will rely on support from ground stations around the world, **coordinated by ESA and NASA.**
 - India has become the **fourth country – after Russia, the U.S. and China** – to land on the moon and also the first to land on the moon's South Pole.

Main components of Chandrayaan-3

- Lander:** It was responsible for the soft landing on the Moon, which carried the rover and various scientific instruments to perform in-site analysis.

Dark Matter

News Excerpt:

Recently, in a study scientists estimate that **up to 85% of the matter in the universe could be made of what's called dark matter.**

Other missions of India similar to

- **Indian Human Spaceflight Programme** – Indian in space programme.
- **Shukrayaan** – India's venus exploration mission.
- **Mars Orbiter Mission** – India's mars exploration programme.
- **Aditya-L1** – India's sun observation mission.

Pre-Connect

- The discovery of **supernova 1997ff**, located about 10 billion light-years away, provided evidence for dark energy.
- About halfway into the universe's history, several billion years ago — dark energy became dominant, and the expansion accelerated.

Universe began with an explosion of space itself - the Big Bang.

- It is everything and includes all of space, and all the matter and energy that space contains.
- **It is thought to consist of three types of substance:** Normal matter, dark matter and dark energy.

About Dark Matter

The visible universe—including Earth, the sun, other stars, and galaxies **makes up less than 5 per cent of the mass of the universe.**

- The rest of the universe appears to be made of a mysterious, invisible substance called **dark matter.**
- Unlike normal matter, dark matter does not interact with the electromagnetic force.

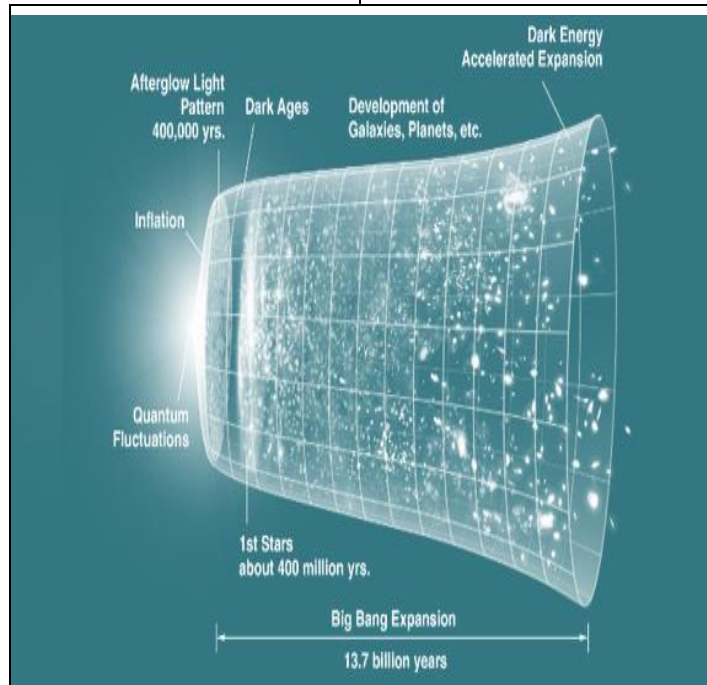
- It is completely invisible to light and other forms of electromagnetic radiation.
- We can't see dark matter, but we may see its effects through its gravitational force.

About Dark Energy

- It is the name given to the mysterious force that's causing the **rate of expansion of our universe to accelerate over time**, rather than to slow down. It is a hypothetical form of energy that exerts a negative, repulsive pressure, behaving like the opposite of gravity.

Importance of Dark Energy

- Dark energy is believed to make up about **70% of the mass-energy density of the entire Universe.**



It plays a central role in structure formation and galaxy evolution and has measurable effects on the anisotropy of the cosmic microwave background. **Cosmic Microwave Background**

- The Cosmic Microwave Background (CMB) is the **cooled remnant of the first light that could ever travel freely throughout the Universe.**

- This 'fossil' radiation, the furthest that any telescope can see, was released soon after the **'Big Bang'.**

Various experiments on dark energy and matter:

LUX-ZEPLIN (LZ): is a next generation dark matter experiment, selected by the **US Department of Energy (DOE) as one of the three 'G2' (for Generation 2) dark matter experiments.**

XENON1T: It have been designed to directly detect dark matter, by searching for signs of dark matter 'hitting' ordinary matter, but dark energy is even more elusive.

Space Junk

News Excerpt:

Recently, a **Space Debris** was found in a **Western Australia beach**, claimed by India's space agency to be from one of its Polar Satellite Launch Vehicles (PSLV).

Pre-Connect

- The Subject of "Space" comes under the **list 3 of Schedule 7 of the Indian Constitution i.e.- the Residual list.**
- The Indian Space Research Organisation, commonly referred to as **ISRO** is the **National Space Agency of India.**
- It operates under the **Department of Space (DOS)** which is directly overseen by the Prime Minister of India, while the Chairman of ISRO also acts as the executive of DOS.

About Space Debris

- Space debris, **also known as Space Junk** is any piece of machinery or debris left by humans in space.
- It can refer to big objects such as dead satellites that have failed or been left in orbit at the end of their mission.
- It can also refer to smaller things, like bits of debris or paint flecks that have fallen off a rocket.

Problems associated with the Space Debris

- **Space debris represents a risk to spacecraft** - Collisions with debris have become a hazard to spacecraft; the smallest objects cause damage akin to sandblasting, especially to solar panels and optics like telescopes or star trackers that cannot easily be protected by a ballistic shield.
- **It can cause Property loss or damage,**
- **It can lead to loss of Human lives,**
- **It can lead to Space War,**
- **It has increased the cost of the Space Projects**-Currently, depending on the orbit, up to 10% of the costs of a mission correspond to tasks focusing on

reducing impact risks with space debris. If this continues to grow, costs will increase.

Active De-orbiting measures:

Active deorbiting is crucial for **collecting** and **moving** debris to a **lower orbit**, enabling faster de-orbitation.

Following are the ways that can be used for De-Orbiting:

India's Initiatives on Space Debris:

- **Project NETRA**- It is an early warning system in space to detect debris and other hazards to Indian satellites.
- **Centre for Space Debris Research** – It has been set up by ISRO to monitor and mitigate the threat of space debris.
- **System for Safe and Sustainable Operations Management (IS4OM)** set up by ISRO in the year 2022 to continually monitor objects posing collision threats, predict the evolution of space debris, and mitigate the risk posed by space debris.
- ISRO also carried out **21 collision avoidance manoeuvres** of Indian operational space assets in 2022 to avoid collisions with other space objects.

Global Initiatives

- **ESA Initiatives** - Since the mid-1990s, ESA has performed **collision avoidance for their LEO satellites** via **ESA's Clean Space initiative**, the agency is committed to the development and testing of novel technological concepts aimed at the

Harpoon Systems	<ul style="list-style-type: none"> • It involves deploying a device that can physically capture a piece of debris. This method is beneficial for capturing larger pieces of debris.
Nets and Snares	<ul style="list-style-type: none"> • A spacecraft equipped with a net or snare can approach the debris, deploy the capturing mechanism, and secure the object for subsequent removal. Suitable for small debris.
Robotic Arms	<ul style="list-style-type: none"> • It can grasp, manipulate, and secure debris. These arms can be attached to a dedicated debris removal spacecraft.
Electrodynamic Tethers	<ul style="list-style-type: none"> • These use an electrically conductive tether to interact with the Earth's magnetic field, generating thrust. It changes the orbit of the debris, causing it to re-enter the Earth's atmosphere and burn up.
Propellantless Deorbit Devices	<ul style="list-style-type: none"> • These include solar sails or aerodynamic drag devices. • These technologies harness natural forces, like solar radiation pressure or atmospheric drag, to gradually lower the orbit of the debris until it re-enters the Earth's atmosphere.
Ground-Based Lasers	<ul style="list-style-type: none"> • These nudge the debris by imparting momentum through laser ablation.

mitigation of space debris generation. Those activities are grouped under the **CleanSat project**.

- **The United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS), 2010** –It was established where the working group primarily focused on limiting the generation of space debris in the environment. The UN COPUOS guidelines are **voluntary and non-binding** fundamental principles which means that it has no legal obligation for the States and their nationals to comply.
- **The Inter-Agency Space Debris Coordination Committee (IADC)** is an inter-governmental forum whose aim is to co-ordinate efforts to deal with debris in orbit around the Earth founded in 1993.
- **The Outer Space Treaty** – It provides the basic framework on international space law, including the following principles:
 - The exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind.
 - Outer space shall be free for exploration and use by all States.

India's first satellite network portal site

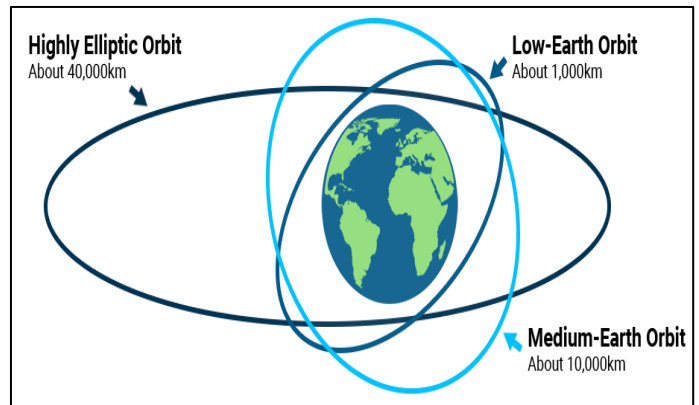
News Excerpt

The Gujarat government signed a memorandum of understanding with **OneWeb India Communications Pvt Ltd** for setting up a 'satellite network portal site' in Gujarat.

Pre-Connect

- According to India's inequality report of Oxfam international, **Rural internet usage in India stands at 31%**, while **urban usage is 67%**.
- **Merely 9% of students have internet-equipped computers**, and **25% can access it through various devices**, revealing digital disparities between urban and rural areas and within the student population.
- Satellite broadband technology, including **low Earth orbit (LEO) constellations like StarLink, Kuiper, and OneWeb**, is gaining prominence for global communication.
- **LEO satellites, positioned 500-1,200 km above Earth**, offer high-speed and low-latency connectivity, reducing data transmission delays.
- According to an estimate India requires at least **2 satellite network portals (SNPs)** due to its vast geography.

- Current shift towards LEO satellite communications signifies a growing reliance on advanced satellite technologies for seamless connectivity.



Satellite Broadband Technology:

- Satellite broadband technology involves using **satellites in space to provide high-speed internet access to remote or underserved areas on Earth**.
- This technology has **evolved with the emergence of low Earth orbit (LEO) satellite constellations** like **StarLink, OneWeb, and Kuiper**.
- These constellations consist of numerous small satellites orbiting closer to Earth, enabling faster data transmission and reduced latency compared to geostationary satellites.

How does satellite internet work?

- **Satellite internet works by transmitting an internet signal from an internet service provider to a satellite in space.**
 - The signal is then beamed back to users on Earth, where it is captured by a satellite dish.
- The satellite dish is typically connected to a modem, which then connects the user's computer or other devices to the internet signal.
- This process is repeated every time data is sent or received, allowing users to access the internet via satellite.

Satellite Network Portals (SNPs):

- Satellite network portals are online platforms that offer users access to satellite services.
- They serve as gateways for managing satellite communication aspects like satellite internet and navigation.
- These portals provide tools for tasks such as tracking satellite positions, analyzing imagery, and configuring settings, aiding users in effectively utilizing satellite technology.

OneWeb:

www.ksgindia.com

DELHI VN: 9717380832 & DELHI ORN: 9811293743 | JAIPUR: 8290800441 | PATNA: 7463950774 | BHOPAL: 7509975361 | INDORE: 7314977441
| BENGALURU: 7619166663 | HYDERABAD: 79960 66663 | KOLKATA: 9007709895 | IMPHAL: 9650245599

- OneWeb is a Low Earth Orbit (LEO) satellite startup that wants to create a world-wide network of communication.
- By leveraging LEO satellites, it provides broadband Internet connectivity with a decreased latency of less than 100 ms.

Potential in India

- Satellite broadband holds significant potential, especially for **bridging the digital divide in rural and remote regions** where traditional infrastructure is lacking.
- It can provide reliable internet **access to areas with challenging terrain or inadequate connectivity** options.
- This technology can encourage **e-learning, telemedicine, e-commerce, and communication services, empowering communities and boosting economic growth.**

NASA'S QUESST Mission

News Excerpt:

National Aeronautics and Space Administration (NASA) is developing a supersonic aircraft, called **X-59s**, as part of its **QUESST mission**.

About QUESST Mission:

The goal is to achieve a regulatory shift in the laws that focuses on the sound an aircraft creates, instead of a speed limit.

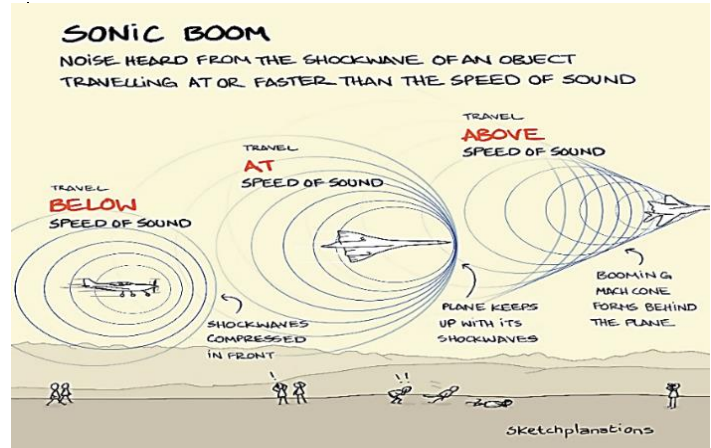
Objective:

- It aims to collect data that could make supersonic flight over land possible, dramatically reducing travel time in the United States or anywhere in the world.
- Design and build technology that reduces the loudness of a **sonic boom** to a gentle thump to people on the ground.
- Fly the X-59 over several U.S. communities to gather data on human responses to the sound generated during supersonic flight and deliver that data set to U.S. and international regulators.

Phases:

To achieve the goals of the mission, NASA has laid out QUESST in **four phases** –

- **Phase 1 (2018–2024):** Aircraft Development
- **Phase 2 (2024):** Acoustic Validation
- **Phase 3 (2025-2026):** Community Response Study
- **Phase 4 - 2027:** Final data to regulators



WHAT ARE SONIC BOOMS?

A **Sonic boom** is a shock wave that is produced by an aircraft or other object flying at a speed equal to or exceeding the speed of sound and that is heard on the ground as a sound like a clap of thunder. When such an aircraft flies at a low altitude, the shock wave may be of sufficient intensity to cause glass breakage and other damage.

ADITYA – L1 MISSION

News Excerpt:

India's first solar observatory mission - **Aditya-L1** was launched by the Indian Space Research Organisation (ISRO) on September 2, 2023.

Need behind the study of the Sun from space:

- Studying the Sun helps us understand more about other stars.
- Sun has various explosive phenomena. These can damage our satellites and communication systems. Studying the Sun and its effects on **the space weather** may help in providing early warnings for such events.
- Earth's atmosphere and the magnetic field act as protective shields that block out harmful radiations, such as UV light. This means studying the Sun from the Earth cannot provide a complete picture.

Space agencies of different countries exploring the Sun

NASA (USA)	PARKER SOLAR PROBE
JAXA (JAPAN)	HINOTORI, HINODE
ESA (EUROPE)	ULYSSES, PROBA-3, SMILE
CHINA	ASO-S
NASA + ESA	THE SOLAR ORBITER

About Aditya – L1:

- The PSLV will initially place the Aditya L-1 in a Lower Earth Orbit. (LEO)
- Subsequently, the spacecraft’s orbit around the Earth will be raised multiple times before it is put on a path to a halo orbit around the **L1 Lagrange point**.
- The spacecraft will finally be stationed in a halo orbit around the **Lagrange point 1 (L1) of the Sun-Earth system**, which is about 1.5 million km from the Earth.
- It will cover its journey to the L1 point in about four months.

WHAT ARE LANGRANGE POINTS?

- There are five Lagrange points, L1 to L5, between any two orbiting celestial bodies.
- These points can act as parking spots in space where the gravitational pull of the celestial objects equals the centripetal force required to keep a satellite in orbit.
- This means satellites placed at Lagrange points do not need to expend a lot of fuel to remain in position.
- Going to Lagrange point 1 places the spacecraft at a point beyond the Moon between the Earth and the Sun.
- This offers the spacecraft an unobstructed view of the Sun even during phenomena like an eclipse.

Objectives of Aditya L-1 mission:

The mission’s main objective is to expand our knowledge of the Sun, and how its radiation, heat, flow of particles, and magnetic fields affect us. Below is the list of objectives that the mission will embark upon:

- To study the upper atmospheric layers of the Sun called **chromosphere and corona**. While the corona is the outermost layer, the chromosphere is just below it.
- To examine **coronal mass ejections (CMEs)**, which are large expulsions of plasma and magnetic fields from the Sun’s corona.
- To analyse the corona’s magnetic field and the driver of the **space weather**.
- To understand why the Sun’s not-so-bright corona is a million degrees Celsius hot when the temperature on the surface of the Sun is just about 5,500 ° C.
- To help scientists know the reasons behind the acceleration of particles on the Sun, which leads to **the solar wind** - the constant flow of particles from the Sun.

Payloads: The spacecraft will carry **seven payloads** to observe solar activities for five years.

Sl. No.	Payload	Capability
1	Visible Emission Line Coronagraph (VELC)	Corona/Imaging & Spectroscopy
2	Solar Ultraviolet Imaging Telescope (SUIT)	Photosphere and Chromosphere Imaging- Narrow and Broadband
3	Solar Low Energy X-ray Spectrometer (SoLEXS)	Soft X-ray spectrometer: Sun-as-a-star observation
4	High Energy L1 Orbiting X-ray Spectrometer (HEL10S)	Hard X-ray spectrometer: Sun-as-a-star observation
5	Aditya Solar Wind Particle Experiment (ASPEX)	Solar wind/ Particle Analyzer Protons and heavier Ions with directions
6	Plasma Analyser Package for Aditya (PAPA)	Solar wind/ Particle Analyzer Electrons and heavier Ions with directions
7	Advanced Tri-axial High-Resolution Digital Magnetometers	In-situ magnetic field (Bx, By and Bz)

Solar Ultraviolet Imaging Telescope (SUIT)

- The telescope **is set to be integrated with the ADITYA-L1 mission**.
- SUIT will record such images, which will be crucial for maintaining the Ozone and Oxygen content in the atmosphere of the Earth.
- SUIT will also measure **the UV radiation hazardous for skin cancer**.
- Integrated with Aditya-L1 mission The SUIT telescope will address fundamental questions such as the existence of a higher temperature atmosphere above the cooler surface of the Sun and the origin and variation of near-ultraviolet radiation and high-energy solar flares.
- Through SUIT, scientists will have a seamless measurement of solar radiation from **Hard X-ray to Infrared, as well as in-situ measurements of particles in the solar wind**, including the Sun’s magnetic field at the L1 point.

Private Sector in Space

News Excerpt:

Chandrayaan-3's spectacular launch underscores the gains of opening up the space sector to private players. A number of private companies have contributed to the development of ISRO's Chandrayaan-3 spacecraft which successfully landed near the south pole of the Moon.

Pre-Connect

Space economy

- As per Space Tech Analytics, India is the **sixth-largest player** in the industry internationally having 3.6% of the world's space-tech companies (as of 2021).
- The Indian Space Industry was valued at \$7 billion in 2019 and aspires to grow to \$50 billion by 2024.
- As per Tracxn data, funding into the sector's start-ups (in India) nearly tripled to \$67.2 million on a year-over-year basis in 2021.
- The whole space programme for the private sector unfolded with the formation of the **Indian National Space Promotion and Authorisation Centre (IN-SPACe)**, as a nodal agency that functions as an autonomous agency in the Department of Space (DOS).
- The government has also formed a body that will represent startups in the space sector - the **Indian Space Association (ISpA)**. It has brought all the private entities such as **Agnikul, Astrome etc.** under one umbrella.
- **NewSpace India Ltd (NSIL)** is mandated to transfer the matured technologies developed by the ISRO to Indian industries.
- There are already more than 100 space startups in India and collectively they have raised more than \$245.35 million in funding.

Provisions for private players in Indian Space Policy 2023:

- The entire gamut of space activities is **now open to the private sector**. Private sectors are allowed to undertake end-to-end activities in the space sector through establishment and operation of space objects, ground-based assets, and related services, such as communication, remote sensing, navigation, etc.
- Satellites could be self-owned, procured or leased; communication services could be over India or outside; and remote sensing data could be disseminated in India or abroad.

- **NGEs (non-governmental entities)** can design and operate launch vehicles for space transportation and establish their own infrastructure.
- NGEs can now make filings with the **International Telecommunication Union (ITU)** and engage in commercial recovery of asteroid resources.

Bhartiya Space Station and Space Vision

News Excerpt:

The visionary roadmap for ISRO was charted during a review meeting for the upcoming Gaganyaan mission, which is set to be India's first manned mission to space and is expected to be implemented by 2035.

Gaganyaan mission:

- The Gaganyaan project envisages a demonstration of human spaceflight capability by launching **a crew of 3 members to an orbit of 400 km for 3 days** in a space mission and bringing them back safely to Earth, by landing in Indian sea waters.
- The prerequisites for the Gaganyaan mission include the development of many critical technologies like a human-rated launch vehicle, a Life Support System, crew emergency escape provision etc.

ISRO's upcoming move:



- Along with the **Bharatiya Space Station (BSS)**, **ISRO plans to send an Indian to the Moon by 2040.**

What is the Vision for 2040?

- Vision 2040 is designed for **landing an Indian astronaut on the Moon** is a lunar mission. The

Department of Space will develop a roadmap for Moon exploration to realize this vision.

- This will encompass Chandrayaan missions, developing a **Next Generation Launch Vehicle (NGLV)**, constructing a new launch pad, setting up human-centric laboratories, and associated technologies.

Galactic Tide

News Excerpt:

Like the Earth's oceans at their shores, the universe's galaxies also experience tides, but on a much larger scale.

About Galactic tides:

- They are caused by gravitational forces within a galaxy, arising in the interactions between celestial objects like stars and gas clouds.

Effects:

- They can reshape a galaxy structure by creating tidal tails and bridges, promoting star formation, and disrupting smaller star systems.
- It disrupts the orbits of stars, leading to long-term changes in galactic structure.
- They have a say in how proximate galaxies do and don't interact.
- It also affects the supermassive black holes at galaxy centres, leading to events that change how these cosmic beasts interact with nearby stars.

Asteroid Bennu

News Excerpt:

Recently, **OSIRIS-Rex (NASA's mission)** collected around 250 grams of rocks and dust samples from asteroid Bennu.

About asteroid Bennu:

- Bennu is an asteroid orbiting the sun (with a period of 436 days) such that it comes relatively close to the Earth once every six years or so.
- It is a **carbonaceous asteroid** that settled into its present form and composition within 10 million years after the solar system's formation, surviving the last 4.5 billion years nearly intact.
- The 'leftover' pieces of debris are expected to reveal the solar system's ingredients.
- Scientists believe that when rocks such as Bennu crashed into the Earth, they delivered the compounds required for the formation of life.
- As Bennu could smash into the Earth between 2178 and 2290, studying it could inform ways to prevent this collision. The particles that form Bennu's

surface are loosely packed together and lightly bound.

Nasa's Calipso Mission

News Excerpt:

Recently, NASA announced that the CALIPSO mission that analyzed climate, weather, and air quality ended.

About CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation):

- It was launched on April 28, 2006, jointly by NASA and France's CNES (Centre National d'Etudes Spatiales) along with the **cloud-profiling radar system** on the **CloudSat satellite**.
- It provides new insight into the role that clouds and atmospheric aerosols (airborne particles) play in regulating Earth's weather, climate, and air quality.
- It combines an active **lidar instrument** with passive infrared and visible imagers to probe the vertical structure and properties of thin clouds and aerosols over the globe.
- The two satellites circled the planet in a **Sun-synchronous orbit** from the North to the South poles.

Sun-synchronous orbit (SSO) is a particular kind of polar orbit.

- Satellites in SSO, travelling over the polar regions, are synchronous with the Sun.
- This means they are synchronized to always be in the same 'fixed' position relative to the Sun.
- This means the satellite always visits the same spot at the same local time – for example, passing the city of Paris at noon precisely every day.
- They measured the altitude of clouds and layers of airborne particles like dust, sea salt, ash, and soot while probing the "vertical structure" of the atmosphere.
- It helped scientists to build more sophisticated models to understand complex atmospheric processes like **cloud formation, atmospheric convection, precipitation and particle transport**.

Bluewalker 3 Satellite

News Excerpt:

Recently, scientists with the International Astronomical Union announced that one of the brightest objects visible in the night sky is not a star or a planet but rather the BlueWalker 3 prototype satellite.

About the satellite:

- It is part of a satellite constellation planned by its owner, AST SpaceMobile, intended to deliver mobile or broadband services anywhere in the world.

- Observations of the BlueWalker 3 showed it was one of the brightest objects in the night sky, outshining all but the brightest stars, the researchers said.
- BlueWalker 3 actively transmits at radio frequencies close to bands reserved for radio astronomy, and existing observatory protection from radio interference may not be sufficient.

Miura-1 Rocket

News Excerpt:

Spanish company PLD Space launched its reusable Miura-1 rocket recently from a site in southwest Spain.

About:

- The rocket is the first step in the development of MIURA5, a 35-meter-high, two-stage mini-launch vehicle designed to place satellites weighing less than 500 kilograms (1,100 pounds) into orbit from 2025.

NASA's WISE Telescope

News Excerpt:

The infrared brightening of the collision of two giant stars was observed by NASA's WISE space telescope. WISE only looks at the star every 300 days and probably missed the initial flash of light from the impact.

About:

- WISE (Wide-field Infrared Survey Explorer) was launched in 2009, repeatedly mapping the entire sky in infrared light.
- Its catalogue of three-quarters of a billion objects led to the discovery of the coolest and nearest brown dwarfs - objects intermediate between stars and planets.
- This is an all-aluminium optical system that will produce images of the sky with 2.75 arcsec resolution in four infrared spectral bands.

David's Sling

News Excerpt:

Israel's mid-range air defence missile system, David's Sling, was successfully deployed in operations for the first time in cross-border fighting with Gaza militants.

About:

- It is designed to **shoot down rockets fired from 100 km to 200 km (62 to 124 miles)** away and is part of Israel's shield that already includes short-

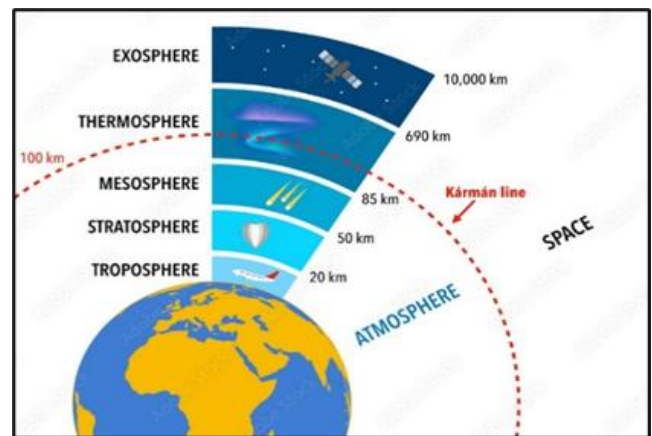
range Iron Dome and long-range Arrow-2 and Arrow-3 missiles.

- It has been developed and manufactured jointly by Israel's state-owned Rafael Advanced Defense Systems Ltd and the US Raytheon Co.
- Unlike the mobile Iron Dome, David's Sling is stationary and can protect the entirety of Israel from its permanent location.

Karman Line

About:

Karman Line is an imaginary line that demarcates the Earth's atmosphere from space and is located at 100 km above sea level.



Features:

- The Karman Line was established to regulate airspace by the Federation Aeronautique Internationale (FAI)
- It marks, roughly, the altitude beyond which a traditional aircraft cannot fly.
- Any aircraft flying beyond it needs a propulsion system to pull away from the Earth's tug.
- It also acts as a legal reference that separates airspace that a country can claim to own from space itself, which is governed like international waters.
- "Any individual who crosses the Karman Line qualifies as an astronaut."

Iran's Noor 3 satellite

Iran launches 3rd military satellite Noor to orbit.

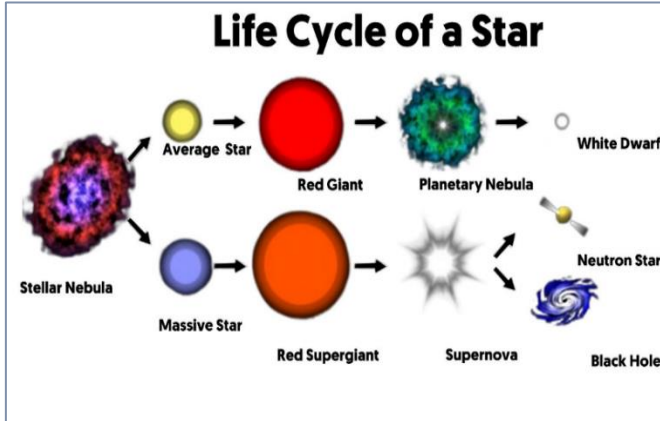
About:

- The Noor 3 imaging satellite orbits at an altitude of 450 kilometres (280 miles) above the Earth's surface.
- It was launched by the three-stage Qased, or messenger carrier.

Supergiant Betelgeuse star

News Excerpt:

Scientists have established, why the red supergiant star Betelgeuse turned dim between 2018 and 2020, dismissing theories that suggested that it might be entering the last stage of its evolution i.e., **Supernova** or the ultimate explosion.



Cause of the dimming:

- Scientists observed that even when the star appeared dim, its photosphere brightened up. The dimming was due to a burst of **dust**, in the form of **silicon monoxide**, coming from the star.
- The burst also might have been caused by the **sudden cooling of the star's surface**.
- The changes in the structure of the photosphere and the silicon monoxide are consistent with both the formation of a cold spot on the star's surface and the ejection of a cloud of dust.
- This fact was established by the **MATISSE telescope**.

About the MATISSE Telescope:

- **MATISSE (Multi AperTure mid-Infrared SpectroScopic Experiment)** is a new spectro-interferometer, part of the second generation of instruments for the Very Large Telescope Interferometer (**VLT**) of the **European Southern Observatory**.
- It is capable of combining the light from up to four of the other telescopes which allows it to increase the detail of data obtained greatly.
- The telescope observes infrared light only.

Range of Operation:	4.5 km to 25 km
Altitude of Operation:	100 m up to 20 km
Length:	5870 mm
Diameter:	350 mm
Weight:	710 kg
Guidance System:	Command Guidance
Target types:	Helicopters, Fighter aircraft, UAVs etc.

China's Shenzhou-17 Mission

News Excerpt:

China has launched its youngest-ever crew of astronauts to the **Tiangong space station**, marking a significant advancement in the country's space ambitions for the future.

- It was launched from the **Jiuquan Satellite Launch Center** on the edge of the **Gobi Desert** in northwestern China atop a **Long March 2-F rocket**.

About the mission:

- The Shenzhou-17 crew will take over from the **Shenzhou-16 crew** which has completed all its tasks.
- Carrying three **Taikonauts (Chinese astronauts, it comes from the Chinese word 'taikong' meaning space or cosmos)**, it is the second manned spacecraft launched by China this year after Shenzhou-16.
- The astronauts will live aboard the orbiting lab for

Space Missions	Year of launch	Details
Chang'e 1	2007	China's first lunar orbiter
Tiangong-1, or "Heavenly Palace 1"	2011	China's first space lab was launched to carry out docking and orbit experiments.
Chang'e-4 lunar probe	2019	It successfully touched down on the far side of the moon
Beidou 3	2020	A global satellite navigation system providing GPS-like services to China and other customers.
Tianwen-1 spacecraft	2021	It sets down on Mars with the Zhurong rover, completing China's first landing on another planet.
Xihe satellite	2021	For solar observation

the next six months, performing a variety of scientific experiments in **space medicine, space technology**, and other areas.

Tiangong space station:

- It orbits Earth at an altitude between **340 to 450 kilometers**, approximately the same orbital height as the International Space Station (ISS).

Fast Radio Bursts

News Excerpt:

Astronomers have discovered a powerful radio wave burst, named FRB 20220610A, that has travelled 8 billion years to reach Earth.

About:

Fast Radio Burst (FRB):

- FRBs are intense, millisecond-long bursts of **radio waves with unknown origins**.
- The first FRB was discovered in **2007**.
- Fast radio bursts have tremendous energy at their sources, but they lose energy as they travel billions of light-years to reach Earth. By the time they arrive, the signal strength becomes too weak.
- Possible causes of fast radio bursts include **magnetars, colliding neutron star binaries, and merging white dwarfs**.
- Its importance lies in the fact that it emits so much energy in a few seconds which the sun will emit in 3 days. Hence it stores a large sum of mysteries that need to be deciphered.
- Scientists believe that fast radio bursts may be a unique method that can be **used to “weigh” the universe** by measuring the matter between galaxies that remains unaccounted for.

Akash Missile System

News Excerpt:

India became the **first country** to demonstrate the capability of engaging four aerial targets simultaneously at 25 km ranges by command guidance using a single firing unit.

About Akash Weapon System (AWS):

- It is a **Short-Range Surface Air Missile (SRSAM) Defence System**.
- The Akash Weapon System is indigenously designed and developed by the **Defence Research and Development Organization (DRDO)** and produced by defence public sector units and other industries.
- AKASH Weapon System **can simultaneously engage Multiple Targets** in Group Mode or Autonomous Mode.
- It has built-in Electronic Counter-Counter Measures (ECCM) features.
- AKASH Weapon Systems has been inducted and is operational with the Indian Air Force (IAF) and the Indian Army (I.A.).

Features:

- Fully automatic with quick response time from target detection to kill.
- Open system architecture ensures adaptability to existing and futuristic Air Defence environments.
- High immunity against active and passive jamming.
- Secured mode of communication between combat elements.
- Self-sufficient in electrical power with in-built power sources.
- It is road and rail transportable with quick mobilization and deployment capabilities.

Demonstration of Akash Missile system:

- The demonstration was conducted by the IAF during **Astrashakti 2023** at Suryalanka Air Force Station on **December 12, 2023**. **Astrashakti** means the power of weapons.

Methane’ Discovered on ‘Warm- Jupiter’ Exoplanet

News Excerpt:

Methane's short duration in a planetary atmosphere has captured the scientific attention of many researchers.

Discovery of Methane:

- Astronomers have **spotted water vapour in the atmospheres** of around a dozen planets thus far. Still, the **detection of methane** though commonly found in the atmospheres of solar system worlds like **Jupiter, Saturn, Uranus, and Neptune** — using space-based spectroscopy **has been far rarer**.
- So, the scientists are now done with the **James Webb Space Telescope**.
- This was the first-time scientists had seen such an **obvious methane spectral feature** with our eyes in a transiting exoplanet spectrum.

Why is it an Important Discovery?

- Methane is an essential gas in **tracing atmospheric composition**.
- It is essential to know the **chemistry of Giant planets**.
- It is also hypothesized to be, in combination with oxygen, **a possible signature of biology**.

About Warm -Jupiter Exoplanet

- The exoplanet exists with a temperature of about **825 kelvins**.
- **WASP-80 b** is the exoplanet that scientists call a ‘warm Jupiter’.

- WASP-80 b goes around **its red dwarf star once every three days** and is situated **163 light-years away from us** in the constellation **Aquila**.
- This planet cannot be seen directly with even the most advanced telescope like Webb. Instead, researchers study the combined light from the star and planet using the **transit method** (which has been used to discover most known exoplanets) and **the eclipse method**.
- Like all planets, **WASP-80 b** emits some of its light through **thermal radiation**. This light's wavelength category and intensity **depend on the planet's temperature**.

• **Transit Method:** Scientists observed the system from our perspective when the planet moved in front of its star, causing the starlight we see to dim a bit. It's like when someone passes before a lamp, and the light dims.

• **Eclipse Method:** Scientists observed the system from their perspective as the planet passed behind its star, causing another small dip in the total light they received. All objects emit some light, called **thermal radiation**, with the intensity and colour of the emitted light depending on how hot the object is.

India set to launch its first X-Ray Polarimeter Satellite: ISRO

News Excerpt:

XPoSat will be launched by the **Polar Satellite Launch Vehicle (PSLV)** from the **Satish Dhawan Space Center in Sriharikota**.

About the XPoSat:

- It aims to investigate the polarisation of intense X-ray sources in the energy band of **8-30 keV**.
- **It is India's First** dedicated polarimetry mission to study **various dynamics of bright astronomical X-ray sources in extreme conditions**.
- According to ISRO, the forthcoming XPoSat mission will bring significant value by focusing on **imaging, time-domain investigations, and spectroscopy**.
- The **mission life** is expected to be approximately **five years**.
- It is **designated for observation from a Low Earth Orbit** (non-sun synchronous orbit of ~650 km altitude, low inclination of approximately six degrees), **carrying two scientific payloads**.
- With these **two payloads**, the XPoSat mission can **simultaneously study temporal, spectral, and polarisation features of the bright X-ray sources**.

- The XPoSat payloads will observe the X-ray sources during the spacecraft's transit through the Earth's shadow, i.e., during the eclipse period.
- The **primary payload** of XPoSat, **POLIX** (Polarimeter Instrument in X-rays), is **designed to measure polarimetry parameters** - specifically the degree and angle of polarisation - in the medium X-ray energy range of 8-30 keV photons originating from astronomical sources.
 - The POLIX payload was developed by the **Raman Research Institute (RRI), Bengaluru**, with support from various ISRO centres.
- The **secondary payload** is the **XSPECT** (X-ray Spectroscopy and Timing), which will provide **spectroscopic information within the energy range of 0.8-15 keV**.
 - The XSPECT payload was developed by the **U.R. Rao Satellite Centre (URSC), ISRO**.

The objective of the satellite:

- The mission objectives include the **measurement of X-ray polarization in the energy band of 8-30 keV emanating from X-ray sources**.
- Long-term spectral and temporal studies of cosmic X-ray sources in the 0.8-15 keV energy band.
- The XPoSat payloads will observe the **X-ray sources during its transit through the Earth's shadow, i.e., during the eclipse period**.

NASA's "Atmospheric Waves Experiment"

News Excerpt:

NASA's first-ever experimental endeavour, the **Atmospheric Waves Experiment**, aims to investigate the interaction between **space weather** and **terrestrial weather**.

About Space Weather:

- The Sun and its activities, such as solar flares and emissions and the types of matter that predominate in the space surroundings, continue to impact the environment around Earth and the other planets.
- When the weather over Earth turns extreme, **Space weather**, too, can suffer extreme events.
 - These directly influence crucial Earthly installations such as satellite-based communication systems, radio communication networks, and space-based aircraft orbits or stations.

- They also impact the seamless functioning of power grids, navigation systems, and Global Positioning Systems (GPS).

About Atmospheric Gravity Waves (AGW):

- **Atmospheric Gravity Waves (AGW)** are one such vertical wave.
- The waves are often produced by abrupt disturbances or extreme weather events that cause stable air to be displaced vertically.
- Natural phenomena like **thunderstorms, hurricanes, tornadoes, regional orography**, and others have the potential to send out a variety of periodic waves, including Atmospheric Gravity Waves (**AGWs**), in the lower levels of the atmosphere.

The objective of NASA's AWE experiment:

- It will map the Earth's atmosphere's vivid airglows with precision.
- It is an **Advanced Mesospheric Temperature Mapper (AMTM)**, an instrument that will **scan or map the mesopause** (a region between the mesosphere and thermosphere).
 - By utilizing the four identical telescopes that make up an imaging radiometer, researchers intend to measure the wavelength-specific brightness of the light
- This information can be converted into a **temperature map, revealing the airglow movement** and, ultimately, giving **clues on their role in the upper atmosphere and Space weather.**

Advanced Mesospheric Temperature Mapper (AMTM)

- It is a remote sensing instrument developed at Utah State University to map temperature structures in the hydroxyl airglow emission at ~87 km.
- These maps can then be used to quantify wave field characteristics and to observe general climatology trends.

Airglow

- Airglow is the **light of excited atoms** high in Earth's atmosphere.
- It's usually **too faint for the eye alone to see**. But under very dark skies, photographers can capture it.
- The phenomenon typically **occurs when molecules (mostly nitrogen and oxygen) are energized by ultraviolet (U.V.) radiation from sunlight**.
- To release that energy, atoms in the lower atmosphere bump into each other and lose energy in the collision.

However, the upper atmosphere is thinner, so atoms are less likely to collide. Instead, they release their energy by emitting photons. **The result is colorful airglow.**

NASA spacecraft 'Psyche'

News Excerpt:

Recently, NASA picked up a laser signal fired from its Psyche spacecraft, which is currently over 16 million km away.

About Psyche Spacecraft Mission

Launch Services Program is responsible for the launch vehicle's insight and approval and manages the Psyche mission's launch service.

- The Psyche mission is a journey to a unique **metal-rich asteroid orbiting the Sun between Mars and Jupiter**. About **2.5 years after launch**, the spacecraft will **fly by Mars for a gravity boost**.
- **Trajectory:** The Psyche spacecraft was targeted to launch in **summer 2022** and travel to the asteroid using **solar-electric (low-thrust) propulsion**, arriving in **2026, following a Mars flyby and gravity-assist in 2023**.
- Scientists believe this asteroid is the **nickel-iron core of an early planet**, studying which could provide **unique insights into the impenetrable iron core of our own planet**.

NASA's Deep Space Optical Communication (DSOC) experiment

- The Psyche mission will test a sophisticated **new laser communication technology** that **encodes data in photons at near-infrared wavelengths (rather than radio waves)** to communicate between a probe in deep space and Earth.
- **Using light instead of radio allows the spacecraft to communicate more data** in a given amount of time.
- DSOC will allow **data rates at least 10 times higher than state-of-the-art radio telecommunications** systems of comparable size and power, enabling higher resolution images, larger volumes of science data, and even streaming video.
- The **Psyche spacecraft** is the **first to carry a DSOC transceiver** and will be testing high-bandwidth optical communications to Earth **during the first two years** of the spacecraft's journey to the main asteroid belt.

Gravitational Lensing

News Excerpt:

Recently, Astronomers for the first time have discovered one of the biggest black holes inside a galaxy, hundreds of millions of light years from Earth, through gravitational lensing throwing the field open for detecting more black holes and investigating their origins.

About Gravitational Lensing:

- **Gravitational lensing** is a phenomenon in which the light from a distant celestial body is bent and distorted by the gravitational field of an intervening object, such as a **galaxy cluster**, that lies between the distant object and the observer.
- This distortion of light can create magnified, stretched, or multiple images of the distant object, allowing astronomers to study the object in greater detail that would otherwise be too far away or too faint to be seen.
- According to **Einstein's general relativity**, light bends when it passes near a massive object in a phenomenon known as **gravitational lensing**.
- This effect is only visible in rare cases and only the best telescopes including the **NASA/ESA Hubble Space Telescope** can observe the results of gravitational lensing.
- This observation used one of the most powerful astronomical cameras in the world, the **Hyper Suprime-Cam (HSC)** mounted on the **8.2m diameter Subaru Telescope** on the summit of Mauna Kea in Hawaii collaborating with scientific community of Japan, Taiwan and Princeton University.

Foucault pendulum

News Excerpt:

Foucault pendulum featured in Parliament's Constitutional Gallery area.

About

- The Foucault pendulum is a simple and elegant scientific device used to demonstrate the rotation of the Earth.
- It consists of a long, heavy pendulum suspended from a fixed point, which is free to swing back and forth in any direction.

The pendulum, created by the **National Council of Science Museum (NCSM)** in Kolkata, is the tallest of its kind in India, standing 22 metres tall and weighing 36 kilogrammes.

- As the pendulum swings, it appears to change its direction of swing due to the rotation of the Earth beneath it.
- The concept behind the Foucault pendulum is based on the **principle of conservation of angular momentum**.
- As the Earth rotates, the plane of oscillation of the pendulum remains fixed in space while the Earth moves beneath it.
- This causes the apparent change in direction of the pendulum's swing, creating a slow rotation over time.
- **By observing the pendulum's movement, one can determine the rotation rate and direction of the Earth.**

Carbon molecule in Orion Nebula

News Excerpt:

The CH₃⁺ molecule, which is also known as **methylation**, has been detected in space for the first time by the James Webb Space Telescope (JWST).

James Webb Space Telescope (JWST)

- It is the world's premier space science observatory led by **NASA with its partners, ESA (European Space Agency) and the CSA (Canadian Space Agency)**.
- Webb will **solve mysteries in our solar system**, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it.
- Recently, it has gazed at the **Crab Nebula**, a supernova remnant located 6,500 light-years away in the **constellation Taurus**.

About

Scientists found the fingerprints of the CH₃⁺ molecule in light coming from a swirling disk of dust and gas around a young star. The disk is in the Orion Nebula, 1,350 light years from Earth.

- Organic molecules are carbon based. They contain carbon atoms bonded to hydrogen atoms but can also bond to other elements, such as oxygen, nitrogen or phosphorus.
- Everything that makes us and all life on Earth is carbon based. CH₃⁺ is a very simple organic molecule, just one carbon atom and 3 hydrogen atoms. But it reacts with other molecules to form more complex ones. **Its presence in space tells us that basic building blocks for life are out there.**
- The James Webb Space Telescope (JWST) is the largest space telescope, made to conduct infrared astronomy.

- Its high-resolution and high-sensitivity instruments allow it to view objects too old, distant, or faint for the Hubble Space Telescope.

Low frequency Gravitational Waves

News Excerpt:

Scientists have found evidence to suggest that the universe is filled with low-frequency gravitational waves.

About

These are ripples in the fabric of space-time that are created by huge objects moving around, colliding, and merging with each other, and predicted by Albert Einstein's General **Theory of Relativity** more than 100 years ago.

- Gravitational waves were first detected in **2015** using an experiment, involving Laser Interferometer Gravitational Observatory (LIGO) detectors. But those waves were of high frequency, believed to be produced by the merger of two relatively small black holes that took place about 1.3 billion years ago.

How were low-frequency gravitational waves detected?

Researchers used six large radio telescopes around the world, including the one in Pune, to study objects called **pulsars** — distant rapidly-rotating neutron stars that emit pulses of radiation, observed from the Earth as bright flashes of light. These bursts take place at extremely precise intervals, and therefore scientists use pulsars as **cosmic clocks**.

- There are much more massive black holes that are constantly merging, black holes that are millions or billions of times larger than our Sun usually at the centre of the galaxies.
- They can produce detectable gravitational waves from times much before their merger. In fact, the merger process can take millions of years, providing a steady supply of gravitational waves. And there are many such events happening all the time. So, there is a sort of **gravitational wave background** that exists all the time.

What are gravitational waves?

In his theory of gravitation, Isaac Newton postulated that the force that makes an apple fall to Earth is also the one that keeps the moon in its orbit around the Earth. Essentially, every celestial body exerts an attractive force on every other. This force, he proposed, was proportional to the masses of the two bodies and inversely proportional to the square of the distance between

them. So, the greater the distance between the bodies, the lower the gravitational force between them.

Gravitational waves and electromagnetic waves -

- Almost 95 per cent of the universe is known to consist of dark matter and dark energy, which don't emit any light or any other electromagnetic waves.
- Gravitational waves essentially give us the ability to 'see' what remains 'invisible' to us in the universe.
- The acceleration of electric charges creates electromagnetic waves, propagating in space and time.
- However, gravitational waves, created by the acceleration of mass, are waves of the spacetime 'fabric' itself.

What is space Time

In his Special Theory of Relativity, Einstein proposed that space and time don't exist as independent entities, combining the three dimensions (height, width and depth) of space and one dimension of time into a single four-dimensional continuum, known as spacetime.

Dark Stars

About

"Dark Stars" are theoretical objects powered by particles self-annihilation of dark matter—the invisible stuff that is thought to make up about 85 per cent of the matter in the universe.

Inconclusive

The researchers can't yet prove that the objects are dark stars—only that their characteristics are consistent with being either dark stars or galaxies populated by regular fusion-powered stars.

- In Contradiction to their name, dark stars could typically have glowed a billion times more luminous than the sun and grown to a million times its mass.
- Dark stars have never been definitively observed, but cosmological simulations suggest that they should have formed soon after the big bang from clouds of pure hydrogen and helium that collapsed at the centers of protogalaxies rich in dark matter.
- **Dark matter** is a mysterious form of matter that does not interact with electromagnetic forces; scientists only know it exists because of its gravitational effects, and they don't know what it's made of.

VOYAGER 2 Mission

News Excerpt:

Recently, NASA detected a signal from its Voyager 2 spacecraft on August 1, after losing communication for over a week.

About Voyager 2 Mission

- Voyager 2 launched on Aug. 20, 1977, about two weeks before the Sept. 5 launch of Voyager 1.
- NASA's Voyager 2 is the second spacecraft to enter interstellar space. On Dec. 10, 2018, the spacecraft joined its twin—Voyager 1—as the only human-made objects to enter the space between the stars.
- Voyager 1 and 2 were designed to take advantage of a rare planetary alignment to study the outer solar system up close.
- Voyager 2 targeted Jupiter, Saturn, Uranus and Neptune.

Reason for sending the Voyager spacecraft into space

- In 1972, NASA cancelled its plans of exploring the five outer planets (Mars, Jupiter, Saturn, Uranus and Neptune) with four highly complex spacecraft — the proposal, estimated to cost \$ 1 billion, was scrapped due to budgetary constraints. In place of this voyager mission was sent.

Features Of Voyager spacecraft Mission

- Voyager 1 and Voyager 2 are identical spacecraft. Each of them is equipped with instruments to carry out 10 different experiments.
- The instruments include **television cameras** — to take images of planets and other celestial bodies — **infrared and ultraviolet sensors, magnetometers, plasma detectors, and cosmic-ray and charged-particle sensors.**
- Both spacecraft feature a **large antenna**, 3.7 metres in diameter, which is used to receive commands from Earth and radio their findings back to the planet.
- Unlike other Spacecrafts which are powered by solar energy. Voyagers are **Nuclear-powered Spacecrafts.**
- Each Voyager spacecraft is adorned with a golden phonograph record — a 12-inch disc, intended to be a sort of time capsule from Earth to any extraterrestrial life that might intercept the probes in the distant future.

Tellurium

News Excerpt:

Physicists have found evidence that **Tellurium** is produced in **Neutron Star Mergers**. The discovery of tellurium bolsters the theory that these **neutron star mergers are responsible for forming most of the heavy elements in the universe.**

About Tellurium:

- Tellurium is present in the **Earth's crust only in about 0.001** parts per million.
- It is obtained commercially **from the anode muds** produced during the electrolytic refining of copper. These contain up to **about 8% tellurium.**
- This element is a **poor conductor of heat** and only a **fair conductor of electricity.**
- Tellurium burns in air or oxygen with a **blue-green** flame, forming the dioxide (TeO₂).

Uses of Tellurium:

- It is used in **alloys**, mostly with **copper and stainless steel**, to improve their machinability.
- When added to lead, it becomes more resistant to acids and its strength and hardness are improved.
- It has been used to **vulcanize rubber, tint glass, and ceramics, in solar cells, and rewritable CDs and DVDs.**
- It is used as a **catalyst** in oil refining.
- It can be **doped with silver, gold, copper, or tin** in semiconductor applications.
- Tellurium found historical applications in the **treatment of microbial infections** before the discovery of antibiotics.

About Neutron Star Mergers:

- When two neutron stars orbit each other, they gradually **spiral inward due to strong gravitational forces.**
- When these two meet, their merger leads to the **formation of either a more massive neutron star or a black hole.**
- The **James Webb Space Telescope** has detected some of these heavy elements being created in a star merger for the **first time.**

Dinkinesh asteroid

News Excerpt:

NASA's Lucy spacecraft has captured its first images of the main belt asteroid Dinkinesh, marking the beginning of a 12-year voyage.

About Dinkinesh asteroid:

- It was discovered in **1999 by the LINEAR survey.**

- Dinkinesh is a slow rotator with a moderately large light-curve amplitude.
- It is an **S-type asteroid**, which means it is composed **mainly of silicates and some metal**.
- It will be Lucy mission's 1st fly-by target on November 1, 2023, during its cruise to the Trojan Clouds.
- The observations were made by Lucy's high-resolution camera, the **Lucy Long Range Reconnaissance Imager** (L'LORRI instrument).

Lucy Mission:

- Launched by NASA from the Cape Canaveral Space Force Station in Florida in 2021.
- 12-year **mission** that will take close observations of **nine of Jupiter's Trojans** and two main belt asteroids along with that.
- First spacecraft sent to study the **Trojan asteroids**, which orbit the Sun in the same path that the planet Jupiter takes.

Naming sites on the Moon: Outer Space treaty

PM Modi announced the name '**Shiv Shakti**' to the point where the Chandrayaan-3 lander touched down on the lunar surface.

Debate on naming the place on the Moon:

- The **Moon does not come under any single jurisdiction**.
- In 1966, the **United Nations Office for Outer Space Affairs** came out with the **Outer Space Treaty**.
- Setting some common principles for space exploration, the Treaty said: "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means".
- This meant countries had to cooperate in their Space exploration activities and could not stake a claim to the Moon. It can plant a flag in some places.

- However, the treaty **didn't talk about the naming of sites on the Moon**.

Who names the landing sites on the Moon?

- **International Astronomical Union (IAU)** (1919):
 - The Union headquartered in Paris, has **92** member countries of which **India too is a part**.
 - IAU determines some other rules for Space activities which similarly applies to the naming process.
 - **Process of naming a place on the moon:**
 - Upon successful review by vote of the expert members in planetary science, of the Working Group, Approved names are immediately entered into the **Gazetteer of Planetary Nomenclature**, and posted on its web.
 - Any objections can be raised by mailing to **the IAU General Secretary** within **3 months** from the time the name was implemented/used.

Other Indian names on the Moon		
Sarabhai crater	Jawahar Sthal	Tiranga Point
It is a small, circular, bowl-shaped crater on the Mare Serenitatis, in the northeast quadrant of the Moon. It is the landing site of Apollo 17 and Luna 21 missions.	After the Chandrayaan-1 mission in 2008, a spot where the probe crashed, was named "Jawahar Sthal" after the first Indian PM, Jawaharlal Nehru.	This point represents, where the Chandrayaan-2 mission crashed, which was the second attempt by India to reach the Moon.

DISEASES

Diseases in News	Details
<p>H1N2 News Excerpt: The UK Health Security Agency reported the country's first human case of the H1N2 virus, also known as the pig virus.</p>	<p>About H1N2:</p> <ul style="list-style-type: none"> • The virus is called influenza A(H1N2) v. • It is similar to a strain of flu circulating in pigs. • A(H1N2) v is a subtype of the influenza A virus. • Influenza A viruses circulate in seven species, including humans, birds, and pigs, but normally stay within their species. <p>Influenza A Virus:</p> <ul style="list-style-type: none"> • The primary subtypes of influenza A virus are H1N1, H1N2, and H3N2. • The influenza A virus causes influenza (the flu), a highly contagious respiratory infection. • Influenza B and, in rare cases, influenza C can also cause the flu. • It is spread by droplets from an infected person's nose or throat, generally by coughing and sneezing. • Influenza A infections are most common in winter. • The proteins on the surface of the influenza A virus are called hemagglutinin (H) and neuraminidase (N). • Some influenza A subtypes can infect animals, including: <ul style="list-style-type: none"> • Birds (causing avian flu) • Pigs (causing swine flu)
<p>POMPE DISEASE News Excerpt: India's first patient diagnosed with the rare Pompe disease died recently after spending nearly six years in a semi-comatose state. According to the Central government, an estimated 70 million people in India suffer from 450 rare diseases.</p>	<p>About Pompe disease:</p> <ul style="list-style-type: none"> • A rare inherited disorder that affects one child per million, caused by a deficiency of the enzyme acid alpha-glucosidase (GAA). • It results in the accumulation of glycogen in cells, particularly in muscles. • Some common side effects and symptoms include progressive muscle weakness, difficulty in mobility, respiratory issues, heart problems, and difficulty swallowing. • There are two forms of Pompe disease: <ul style="list-style-type: none"> ○ Early onset (infantile form) is caused by the complete or near complete deficiency of GAA. • Late onset (juvenile/adult) results from partial deficiency of GAA and can begin as early as the first decade of childhood or well into adulthood.
<p>H9N2 FLU News Excerpt: The Union Health Ministry is closely monitoring the reported outbreak of H9N2 cases and clusters of respiratory illness in children in northern China.</p>	<p>About the H9N2 Virus (Avian influenza virus):</p> <ul style="list-style-type: none"> • H9N2 is a subtype of the influenza A virus that causes both human and bird flu. • In 1966, the H9N2 subtype was isolated for the first time in Wisconsin, United States. • H9N2 viruses are present in wild birds all over the world and are endemic in many areas of poultry. • There is a risk of occasional infection and small clusters of human infections due to exposure to diseased birds or contaminated settings, according to the World Health Organisation (WHO). • In 1998, Hong Kong reported the first incidence worldwide. • Symptoms: Mild, flu-like symptoms or eye inflammation to severe, acute respiratory disease or death. <p>In India:</p> <ul style="list-style-type: none"> • The virus was picked up in February 2019 during a community-based surveillance study in 93 villages of Korku tribes in the Melghat district of Maharashtra. • Vaccine by India: Bhopal-based ICAR-National Institute of High-Security Animal Diseases (NIHSAD) has developed the "Inactivated low pathogenic avian influenza (H9N2) vaccine for chickens". • It is the first indigenous vaccine for the H9N2 virus for animals.

	<ul style="list-style-type: none"> The Indonesian government has built an effective vaccination strategy against H5N1 and H9N2 strains.
<p>WHITE LUNG SYNDROME News Excerpt: There is an outbreak of respiratory illness- 'White Lung Syndrome' in children from China to the US and some parts of Europe.</p>	<p>About White Lung Syndrome:</p> <ul style="list-style-type: none"> When we see the X-ray or CT scans of the lungs, they appear black. This indicates that air is present in the lungs. Whenever there is an inflammation or collection of fluid in the lungs, which restricts the air sacs, the lungs show up white. The white patches are because of a bacterial or viral infection. It includes some respiratory illnesses like acute respiratory distress syndrome, silica-related conditions, and pulmonary alveolar microlithiasis. Causes: Combination of bacterial, viral, and environmental factors. Symptoms: cough, fever, runny nose, phlegm pileup in sinuses, difficulty breathing, and fatigue. <p>Other Chronic Respiratory related diseases:</p> <ul style="list-style-type: none"> Silicosis- caused by inhaling silica dust. Acute respiratory distress syndrome (ARDS)- occurs when fluid builds up in the air sacs in the lungs. Pulmonary Alveolar Microlithiasis (PAM)- caused by deposits of calcium in the air sacs of the lungs.
<p>Elephant Endotheliotropic HerpesVirus News Excerpt: A new study has assessed the circulation of the Elephant Endotheliotropic HerpesVirus subtypes (EEHV) responsible for the recent rise of the disease in Asian Elephants.</p>	<p>About Elephant Endotheliotropic Herpesvirus (EEHV):</p> <ul style="list-style-type: none"> EEHV is a double-stranded DNA virus that is classified in the family Herpesviridae. It causes acute, fatal hemorrhagic disease in wild and captive juvenile Asian and African elephants. If severe, EEHV can result in death within 24 hours of infection. EEHV consists of eight genotypes that include EEHV1 through EEHV6, each varying in their lethality.
<p>LATHYRISM News Excerpt: Scientists are working to aid research on improved varieties of grass pea.</p>	<p>About Lathyrism:</p> <ul style="list-style-type: none"> Lathyrism is one of the oldest known neurotoxic disorders, with symmetrical spastic leg weakness with no sensory deficit, resulting from excessive consumption of grass pea (Lathyrus sativus) an environmentally tolerant legume that has seed with high protein content. <ul style="list-style-type: none"> It is an irreversible Neurological Disease that leads to paralysis of the lower limbs. <p>Common causes are:</p> <ul style="list-style-type: none"> Ingestion of beta-aminopropionitrile. Consumption of peas of species Lathyrus sativus which has a neurotoxin called beta oxalyl amino alanine (BOAA).
<p>NOROVIRUS News Excerpt: Norovirus cases rise in the UK, with more than 1,500 infected.</p>	<p>About:</p> <ul style="list-style-type: none"> Norovirus is a highly contagious virus that causes acute gastroenteritis (inflammation of the stomach and intestines) leading to symptoms like nausea, vomiting, diarrhea, fever, headaches, and body aches. The primary route is oral-faecal. It is transmitted through contaminated food, water, and surfaces and can be contracted multiple times as the virus has different strains. The virus is resistant to many disinfectants and can survive in heat up to 60°C. Therefore, merely steaming food or chlorinating water does not kill the virus.

	<ul style="list-style-type: none"> The basic precaution is washing hands frequently with soap and maintaining hydration.
<p>Noma News Excerpt: The World Health Organization (WHO) added one of the world's most under-recognized health challenges, NOMA, to its official list of neglected tropical diseases (NTD).</p>	<p>About:</p> <ul style="list-style-type: none"> It is also known as cancrem oris or gangrenous stomatitis, which is a severe gangrenous disease of the mouth and face. <ul style="list-style-type: none"> The name of the disease comes from the Greek word "nomē", meaning "to devour", as noma eats away facial tissue and bones if not treated early. It mainly affects children aged 2-6 years old and is found most commonly among those living in poor communities. Noma is associated with extreme poverty, malnutrition, poor access to sanitation, weakened immune systems, infections, and oral hygiene with a mortality rate of approximately 90%. The disease is also called the 'face of poverty', as effective drugs and adequate surgical treatment remains inaccessible for many due to extreme poverty.
<p>JN.1 variant of COVID News Excerpt: A new coronavirus variant named JN.1 has been detected.</p>	<p>About the JN.1 variant of COVID:</p> <ul style="list-style-type: none"> This variant is considered to be the Omicron subvariant BA.2.86 or Pirola. Pirola and JN.1 are considered to be Variants of Interest. Variants of Interest: These variants are less effectively neutralized in labs by antibodies from infection or vaccination and have the potential to spread. JN.1 contains only one additional mutation on the spike protein as compared with Pirola, Pirola contains more than 30 mutations on the spike protein. Mutations in the spike protein increase its infectivity and ability to evade immune responses. Symptoms associated with JN.1 include - fever, runny nose, sore throat, headache, and mild gastrointestinal symptoms such as abdominal pain and diarrhoea.
<p>Mpox News Excerpt: Recently, the World Health Organization confirmed the sexual transmission of Mpox in Congo. This is the first definitive proof of sexual transmission of monkeypox in Africa. After COVID-19, Monkey Pox (earlier M Pox) no longer constitutes a Global Health Emergency as announced by the World Health Organisation after a recommendation from the emergency committee noticed decrease in reported cases and a robust response from</p>	<p>About Mpox:</p> <ul style="list-style-type: none"> Mpox (formerly known as monkeypox) virus is part of the same family of viruses as the variola virus, which causes smallpox. Monkeypox virus (MPXV) is an enveloped double-stranded DNA virus that belongs to the Orthopoxvirus genus of the Poxviridae family. Symptoms: painful rash, enlarged lymph nodes, and fever. The natural reservoir of the virus is unknown - various small mammals such as squirrels and monkeys are susceptible. Person-to-person transmission of mpox can occur through direct contact with infectious skin or other lesions. M Pox was first discovered in 1958 as there were two outbreaks of disease similar to smallpox in colonies of monkeys and hence was named monkeypox. It was found that it is a viral zoonotic disease with less clinical severity than smallpox. Early symptoms of Monkeypox include enlargement of the lymph gland through which it can be distinguished from smallpox. It mainly occurs in communities where there is often a high background prevalence of malnutrition, parasitic infections, and other significant health-compromising conditions, any of which could impact the prognosis of a patient with MPox. Its symptoms include fever, malaise, and headache more severe than chickenpox infection. Laboratory confirmation of mpox is done by testing skin lesion material by PCR. <p>Transmission</p> <ul style="list-style-type: none"> Human-to-human transmission

<p>countries affected by the virus.</p>	<ul style="list-style-type: none"> • Animal-to-human transmission: • Treatment: JYNNEOS is a 2-dose vaccine developed to protect against mpox and smallpox infections. People need to get both doses of the vaccine for the best protection against mpox. The second dose should be given 4 weeks after the first dose. • Vaccination is an important tool in stopping the spread of mpox. <p>In India:</p> <ul style="list-style-type: none"> • India reported its first case of Monkeypox in July 2022 in an old man from Kerala who arrived from UAE, also the first in the WHO South-East Asia Region. • India, so far, has reported 71 cases of monkeypox with one death in the southern state of Kerala till October 2022. • As per ICMR-NIV analysis, in India 90%–99% of the genome of M Pox are of A.2 lineage (US) of virus which is different from the B.1 strain (Europe).
<p>Late Blight Disease</p> <p>News Excerpt: Several farmers of Sanaur in Patiala district have claimed that their tomato and potato crops have been damaged by blight disease, triggered by bad weather and fog.</p>	<p>About Late Blight Disease:</p> <ul style="list-style-type: none"> • It is a fungal disease of potato and tomato plants, caused by the water mold <i>Phytophthora infestans</i>. • Symptoms: <ul style="list-style-type: none"> ○ The first symptoms appear as small, light to dark green, circular to irregular-shaped water-soaked spots. ○ During cool, moist weather, these lesions expand rapidly into large, dark brown or black lesions, often appearing greasy. ○ A pale green-to-yellow border often surrounds the lesions. ○ When plants have become infected, lesions (round or irregularly shaped areas) appear on the leaves, petioles, and stems. ○ A whitish growth of spore-producing structures may appear at the margin of the lesions on the underleaf surfaces. • The disease occurs in humid regions with temperatures ranging between 4 and 29 °C (40 and 80 °F). • Potato or tomato plants that are infected may rot within two weeks. • The Great Famine in Ireland in the mid-19th century was caused by the late blight of the potato plant.
<p>Guillain-Barré Syndrome</p> <p>News Excerpt The Peruvian government recently declared a state of national emergency due to a spike in the number of cases of a rare neurological disorder called Guillain-Barré Syndrome.</p>	<p>About: In GBS, the body’s immune system — which normally protects it from infections and other foreign bodies mistakenly attacks its own peripheral nerve cells.</p> <p>It’s also called:</p> <ul style="list-style-type: none"> • Acute Inflammatory Demyelinating Polyneuropathy • Landry’s Ascending Paralysis <p>Causes of GBS</p> <ul style="list-style-type: none"> • Approximately 50% of cases occur shortly after a microbial infection (viral or bacterial), like flu or food poisoning. It may be triggered by: <ul style="list-style-type: none"> ○ Infection with campylobacter: A type of bacteria often found in undercooked poultry. <p>Autoimmune trigger: In this, the patient’s defense system of antibodies and white blood cells are called into action against the body, damaging myelin (nerve covering or insulation), leading to numbness and weakness.</p> <ul style="list-style-type: none"> • Risk factors: GBS can affect all age groups, It’s slightly more common in males than females. • Vaccinations: The chances of developing the condition of GBS after having a vaccination are extremely small.

	<p>Treatments of GBS:</p> <p>Intravenous immunoglobulin (IVIG)</p> <ul style="list-style-type: none"> • IVIG is a treatment made from donated blood that contains healthy antibodies. • It is given directly into a vein. • These are given to help stop the harmful antibodies damaging the nerves. <p>Plasma exchange (plasmapheresis)</p> <ul style="list-style-type: none"> • A plasma exchange, also called plasmapheresis, is sometimes used instead of IVIG. • This involves being attached to a machine that removes blood from vein and filters out the harmful antibodies that are attacking your nerves before returning the blood to body. <p>India's stand:</p> <ul style="list-style-type: none"> • India is far behind in GBS research as compared to other countries like USA, as there might be a low case report of the GBS in Indian population.
<p>Conjunctivitis Infection News Excerpt: Recently, In July Bengaluru hospitals saw a spurt in conjunctivitis cases.</p>	<p>About Conjunctivitis Infection</p> <ul style="list-style-type: none"> • Conjunctivitis, also known as 'pink eye', is an inflammation of a thin transparent membrane covering the eyeball called conjunctiva. • Pink eye is most often caused by a viral infection. It also can be caused by a bacterial infection, an allergic reaction or — in babies — an incompletely opened tear duct. <p>Symptoms:</p> <ul style="list-style-type: none"> • Redness in one or both eyes, Itchiness in one or both eyes, A gritty feeling in one or both eyes, A discharge in one or both eyes that forms a crust during the night that may prevent your eye or eyes from opening in the morning, Tearing, Sensitivity to light, called photophobia. <p>Issues and Concerns</p> <ul style="list-style-type: none"> • Corneal scarring: It is rare and often preventable. But if left untreated, there can be permanent tissue damage. • Secondary Infection: It occurs when a different infection, known as a primary infection, has made a person more susceptible to disease. It occurs either after or because of another infection.
<p>Middle East Respiratory Syndrome (MERS) News Excerpt: United Arab Emirates reports new MERS coronavirus case.</p>	<p>About</p> <ul style="list-style-type: none"> • Middle East respiratory syndrome (MERS) is a viral respiratory disease caused by Middle East respiratory syndrome coronavirus (MERS-CoV). • MERS-CoV is a zoonotic virus, meaning it is transmitted between animals and people and linked to human infections in dromedary camels. • It was first identified in Saudi Arabia in 2012. Since its detection, 27 countries reported MERS cases from North American, European, African, and Asian continents. • Typical MERS symptoms include fever, cough and shortness of breath, pneumonia, and gastrointestinal symptoms, including diarrhoea, have been reported. Approximately 35% of MERS cases reported to WHO have died. • Coronaviruses are a large family of viruses that can cause diseases ranging from the common cold to severe acute respiratory syndrome (SARS) and Coronavirus disease-2019 (COVID-19).
<p>Havana Syndrome News Excerpt: The Central government has told the Karnataka High Court that it will look into</p>	<p>About Havana Syndrome:</p> <ul style="list-style-type: none"> • A set of mental health symptoms said to be experienced by US intelligence and embassy officials in various countries. • It traces its roots to Cuba in late 2016, a year after the US opened its embassy in Havana.

<p>the matter of the 'Havana Syndrome' in India.</p>	<ul style="list-style-type: none"> • Symptoms: Headache, nausea, Insomnia, depression, impaired balance, concentration and memory loss <p>Causes of Havana Syndrome</p> <ul style="list-style-type: none"> • Initially, the suspicion was on Cuban intelligence or a section within the Cuban establishment. It was speculated to be a "sonic attack". • However, further study by US scientists and medical examination of the victims began to suggest subjection to high-powered microwaves. • Greater exposure to high-powered microwaves causes damage to the nervous system. • The use of microwaves as a counter-intelligence tactic has been experimented with since the Cold War by both Russia and the US. <p>Havana Syndrome in India:</p> <ul style="list-style-type: none"> • A US intelligence officer travelling with the CIA director in India reported these symptoms in 2021. • However, sources in the Indian security establishment denied any such weapon being in the possession of an Indian agency.
<p>Leptospirosis About: Leptospirosis has emerged as an important infectious disease in the world today.</p>	<p>Symptoms of leptospirosis</p> <ul style="list-style-type: none"> • The severity of a leptospirosis infection ranges from a mild flu-like illness to being life-threatening. • The infection can affect many organs, reflecting the systemic nature of the disease. This is also why the signs and symptoms of leptospirosis are often mistaken for other diseases. • In milder cases, patients could experience a sudden onset of fever, chills, and headache – or no symptoms at all. But in severe cases, the disease can be characterised by the dysfunction of multiple organs, including the liver, kidneys, lungs, and the brain. • Animals exhibit a variety of clinical symptoms and indications. In cattle and pigs, the disease can potentially cause reproductive failure, stillbirths, and weak calves or piglets. Dogs experience a range of symptoms, including fever, jaundice, vomiting, diarrhoea, renal failure, and even death.
<p>Polycystic Ovary Syndrome (PCOS) News Excerpt: Polycystic Ovarian Syndrome (PCOS) is a commonly seen hormonal disorder in reproductive women.</p>	<p>About: It is a common diagnosis in women presenting with infertility. PCOS is a syndrome, not a disease. It is a lifelong condition that continues far beyond childbearing years. An estimated one in five (20%) Indian women suffer from PCOS.</p>
<p>Middle East Respiratory Syndrome (MERS) Context United Arab Emirates reports new MERS coronavirus case</p>	<p>About</p> <ul style="list-style-type: none"> • Middle East respiratory syndrome (MERS) is a viral respiratory disease caused by Middle East respiratory syndrome coronavirus (MERS-CoV). MERS-CoV is a zoonotic virus, meaning it is transmitted between animals and people and linked to human infections in dromedary camels. • It was first identified in Saudi Arabia in 2012. Since its detection, 27 countries reported MERS cases from North American, European, African, and Asian continents. • Typical MERS symptoms include fever, cough and shortness of breath, pneumonia, and gastrointestinal symptoms, including diarrhoea, have been reported. Approximately 35% of MERS cases reported to WHO have died. • Coronaviruses are a large family of viruses that can cause diseases ranging from the common cold to severe acute respiratory syndrome (SARS) and Coronavirus disease-2019 (COVID-19).

<p>Inflammatory Bowel Disease (IBD) Context A recent study published in the Lancet journal discovered that Inflammatory Bowel Disease (IBD) is now as prevalent in rural India as it is in urban areas.</p>	<p>About Inflammatory Bowel Disease (IBD), IBD is a term that describes disorders involving long-standing (chronic) inflammation of tissues in your digestive tract.</p> <p>Types of IBD include</p> <ul style="list-style-type: none"> • Ulcerative colitis and Crohn's disease. It's a chronic condition that have no known cure. It is usually characterized by diarrhoea, rectal bleeding, abdominal pain, fatigue, loss of appetite and weight loss. For some it is a mild disease for others it can lead to life threatening complications. • The lancet study was conducted in rural Telangana. It points to urbanisation of rural areas as a leading cause of this shift. • The changing environments and dietary habits, the availability of processed food has increased. With globalisation, IBD made its entry into the developing world • It's suggested that the government increases awareness of lifestyle diseases in rural areas and emphasise the importance of diet and exercise for the rural population. Constant monitoring is recommended, along with regulations on ultra-processed food, like those in European countries.
<p>Migraine Disease Context Researches on exploring new migraine treatments.</p>	<p>About</p> <ul style="list-style-type: none"> • A migraine is a headache that can cause severe throbbing pain or a pulsing sensation, usually on one side of the head. It's often accompanied by nausea, vomiting, and extreme sensitivity to light and sound. • Migraine attacks can last for hours to days, and the pain can be so bad that it interferes with daily activities. • Around 15% of world population suffers from migraine. <p>Origins</p> <ul style="list-style-type: none"> • Migraine attacks are thought to originate in the meninges, layers of membrane that protect the brain. • When sensitized, neurons send signals to the brain which trigger headache, photophobia, etc. • These neurons are also close to blood vessels, which is why headaches can feel like they pulse along with your heartbeat. • It primarily affects the brain, but also involves the whole body such as the immune, digestive, and cardiovascular system. That is why taking pain killers doesn't work in migraine. <p>Triggers and Symptoms</p> <ul style="list-style-type: none"> • Bright lights, loud sounds, strong smells, lack of sleep, dehydration, caffeine, alcohol, hormone fluctuations and stress. • Mood changes, food cravings, visual phenomena (seeing various shapes, bright spots, or flashes of light), pins and needles sensations in an arm or leg, weakness, or numbness in the face or one side of the body. <p>Treatments</p> <ul style="list-style-type: none"> • CGRP monoclonal antibodies and triptans provide relief but they don't work for everyone. • Research is going on in Neuromodulation devices (e-TNS), oxytocin nasal sprays and dietary supplementation such as grape seed extracts, chicken broth, etc.
<p>Duchenne Muscular Dystrophy Context- 'disease-modifying' treatment for Duchenne's Muscular Dystrophy (DMD) developed by Indo-Japanese researchers.</p>	<p>About- DMD is a rare genetic disease that affects only male children, with approximately 80,000 patients in India.</p> <ul style="list-style-type: none"> • Modification is done by, using a food additive — a beta-glucan produced by N-163 strain of a yeast <i>Aureobasidium pullulans</i>. • Research showed no adverse reaction in the participants and it potentially delayed progress of disease without side effects to the liver and kidneys. <p>Static info- Muscles need lubricant. Dystrophin, an enzyme secreted in the muscles, helps in wear and tear and regeneration of muscles. Because of the genetic disorder, muscles cannot produce dystrophin.</p>

	<ul style="list-style-type: none"> • Currently available treatments were gene therapy, Exon-skipping and disease modifying agents (anti-inflammatory medicines such as steroids)
<p>Thalassaemia Disease: News Excerpt: The drug regulator in the United Kingdom has also approved the gene therapy Casgevy for patients with Thalassaemia.</p>	<p>About</p> <ul style="list-style-type: none"> • Thalassaemia is an inherited blood disorder. • In the case of thalassaemia, too, people who inherit a pair of genes from both parents' experience symptoms like severe anaemia. • Low haemoglobin levels caused by thalassaemia lead to exhaustion, dyspnea, and erratic heartbeats. • People with the condition need blood transfusions throughout their life. • Additionally, the transfusions cause the body to accumulate too much iron, thus necessitating additional treatment. • As per the National Health Mission (2016) report, with roughly 1-1.5 lakh children suffering from thalassaemia major, India likewise has the highest number of such cases worldwide.
<p>Measles</p> <p>News Excerpt: Global measles cases surge, WHO reports discrepancies; India refutes, cites vaccination program success.</p>	<p>About:</p> <ul style="list-style-type: none"> • Measles is caused by a single-stranded, enveloped RNA virus with 1 serotype. • It is classified as a member of the genus Morbillivirus in the Paramyxoviridae family. • Humans are the only natural hosts of the measles virus. • It spreads easily when an infected person breathes, coughs, or sneezes. • Measles infects the respiratory tract and then spreads throughout the body. • Symptoms include a high fever, cough, runny nose, and a rash all over the body. <p>Report of the WHO and the U.S. Centres for Disease Control and Prevention (CDC):</p> <ul style="list-style-type: none"> • Measles cases increased by 18% globally in 2022, with deaths rising by 43% compared to 2021. • Globally, 22 million children did not receive their first measles shot in 2022 and half of them live in 10 countries including India, where an estimated 1.1 million infants did not get the first dose of the vaccine. <p>Measles in India:</p> <ul style="list-style-type: none"> • India is the capital of the recent outbreak of measles in the world. There were 172 confirmed measles outbreaks from October 2021 to September 2022, with a total no. of cases of 12,589. <p>The Measles-Rubella (MR) 2020 program:</p> <ul style="list-style-type: none"> • It had the goal to eliminate measles by 2020, but due to the COVID-19 outbreak, it was revised to 2023. • MR campaign targets around 41 crore children in the age group of 9 months to 15 years (covering 1/3 of the total population of the country) followed by 2 doses in routine immunization at 9-12 months and 16-24 months. The rubella component is now under routine immunization as an MR vaccine.