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What is Virovore?

- Researchers have found the first known “Virovore,” or organism that eats viruses.
- These virus-eating species of protists — which are their own kingdom on the tree of life and are not an animal, plant, or fungi — are now classified as **Virovores**.
- It is a species of **Halteria - microscopic ciliates** that populate freshwater worldwide.
 - The microbe Halteria is a common genus of protist known to flit about as its hair-like cilia propel it through the water.
- They’re made up of nucleic acids, nitrogen, and phosphorus. It can eat **huge numbers of infectious chloroviruses that share their aquatic habitat**.
 - Chloroviruses are known to infect microscopic green algae.
- These organisms can sustain themselves **with viruses, consuming many and growing in size**.
- A virus-only diet, termed “virovory,” is enough to fuel **the physiological growth and even population growth of an organism**.

What is the Stem Cell-derived Mitochondria Transplantation?

- A rare disorder caused by deletion in the genomes of their mitochondria was successfully treated for the first time by Stem-cell derived Mitochondria Transplantation.
- It involves the **spontaneous mitochondrial transfer of the stem cell to rescue the injured cells** or the injection of stem cell isolated mitochondria into the injured area to repair the damage.
 - Stem cells are the **most primitive cells at the top of the origin of cell lines**, and they have a **high capacity for differentiation and self-renewal**.
 - In addition, stem cells **can differentiate into various tissues, organs, or functional cells of the human body**; therefore, stem cells hold **great promise for therapeutic tissue engineering and regenerative medicine**.

What are Mitochondria?

- Mitochondria are **membrane-bound semi-autonomous cell organelles** and are often referred to as **the powerhouses of the cell**.
 - They **generate most of the chemical energy needed** to power the cell’s biochemical reactions.
 - Chemical energy produced by the mitochondria is stored **in the form of Adenosine Triphosphate (ATP)**.
- Mitochondria contain their own **Deoxyribonucleic Acid (DNA)**. Generally, mitochondria, and therefore **mitochondrial DNA, are inherited only from the mother in almost all multicellular organisms**.
 - Mitochondria in mammalian sperm are usually **destroyed by the egg cell after fertilization**.
 - **The mitochondria are present at the base of the sperm’s tail**, which is used for propelling the sperm cells; sometimes the tail is **lost during fertilization**.

What are Local Bubbles?

- Recently, new research on a giant cosmic cavity that surrounds the solar system could reveal the universe’s secrets, including questions about the origins of stars.
- Researchers from the Center for Astrophysics (CfA) | Harvard & Smithsonian have generated a 3D magnetic map of the cavity called Local Bubble.
- The **Local Bubble** is a **1,000-light-year-wide cavity** or a **superbubble**. Other **superbubbles** also exist in the **Milky Way**.
- The **Local Bubble** is a **large, low-density region** in the **interstellar medium (ISM)** of our galaxy, the **Milky Way**.
 - The interstellar medium is the material which fills the space between the stars.
- It’s a cavity that is thought to have been created by a series of **supernovae explosions** that occurred about **30 to 50 million years ago**.

What is Lumpy Skin Disease?

- Recently, the Punjab State government has airlifted 25 lakh doses of goat pox vaccine to carry out a free vaccination campaign for early prevention of cattle from lumpy skin disease.

Note:

- Lumpy Skin Disease (LSD) had affected the cattle on a large scale in July, 2022. About 1.75 lakh cattle were affected across the Punjab state and about 18,000 cattle died.
- **Causes:**
 - LSD is caused by infection with the **Lumpy Skin Disease Virus (LSDV)** in cattle or water buffalo.
 - The **Food and Agriculture Organization (FAO)** estimates that its **mortality rate is less than 10%**.
 - The **first reported outbreak of LSD occurred in Zambia in 1929**, and it was initially believed to be caused by poisoning or an allergic reaction to insect bites.
- **Transmission:**
 - LSD is primarily **spread between animals through the bite of vectors**, such as mosquitoes and flies.
- **Symptoms:**
 - The primary symptoms of LSD include **fever, discharge from the eyes and nose, drooling, and blisters** on the skin.
 - Also, affected animals may also **lose their appetite** and have difficulty in eating, leading to **reduced milk production**.
- **Prevention and Treatment:**
 - Currently, India is administering the **goat pox vaccine and sheep pox virus vaccines for LSD**.
 - It's a **heterologous vaccine that offers cross-protection** for cattle against the disease.
 - **Goat pox, sheep pox and LSD** belong to the same **capripoxvirus genus**.
- Key technologies include cloud computing, **big data**, **autonomous robots**, **cybersecurity**, simulation, additive manufacturing, and the **internet of things (IoT)**.
- The term **4IR** was coined by Klaus Schwab, executive chairperson of the WEF, in 2016.
- **Major Examples of its Application:**
 - **Pacemaker:** The **pacemaker** is a near-perfect example of the ongoing **fourth industrial revolution (4IR)**.
 - The **four wireless sensors of the pacemaker** monitor vitals such as **temperature, oxygen levels and the heart's electrical activity**.
 - The device then analyses the vitals and decides when to pace the heart and at what rate. **Doctors can wirelessly access the information** on a tablet or smartphone.
 - **Xenobots:** **Xenobots**, which are less than a millimetre long, are known to be the first **living robot**, were created in 2020 from the stem cells of the **African clawed frog** and can be programmed using **artificial intelligence**.
 - It has a reproductive ability demonstrated in October 2021 by a team of US scientists.
 - When the researchers put the xenobots into a **petri dish**, they were able to gather hundreds of tiny stem cells inside their mouths and **create new xenobots a few days later**.
 - Once perfected, **xenobots could be useful for tasks like cleaning up microplastics** and regrowing or replacing dead cells and tissues inside human bodies.
 - **Smart Railway Coaches:** In **November 2020**, the **Modern Coach Factory (MCF)** at Raebareli, Uttar Pradesh, rolled out **smart railway coaches** that are fitted with a **battery of sensors** to provide a comfortable experience to passengers.
 - The **sensors monitor odour levels in toilets**, check if the doors are safely closed, avoid fire outbreaks and stop **unauthorised travel using CCTV cameras** with face recognition capabilities, among other technologies.

What is the Fourth Industrial Revolution?

Why in News?

Recently, the World Economic Forum (WEF) has chosen Hyderabad, Telangana for establishing its Center for the Fourth Industrial Revolution (C4IR).

The C4IR Telangana will be an autonomous, non-profit organisation with a thematic focus on healthcare and life sciences.

➤ **About:**

- It is **characterised by the use of technology to blur the boundaries** between the **digital, physical, and biological worlds**, and is **driven by data**.

Note:

What is BharOS?

Why in News?

Recently, an IIT Madras-incubated company has developed the BharOS.

➤ About:

- It is an **indigenous mobile operating system (OS)**, like Android or iOS. It is focused on **privacy and security**.
 - A mobile operating system is a software that is the core interface on a smartphone like **Android by Google and iOS by Apple**, which help **smartphone users interact with their device** and access its features, while ensuring safety.
- BharOS is a **contribution towards the idea of a self-reliant India or 'Atmanirbhar Bharat'** by creating a secure OS environment for India-based users.
- BharOS Services are currently being provided to organisations that have **stringent privacy and security requirements** and whose users handle sensitive information that requires confidential communications on restricted apps on mobiles.
- Such users require **access to private cloud services through private 5G networks**.

What is Superconductivity?

Why in News?

- Recently, physicists at the University of L'Aquila in Italy have recently made a breakthrough by achieving a full microscopic understanding of the superconductivity of Mercury for the first time.
- Superconductivity was first discovered in mercury, yet scientists required 111 years to explain how it becomes superconducting.
- **Superconductivity:**
 - **Superconductivity** refers to a state when a material can conduct electricity without any resistance. It is observed in many materials when they are cooled below a **critical temperature**.

➤ Superconductivity of Mercury:

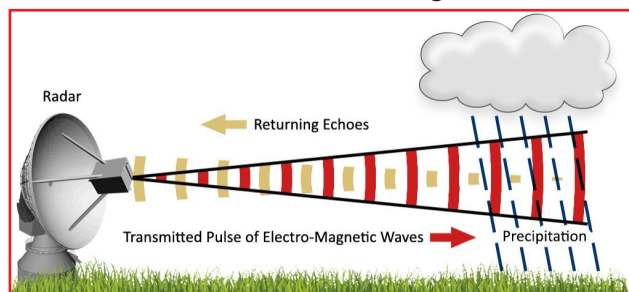
○ About:

- In 1911, Heike Kamerlingh Onnes discover superconductivity in mercury.
- Onnes had invented a way **to cool materials to absolute zero** – the lowest temperature possible.
- Using his technique, he found that at a very low temperature, called the threshold temperature, **solid mercury offers no resistance to the flow of electric current**. It was a watershed moment in the history of physics.

What are Doppler Weather Radars?

Why in News?

- On the Occasion of 148th Foundation Day of India Meteorological Department (IMD), the Ministry of Earth Science has inaugurated the Doppler Weather Radar (DWR) Systems in Jammu & Kashmir, Uttarakhand, and Himachal Pradesh.
- The Ministry of Earth Science is also preparing to cover the entire Country the Doppler weather radar network by 2025 for more accurate forecasts related to extreme weather events.
- Based on Doppler principle, the **radar is designed to improve precision in long-range weather forecasting and surveillance** using a parabolic dish antenna and a foam sandwich spherical radome.
- DWR has the **equipment to measure rainfall intensity, wind shear and velocity and locate a storm centre and the direction of a tornado or gust front**.



Note:

What is Radar?

- **Radar (Radio Detection and Ranging):**
 - It is a device which uses **electromagnetic waves in the microwaves region** to detect location (range & direction), altitude, intensity and movement of moving and non-moving objects.
- **Doppler Radar:**
 - It is a specialized radar that uses the Doppler effect to produce velocity data about objects at a distance
 - **Doppler effect:** When the source and the signal are in relative motion to each other there is a change in the frequency observed by the observer. If they are moving closer, frequency increases and vice versa.
 - It does this by bouncing a microwave signal off a desired target and analyzing how the object's motion has altered the frequency of the returned signal.
 - This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar.
- **Types Of Doppler Radars:**
 - Doppler radar can be divided into **several different categories according to the wavelength which are L, S, C, X, K.**

What is Neuromorphic Computing?

Why in News?

Recently, a team of scientists from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) has developed Artificial Synapse for Brain-Like Computing or Neuromorphic Computing.

They have used scandium nitride (ScN), a semiconducting material with supreme stability and Complementary Metal-Oxide-Semiconductor (CMOS) compatibility, to develop brain-like computing.

- **About:**
 - Inspired by the human brain and the functioning of the nervous system, **Neuromorphic Computing was a concept introduced in the 1980s.**

- Neuromorphic Computing refers to the **designing of computers that are based on the systems found in the human brain** and the nervous system.
- Neuromorphic computing devices can work as efficiently as the human brain **without acquiring large room for the placement of software.**
 - One of the technological advancements that has rekindled the interest of scientists in neuromorphic computing is the development of the **Artificial Neural Network model (ANN).**

What is Aditya-L1 Mission?

Why in News?

Recently, the Visible Line Emission Coronagraph (VLEC), the primary payload on board Aditya-L1, was handed over to Indian Space Research Organisation (ISRO) by the Indian Institute of Astrophysics (IIA).

ISRO is planning to launch the Aditya-L1 mission, first Indian space mission to observe the Sun by June or July 2023 to observe the Sun and the solar corona.

➤ Launch Vehicle:

- Aditya L1 will be launched using the **Polar Satellite Launch Vehicle (PSLV)** with 7 payloads (instruments) on board.
- The 7 payloads include:
 - VELC
 - Solar Ultraviolet Imaging Telescope (SUIT)
 - Solar Low Energy X-ray Spectrometer (SoLEXS)
 - Aditya Solar wind Particle Experiment (ASPEX)
 - High Energy L1 Orbiting X-ray Spectrometer (HEL1OS)
 - Plasma Analyser Package for Aditya (PAPA)
 - Advanced Tri-axial High Resolution Digital Magnetometers

➤ Objective:

- Aditya L1 will study the **Sun's corona, Sun's photosphere, chromosphere, solar emissions, solar winds and flares, and Coronal Mass Ejections (CMEs)**, and will **carry out round-the-clock imaging of the Sun.**
 - The mission **will be launched by ISRO to the L1 orbit** which is about 1.5 million km from the Earth. The orbit **allows Aditya-L1 to look at the Sun continuously.**

Note:

What are Solitary Waves?

Why in News?

Recently, Indian Institute of Geomagnetism (IIG), an autonomous institute of the Department of Science and Technology (DST) has found evidence of “solitary waves” in the weak magnetic field around Mars for the first time.

Scientists used high-resolution electric field data from NASA’s MAVEN spacecraft to make the discovery of solitary waves.

➤ About:

- Solitary waves are the **distinct electric field fluctuations** (bipolar or monopolar) that follow constant amplitude-phase relations.
- Their **shape and size are less affected** during their propagation.

➤ Significance:

- Solitary waves have been found to play a significant role in the dynamics of various **physical systems**, such as in the **Earth’s magnetosphere** and in the **Martian magnetosphere**.
 - In the **Earth’s magnetosphere**, they are known to be responsible for the **energization and transport of plasma particles**, which can affect the behaviour of satellites and other space-borne equipment.
 - In the **Martian magnetosphere**, their significance is not fully understood yet, but it has been suggested that **they may play a role in the loss of atmospheric ions on Mars**.

What are Exoplanets?

Why in News?

Recently, the National Aeronautics and Space Administration’s (NASA) James Webb Space Telescope has discovered its first new exoplanet named- LHS 475 b.

Owing to the Webb telescope’s advanced capabilities, researchers may detect more Earth-sized planets in future.

➤ About:

- Exoplanets are planets **that orbit other stars and are beyond our solar system**. The first confirmation of detection of **exoplanets occurred in 1992**.

- According to NASA, to date, **more than 5,000 exoplanets have been discovered**.
- Scientists believe that there are more planets than stars as each star have at least one planet orbiting it.
- Exoplanets come in a host of different sizes. They can be **gas giants bigger than Jupiter or as small and rocky as Earth**. They are also known to have **different kinds of temperatures** — boiling hot to freezing cold.

What is Shukrayaan I Mission?

Why in News?

Indian Space Research Organisation’s (ISRO) Venus mission, Shukrayaan I may be postponed to 2031. ISRO’s Venus mission was expected to be launched in December 2024.

Both the U.S. and the European space agencies have Venus missions planned for 2031 — VERITAS and EnVision, respectively — while China may launch around 2026 or 2027.

➤ About:

- Shukrayaan I will be an **Orbiter Mission**. Its scientific payloads **currently include a high-resolution Synthetic Aperture Radar** (SAR) and a ground-penetrating radar.
 - **SAR** would examine Venus’ surface, despite the clouds around the planet, which lowers visibility.
 - It refers to a **technique for producing high-resolution images**. Because of the precision, the radar can penetrate clouds and darkness, which means that it can collect data day and night in any weather.
- The mission is expected to **study Venus’s geological and volcanic activity**, emissions on the ground, wind speed, cloud cover, and other planetary characteristics from an elliptical orbit.
- Shukrayaan-I will be launched on either **GSLV Mk II** or **GSLV Mk III**, the latter allows more instruments or fuel to be carried, according to ISRO.

Note:

What is Generative Artificial Intelligence?

Why in News?

The use of Generative Artificial Intelligence (GAI) is still in its early stages but its impact is likely to grow as technology continues to evolve and improve.

The Government of India is cognizant of the emergence of the technologies related to GAI and their rapid proliferation in sectors like education, manufacturing, healthcare, finance, and others.

➤ About:

- GAI is a rapidly growing branch of AI that focuses on generating new content (such as images, audio, text, etc.) based on patterns and rules learned from data.
- The rise of GAI can be attributed **to the development of advanced generative models**, such as **Generative Adversarial Networks (GANs)** and **Variational Autoencoders (VAEs)**.
 - These models are trained on large amounts of data and are able to generate new outputs that are similar to the training data. For example, a GAN trained on images of faces can generate new, synthetic images of faces that look realistic.
- While GAI is often associated with **ChatGPT** and **deep fakes**, the technology was initially used to automate the repetitive processes used in digital image correction and digital audio correction.
- Arguably, because **machine learning** and deep learning are inherently focused on generative processes, they can be considered types of GAI, too.

What is the iCET Initiative?

Why in News?

India's National Security Advisor held talks with the US counterpart on the first dialogue on Initiative for Critical and Emerging Technologies (iCET) in the US.

Completing the work on the long-awaited NASA-ISRO Synthetic Aperture Radar (NISAR) earth observation satellite is an excellent example of how the US-India partnership in space can benefit the world.

➤ About:

- The iCET initiative was launched by India and the US in May 2022, and is **being run by the National Security Councils** of both countries.
- Under iCET, both countries have identified **six areas of cooperation which would include co-development and co-production**, that would gradually be expanded to **QUAD**, then to **NATO**, followed by Europe and the rest of the world.
- Under iCET, India is ready to share its core technologies with the US and expects Washington to do the same.

➤ Six Areas of Cooperation:

- The six areas for cooperation are scientific research and development; **quantum** and **artificial intelligence**, defense innovation, space, advanced telecom which would include things like 6G and semiconductors.

➤ Significance:

- iCET would forge **closer linkages between government, academia and industry of the two countries**.
- The objective is to provide **cutting edge technologies** to the rest of the world which are affordable.
- The launch of the ambitious iCET dialogue is seen as **"an alignment of strategic, commercial and scientific approaches"** in the field of technology.
- This is eventually likely to be mirrored in the progress made in Quad – the informal grouping of four countries, Australia, Japan, India and the United States.

What are Quasicrystals?

Why in News?

Scientists have discovered a third natural source of quasicrystals in the Sand Hills of north central Nebraska, USA.

➤ About:

- **Quasicrystals** are fascinating materials that possess a unique combination of properties. They are a **testament to the beauty and power of irregularity** in the natural world.

➤ Difference from Traditional Crystal:

- Unlike **traditional crystals**

Note:

- the atoms in quasicrystals are arranged in a pattern that repeats itself at irregular intervals, rather than in a fixed, repetitive pattern.
 - This deviation from the normal arrangement of atoms in solids makes quasicrystals a **symbol of the power of irregularity**.
- **Common salt crystals**, like those of **Sodium chloride (NaCl)**, adopt a cubic pattern due to their chemical and physical properties.
 - The cubic pattern allows the sodium and chloride ions to **optimise for factors like density and thermal stability**.
- Quasicrystals, on the other hand, **form in a pattern that deviates from the cubic structure** and is less optimal.
 - The structure of their atomic lattice still contains the imprints of some stressful event.

Micro-LEDs

Why in News?

Apple is reportedly **working on a new display technology called microLEDs**, which is considered the next big thing in the display industry.

- **MicroLEDs are self-illuminating diodes** that have brighter and better colour reproduction than **Organic Light Emitting Diode (OLED)** display technology.

What are MicroLEDs ?

➤ About:

- MicroLED technology is based on the **use of sapphires**, which are known for their ability to shine on their own indefinitely.
 - The technology involves the **use of tiny light-emitting diodes (LEDs) that are packed tightly together** to create a bright and high-quality display.
- Unlike OLED displays, **microLED displays use inorganic material** such as gallium nitride.
- A microLED is as **small as cutting a centimetre of hair into 200 smaller pieces**. Each of these microLEDs are semiconductors that receive electric signals.
 - Once these microLEDs are gathered, **they form a module**. Several modules are then combined to form screens.

What are Muons?

Why in News?

As per a new study, researchers are examining the fortress wall of Xi'an, an ancient city in China, by using tiny outer space particles Muons that can penetrate hundreds of metres of stone surfaces.

Scientists have used a muon detector, called CORMIS (Cosmic Ray Muon Imaging System), to examine the wall of Xi'an city.

➤ About:

- Muons are subatomic particles raining from space. They are **created when the particles in Earth's atmosphere collide with cosmic rays**.
 - **Cosmic rays** are the **clusters of high-energy particles** that move through space at almost the **speed of light**.
- According to Scientific American magazine, **"about 10,000 muons reach every square metre of the Earth's surface a minute"**.
- **Properties:**
 - These particles **resemble electrons but are 207 times as massive**. Therefore, they are sometimes called **"fat electrons"**.
 - Because muons are so heavy, **they can travel through hundreds of metres of rock or other matter before getting absorbed or decayed**.
 - In comparison, **electrons can penetrate through only a few centimetres**.
 - Also, muons are highly unstable and **exist for just 2.2 microseconds**.

What is Muography?

➤ About:

- The method of scanning large structures owing to the penetration power of muons is called **Muography**.

➤ Applications of Muography:

- **Archaeology:**
 - With unique advantages, **muography has gained increasing attention from archaeologists** as a novel and innovative tool to **investigate large-scale archaeological sites**.
 - Example: The first use of muography was in the late 1960s when a **Nobel Prize-winning physicist named Luis Alvarez** teamed up with **Egyptologists** to look for **hidden rooms in the Pyramid of Khafre in Giza**.

Note:

What is H5N1 Avian Influenza?

Why in News?

Recent reports of H5N1 (subtype of avian influenza) being transmitted between mammals have raised concerns about its potential to cause a human pandemic.

Scientists are investigating a potential spillover event after a mass mortality event that killed over 700 seals along the Caspian Sea coast where a H5N1 variant was detected in wild birds a few months ago.

➤ About:

- **Avian influenza** or bird flu refers to the disease caused by **infection with avian influenza Type A viruses**.
 - Infrequently, the **virus can infect mammals from birds**, a phenomenon called **spillover**, and rarely can spread between mammals.
- **H5N1, a subtype of avian influenza**, has the potential to infect other mammals such as **minks, ferrets, seals, domestic cats**, and others through contact with infected **birds, their faeces, or infected bird carcasses**.

➤ Symptoms in Humans:

- Range from mild to severe influenza-like illnesses such as **fever, cough, sore throat, muscle aches, nausea, abdominal pain, diarrhea**, vomiting.
- People can also develop severe respiratory illness (e.g., **difficulty breathing, pneumonia, acute respiratory distress, viral pneumonia**) and altered mental status, seizures etc.

➤ Avian Influenza in India:

- In 2019, India has been declared free from **Avian Influenza (H5N1)**, which has also been notified to the **World Organization for Animal Health (OIE)**.
 - **However**, in December 2020 and early 2021, **outbreaks of avian influenza H5N1 and H5N8** were reported in **poultry in 15 states in India**.

Types of Influenza Virus

- There are four types of influenza viruses: **influenza A, B, C, and D**
- Influenza A and B are the two types of influenza that **cause epidemic seasonal infections nearly every year**.
- Influenza C mainly occurs in humans, but has been known to also occur in dogs and pigs.
- Influenza D is found mainly in cattle. It's not known to infect or cause illness in humans yet.

Avian influenza Type A Viruses

- Type A viruses are classified based on two proteins on their surfaces – **Hemagglutinin (HA) and Neuraminidase (NA)**. There are about 18 HA subtypes and 11 NA subtypes.
 - Several combinations of these two proteins are possible e.g., **H5N1, H7N2, H9N6, H17N10, H18N11 etc.**
 - All known subtypes of influenza A viruses can infect birds, **except subtypes H17N10 and H18N11**, which have only been found in bats.

What is Filariasis?

Why in News?

The Ministry of Health and Family Welfare has launched a nationwide Mass Drug Administration (MDA) campaign aimed at ending filariasis disease.

India aims to eliminate filariasis by 2027, three years ahead of the global target.

● About:

- Filariasis is a parasitic infection caused by microscopic, **thread-like worms known as filariae**. It is spread by the bite of infected mosquitoes, and it affects millions of people in tropical and subtropical regions worldwide.

➤ Causes and Transmission:

- **Lymphatic filariasis** is caused by **infection with parasites classified as nematodes (roundworms)** of the family Filariodidea.
- There are 3 types of these thread-like filarial worms:
 - **Wuchereria bancrofti**, which is responsible for 90% of the cases,

Note:

- Brugiamalayi, which causes most of the remainder of the cases,
- Brugiatoriori, which also causes the disease.

➤ Symptoms:

- Lymphatic filariasis infection involves asymptomatic, acute, and chronic conditions.
 - In chronic conditions, it leads to **lymphoedema (tissue swelling) or elephantiasis (skin/tissue thickening) of limbs** and hydrocele (scrotal swelling).

What is Cholera?

Why in News?

African countries are facing Cholera vaccine shortage, that is a looming threat amid increasing cholera cases in the region.

Since the beginning of 2023, there have been 27,300 new cases of cholera including 687 deaths in five African countries.

➤ About:

- It is a life-threatening infectious **disease and a public health hazard**.
- Cholera is an acute, diarrheal illness caused by infection of the intestine with the **bacterium Vibrio cholerae**.
- The infection is often mild or without symptoms, but sometimes can be severe.

➤ Symptoms:

- Profuse watery diarrhoea, Vomiting, Leg cramps

➤ Transmission:

- A person may get **cholera by drinking water or eating food contaminated** with the cholera bacterium.
- The disease can **spread rapidly in areas with inadequate treatment** of sewage and drinking water.

● Vaccine:

- Currently there are three WHO pre-qualified **Oral Cholera Vaccines (OCV), Dukoral, Shanchol, and Euvichol-Plus**.
- All three vaccines require two doses for full protection.

What is Sickle Cell Disease (SCD)?

Why in News?

The Government of India, through the National Health Mission, is supporting the states in their efforts to prevent and manage sickle cell disease.

In Union Budget 2023-24, the government has announced a mission to eliminate Sickle cell Anaemia by 2047.

➤ About:

- **SCD** is a **chronic single gene disorder** causing a debilitating systemic syndrome characterized by **chronic anaemia, acute painful episodes, organ infarction and chronic organ damage** and by a significant reduction in life expectancy.

○ Symptoms:

- Symptoms of sickle cell disease can vary, but some common symptoms include:
 - **Chronic Anaemia:** leading to fatigue, weakness, and paleness.
 - **Painful episodes** (also known as sickle cell crisis): these can cause sudden and intense pain in the bones, chest, back, arms, and legs.
 - **Delayed growth and puberty**

➤ Treatment:

- **Blood Transfusions:** These can help relieve anaemia and reduce the **risk of pain crises**.
- **Hydroxyurea:** This is a medication that can help **reduce the frequency of painful episodes** and prevent some of the long-term complications of the disease.
- It can also be treated by **bone marrow or stem cell transplantation**

➤ Government Initiatives to Tackle SCD:

- Government has released **technical operational guidelines for prevention and control of hemoglobinopathies in 2016** including sickle cell anaemia .
- Integrated centers have also been established in **22 tribal districts for treatment and diagnosis**.
- The **State Haemoglobinopathy Mission** has been established in **Madhya Pradesh** to address the challenges in screening and management of the disease.

Note:

What is a Small Satellite Launch Vehicle?

Why in News?

In its second attempt, the Indian Space Research Organisation (ISRO)'s smallest vehicle, Small Satellite Launch Vehicle (SSLV-D2), was launched from the Satish Dhawan Space Centre, Sriharikota, Andhra Pradesh.

The vehicle's first development flight (SSLV D1) that took place in August 2022 failed to place the satellites in precise orbit.

➤ About:

- SSLV is a **3 stage Launch Vehicle** configured with three Solid Propulsion Stages and Liquid propulsion-based Velocity Trimming Module (VTM) as a terminal.
- It is **2 m in diameter and 34m in length** with a lift off weight of 120 tonnes and is capable of launching a **10 to 500 kg satellite in 500 km planar orbit**.
- The rocket can be assembled by a small team in **only a few days**, compared to the 6 months and around 600 people it takes for ISRO's workhorse **PSLV**.

What is Space Debris?

Why in News?

Recently, the Government of India has announced that 111 payloads and 105 space debris have been identified as Indian objects orbiting Earth.

All orbiting debris will affect the future of outer space and future missions. Indian Space Research Organization (ISRO) has also been carrying out several studies on the impact of growing space debris on the space environment.

➤ About:

- **Space debris** refers to **man-made objects in Earth's orbit** that no longer serve a useful purpose.
 - This includes **defunct satellites, spent rocket stages, and fragments of debris** from collisions or other events.

➤ Potential Hazard:

- **Threat for Operational Satellites:**
 - The floating space debris is a **potential hazard for operational satellites** and colliding with them can leave the **satellites dysfunctional**.

- This **overpopulation of space with objects and debris** is referred to as **Kessler Syndrome**.

○ Reduction of Orbital Slots:

- The accumulation of space debris in specific orbital regions can **limit the availability of desirable orbital slots** for future missions.

○ Space Situational Awareness:

- The **increasing amount of space debris makes it more challenging for satellite operators** and space agencies to accurately track and predict the orbits of objects in space.

➤ Initiatives to Curb Space Debris:

○ India:

- In 2022, **ISRO set up the System for Safe and Sustainable Operations Management (IS 4 OM)** 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.
 - ISRO has also set up a **Centre for Space Debris Research** to monitor and mitigate the threat of space debris.
 - **'Project NETRA'** is also an **early warning system** in space to detect debris and other hazards to Indian satellites.

○ Global:

- The **Inter-Agency Space Debris Coordination Committee (IADC)**, an international governmental forum, was established in 1993 to **coordinate efforts between spacefaring nations** to address the issue of space debris.
- The **United Nations** has established the Committee on the **Peaceful Uses of Outer Space (COPUOS)** to develop guidelines for the **long-term sustainability of outer space activities**, including the mitigation of space debris.
- The **European Space Agency (ESA)** has launched the **Clean Space initiative**, aimed at reducing the amount of space debris and promoting sustainable space activities.

Note:

National Science Day 2023

Why in News?

In 1986, the **Government of India**, designated **February 28 as National Science Day** to commemorate the announcement of the discovery of the "**Raman Effect**".

- This year's edition is being celebrated under the theme of "**Global Science for Global Wellbeing**", in light of **India's G20 presidency**.

What is the Raman Effect?

- **Physicist CV Raman** won the **Nobel Prize in 1930** for his discovery of the **Raman Effect**.
- It refers to the **inelastic scattering of light by matter**, resulting in a shift in the frequency of the scattered light.
 - In simpler words, it is a **change in the wavelength of light** that occurs when a light beam is deflected by molecules.
- The Raman effect forms the **basis for Raman spectroscopy** which is used by chemists and physicists to gain information about materials.
 - **Spectroscopy** is the study of the interaction between matter and **electromagnetic radiation**.

ALMA Telescope

Why in News?

The **Atacama Large Millimetre/submillimetre Array (ALMA)** is a **radio telescope** located in the **Atacama Desert of northern Chile**. It is set to receive software and hardware upgrades.

- The upgrades will enable ALMA to collect more data and **produce sharper images**.

What is ALMA?

- **About:**
 - ALMA is a **state-of-the-art telescope** that studies celestial objects at **millimetre and submillimetre wavelengths** — they can penetrate through dust clouds and help astronomers examine dim and distant galaxies and stars out there.
 - ALMA is an international partnership of the **European Southern Observatory (ESO)**, the

U.S. National Science Foundation (NSF) and the **National Institutes of Natural Sciences (NINS) of Japan**, together with NRC (Canada), MOST and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile.

What are Neutrinos?

Why in News?

Recently, physicists working with the Kamioka Liquid Scintillator Antineutrino Detector (KamLAND) in Japan reported that after analysing two years' data, they could not find signs that neutrinos could be their own anti-particles.

- **About:** Neutrinos are the **second most abundant particles in the Universe after photons** (light particles), produced in copious amounts in the **cores of stars**.
- **Properties:** Because they are so ubiquitous, **their properties are windows into the microscopic structure of the universe**.
 - For example, one open question about neutrinos is whether they are their own antiparticles. If they were, physicists will have a way to explain why the universe has more matter than antimatter.
- **Significance:** Probing of oscillations of neutrinos and their relations with mass are crucial in studying the origin of the universe.
- **Sources of Neutrinos:** Neutrinos are created by various radioactive decays; **during a supernova**, by **cosmic rays striking atoms** etc.

What are Anti-Particles?

- Every elementary particle has an antiparticle. If the two meet, **they will destroy each other** in a flash of energy.
- The electron's antiparticle is the positron. Similarly, **neutrinos have anti-neutrinos**.
- However, an **electron is distinguishable from a positron** because they have opposite charges.
- **Neither neutrinos nor anti-neutrinos have electric charge**, nor any other properties to really differentiate between them.
- One way to classify subatomic particles is as matter particles and force-carrying particles. **Neutrinos are matter particles, or fermions**. Fermions can be further split as Dirac fermions or Majorana fermions. Dirac fermions are not their own anti-particles, whereas Majorana fermions are.

Note:

What is the Standard Model?

Why in News?

Recently, physicists have made a groundbreaking achievement in metrology by measuring the electron's magnetic moment with record-breaking precision. It is significant because it provides the most precise test so far of the Standard Model of particle physics.

The measurement was reported to be 0.13 parts per trillion (ppt), which is 2.2 times more accurate than the previous best record from 14 years ago.

- The **Standard Model (SM)** is a theory that describes the properties of subatomic particles, classifies them into groups, and determines how they are affected by three of the four fundamental forces: **strong-nuclear, weak-nuclear, and electromagnetic**.
 - But it can't explain gravity.
- The **SM predicted the existence of the Higgs boson**, which was discovered in 2012, and has **successfully predicted the properties of many particles**, making it one of the most successful theories in physics.
 - The **Higgs boson is an elementary particle, which means that it cannot be broken down into smaller components**. It has no electric charge, spin, or other intrinsic properties, but it does have mass.
 - The mass of the Higgs boson is around 125 billion electron volts, or about 133 times the mass of a proton.
- Despite its successes, the **SM is unable to explain certain phenomena, such as the excess of matter over antimatter in the universe, dark matter, and dark energy**.
- Further research in this field could help us understand more about the fundamental nature of the **universe and how it operates**.

What is Autism?

Why in News?

It is found that Gut Microbiome composition in humans implicates several diseases, including Autism, Crohn's disease etc.

Gut microbiome or gut microbiota, are the microorganisms, including bacteria, archaea, fungi, and

viruses that live in the digestive tracts of humans, they affect the body from birth and throughout life by controlling the digestion of food, immune system, central nervous system and other bodily processes.

● About:

- Autism spectrum disorder (ASD) is the term for a **group of neurodevelopmental disorders**.
- Researchers are yet to fully understand the aetiology of ASD. However, they are beginning to find that a disorder in the gut-brain axis could have a prominent part.
 - Aetiology is the study of the factors that cause a condition or disease.
- It is a complex brain development disability which makes **itself visible during the first 3 years of a person's life**.
- It is **not mental retardation** as people with autism **may show excellent skills in spheres like art, music, writing** etc. The level of intellectual functioning in individuals with ASDs is extremely variable, extending from profound impairment to superior levels.

What is Mad Cow Disease?

Why in News?

Recently, Brazil has halted its beef exports to China after a case of Mad Cow Disease was confirmed in the northern state of Para.

➤ About:

- Also known as **Bovine Spongiform Encephalopathy (BSE)** is degenerative, transmissible, **slowly progressive, and a fatal infection that affects the central nervous system** of adult cattle.

➤ Causes:

- BSE is caused by a **protein called a prion** normally found on cell surfaces, the normal prion protein changes into an abnormal prion protein that is harmful.
 - After getting altered, these proteins destroy the nervous system tissue- the brain and spinal cord.
- The body of a sick cow **does not even know the abnormal prion** is there. Without knowing it is there, the **cow's body cannot fight off the disease**.

Note:

- **Transmission:**
 - A cow gets BSE by eating feed contaminated **with parts that came from another cow that was sick with BSE.**
- **Symptoms:**
 - A common sign of BSE in cows is incoordination. A sick cow has **trouble walking and getting up and may also act very nervous or violent.**
 - It usually takes **four to six years from the time a cow is infected with the abnormal prion to when it first shows symptoms of BSE.** This is called the **incubation period.** During the incubation period, there is no way to tell that a cow has BSE by looking at it.
 - Once a cow starts to show symptoms, it gets sicker and sicker until it dies, usually within two weeks to six months.
- **Treatment:**
 - There is **no treatment for BSE and no vaccine** to prevent it.

What is Japanese Encephalitis?

Why in News?

A study conducted in Gorakhpur district, India, involving 266 children vaccinated with the Chinese SA-14-14-2 vaccine (a live, attenuated vaccine) for Japanese encephalitis, found very low levels of neutralising antibodies IgG at different time points after vaccination.

However, the study did not measure cell-mediated immune responses (T-cell immune responses)

- **About:**
 - **Japanese Encephalitis (JE)** is a **viral infection** that can cause inflammation in the **brain.**
 - It is caused by a flavivirus that **belongs to the same genus as dengue, yellow fever and West Nile viruses.**
 - Japanese encephalitis virus (JEV) is also a major cause of **Acute Encephalitis Syndrome (AES)** in India.
- **Transmission:**
 - The disease is transmitted to humans through bites from **infected mosquitoes** of the **Culex species.**
 - These mosquitoes breed mainly in **rice fields** and large water bodies rich in **aquatic vegetation.**

- **Treatment:**
 - There is **no antiviral treatment for patients** with JE.
 - Treatment, available, is **supportive to relieve symptoms** and stabilise the patient.
- **Prevention:**
 - **Safe and effective JE vaccines** are available to prevent the disease.
 - **JE vaccination** is also included under the **Universal Immunisation Program** of the Government of India.

What are Antibodies?

- **About:** An **antibody is a protein produced by the body's immune system** when it detects harmful substances, called antigens.
- **Types:** There are **5 types of heavy chain constant regions** in antibodies (immunoglobulin) and according to these types, they are classified into IgG, IgM, IgA, IgD, and IgE.
 - **IgG is the main antibody in blood and it has a powerful ability to bind to bacteria and toxins,** and thus it takes on an important role in the biological defense system. It is the only isotype that can pass through the placenta, and **IgG transferred from the mother's body protects a newborn.**

What is DNA Vaccine?

- A **DNA vaccine is a type of vaccine that uses a small piece of DNA** that codes for a specific antigen (**a molecule that triggers an immune response**) from a pathogen, such as a virus or bacterium, to stimulate an immune response.
- The **DNA is injected directly into the body's cells,** where it instructs the cells to produce the antigen.
 - The **immune system then recognizes the antigen as foreign and mounts an immune response against it,** which helps to develop immunity to the pathogen.
- DNA vaccines are **third-generation vaccines.**
- The **ZyCoV-D is the world's first and India's indigenously developed DNA based vaccine for COVID-19.**

Note:

E-pharmacy in India

Why in News?

In February 2023, the **Ministry of Health** issued show cause notices to at least **20 companies**, including **Tata-1mg, Flipkart, Apollo, PharmEasy, Amazon, and Reliance Netmeds** for selling medicines online.

What is the Current Status of E-pharmacy in India?

➤ About:

- The growth of **e-pharmacy in India** has been significant in recent years and is expected to grow at a robust growth rate of **21.28% compound annual growth rate during 2021-2027**.
- The main factors driving this growth include **increasing internet and smartphone penetration, rising healthcare costs**, and a growing demand for **convenience and accessibility**.

➤ E-Pharmacies' Growth:

- The acute need for doorstep delivery of drugs was felt during **Covid-19**. **Nearly 8.8 million households** used home delivery services during the lockdown.
 - **E-pharmacies call themselves facilitators of doorstep delivery** and claim tie-ups with retail chemists for vending medicines.

➤ Concerns:

- **Impact on Quality of Drugs:**
 - The **sale, stock, offer for sale or distribution of drugs through online, internet or other electronic platforms without a licence** have potential impact on quality of drugs and pose risk to public health.
 - As there arises a cope of **misuse of drugs through self-medication** and indiscriminate use of the drugs.
- **No Statutory Backing:**
 - The **Drugs and Cosmetics Act, 1940** regulates the import, manufacturing and distribution of drugs in India.
 - However, there is **no statutory definition of "e-pharmacy"** either under the **Drugs and Cosmetics Act, 1940** or the **Pharmacy Act, 1948**.
 - However, the electronic sale of physician-prescribed drugs from online drug store sites is expressed **under the IT Act, 2000**.

What is Proton Beam Therapy (PBT)?

Why in News?

Currently, there are no government facilities that offer proton beam therapy treatment in India. The treatment is considered a viable alternative to radiation for treating solid tumours, especially for head and neck cancers.

➤ About:

- PBT is a type of cancer treatment that uses a **beam of high-energy protons to destroy cancer cells**.
 - A proton is a positively charged elementary particle that is a fundamental constituent of all atomic nuclei.
- Unlike traditional radiation therapy, which uses **X-rays**, **PBT can precisely target the tumour** while minimising radiation exposure to surrounding healthy tissue.
- PBT is typically delivered via a **large, complex machine called a cyclotron**, which accelerates protons to high speeds and delivers them to the tumour site.

➤ Problems Associated with Proton Beam Therapy:

- Setting up a PBT centre is fraught with **infrastructural and regulatory challenges** stemming from safety concerns from the **Department of Atomic Energy**.
 - There are concerns about **safety since hydrogen is a highly volatile element**, and daily checks are required to prevent leaks.
- A PBT machine is a huge contraption, up to three storeys tall and costs nearly **₹500 crore**.

➤ PBT in India:

- **Apollo Hospital in Chennai is the only centre in South and West Asia that offers PBT**.
- The hospital has treated up to 900 patients, and **47% of cases were brain tumours**.
 - **Prostate, ovaries, breast, lungs, bones, and soft tissues cancer patients** have also seen promising results through PBT

Note:

QR-Code Based Coin Vending Machine

Why in News?

RBI (Reserve Bank of India) is about to launch a pilot project to assess the functioning of a **QR-code Based Coin Vending Machine (QCVM)**.

- The pilot is **initially planned to be rolled out at 19 locations in 12 cities** across the country. With particular focus on ease and accessibility, the machines are intended to be installed at public places such as railway stations, shopping malls and marketplaces.

What is QCVM?

- QCVM is a cashless coin dispensation machine **which would dispense coins against a debit to the customer's bank account** using **UPI (Unified Payment Interface)**.
- Customers would be endowed the option of withdrawing coins in required quantities and denominations.
- It will **ease the accessibility to coins**.
- Unlike a cash-based traditional Coin Vending Machine, the QCVM would **eliminate the need for physical tendering of banknotes** and their authentication.

What is Space Debris?

Why in News?

Since, United Nations agreed on a treaty to conserve and sustainably use the high seas beyond national boundaries, scientists are calling for a legally-binding agreement to protect the Earth's orbit from space debris.

The United Nations Committee on the Peaceful Uses of Outer Space has laid out guidelines to mitigate space debris, but there is no international treaty that seeks to minimise it.

- **About:**
 - Space debris refers to the **collection of artificial objects in orbit around the Earth** that have lost their utility or are no longer in use.
 - These objects include **non-functional spacecraft, abandoned launch vehicle stages, mission-related debris**, and fragmentation debris.
- **Concern:**
 - The **number of satellites orbiting Earth** is expected

to reach **60,000 by 2030**, up from the current **9,000**, and the amount of untracked debris is a cause for concern.

- **Around 27,000 pieces of "space junk" are being tracked by NASA** but over **100 trillion untracked pieces of old satellites circle the planet**.
- Currently, **companies are not incentivised to clean up orbits** or to include de-orbiting functions in satellites.
 - **De-orbiting** means bringing dead satellites back to Earth.
- The **current Outer Space Treaty** is hindered by ever-changing geopolitics, technology and commercial gain.
- **Initiatives to Curb Space Debris:**
 - **India:**
 - In 2022, ISRO set up the **System for Safe and Sustainable Operations Management (IS 4 OM)** to continually monitor objects posing collision threats.
 - **'Project NETRA'** is also an early warning system in space to detect debris and other hazards to Indian satellites.
 - **Global:**
 - **Inter-Agency Space Debris Coordination Committee (IADC)**
 - **Clean Space Initiative of European Space Agency (ESA)**

What is the Piezoelectric Effect?

Why in News?

Recently, scientists have reported evidence of the Piezoelectric effect in liquids.

The effect has been known for 143 years and in this time has been observed only in solids.

- The piezoelectric effect is a phenomenon in which **certain materials produce an electrical charge in response to mechanical stress or pressure**. This effect occurs when the material is subjected to a force that causes its molecules to become polarized, meaning that the positive and negative charges within the material are separated from each other.

Note:

- When this polarization occurs, an electric potential is generated across the material, and if the material is connected to a **circuit, a current can flow.**
 - The reverse is also true: if an electric potential is applied to the material, it can cause a mechanical deformation.
- Piezoelectric materials are **used in a variety of applications, such as in sensors, actuators, and energy harvesting devices.** Some examples of common piezoelectric materials include quartz, ceramics, and certain types of crystals.
 - Example: Quartz is the **most famous piezoelectric crystal:** it is used in this capacity in analog wristwatches and clocks.
 - The Piezoelectric effect was discovered in 1880, in quartz, by Jacques and Pierre Curie.

What is a Geomagnetic Storm?

Why in News?

Recently, Earth has been hit by a powerful Geomagnetic Storm, having a severity grade of G4 according to the US National Ocean and Atmospheric Administration (NOAA).

Severity grade of G4, which is the second-highest grade possible, can potentially cause widespread voltage control problems for power grids. It can also cause protection systems to mistakenly trip key electric assets of the grid.

- A geomagnetic storm **refers to the disruptions to the Earth's magnetic field** caused by solar emissions.
- When a **Coronal Mass Ejection (CME)** or a high-speed solar stream reaches our planet, it **slams into the magnetosphere.**
 - The Earth's magnetosphere is created by its magnetic fields and it usually **protects us from the particles emitted** by the Sun.
- When a CME or a high-speed stream arrives at Earth, it peels open the planet's magnetosphere, kind of like an onion. This allows energetic **solar wind particles to stream down and hit our atmosphere** over the poles.
- Solar weather events like this can also supercharge **auroras**, sometimes making them visible in places where they wouldn't have been otherwise.

GPT-4

Why in News?

OpenAI has recently launched its **ChatGPT Plus subscription for Indian users**, providing them with early access to the latest language model **GPT-4.**

- This move comes at a time when tech giants are **competing to offer the best generative AI to the customers.**

How is GPT 4 Different from Other Previous Models?

- According to OpenAI, **GPT-4 is more advanced than its predecessors** when it comes to **creativity, visual comprehension and context.**
 - It also possesses the ability to collaborate with users on various creative projects, including **music, screenplays, technical writing**, etc.
- It can process up to **25,000 words of text and facilitate extended** conversations.
- **GPT-4 can encompass more than just text** – it also accepts images as input.
 - On the contrary, **GPT-3 and GPT-3.5 only operated in one modality, text, allowing users only to ask questions by typing them out.**
- GPT-4 is **more multilingual** and OpenAI has demonstrated that **it outperforms GPT-3.5 and other Large Language Models (LLMs)** by accurately answering thousands of multiple-choice across 26 languages.
 - It handles English best with an 85.5% accuracy, but Indian languages like Telugu aren't too far behind either, at 71.4%.

What is ChatGPT?

- ChatGPT is a **variant of GPT (Generative Pre-trained Transformer)** which is a large-scale neural network-based language model developed by OpenAI.
- GPT models are trained on vast amounts of text data to generate human-like text.
 - It can generate responses to a wide range of topics, such as answering questions, providing explanations, and engaging in conversations.
 - In addition to being able to **"admit its mistakes, challenge false premises, and refuse unsuitable requests,"** the ChatGPT can also "answer follow-up questions."
- The chatbot was also trained using **Reinforcement Learning from Human Feedback (RLHF).**

Note:

Starberry-Sense

Why in News?

Researchers at the **Indian Institute of Astrophysics (IIA)** have developed a low-cost star sensor for astronomy and small **CubeSat class satellite missions**.

- The star sensor named **Starberry-Sense** can help small **CubeSat class satellite** missions find their orientation in space.
- The **Department of Science and Technology (DST)** said that the Starberry-Sense is ready for launch on the **PS4-Orbital Platform** by **ISRO** and can be used for CubeSats and other **small satellite missions** in the future.

What is Star Sensor?

- Star sensor is one of the precise attitude determination sensors. It is an electro-optical system that takes an image from a set of stars and by comparing it with the star catalogue determines angle deviation of the satellite and modifies its attitude. Star sensor is composed of baffle, optical system, detector, and electronic and image processing system.

Why Starberry-Sense is Better than Other Star Sensor?

- This star sensor is **less expensive than those on the market by less than 10%** based on the commercial/off-the-shelf components which are readily available.
- The system is developed by using **Raspberry Pi Zero** which is available at low cost.
 - The Raspberry Pi Zero is a **compact size** (smaller than a credit card) computer with low **power consumption**, and ability to run **custom software** make it a suitable platform for a star sensor application.

Green and Self-Powered Desalination Plant in Lakshadweep

Why in News?

Recently, the **National Institute of Ocean Technology (NIOT)**, an autonomous institute under the Union Ministry

of Earth Sciences (MoES) is establishing a **Green and Self-powered Desalination Plant in Lakshadweep**.

- The NIOT is working on an initiative to **provide potable water in six islands of Lakshadweep using Low Temperature Thermal Desalination (LTTD) technology**. The NIOT is now trying to make this process emission-free.
- Currently, the desalination plants, each of which provides **at least 100,000 litres of potable water every day**, are powered by diesel generator sets.

What is the Green and Self-powered Desalination Plant?

● About:

- The proposed desalination plant will **use a combination of renewable energy sources like solar, wind, and wave energy** to power the plant. The plant will be equipped with **reverse osmosis (RO) technology** to desalinate seawater and produce potable water. The NIOT plans to set up the plant in one of the islands, where there is a high potential for renewable energy generation.
- The plant is the first of its kind in the world as it will **generate drinking water from sea water using indigenous technology, green energy** and environmentally friendly processes and it is self-powered.

➤ Need:

- The process of **LTTD is not fossil-fuel free** and also consumes diesel and **works by diesel generator sets**, a precious commodity in the islands that has to be shipped from the mainland critical for powering the electric grid.

What is Low Temperature Thermal Desalination Technology?

- LTTD is a **desalination technique that turns seawater into drinkable water**.
- This method is based on the idea that ocean water **1,000 to 2,000 feet below the surface is 4–8°C colder than surface water**. Therefore, a tank is used to collect and apply high pressure to salty surface water (via an external power source).
- The vaporized water under pressure is contained in tubes or a chamber. Cold ocean water is drawn up via these tubes, where the **vapour condenses to create fresh water** and the salt that results is diverted away and the condensed fresh water can be used for drinking.

Note:

What is Desalination Plant?

- A **desalination plant** turns salt water into water that is fit to drink.
 - **Desalination** is the process of **removing salts from water** to produce water that meets the quality (salinity) requirements of different human uses.
- Most commonly used **technology** for the process is **reverse osmosis**.

What is the Sky Canvas Project?

Why in News?

Recently, a Japanese company, ALE, plans to launch satellites that will trigger an artificial meteor shower, called Sky Canvas in 2025.

- The **Sky Canvas** project aims to give people all over the world **“the opportunity to view the world’s first live human-made meteor shower.”**
- ALE plans to use a **pressure-driven system of gas tanks** that will **shoot pellets at a speed of 8 kilometers per second** to trigger the artificial meteor shower.
 - The metal “shooting star” particles will be **taken to a low-Earth orbit by small satellites**.
 - Once the orbit stabilises, the particles will be released, and they will travel around part of the planet before entering the atmosphere at an altitude of **60 to 80 kilometres**.

The company also hopes to collect **atmospheric data in the mesosphere (the third layer of the atmosphere) to further scientific understanding of climate change.**

The Mesosphere is **too low to be observed by satellites and too high for weather balloons or aircraft.**

NASA’s TEMPO Mission

Why in the News?

Recently, a **SpaceX Falcon 9** rocket launched the **Tropospheric Emissions Monitoring of Pollution (TEMPO) instrument** from Florida.

What is TEMPO?

- **About:**
 - **TEMPO** is a **NASA device** that can track **air**

pollution over North America from space. It will allow scientists to **monitor air pollutants and their emission sources** down to the neighbourhood level.

- The TEMPO instrument is a grating spectrometer, **sensitive to visible and ultraviolet wavelengths of light**.
- **Features:**
 - TEMPO is hosted on an **Intelsat communications satellite** in geostationary orbit.
 - It will be able to **measure atmospheric pollution** down to a spatial resolution of **4 square miles or neighbourhood level**.
- **Applications and Importance:**
 - TEMPO will have multiple applications from **measuring levels of various pollutants to providing air quality forecasts** and helping the development of emission-control strategies
 - More than **40% of the US population live in places with unhealthy levels of particle pollution or ozone**, and air pollution is blamed for some 60,000 premature deaths a year.

What is a Geostationary Orbit?

- **Geostationary orbit** is an orbit around the Earth where a **satellite’s orbital period matches the Earth’s rotation**, allowing the satellite to stay in a fixed position over the same point on the Earth’s surface.
- The height of a geostationary orbit is approximately 35,786 kilometers (22,236 miles) above the Earth’s equator.
- Satellites in geostationary orbit are typically used for **communication and weather observation purposes**, as they can provide constant coverage of a specific region without the need for frequent repositioning.

Discovery of a New Uranium Isotope

Why in News?

In pursuit of a ‘**magic number**’, Physicists in Japan have recently discovered a **new isotope of uranium** with **atomic number 92 and mass number 241**.

Note:

What are the Major Highlights of Discovery?

- **About:**
 - The researchers accelerated **uranium-238 nuclei into plutonium-198 nuclei at the KEK Isotope Separation System (KISS)**. In a process called multinucleon transfer, the two isotopes exchanged protons and neutrons.
 - The resulting nuclear fragments contained different isotopes.
 - The team used **time-of-flight mass spectrometry** to measure the mass of each nucleus.
- **Findings:**
 - It was identified as **uranium-241 and measured the mass of its nucleus**. Theoretical calculations suggest that this **new isotope could have a half-life of 40 minutes**.
 - This discovery is the **first of its kind since 1979** due to the extreme difficulty of synthesising a nuclide in this region by general reaction.
- **Importance:**
 - This finding is significant in **refining our understanding of nuclear physics** and has implications in **designing nuclear power plants and models of exploding stars**.
 - Measuring the mass of uranium and its neighbourhood elements yields **essential nuclear information to understand the synthesis of such heavy elements** in explosive astronomical events.
- **Future Implications:**
 - This new approach using multinucleon transfer reaction and KISS is expected to **lead to the discovery of more neutron-rich actinide nuclides**, elucidating the stability of nuclides and the process of astronomical nucleosynthesis.

Note:

Uranium (chemical symbol U) is a naturally occurring radioactive element. In its natural state, Uranium consists of three isotopes (**U-234 (0.0057%), U-235 (0.72%) and U-238 (99.28%)**). Other isotopes that cannot be found in natural uranium are **U-232, U-233, U-236 and U-237**.

What are Magic Numbers'?

- In **nuclear physics**, "magic numbers" are specific

numbers of nucleons (protons or neutrons) that correspond to **particularly stable configurations within atomic nuclei**.

- These numbers are believed to arise from the underlying shell structure of atomic nuclei.
 - The heaviest known 'magic' nucleus is **lead (82 protons)**.

What is a James Webb Space Telescope?

Why in News?

The James Webb Space Telescope, launched in 2021, has captured a clear image of the planet Uranus and its rings.

- The **James Webb Space Telescope (JWST)** is a **large, infrared telescope** designed to observe the most distant objects in the universe.
 - The JWST is the **successor to the Hubble Space Telescope**.
- It is a collaboration between **NASA**, the **European Space Agency (ESA)**, and the **Canadian Space Agency (CSA)**.
- The telescope was launched in **December 2021** and is **currently at a point in space known as the Sun-Earth L2 Lagrange point**, approximately **1.5 million km beyond Earth's orbit around the Sun**.
 - **Lagrange Point 2** is one of the **five points in the orbital plane of the Earth-Sun system**.
 - **Lagrange Points** are positions in space where the **gravitational forces of a two-body system (like the Sun and the Earth)** produce enhanced regions of attraction and repulsion.
- Its primary mission is to study the **early universe**, the **formation of galaxies, stars, and planets**, and the atmospheres of **exoplanets**.

European Space Agency's Juice Mission

Why in News?

Recently, the European Space Agency is set to launch the Jupiter Icy Moons Explorer (Juice) mission to explore **Jupiter** and its icy moons, namely **Ganymede, Callisto, and Europa**.

Note:



What is Juice Mission?

➤ About:

- **Launched from French Guiana** on an Ariane 5 launcher. The mission is set to reach Jupiter in 2031.
- The spacecraft was constructed by Airbus Defence and Space, a division of the Airbus group.

➤ Objectives:

- The main objective of the mission:
 - To create **detailed maps of the moons' surfaces** and look beneath them to probe the potential habitable environments by analyzing the water bodies underneath.
 - To create a **comprehensive picture of Jupiter** by trying to understand its origin, history, and evolution.
- The focus will be on **Ganymede (the largest moon in the Solar System, which generates its magnetic field)**.
 - The three moons, Ganymede, Callisto, and Europa, are believed to hold immense amounts of water, potentially making them habitable.
- Juice isn't equipped to detect life but can find out whether there could be places around Jupiter, inside the icy moons, where the necessary conditions, such as water, biological essential elements, energy, and stability, to sustain life are present.

What is Jupiter?

- Fifth in line from the Sun, Jupiter is, by far, the **largest planet in the solar system** – more than twice as massive as all the other planets combined.
 - Jupiter, Saturn, Uranus and Neptune are called **Jovian or Gas Giant Planets**. These have thick atmosphere, **mostly of helium and hydrogen**.
- Jupiter's iconic **Great Red Spot** is a giant storm bigger than Earth that has raged for hundreds of years.
- Jupiter **rotates once about every 10 hours** (a Jovian day), but takes about **12 Earth years** to complete **one orbit of the Sun** (a Jovian year).
- Jupiter has **more than 75 moons**.
 - The planet Jupiter's **four largest moons are called the Galilean satellites** after Italian astronomer Galileo Galilei, who first observed them in 1610.
 - These large moons, named **Io, Europa, Ganymede, and Callisto**, are each distinctive world.

- In 1979, the **Voyager mission** discovered Jupiter's faint **ring system**.
- **Nine spacecraft** have visited Jupiter. Seven flew by and two have orbited the gas giant.
 - The **Galileo probe (NASA)** which orbited the planet between 1995 and 2003.
 - **Juno (NASA)** has been circling the planet since 2016.

What is Mission Def-Space?

Why in News?

Recently, the Indian Space Association (ISPA) in association with the Defence Research and Development Organization (DRDO) organized the Indian DefSpace Symposium which focuses on the growing government and military focus on the space domain and explores ways to enhance India's space capabilities.

- It is an ambitious effort to **develop innovative solutions for the three Services (Indian airforce, Navy, and Army)** in the space domain through the Indian industry and start-ups.
- 75 challenges are being opened to get **innovative solutions**, based on the defence requirements in the space domain.
- Startups, innovators and the private sector will be invited to **find solutions for the problems that will include both offensive and defensive capabilities**.
- It aims to develop a range of military applications for space warfare and to enable the private industries to **offer solutions to the armed forces for future offensive and defensive requirements**.
- Defense applications in space will not only help the Indian armed forces **but can also be extended to friendly foreign nations**.

What is Quantum Communication?

Why in News?

RRI (Raman Research Institute) has inked a Memorandum of Understanding (MoU) with the Indian Navy on Quantum Technologies to develop secure maritime communications.

Note:

RRI is an autonomous institute of the Department of Science and Technology (DST).

➤ Quantum Communication:

- Quantum communication is a **subfield of quantum technology** that focuses on the development of secure communication systems that use the principles of quantum mechanics.
- Quantum communication uses a **fundamentally different approach to encryption**.
 - The most common example of quantum communication is **QKD**, which allows two parties to generate an **encryption key that is virtually uncrackable**.

➤ Mechanism of Quantum Communication:

- **Encoding Information:** Information is encoded onto quantum bits (qubits), which can exist in **multiple states simultaneously**.
 - This property is known as **superposition**.
- **Transmitting Information:** The encoded qubits are **transmitted over a quantum communication channel**, such as a **fiber optic cable** or a **free-space link**.
 - The qubits are **typically transmitted one at a time**.
- **Receiving Information:** The receiving party measures the qubits using a quantum measurement device.
 - The measurement **process collapses the superposition state of the qubit to a single state**, revealing the encoded information.
- **Detecting Eavesdropping:** One of the key features of quantum communication is that any **attempt to eavesdrop on the communication will disturb the quantum state of the qubit**, making it immediately detectable.
 - This is known as the **“no-cloning theorem” and is a fundamental principle** of quantum mechanics.
- **Establishing a Secret Key:** By exchanging a sequence of qubits, the **transmitting and receiving parties can establish a secret key that can be used for secure communication**.
 - This key can be used with conventional encryption algorithms to **ensure the confidentiality and integrity** of transmitted information.

What is LIGO-India Project?

Why in News?

Recently, the government approved the construction of the Laser Interferometer Gravitational-Wave Observatory (LIGO) project after seven years of in-principle approval.

It will be built by the Department of Atomic Energy and the Department of Science and Technology with the U.S. National Science Foundation and several national and international research institutions.

➤ About:

- The project aims to detect **gravitational waves** from the universe.
- The Indian LIGO would have **two perpendicularly placed 4-km long vacuum chambers**, that constitute the most sensitive interferometers in the world.
- It is expected to begin scientific runs **from 2030**.

➤ Location:

- It will be located in the **Hingoli district of Maharashtra**, about 450 km east of Mumbai.

➤ Purpose and Significance:

- It **will be the fifth node** of the planned network and will bring India into a **prestigious international scientific experiment**.
- It will make India a unique platform that brings together the frontiers of science and technology of the **quantum and the cosmos**.

➤ Benefits of LIGO-India:

- The LIGO-India project would have **several spin-off benefits** to Indian science, apart from making India an **integral part of one of the most prestigious international scientific experiments**.
- The observatory is expected to enable dramatic returns in astronomy and **astrophysics**, as well as leapfrog Indian science and **technology in cutting-edge** frontiers of great national relevance.

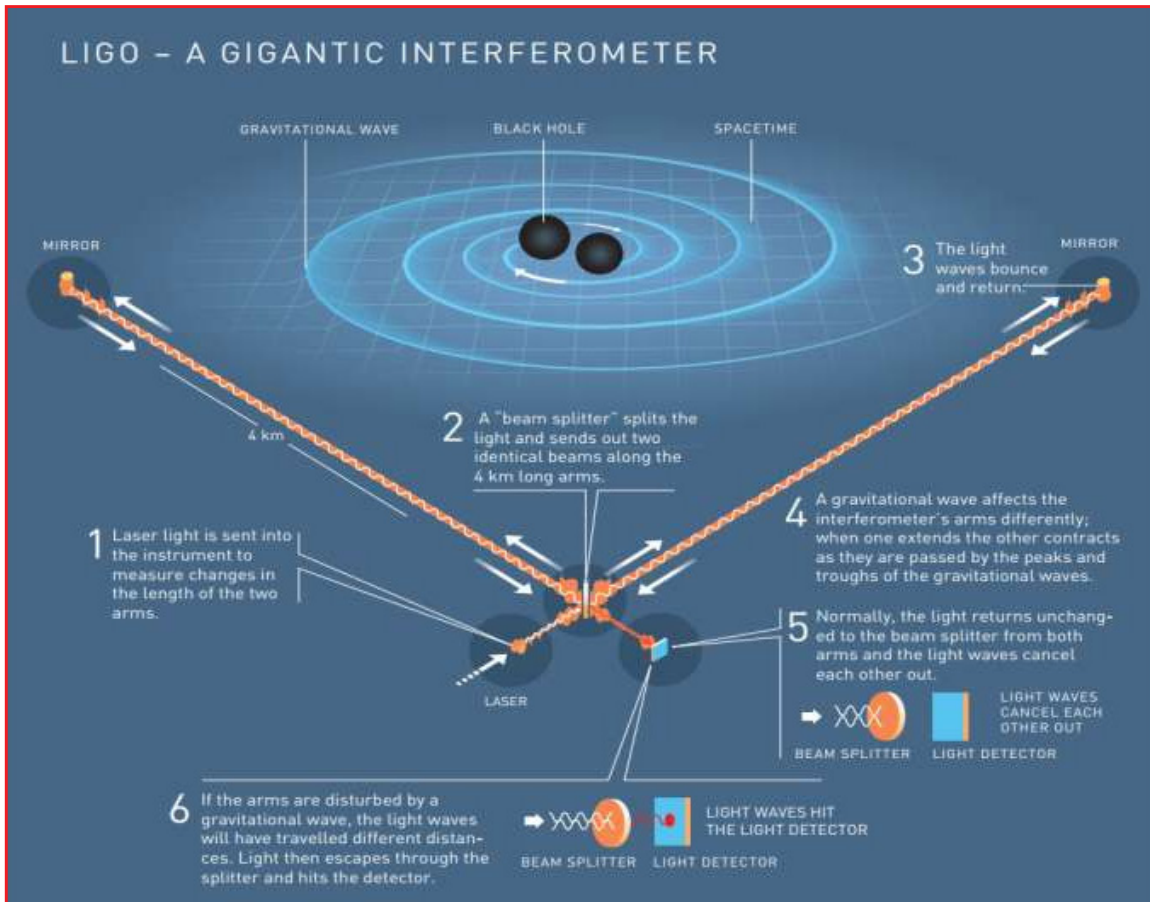
What are Gravitational Waves?

- Gravitational waves were first postulated (1916) in **Albert Einstein’s General Theory of Relativity**, which explains how gravity works.
- These waves are produced by the movement of massive celestial bodies, such as black holes or neutron stars, and are the ripples in spacetime that propagate outward.

Note:

What is LIGO?

- **About:** LIGO is an international network of laboratories that detect gravitational waves.
 - LIGOs are designed to measure changes in distance that are several orders of magnitude smaller than the length of the proton. Such high precision Instruments are needed because of the extremely low strength of gravitational waves that make their detection very difficult.



- **First Detection of Gravitational Waves:**
 - The LIGO in the US first detected **gravitational waves in 2015**, which led to a **Nobel Prize in Physics in 2017**.
 - These gravitational waves were produced **by the merger of two black holes, which were about 29 and 36 times the mass of the Sun**, 1.3 billion years ago.
 - Black hole mergers are **the source of some of the strongest gravitational waves**.

What is the Genome India Project?

Why in News?

Government aims to sequence 10,000 genomes by the end of the year 2023 under the Genome India Project (GIP).

The Department of Biotechnology, Ministry of Science and Technology has sequenced close to 7,000 genomes and 3,000 of these are already available for public access.

Note:



drishti

➤ Need:

- India's population of **1.3 billion is made up of over 4,600 diverse population groups**, many of which are endogamous (Matrimony in Close Ethnic Groups).
- These groups have **unique genetic variations and disease-causing mutations** that cannot be compared to other populations.
 - By creating a database of Indian genomes, researchers can learn about these unique genetic variants and use the information to create personalized drugs and therapies.
- The **United Kingdom, China, and the United States** are among the countries that **have programmes to sequence at least 1,00,000 of their genomes**.

➤ About:

- It is a scientific initiative inspired by the **Human Genome Project (HGP)**, an international effort that successfully decoded the entire **human genome between 1990 and 2003**.
- The project was started in **2020**, aiming to **better understand the genetic variations and disease-causing mutations** specific to the Indian population, which is one of the most genetically diverse in the world.
- By sequencing and analyzing these genomes, researchers hope to gain insights into the **underlying genetic causes of diseases and develop more effective personalized therapies**.
- The project involves the collaboration of 20 institutions across India and is being **led by the Centre for Brain Research at the Indian Institute of Science** in Bangalore.

Large Hadron Collider

Why in News?

The **LHC (Large Hadron Collider)** has recently undergone upgrades to make it more accurate and sensitive and will start collecting data in May 2023.

- The LHC has undergone upgrades to increase its sensitivity and accuracy, allowing scientists to **study particles with even higher energy**.

What is Hadron?

- Hadron is any member of a class of subatomic particles that are built from quarks and thus react through the agency of the strong force. The hadrons embrace mesons, baryons (e.g., protons, neutrons, and sigma particles), and their many resonances.

What is LHC?

➤ About:

- The LHC is a huge experiment that collides two beams of particles to study physics at very high energies. It's the largest science experiment in the world and is operated by **CERN (European Organisation for Nuclear Research)**
- The LHC is a circular pipe that is **27 km long and is located on the Franco-Swiss border near Geneva, Switzerland**.
- It consists of **two D-shaped magnetic fields created by almost 9,600 magnets**.

➤ Working Mechanism:

- Protons, which are subatomic particles made up of **quarks and gluons, are accelerated inside the LHC** using these magnets.
 - Quarks and gluons are subatomic particles that **make up protons and neutrons**. Quarks come in six different "flavors": up, down, charm, strange, top, and bottom. Gluons are particles that "glue" **quarks together inside protons and neutrons** through the strong nuclear force.
 - **Protons are not the only particles accelerated in the LHC**.
- By switching the direction of the magnetic field rapidly, **protons can be accelerated through the beam pipe**.
- Other components help to focus the particles and keep them from hitting the pipe's walls.
- The protons eventually move **at 99.999999% of the speed of light**.

Indian Space Policy 2023

Why in News?

The **Indian Space Policy 2023** was approved by the **Cabinet Committee on Security**. The policy seeks to institutionalise **private sector participation in the space**

Note:



sector, with ISRO focusing on **research and development of advanced space technologies**.

What are the Major Provisions of Indian Space Policy 2023?

- **About:**
 - The policy will pave the **way forward with much-required clarity in space reforms** and augment private industry participation to drive the space economy opportunity for the country.
- **Delineation of Roles:**
 - The policy delineates the roles and responsibilities of **Indian Space Research Organisation (ISRO)**, **space sector PSU NewSpace India Limited (NSIL)**, and **Indian National Space Promotion and Authorization Center (IN-SPACe)**.
 - **Strategic activities related to the space sector will be carried out by NSIL**, which will work in a demand-driven mode.
 - **IN-SPACe will be the interface between ISRO and non-governmental entities.**
 - **ISRO will focus its energies on developing new technologies**, new systems and research and development.
 - The operational part of ISRO's missions will be moved to the **NewSpace India Limited**.
- **Entry of Private Sector:**
 - The policy will allow the **private sector to take part in end-to-end space activities** that include building satellites, rockets, and launch vehicles, data collection and dissemination.
 - The **private sector can use ISRO facilities** for a small charge and is encouraged to invest in creating new infrastructure for the sector.
- **Impact:**
 - The policy will help India increase its share in the global space economy substantially from less than **2% to 10% in the future**.

What is a Black Hole?

Why in News?

Astronomers have discovered an ultramassive black hole using gravitational lensing, a phenomenon where a foreground object bends light from a distant object behind it.

- **About:**
 - Black holes are regions of space-time where **gravity is so strong that nothing, not even light, can escape from them**.
 - They are formed when a **massive star collapses in on itself at the end of its life**, creating an incredibly dense object with a gravitational pull that is so strong that it **warps space-time around it**.
- **Types of Black Holes:**
 - **Stellar Black Hole:** It is formed by the **collapse of a single massive star**.
 - **Intermediate Black Hole:** Their masses are between **100 and 100,000 times that of the sun**.
 - **Supermassive Black Hole:** Their masses ranging from **millions to billions of times that of the sun**, found at the centres of most galaxies including our own **Milky Way galaxy**.
- **Importance:**
 - Black holes are important for **understanding the universe and its evolution**.
 - They play a role in the **formation and evolution of galaxies** and the distribution of matter throughout the universe.
 - Studying black holes can also help us **understand the fundamental properties of space, time, and gravity**

What is Gravitational Lensing?

- **Gravitational lensing** is a phenomenon where the **path of light from a distant object is bent by the gravitational field** of a massive object, such as a **galaxy or a black hole**.
- This bending of light can **cause distant objects to appear distorted or magnified**, depending on the alignment of the massive object and the observer.
- The effect of gravitational lensing was first predicted by **Albert Einstein in his theory of general relativity**, and has since been observed and studied by astronomers

What are the Laws on Civil Nuclear Liability?

Why in News?

The plan to build six nuclear power reactors in Maharashtra's Jaitapur, which is currently the world's

Note:

biggest nuclear power generation site under consideration, has been delayed for over a decade due to issues related to India's nuclear liability law.

➤ **About:**

- Laws on civil nuclear liability ensure that compensation is available to the victims for nuclear damage caused by a nuclear incident or disaster and set out who will be liable for that damage.

➤ **International Conventions:**

- The **IAEA** serves as depositary for several international legal instruments on civil liability for nuclear damage, these include **the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Compensation for Nuclear Damage**.

- The umbrella **Convention on Supplementary Compensation (CSC)** was adopted in 1997 with the aim of **establishing a minimum national compensation amount**.

- India has **ratified CSC in 2016**.

➤ **India's Civil Liability for Nuclear Damage Act (CLNDA) of 2010:**

○ **Objective:**

- India enacted the CLNDA in 2010 to put in place a speedy compensation mechanism for victims of a nuclear accident.

○ **Liability on Operator:**

- The CLNDA provides for **strict and no-fault liability on the operator of the nuclear plant**, where it will be **held liable for damage regardless of any fault** on its part.
- It specifies the amount the **operator will have to pay in case of damage caused by an accident at ₹1,500 crore**.
 - It also requires the operator to cover liability through insurance or other financial security.

○ **Government's Role:**

- In case the damage claims exceed ₹1,500 crore, the CLNDA expects the government to step in.
- It has limited the government liability amount to the **rupee equivalent of 300 million Special Drawing Rights (SDRs)**.

- **Supplier Liability Clause:** Having realised that the defective parts were partly responsible for the **Bhopal gas tragedy in 1984**, the govt went beyond the provisions of CSC to provide for **supplier liability** over and above that of the operator in CLNDA.

- Under this provision, the **operator of the nuclear plant can seek recourse from suppliers in the event of a nuclear incident caused by supplier actions**, including the supply of equipment or materials with defects, sub-standard services, or the actions of supplier employees.

Note:

- The CSC provides for **"only" two conditions** under which the national law of a country may provide the operator with the "right of recourse", where they can extract liability from the supplier:
 - if it is expressly agreed upon in the contract or
 - if the nuclear incident "results from an act or omission done with intent to cause damage".

What is Multiple Sclerosis?

Why in News?

Recently, Scientists have fabricated monolayers of pure Myelin Basic Protein (MBP).

MBP is a major protein component of the myelin sheath, a protective membrane that wraps around the axon of nerve cells and acts as a model protein in studying diseases like multiple sclerosis (MS).

➤ **About:**

- Multiple Sclerosis (MS) is a **chronic autoimmune disease** that affects the **central nervous system (CNS)**.
 - In MS, the immune system attacks and damages the **myelin sheath**, a protective covering that surrounds the **nerve fibers in the brain and spinal cord, causing a range of symptoms**.

➤ **Symptoms:**

- **Muscle weakness** and Numbness
 - **Bladder Problems:** A person may have difficulty emptying their bladder or need to urinate frequently or suddenly
 - **Bowel problems, Fatigue, Dizziness, and damaged nerve fibers** in the spinal cord.
- Since symptoms are common, people don't often recognise the disease early and often takes many years for someone to be diagnosed, as it is impossible to determine a specific cause or trigger.

Note:

➤ Causes:

- The exact cause of the disease is unknown, but it could be a combination of:
 - **Genetic factors:** Susceptibility may pass down in the genes
 - **Smoking and Stress**
 - **Vitamin D and B12 deficiency**

What is the Central Nervous System?

- Central nervous system (CNS) is composed of the **brain and spinal cord**:
 - The brain is responsible for **processing information and controlling body functions**.
 - The **spinal cord acts as a relay between the brain and the rest of the body**.
- The CNS is protected by the **skull and spinal column**.
 - Neurons are the basic building blocks of the CNS.
 - The CNS uses neurotransmitters to communicate between neurons.
- Disorders of the CNS can result in a wide range of neurological conditions such as **Alzheimer's, Parkinson's, and Multiple sclerosis**.

PSLV C55 and TeLEOS-2 Satellite

Why in News?

Recently, **ISRO (Indian Space Research Organization)** has successfully launched the **PSLV (Polar Satellite Launch Vehicle)-C55/TeLEOS-2 mission** from the Satish Dhawan Space Centre, Sriharikota in Andhra Pradesh.

What is the PSLV C55/TeLEOS-2 Mission?

- **About:**
 - This is the 57th flight of PSLV and 16th mission using the PSLV Core Alone configuration (PSLV-CA).
 - It is a dedicated commercial mission through **NSIL (NewSpace India Limited)** with **TeLEOS-2** as primary satellite and **Lumelite-4** as a **co-passenger satellite**, both belonging to Singapore.
 - The scientists used **PSLV Orbital Experimental Module-2 (POEM-2)** as an **orbital platform** to carry out the scientific experiments through non-separating payloads carried by it.

➤ TeLEOS-2:

- It is an **Earth Observation Satellite (EOS)** and will be the **primary satellite being carried by the rocket**.
 - In 2015, ISRO launched TeLEOS-1, which was launched into a low Earth orbit for remote sensing applications. **ISRO has so far launched nine satellites belonging to Singapore**.
- TeLEOS-2 carries a **Synthetic Aperture Radar (SAR)** payload capable of imaging at **1m full-polarimetric resolution**. It will be able to provide all-weather day and night coverage.
 - SAR is a type of active radar imaging technology that **uses the motion of the radar antenna to create a high-resolution 3D image** of the target area.

What is POEM?

- POEM is an **experimental mission by ISRO** which performs in-orbit scientific experiments during the 4th stage of the PSLV launch vehicle as an orbital platform.
 - The PSLV is a four-stage rocket where the first three spent stages fall back into the ocean, and the final stage (PS4) — after launching the satellite into orbit — ends up as space junk.
- POEM has a dedicated **Navigation Guidance and Control (NGC)** system for attitude stabilization, which stands for controlling the orientation of any aerospace vehicle within permitted limits.
 - The NGC will act as the platform's brain to stabilize it with specified accuracy.

What is the Starship Project?

Why in News?

Recently, SpaceX launched an uncrewed test flight of its Starship cruise vessel from the Super Heavy rocket. However, the vehicle exploded when the upper-stage Starship failed to separate from the lower-stage Super Heavy.

SpaceX is a private company founded in 2002 by Elon Musk.

- SpaceX's **Starship spacecraft and Super Heavy rocket** – collectively referred to as **Starship** – represent a **fully reusable transportation system** designed to carry both crew and cargo to **Earth orbit, the Moon, Mars and beyond**.

Note:

- Starship will be able to carry up to **150 metric tonnes fully reusable and 250 metric tonnes expendable**.
- **Starship Super Heavy** is powered by an array of Raptor engines, which are fueled by **liquid methane (CH₄) and liquid oxygen (LOX)**.
- A total of **33 Raptor engines power the first-stage booster**.
- It leverages **stanker vehicles** (essentially the Starship spacecraft minus the windows) to refill the Starship spacecraft in **low-Earth orbit**.
- Development and manufacturing of Starship takes place at **Starbase**, one of the world's **first commercial spaceports designed for orbital missions**.

What are the other Major Projects of Space X?

- **Falcon 9:**
 - **Falcon 9** is a **reusable, two-stage rocket for the reliable and safe transport of people and payloads into Earth orbit** and beyond.
- **Falcon Heavy:**
 - SpaceX claims **Falcon Heavy** to be the most powerful rocket in the world by a factor of two.
 - It is composed of **three Falcon 9 nine-engine cores** whose 27 Merlin engines **together generate more than 5 million pounds of thrust** at liftoff.
 - Merlin engines use a **rocket grade kerosene (RP-1) and liquid oxygen** as rocket propellants in a **gas-generator power cycle**.
- **Starlink and Starshield:**
 - **Starlink** provides high-speed, low-latency broadband internet across the globe.
 - Its high-speed, low-latency service is made possible via the **world's largest constellation of highly advanced satellites** operating in a low orbit around the Earth.
 - **Starshield leverages Starlink technology** and launch capability to support national security efforts.
 - While Starlink is **designed for consumer and commercial use**, **Starshield is designed for government use**.

What are India's Efforts in Commercialisation of Space?

- **Skyroot's Vikram S** series and **Dhawan engines**
- **Draft Spacecom Policy 2020**
- **IN-SPACE**
- **NewSpace India Limited (NSIL)**
- **Indian Space Association (ISpA)**
- **Antrix Corporation Limited (ACL)**

Who was Jagdish Chandra Bose?

Why in News?

Researchers from Tel Aviv University have discovered that plants make distinct, high-pitched sounds in the ultrasonic range when faced with stress, such as needing water.

This discovery is seen as a logical extension of the work of Indian scientist Jagdish Chandra Bose, who demonstrated that plants could experience sensations and feel pleasure and pain, highlighting the continued relevance of his work in modern science.

➤ About:

- Born on 30th November 1858 to Bama Sundari Bose and Bhagawan Chandra, Bengal.
- He was a **Plant Physiologist and physicist** who invented the **crescograph**, a device for measuring the growth of plants. He for the first time demonstrated that plants have feelings.

➤ Education:

- He earned a **BSc from University College London**, which was connected with the University of London in 1883, and a BA (Natural Sciences Tripos) from the University of Cambridge in 1884.

➤ Scientific Contribution:

- He was a biologist, physicist, botanist and an early writer of science fiction.
- Bose discovered **wireless communication and was named the Father of Radio Science** by the **Institute of Electrical and Electronics Engineering**.
- Bose is widely believed to be the **first one to generate electromagnetic signals in the microwave range**.
- He was responsible for the **expansion of experimental science in India**.

Note:

- Bose is **considered the father of Bengali science fiction**. A crater on the moon has been named in his honour.
- He founded **Bose Institute**, a premier research institute of India and also one of its oldest. Established in 1917, the Institute was the **first interdisciplinary research centre in Asia**.
- **Books:**
 - His books include **Response in the Living and Non-Living (1902)** and **The Nervous Mechanism of Plants (1926)**.
- **Death:**
 - He died on 23rd November 1937 in Giridih, Bihar.

What are Electromagnetic Ion Cyclotron Waves?

Why in News?

Scientists have identified Electromagnetic Ion Cyclotron (EMIC) waves, a form of plasma waves in the Indian Antarctic station, Maitri.

These waves play an important role in precipitation of killer electrons (electrons having speed close to speed of light, which form the radiation belt of planet Earth), which are hazardous to space-borne technology/instruments.

- The **EMIC waves** are the **discrete electromagnetic emissions** observed in the Earth's magnetosphere.
- These waves are **generated in the equatorial latitudes** and propagate along magnetic field lines to its footprint in the high latitude ionosphere.
- Their signatures can be **recorded in both space as well as ground-based magnetometers**.

Magnetosphere

- **Magnetosphere** is the cavity in which the Earth lies and stays **protected from the wrath of the Sun**.
- It is formed by the **interaction between Earth's magnetic field and the solar wind**, which is a **continuous stream of charged particles**, mainly electrons and protons, flowing from the Sun.
 - **Earth's magnetic field** is generated by the motion of **molten iron in its outer core**.

Magnetometer

- A magnetometer is a **scientific instrument used to measure the strength and direction of magnetic fields**.
- It can be used to study the **Earth's magnetic field**, as well as magnetic fields of other celestial bodies, such as planets, moons, stars, and galaxies.
 - **Magnetometers work based on the principles of electromagnetic induction** or magnetoresistance.

What are Plasma Waves?

Why in News?

Scientists have identified Electromagnetic Ion Cyclotron (EMIC) waves, a form of plasma waves in the Indian Antarctic station, Maitri.

These waves play an important role in precipitation of killer electrons (electrons having speed close to speed of light, which form the radiation belt of planet Earth), which are hazardous to space-borne technology/instruments.

The study can help understand the impact of energetic particles in the radiation belts on the low orbiting satellites.

➤ About:

- Plasma waves are a type of **electromagnetic wave** that propagates through **plasma**, which is a **state of matter**.
 - Plasma is formed when a **gas is heated to high temperatures or subjected to strong electric fields**, causing its atoms to become ionised, **meaning they lose or gain electrons and become charged particles**.
- More than **99% of the matter in the visible universe consists of plasma**.
 - **Our Sun, solar wind, the interplanetary medium, near-Earth region, magnetosphere**, and the upper part of our atmosphere all consist of plasma.

What are the Other States of Matter?

➤ About:

- States of matter are the different physical forms that matter can exist in, based on their unique properties such as **shape, volume, and particle arrangement**.

Note:

- The three most commonly known states of matter are **solid, liquid, and gas**.
 - Additionally, there are two less common states of matter known as **plasma and Bose-Einstein condensate**.
- **Bose-Einstein Condensate:** It is a state of matter that occurs at very low temperatures, close to absolute zero. It was first predicted by **Albert Einstein** and Indian physicist **Satyendra Nath Bose** in the 1920s.

India's Science and Technology Innovation Ecosystem

Why in News?

Recently, **YUVA Portal** was launched to connect and identify potential young start-ups in India's **science and technology innovation ecosystem**.

- "One Week - One Lab" campaign was launched earlier. **Astronomy lab** in Haryana's Karnal was also launched, which provides opportunities for **people with disabilities** to excel in various forms of skill, art, and craft.

What are the Recent Developments in India's S&T Innovation Ecosystem?

- **About:**
 - India is leading global excellence in **technology, innovation, and start-ups**, as emphasised by the Prime Minister's recent address at the **108th Indian Science Congress**.
 - India is ranked 40th out of 132 among the top innovative economies globally as per the **Global Innovation Index (GII) 2022**.
- **Indian Sign Language AstroLab:**
 - The **Indian Sign Language AstroLab**, equipped with **65 pieces of equipment including a large telescope and audiovisual aids**, offers virtual access to educational videos in Indian sign language, promoting inclusivity and accessibility.
- **CSIR-NPL:**
 - **Council of Scientific and Industrial Research (CSIR)- National Physical Laboratory (CSIR-NPL)** has played a role as the **custodian of Indian Standard**

Time (IST), generated using an atomic time scale consisting of Cesium atomic clocks and Hydrogen masers and **instandardising measurements of gas and airborne particles** for monitoring atmospheric pollution.

- The **CSIR Labs** specialise in various areas of **research, from genome to geology**, food to fuel, minerals to materials, and more, contributing to India's scientific and technological advancements.
- NPL conducts **multidisciplinary R&D to establish futuristic quantum standards** and upcoming technologies, develops import substitutes under the "**Make in India**" program, and provides training under the "Skill India" program.
- **One Week - One Lab Campaign:**
 - "**One Week - One Lab**" program aims to create awareness about the technologies and services offered by **CSIR-NPL**, provide solutions to **societal problems**, and **develop scientific temperament among students**.
 - **180 schools in Delhi-NCR have been exposed to NPL labs** for different activities, and more schools will be included in future interactions.

Mitochondrial Replacement Therapy

Why in News?

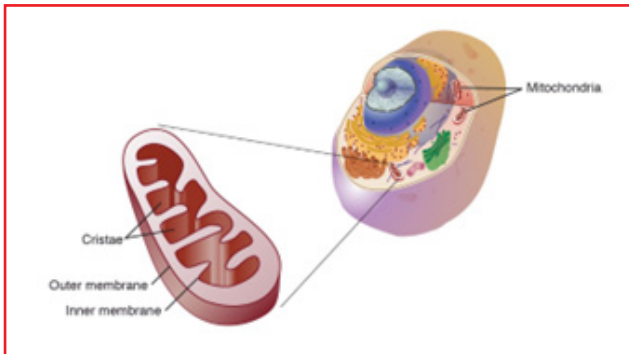
The recent news of a **baby born in the UK with three parents' DNA** has sparked curiosity and discussions about the scientific breakthrough behind this remarkable achievement.

- This revolutionary technique, known as **mitochondrial replacement therapy (MRT) or three-parent IVF**, aims to prevent the **inheritance of mitochondrial diseases**.

What is Mitochondria?

- **About:**
 - Mitochondria are **membrane-bound organelles** found in the cells of most **eukaryotic organisms**.
 - They are often referred to as the "**powerhouses**" of cells because they generate the **majority of the cell's energy** in the form of **adenosine triphosphate (ATP)**.

Note:



- **Functions:**
 - Mitochondria carry out **cellular respiration**, a process that converts nutrients into ATP.
 - Mitochondria convert energy from **carbohydrates, fats, and proteins into a usable form for the cell.**
 - They metabolize **glucose to produce ATP**, which powers various cellular processes.
 - Mitochondria participate in **cell signaling pathways**, influencing processes like **cell growth, differentiation, and apoptosis.**
- **Inheritance:**
 - Mitochondria have their own DNA, known as **mitochondrial DNA (mtDNA)**, which encodes a **small number of essential proteins.**
 - In most animals, **mtDNA is inherited solely from the mother.**
 - Mutations in mtDNA can lead to **mitochondrial disorders** and various health conditions.
- **Mitochondrial Diseases:**
 - Certain mutations in mitochondria can lead to mitochondrial diseases, **affecting energy production and impacting various organs**, including the brain, nerves, muscles, kidneys, heart, and liver.
 - These diseases can result in severe symptoms, such as **organ failure, muscle wastage, and even brain damage.** Unfortunately, there is **no cure for mitochondrial diseases**, but they can be managed to some extent.
 - Few examples of mitochondrial diseases are **Leigh Syndrome, Kearns-Sayre syndrome (KSS), Mitochondrial Myopathy and Mitochondrial DNA Depletion Syndrome.**

What is Mitochondrial Donation Treatment (MDT)/MRT?

- **About:**
 - To address the issue of mitochondrial diseases, scientists and researchers developed an **advanced In Vitro Fertilization (IVF) technique** called **Mitochondrial Donation Treatment (MDT)** or **three-parent IVF.**
 - This technique involves a complex process to ensure that the **baby inherits healthy mitochondria** while carrying the **genetic material from both biological parents.**

What are Auroras?

Why in News?

A significant geomagnetic storm is anticipated, triggered by strong solar storm. This occurrence has the potential to “supercharge” auroras, creating a spectacular visual display in the night sky.

- **About:**
 - Auroras are **luminous phenomena that occur near the North (Aurora Borealis) and South Poles (Aurora Australis).**
 - They are caused by the **interaction of charged particles from the Sun with the Earth’s magnetic field and atmosphere.**
- **Composition and Colors:**
 - Auroras consist of **gases and particles, including oxygen and nitrogen.**
 - The collisions of these particles with the atmosphere **release energy in the form of light.**
 - The colors observed in auroras depend on the **type of gas and altitude of the collisions.**
- **Geomagnetic Storms and Auroras:**
 - Geomagnetic storms, triggered by **solar events like coronal mass ejections (CMEs) and solar flares, enhance auroral activity.**
 - CMEs are **eruptions of plasma and magnetic fields from the Sun**, while **solar flares are bursts of energy.**
 - CMEs often occur alongside solar flares, which are explosions on the Sun’s surface, but they are **also known to occur independently.**

Note:

- **Solar Storms and Aurora Intensity:**
 - Strong solar storms result in **increased solar activity**, leading to **more pronounced auroral displays**.
 - The number of charged particles reaching the Earth's atmosphere during these storms intensifies the auroras.
 - The **strength of the solar storm** and the **alignment of the Earth's magnetic field** affect the **visibility and vibrancy** of the auroras.
- **Cultural and Scientific Significance:**
 - Auroras hold cultural and spiritual significance in various indigenous communities around the world.
 - Scientific research on auroras helps us understand the **Earth's magnetosphere, solar-terrestrial interactions, and space weather**.

What is a Geomagnetic Storm?

- **About:**
 - A geomagnetic storm refers to the **disruptions to the Earth's magnetic field caused by solar emissions**.
- **Cause:**
 - The largest storms that result from these conditions are associated with solar coronal mass ejections (CMEs). When a **CME or a high-speed solar stream** reaches our planet, it slams into the magnetosphere.
 - The Earth's magnetosphere is created by its magnetic fields and it usually protects us from the particles emitted by the Sun.
 - When a CME or a high-speed stream arrives at Earth, it **peels open the planet's magnetosphere**, kind of like an onion. This allows **energetic solar wind particles to stream down and hit our atmosphere over the poles**.
- **Conditions:** The solar wind conditions that are effective for creating geomagnetic storms are:
 - **Sustained (for several to many hours) periods of high-speed solar wind**
 - A **southward directed solar wind magnetic field** (opposite the direction of Earth's field) at the dayside of the magnetosphere.

What is the Life Cycle of a Star?

- **Birth:** A star's life cycle begins with a **Nebula**, where gravity pulls gas and dust together to form a protostar.

- **Nebulae** are huge clouds of gas and dust.
- **Main Sequence Stage:** When the core **gets hot enough**, **Nuclear Fusion** starts, and the star enters the main sequence stage.
 - During the main sequence stage, the **star burns hydrogen in its core, producing energy that keeps the star stable** and shining brightly.
 - Smaller stars burn fuel slowly and can shine for billions of years, while massive stars **burn it fast and may only last for hundreds of thousands of years**.
- **Old Age and Death:** As a star's hydrogen runs out, it expands and cools, becoming a red giant. Smaller stars turn into a planetary nebula, then **white dwarf**, and eventually a **black dwarf**.
 - More massive stars **explode as a supernova, scattering materials into space**, and leaving behind a neutron star or a **black hole**.

Decarbonisation of Steelmaking

Why in News?

Hydrogen is a crucial part of the world's plans to **greenify** its manufacturing and **automobile industries** as a fuel whose production and use **needn't emit carbon**.

- **Hydrogen** can also be used as a reducing agent instead of **carbon monoxide (CO)**, which would result in **much lower greenhouse gas emissions**.

What is the Use of Hydrogen in Industries other than Steel Making?

- **Energy Production:** Hydrogen can be used as a fuel for power generation, either through combustion or fuel cells. In fact, **hydrogen fuel cells** are already used in some vehicles and are being explored as a **renewable energy** source for buildings.
- **Chemical Production:** Hydrogen is used as a **feedstock for the production of chemicals** like ammonia, methanol, and other hydrocarbons which are used in various industries (agriculture, transportation, and construction).
- **Electronics:** Hydrogen is used in the **manufacturing of electronic components, such as semiconductors**, and in the production of flat panel displays and **light-emitting diodes (LEDs)**.

Note:

- **Food Processing:** Hydrogen is used in the food processing industry as a **reducing agent to preserve the quality and appearance** of food products.
 - **Medical Applications:** Hydrogen is being investigated as a **potential medical gas with anti-inflammatory and antioxidant properties**. It is also used as a tracer gas in medical diagnostics.
- Note:**
- The **National Green Hydrogen Mission** is a program to incentivise the commercial production of green hydrogen and make India a net exporter of the fuel.
 - The **National Hydrogen Energy Mission (NHEM)** was announced in **Union Budget 2021-22** for promoting the **development and deployment of hydrogen energy technologies** in the country.

What is the Status of Steel Production in India?

- **Production and Consumption:** India is currently the **world's 2nd largest producer** of crude steel (as of 2021) and also the **2nd largest consumer of finished steel in 2021** (preceded in both cases by China).
- **Important Steel-Producing Centers in India:** Bhilai (Chhattisgarh), Durgapur (West Bengal), Burnpur (West Bengal), Jamshedpur (Jharkhand), Rourkela (Odisha) and Bokaro (Jharkhand).
- **Export:** India is a **significant exporter of steel products**, with major export destinations including the US, the UAE, and Nepal.
- **Government Policies:** The **National Steel policy** was launched in 2017 which projects **crude steel capacity of 300 million tonnes (MT)**, production of **255 MT** and a robust finished steel per capita consumption of **158 Kgs by 2030-31**.
- **Steel Industry and GHG Emissions:**
 - According to the **International Energy Agency (IEA)**, the **steel industry** is responsible for around **7% of global CO₂ emissions**, making it one of the largest industrial emitters of **greenhouse gases**.
- **Pollutants from Steel Industries:**
 - **Particulate Matter (PM2.5 and PM 10)**
 - **Oxides of Sulphur**
 - **Oxides of Nitrogen**
 - **Carbon Monoxide (CO)**
 - **Carbon Dioxide (CO₂)**
 - **Solid Waste**

➤ Green Steel:

- The Ministry of Steel seeks to reduce CO₂ in steel industry through promotion of **Green Steel (manufacturing steel without using fossil fuels)**.
 - This can be done by using **low-carbon energy sources** such as **hydrogen, coal gasification, or electricity** instead of the traditional **carbon-intensive manufacturing route of coal-fired plants**.
 - It eventually **lowers GHG emissions**, cuts cost and improves the quality of steel.

Psychedelic Substances

Why in News?

In recent years, there has been renewed interest in the use of **Psychedelics** in the clinical and research domain of **Psychiatry**.

- In India, the **Narcotic Drugs and Psychotropic Substances Act 1985** prohibits the use of psychedelic substances.

What are Psychedelics?

➤ About:

- Psychedelics are a group of drugs that **alter perception, mood, and thought processing** while a person is still clearly conscious. Usually, the person's insight also **remains unimpaired**.
- Psychedelics are **non-addictive and non-toxic**. Compared to illicit drugs, psychedelics **cause much less harm to the end user**.
 - The two most commonly used psychedelics are **d-lysergic acid diethylamide (LSD)** and **psilocybin**.
 - Less common ones include **mescaline**, found in the North American **peyote cactus (Lophophora williamsii)**, and **N,N-dimethyltryptamine**, the principal component of the South American ceremonial sacrament ayahuasca.

Note:

What is Narcotic Drugs and Psychotropic Substances Act 1985?

- It was enacted in 1985 and deals **with drugs and their trafficking** in the country.
 - The act has since been amended thrice in 1988, 2001, and 2014.
 - The Act prohibits the production, manufacture, sale, purchase, transportation & consumption of many **narcotic drugs or psychotropic substances**, including cannabis, heroin, opium etc. The law,
 - However **Bhang** is not prohibited under the Act.
 - **Section 20** of the NDPS Act lays out the punishment for the **production, manufacture, sale, purchase, import and inter-state export of cannabis**, as defined in the Act. The prescribed punishment is based on the number of drugs seized.
 - It also provides for the death penalty in some cases **where a person is a repeat offender**.

What are the Characteristics of Pygmy Hog?

Why in News?

According to an article published in the journal 'Science', the African Swine Fever could fatally affect the population of pygmy hogs, the world's rarest and smallest pigs.

The disease has already decimated porcine (related to pigs) populations across Asia since its advent in China in 2018.

- **Scientific Name:**
 - *Porcula Salvania*
- **Features:**
 - It is **one of the very few mammals that build its own home**, or nest, complete **with a 'roof'**.
 - It is also an **indicator species**. Its presence reflects the health of its primary habitat, the tall, wet grasslands of the region.
- **Habitat:**
 - It thrives in wet grassland.
 - Once, it used to be found along a narrow strip of tall and wet grassland plains on the Himalayan foothills – from UP to Assam, through Nepal's terai areas, Bhutan and Bengal's duars.
 - **Today, it is found only in India (Assam)**

Protection Status:

- **IUCN Red List: Endangered**
- **CITES: Appendix I**
- **Wildlife (Protection) Act, 1972: Schedule I**

Threats:

- Habitat (grassland) loss and degradation
- Illegal hunting

Conservation Effort - Pygmy Hog Conservation Programme 1995:

- Once thought to be extinct, it was **rediscovered in 1971**. The Durrell Wildlife Conservation Trust, UK, initiated the Pygmy Hog Conservation Programme in 1995 in collaboration with **IUCN, Assam Forest Department and MoEF&CC**.
 - It is currently being implemented by NGOs - Aaranyak and EcoSystems India.
- Between 2008 and 2022, 152 of them were reintroduced into four **protected areas (PAs) in Assam**, including the recent release of 36 individuals in **Manas National Park**.
 - Between 2011 and 2015 animals were reintroduced into the **Orang National Park**.
 - By 2025, the PHCP plans to release 60 pygmy hogs in **Manas NP**.

What is Food Fortification?

Why in News?

A recent study conducted in Maharashtra on 43 women to assess the impact of fortifying tea with folate and vitamin B12 has found a significant increase in Folate and Vitamin B12 levels. It also highlighted a significant increase in hemoglobin levels.

However, the study has been found erroneous primarily because of its sample size.

About:

- **Fortification** is the addition of key vitamins and minerals such as iron, iodine, zinc, Vitamin A & D to staple foods such as rice, milk and salt to improve their nutritional content. These nutrients may or may not have been originally present in the food before processing.

Status of Food Fortification in India:

- **Rice:** Department of Food and Public Distribution (DFPD) has been running a "**Centrally Sponsored**

Note:

Pilot Scheme on Fortification of Rice & its distribution through **Public Distribution System**”.

- The scheme was initiated in 2019-20 for a three-year pilot run.
- This scheme will run till 2023 and rice will be supplied to the **beneficiaries at the rate of Rs 1/kg.**
- **Wheat:** The decision on fortification of wheat was announced in 2018 and is being implemented in 12 states under India’s flagship **Poshan Abhiyaan** to improve nutrition among children, adolescents, pregnant mothers and lactating mothers.
- **Edible Oil:** Fortification of edible oil, too, was made compulsory across the country by FSSAI in 2018.
- **Milk:** In 2017, the **National Dairy Development Board of India (NDDDB)** initiated the fortification of milk by encouraging companies to add vitamin D.

What is Sustainable Aviation Fuel (SAF)?

Why in News?

Recently, the Indian Institute of Petroleum (IIP), a laboratory of the Council of Scientific and Industrial Research (CSIR), has tied up with Boeing, Indigo, Spicejet and the three Tata Airlines - Air India, Vistara and AirAsia India to support the production of Sustainable Aviation Fuel (SAF).

➤ About:

- **Sustainable Aviation Fuel (SAF)**, also referred to as **bio-jet fuel**, is created using **domestically developed methods** using **cooking oil** and **oil-rich seeds from plants**.
- The **SAF samples** produced by the institutes are undergoing strict testing at the **US Federal Aviation Administration Clearinghouse** to meet the standards required for the **ASTM D4054 certification** from **ASTM International**.

➤ Sources of Production:

- The **CSIR-IIP** has created fuel using different materials, such as **non-edible** and **edible oils**, as well as used **cooking oil**.
- They used various sources, including **palm stearin, sapium oil, palm fatty acid distillates, algae oil, karanja, and jatropha**.

➤ Benefits of SAF Scaling in India:

- **Scaling up the production and use of SAF** in India can bring several benefits, including **reducing GHG emissions, improving air quality, enhancing energy security, creating jobs in the renewable energy sector, and promoting sustainable development**.
- It can also help the **aviation industry** meet its **environmental targets** and contribute to global efforts to combat **climate change**.
- **Biofuel for aviation** can be mixed with regular **jet fuel** and used together. Compared to traditional fuel, it has **lower sulfur content**, which can decrease **air pollution** and support India’s goal of achieving **Net Zero emissions**.

ISRO’s new NavIC Satellite NVS-01

Why in News?

The NVS-01 satellite was successfully launched by **the Indian Space Research Organisation (ISRO)** using the **GSLV-F12**, and after a 19-minute flight, it was accurately placed into a Geosynchronous Transfer Orbit.

- **GSLV-F12** is the 15th flight of India’s **GSLV (Geosynchronous Satellite Launch Vehicle)** and the 9th flight with indigenous cyro stage. This is the 6th operational flight of **GSLV** with indigenous cryogenic stage.

What is NVS-01?

➤ About:

- This satellite is the **first of the second-generation satellites of ISRO’s NVS (Navigational Satellite)** series of payloads.
- It weighs 2,232 kg, making it the heaviest in the constellation.
- The NVS-01 carried **navigation payloads L1, L5 and S bands**.
- Its purpose is to provide continuity for the **NavIC (Navigation in Indian Constellation)** services, which is an Indian Regional Navigation Satellite System (similar to GPS) that offers accurate and real-time navigation within India and **up to a 1,500 km region around the country**.
 - In the First generation, there are seven satellites in the Indian Regional Navigation Satellite

Note:

System (IRNSS) constellation, operationally named NavIC, weighing much less — around 1,425 kg — at liftoff.

➤ **Atomic Clock:**

- The satellite will have a **Rubidium atomic clock onboard**, a significant technology developed by India.
- Some of the existing satellites in the navigation constellation **lost their ability to provide accurate location data** due to failed atomic clocks. Satellite-based positioning systems rely on precise time measurements from atomic clocks to determine object locations. When the clocks fail, the satellites cannot provide accurate location information anymore.

What is Fortification of Rice?

Why in News?

In a response to the recent wave of criticism surrounding the distribution of iron fortified rice, the Union Food Ministry has released an official statement dismissing the allegations levelled against the iron fortified rice.

➤ **About:**

- **Fortification** is the process of adding nutrients to food products that are not naturally present or are present in insufficient amounts.
- Fortification of rice can be **done by coating the rice grains with a premix of micronutrients**, or by **producing extruded rice kernels that are enriched with micronutrients and then blended with regular rice**.
 - According to **Food Safety and Standards Authority of India (FSSAI)** norms, 1 kg fortified rice shall contain **iron (28 mg-42.5 mg), folic acid (75-125 microgram) and Vitamin B-12 (0.75-1.25 microgram)**.

➤ **Purpose:**

- India has **very high levels of malnutrition among women and children**. According to the Food Ministry, every second woman in the country is anemic and every third child is stunted.
- Rice is a **source of protein and contains various vitamins**. Some nutrients, including **vitamin E, magnesium, potassium, and manganese**, are

lost during milling and polishing (the process by which brown rice becomes white or polished rice).

Vitamin B12

- **Vitamin B12**, also known as **cyanocobalamin**, is **synthesized by most bacteria and algae with the help of enzymes**.
 - It is synthesized in microorganisms that enter the human food chain through incorporation into food of animal origin.
 - It is also crucial to the **normal function of the brain and the nervous system**.
- **Deficiency of Vitamin B12 causes pernicious anaemia**. It is rarely caused due to lack of Vitamin B12 in the diet but because of the **absence of the intrinsic factor in the stomach leading to failure of absorption of Vitamin B12**.

Folic Acid

- **Folate is the natural form of vitamin B9**, water-soluble and naturally found in many foods. It is also added to foods and **sold as a supplement in the form of folic acid**.
- Folic acid needs to be taken by pregnant women before conception.
 - Deficiency of folic acid in pregnant women leads to **Neural Tube Defects in the baby such as Spina Bifida**.
 - Spina bifida is a condition that **affects the spine and is usually apparent at birth**.
- **India & Southeast Asia & some parts of Africa** have the highest cases of neural Tube defects (4.7-9 per 1000 in Punjab & Haryana).
 - In the developed world, it is **less than 1 per 1000**. **Vitamin B12**, also known as **cyanocobalamin**, is **synthesized by most bacteria and algae with the help of enzymes**.
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 - In the developed world, **it is less than 1 per 1000.**

What are FLOPs in computing?

Why in News?

India is set to introduce 18 new petaFLOP supercomputers dedicated to weather forecasting, aiming to enhance the accuracy and resolution of weather predictions.

These state-of-the-art machines will significantly improve forecasting capabilities at the block level, predict cyclones with greater accuracy and lead time, and provide detailed ocean state forecasts.

- **About:**
 - **FLOPs, or Floating-Point Operations per Second**, is a **metric used to measure computational performance and efficiency in high-performance computing (HPC) and artificial intelligence (AI).**
 - Floating-point operations involve mathematical calculations with real numbers that have fractional parts.
 - Using floating-point encoding, extremely long numbers can be handled relatively easily.
- **Significance:**
 - FLOPs are not the sole metric to evaluate a computer's performance. Factors like **memory bandwidth, latency, and architectural features also contribute.**

- However, FLOPs provide a baseline for comparing computational capabilities, particularly in **tasks dominated by floating-point calculations.**

- **Unit of Computing Speed:**

- **Teraflops:**
 - It is a unit of computing speed equal to **one million million (1 trillion) (10^{12}) FLOPs.**
- **Petaflops:**
 - It is a unit of computing speed equal to **1000 TFLOPs (10^{15}).**
- **Exaflops:**
 - It is a unit of computing speed equal to **one billion billion (10^{18}) FLOPs.**

What is Sodium-ion (Na-ion) Battery?

Why in News?

Recently, Indian scientists have made a significant breakthrough in the development of Sodium-ion (Na-ion) batteries by creating new cathode materials that offer high performance, cost-effectiveness, and environmental stability.

- **About:**

- A sodium-ion battery is a type of **rechargeable battery** comparable to the ubiquitous **lithium-ion battery**, but it uses **sodium ions (Na⁺) as the charge carriers rather than lithium ions (Li⁺).**
 - The working principles behind and cell construction of a sodium-ion battery is virtually identical to those of lithium-ion batteries, but sodium compounds are used instead of lithium compounds.
- Sodium-ion batteries are currently **emerging as a potential alternative to current lithium-ion battery technology** due to their **lower cost, higher availability, and reduced impact on the environment.**

- **Importance:**

- The growing significance of **battery-driven electric vehicles** in addressing **climate and environmental concerns** necessitates the development of cost-effective, resource-friendly, safe, and sustainable alkali metal-ion battery systems beyond **conventional Lithium-ion (Li-ion) batteries.**

Note:

- India's abundance of sodium sources makes the **Na-ion battery system particularly crucial in the local context**, offering a readily available and abundant resource for Na-ion battery production.

What are Comb Jellies?

Why in News?

Comb jellies, or ctenophores, are ancient marine animals with unique features that have sparked scientific curiosity. Recent research has discovered a surprising aspect of the comb jelly's nervous system.

- **Comb jellies** are marine animals that have fascinated scientists for decades due to their unique features and evolutionary history.
 - They are among the **earliest branching extant lineages of the animal kingdom** and have a **complex nervous system that differs from other animals**.
- They are **transparent, gelatinous animals** that use **long ciliary comb plates to propel their body through the water column**.
 - They range in size from a few millimetres to over a metre in length and have diverse shapes and colours. **Some of them can produce bioluminescence, a phenomenon where living organisms emit light.**
- They belong to the **phylum Ctenophora**, which contains about **200 species**. They are found in **all oceans and habitats, from polar to tropical regions**, from shallow coastal waters to deep-sea trenches.
 - They **feed on plankton, small fish and other invertebrates**, using sticky tentacles or oral lobes to capture their prey.

Calcium-41 for Radiometric Dating

Why in News?

Scientists have suggested using **Calcium-41 for Radiometric Dating** as an alternative to **Carbon-14** for determining the age of fossilized bones and rocks.

- They have suggested a technique called **Atom-Trap Trace Analysis (ATTA)** as a solution, because ATTA is sensitive enough to **spot Calcium-41, which is a rare isotope**.

What is Calcium-41 and ATTA?

➤ Calcium-41:

- Calcium-41 is a **rare long-lived radioisotope of calcium** with a half-life of 99,400 years.
- Calcium-41 is produced in the **Earth's crust when cosmic rays from space collide with calcium atoms** in soil or rocks.
- This isotope has the potential to be employed in dating methods for objects that are older than what can be accurately determined **using carbon-14 dating**.

➤ ATTA:

- It is based on **laser manipulation and detection** of neutral atoms.
- The sample is vaporized, and the atoms are laser-cooled and loaded into a light and magnetic field cage.
- By tuning the laser's frequency, **Calcium-41 atoms can be detected through electron transitions**.
 - **Electron transition:** In an atom, an electron in one orbital **can transition to the next if it's given a specific amount of energy**; then it jumps back by releasing that energy.
- The researchers reported being able to spot one **calcium-41 atom in every 10^{16} calcium atoms** with 12% precision in seawater.
 - It is selective and avoids confusion with potassium-41 atoms.

What is Radiometric Dating?

➤ About:

- Radiometric dating is a method used to **determine the age of rocks, minerals, and fossils** based on the decay of radioactive isotopes.
 - It relies on the principle that certain **isotopes of elements are unstable and spontaneously decay over time** into more stable forms. The rate of decay is measured by the **half-life, which is the time it takes for half of the parent isotope to decay into the daughter isotope**.
 - Different isotopes have different half-lives, which makes them useful for dating different time ranges.

Note:

- For example, **carbon-14 dating is effective for dating organic materials up to about 50,000 years old.** When an organic entity is alive, its body keeps absorbing and losing carbon-14 atoms. When it dies, this process stops and the extant carbon-14 starts to decay away.
- Using the difference between the relative abundance of these atoms in the body and the number that should've been there, researchers can estimate when the entity died.

What is Carbon Dating?

Why in News?

Recently, the Allahabad High Court allowed the Archeological Survey of India (ASI) to conduct Carbon Dating of a 'Shivling' inside the Gyanvapi Mosque in Varanasi, Uttar Pradesh.

The petitioners have claimed the object inside the Gyanvapi mosque to be a "Shivling". The claim was disputed by the Muslim side, which said the object was part of a "fountain".

➤ About:

- Carbon dating is a widely used method to **establish the age of organic materials**, things that were once living.
 - Living things **have carbon in them in various forms.**
 - The dating method is based on the fact that **Carbon-14 (C-14) is radioactive**, and decays at a well-known rate.
 - C-14 is an isotope of carbon with an **atomic mass of 14.**
 - The most abundant isotope of **carbon in the atmosphere is C-12.**
 - A very small amount of C-14 is also present.
 - The ratio of C-12 to C-14 in the atmosphere is almost static and **is known.**

Half Life:

- Plants get their carbon through photosynthesis; **animals get it mainly through food.** Because plants and animals get their carbon from the

atmosphere, they **too acquire C-12 and C-14 in roughly the same proportion** as is available in the atmosphere.

- When they die, **their interactions with the atmosphere stop.** While C-12 is stable, the **radioactive C-14 reduces to one half of itself in about 5,730 years** — known as its '**half-life**'.
- The changing ratio of C-12 to C-14 in the remains **of a plant or animal after it dies can be measured and** can be used to deduce the approximate time when the organism died.

What is Diabetes?

Why in News?

According to a study, funded by ICMR (Indian Council of Medical Research), one in five healthy individuals has the glucose metabolism of a Prediabetic.

The researchers used Continuous Glucose Monitors (CGMs) to detect Pre-Diabetes. Continuous glucose monitoring automatically tracks blood glucose levels throughout the day and night, which can help make more informed decisions on how to balance food, physical activity, and medicines.

What is Diabetes?

➤ About:

- Diabetes is a **Non-Communicable Disease (NCD)** that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood sugar, or glucose), or when the body cannot effectively use the insulin it produces.

➤ Types of Diabetes:

○ Type 1 Diabetes:

- It is also known as **juvenile diabetes** (as it mostly affects children of age 14-16 years), this type occurs **when the pancreas makes little or no insulin.**
 - Insulin is a hormone the body uses to allow sugar (glucose) to enter cells to produce energy.
- It is predominantly diagnosed in children and adolescents. Although the prevalence is less, it is much more severe than type 2.

Note:

- **Type 2 Diabetes:**
 - It affects the way the **body uses insulin**. While the body still makes insulin.
 - Type 2 diabetes **can occur at any age, even during childhood**. However, this type of diabetes occurs most often in middle-aged and older people.
- **Gestational Diabetes:**
 - This type occurs in women during pregnancy **when the body sometimes becomes less sensitive** to insulin. Gestational diabetes does not occur in all women and usually resolves after giving birth.
- **Impacts of Diabetes:**
 - It affects the five major organs namely, Kidney, Heart, Blood vessels, Nervous System, and Eyes (retina).
- **Factors Responsible:**
 - Factors that lead to increase in diabetes are an unhealthy diet, lack of physical activity, harmful use of alcohol, overweight/obesity, tobacco use, etc.
- **Initiatives to Tackle Diabetes:**
 - **National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS).**
 - **World Diabetes Day**
 - **Global Diabetes Compact**

Regulating Medical Devices:

- Medical devices are **regulated as drugs under the Drugs and Cosmetics Act, 1940**.
- **CDSCO** is the national regulating authority **for medical devices and pharmaceuticals** while **NPPA** is empowered by the **Drugs (Price Control) Order, 2013**, to control the prices of drugs and medical devices.

What is CDSCO?

Why in News?

Recently, Indian Drugs Controller approved the first indigenously developed animal-derived Class D Biomedical Device, Cholederm, that can rapidly heal skin wounds at low-cost with minimum scarring.

What is CDSCO?

- The CDSCO is the Central Drug Authority for discharging functions assigned to the Central Government **under the Drugs and Cosmetics Act, 1940**.
- The CDSCO under Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India is the **National Regulatory Authority (NRA)** of India.
- Its headquarter is in New Delhi
- Major Functions:
 - Regulatory control over the import of drugs, approval of new drugs and clinical trials.
 - Approval of certain licences as Central Licence Approving Authority.

What is the National Pharmaceuticals Pricing Authority (NPPA)?

- NPPA is an organization **under Department of Pharmaceuticals, Ministry of Chemicals and Fertilizers which was set up in 1997** to revise the prices of controlled bulk drugs and formulations and to enforce prices and availability of medicines in the country, under the **Drugs (Prices Control) Order (DPCO), 1995**.
- The prices are now fixed/revised under **Drugs (Prices Control) Order (DPCO), 2013**.
- It also monitors the prices of decontrolled drugs in order to keep them at reasonable levels.

What is Fermi Energy?

Why in News?

Recently, Fermi energy has gained significant attention due to its wide range of daily practical applications in various fields, driven by the principles of quantum physics.

- **About:**
 - Fermi energy is the energy of the highest occupied state of electrons in a material at **absolute zero temperature (-273° C or 0K)**.
 - Fermi energy determines **electron velocity in conduction**, as only electrons with energies close to the Fermi energy can participate in the conduction process.

Note:

- Metals, such as **copper, aluminum, and silver**, exhibit **high Fermi energies**, even at extremely low temperatures.
- The Fermi energy and fermionic behavior of electrons, governed by quantum mechanics, are responsible for various properties of metals, including their **reflectivity, electrical conductivity, and thermal conductivity**.
- Fermi energy is measured by **Fermi level**.
- Understanding Fermi energy is essential for comprehending the **fundamental behaviors** and applications of metals in our daily lives.

X-raying a Single Atom

Why in News?

Recently, scientists achieved a remarkable milestone by **identifying an element through X-ray imaging of a single atom**.

- X-rays, discovered by **Wilhelm Conrad Rontgen in 1895**, have become an integral part of various fields, including medicine and security.
- Previously, the **smallest amount of sample that can be X-rayed is an attogram**, (which is about **10,000 atoms or more**). Scientists have long wanted to be able to X-ray just one atom, which has now been made possible.

What is the new technique for X-raying a single atom?

- **Technique:**
 - Scientists have used a technique called **synchrotron X-ray scanning tunneling microscopy (SX-STM)** to detect the **X-ray signature of a single atom for the first time**.
 - SX-STM combines **synchrotron X-rays**, which are **high-energy X-rays** produced by accelerating electrons in a circular track, with **scanning tunneling microscopy**, which uses a **sharp metal tip to interact with the electrons of a sample at very close distances**.
 - The synchrotron X-rays excite the sample, and the metal tip collects the photoelectrons emitted by the atom, **revealing its identity and chemical state**.

What is X-ray?

- It is a form of **electromagnetic radiation** with **higher energy, high frequency, and shorter wavelength than visible light**.
- It can pass through most objects, including the body, and **produce internal structure images**.
- Produced by **accelerating or decelerating charged particles** or exciting atoms.
 - Widely used in science, medicine, industry, and security applications.
 - Used for **detecting bone fractures, diagnosing diseases, identifying materials, and scanning luggage**.

What is GAGAN Satellite Technology?

Why in News?

India achieved a significant milestone in the aviation sector by conducting Asia's first demonstration of performance-based navigation for helicopters.

The demonstration, which utilised the state-of-the-art GAGAN satellite technology, was conducted for a flight from Juhu in Mumbai to Pune.

- **About:**
 - GAGAN, which stands for **GPS Aided GEO Augmented Navigation**, is a **space-based augmentation system** jointly developed by the **Indian Space Research Organisation (ISRO)** and the **Airports Authority of India (AAI)**.
- **Features:**
 - The system adds greater accuracy to the output of GPS navigation by providing **local geographical positioning**, thereby improving the precision of aircraft location for more efficient traffic management.
 - It enhances the **accuracy and integrity of the GPS signals by correcting the errors caused by atmospheric disturbances, clock drifts and orbital deviations**.
 - This satellite technology also helps aircraft/helicopters with **guided landing at airports that do not have instrument landing systems** for low-visibility operations.

Note:

➤ Benefits:

- **Enhanced safety:** By providing accurate and reliable navigation information, **GAGAN reduces the risk of human errors, collisions, terrain strikes** and controlled flight into terrain (CFIT) accidents.
 - It also improves situational awareness and emergency response capabilities for pilots and air traffic controllers.
- **Improved efficiency:** By allowing optimal flight paths and reduced separation standards, **GAGAN enables more efficient use of airspace and fuel**, resulting in lower emissions and operational costs.
- **Increased capacity:** By increasing the number of flights that can be accommodated in a given airspace, GAGAN enhances the capacity and connectivity of the aviation network.
 - It also **enables access to remote and underserved areas** that lack conventional navigation infrastructure or have challenging terrain.
 - In addition, GAGAN will provide **benefits beyond aviation** to all modes of transportation, including **maritime, highways, and railroads**.

What are Carbon Fibres and Titanium?

Why in News?

Scientists are preparing for a Deep Sea Dive with the Vehicle Matsya-6000 in late 2024 similar to the Titan submersible, which recently went missing.

The Matsya-6000 project under India's Deep Ocean Mission, scheduled for late 2024, aims to explore the Indian Ocean at a depth of about 6,000 meters.

In light of the recent incident of Titan Submersible, the safety systems employed for the crew will undergo reviews to ensure their effectiveness.

- **Carbon Fibre:** Carbon fibre is a polymer that is **known to be quite strong despite being lightweight**. It can be as much as **five times stronger than steel** and twice as stiff.
 - A carbon-fibre composite, compared to titanium, is much stiffer and does not have the same kind of elasticity.
- **Titanium:** Titanium is as **strong as steel but around 45% lighter**. It is twice as **strong as aluminum** but

only 60% heavier, according to the United States Geological Survey.

- A titanium or thick steel pressure vessel is usually a spherical shape that can withstand the crushing pressures at 3,800m – the depth at which the Titanic wreck lies.
- Titanium is elastic and **can adapt to an extended range of stresses without** any measurable permanent strain remaining after the return to atmospheric pressure. It shrinks to adjust to pressure forces and re-expands as these forces are alleviated.

Submarine Vs Submersible

- While the two categories can overlap, a **submarine refers to an underwater vehicle** that is largely independent and has power reserves to **help it depart from a port or come back** to the port after an expedition.
- Meanwhile, a submersible is **generally smaller in size** and has less power, so it needs to **work with a ship in order to be launched** and recovered.
 - The missing submersible Titan was working with a vessel named Polar Prince.

What are the Key Points Related to Matsya-6000?

➤ About:

- Matsya-6000 is an indigenous deep-sea dive submersible being developed by the **National Institute of Ocean Technology (NIOT)** in India. It is designed to explore the depths of the Indian Ocean at a **depth of about 6,000 meters**.
- The mission aims to send three Indian navigators to a point approximately 1,500 km away from Kanyakumari, India.

What is Lab-Grown Meat?

Why in News?

Recently, there has been a significant development in the world of sustainable food production with the United States' approval of lab-grown meat, specifically cell-cultivated chicken, by two California-based companies.

Two California-based companies, Good Meat, and Upside Foods received U.S. government approval to produce and sell the 'cell-cultivated chicken'.

Note:

- Lab-grown meat, officially known as cell-cultivated meat, refers to meat that is grown in a **laboratory setting using isolated cells derived from animals**.
- These cells are provided with the necessary resources, such as nutrients and a suitable environment, **to replicate and grow into edible meat**.
- The process typically takes place in **bioreactors**, specialized containers designed to support the cellular cultivation process.
- The **first country to approve** the sale of alternative meat was **Singapore** in 2020.

Radio Telescope

Why in News?

- **Telescopes** are indispensable tools for astronomers, enabling them to observe and study celestial objects.
 - Among the various types of telescopes, **radio telescopes** are gaining traction by playing a crucial role in unveiling the mysteries of the universe by detecting radio waves.

What is a Radio Telescope?

- **About:**
 - A **radio telescope** is a device that **detects and analyses radio waves from astronomical objects in the sky**.
 - Radio waves are a type of **electromagnetic radiation that have wavelengths ranging from about 1 millimetre to 10 metres**.
 - They can **penetrate dust and gas clouds that block visible light**, so radio telescopes can reveal hidden structures and phenomena in the universe.
- **Features:**
 - They are typically **situated on the ground rather than in orbit due to their large size**.
 - It consists of two main components: a **large antenna** and a **sensitive receiver**.
 - The **antenna is usually a parabolic dish that reflects and focuses the incoming radio waves to a focal point**.
 - The receiver amplifies and converts the radio signals into electrical signals that can be recorded and analysed by computers.

What are Eukaryotes and Prokaryotes?

Why in News?

Recently, there has been considerable interest in understanding the evolution of eukaryotes from prokaryotes, shedding light on the intriguing question of how complex cells with nuclei and organelles emerged.

- Organisms on planet earth, based on the type of cells, are broadly divided into prokaryotes and eukaryotes.
 - **Prokaryotes:**
 - Prokaryotes are organisms that **lack a true nucleus and membrane-bound organelles**. Their genetic material, typically a **circular DNA molecule**, is present in the cytoplasm without being enclosed within a nuclear membrane.
 - Prokaryotes include **bacteria and archaea**.
 - Key features include **small, simple cells without a nucleus** or organelles.
 - **Eukaryotes:**
 - Eukaryotes are organisms that have cells containing a **well-defined nucleus enclosed within a membrane**.
 - Eukaryotic cells have a variety of membrane-bound organelles, such as **mitochondria, endoplasmic reticulum, Golgi apparatus**, and a complex network of internal membranes. These organelles perform specialized functions within the cell.
 - Key features include **large, complex cells with a nucleus** and various organelles.

What is a Supercapacitor?

Why in News?

Scientists at the Gujarat Energy Research and Management Institute (GERMI) have achieved a breakthrough in energy storage technology with the development of a paper-based supercapacitor.

This cutting-edge supercapacitor, derived from seaweed, boasts remarkable attributes such as being lightweight, biodegradable, and capable of fully charging a device within a mere 10 seconds.

Note:

- A supercapacitor is an electrochemical charge storage device. They are also known as ultracapacitors.
 - It has significant advantages such as high-power density, long durability, and ultrafast charging characteristics as compared to conventional capacitors and **Lithium-Ion batteries (LIB)**.
 - Main components of supercapacitors include **electrode, electrolyte, separator, and the current collector**.

What are Seaweeds?

Why in News?

Scientists at the Gujarat Energy Research and Management Institute (GERMI) have achieved a breakthrough in energy storage technology with the development of a paper-based supercapacitor.

This cutting-edge supercapacitor, derived from seaweed, boasts remarkable attributes such as being lightweight, biodegradable, and capable of fully charging a device within a mere 10 seconds.

- **About:**
 - **Seaweeds** are macroalgae attached to rock or other substrata and are found in coastal areas.
 - They are classified as **chlorophyta (green), rhodophyta (red) and phaeophyta (brown) on the basis of their pigmentation**.
 - Among them, chlorophyta holds more potential components — **carbohydrates, lipids, proteins and bioactive compounds**.

What is Leptospirosis?

Why in News?

Leptospirosis is a potentially fatal bacterial disease that has become more prevalent during the monsoon months, posing a significant occupational hazard for those working in agricultural settings or in sanitary services that bring them into contact with contaminated water.

- **About:**
 - Leptospirosis is caused by the **bacterium Leptospira interrogans**, which is primarily found in the **urine of infected animals**.

- **Wild and domestic animals**, including rodents, cattle, pigs, and dogs, serve as carriers of the disease.

➤ Symptoms:

- Leptospirosis can manifest with a range of symptoms, from a **mild flu-like illness to life-threatening conditions**.
 - Common symptoms include **sudden fever, chills, and headache**, or sometimes **no symptoms at all**.
 - Severe cases can lead to **organ dysfunction, affecting the liver, kidneys, lungs, and the brain**.

What is Dengue?

Furthermore, public health experts are sounding the alarm about a potential severe dengue outbreak and emphasizing the need for enhanced clinical and virological surveillance. Changes in circulating dengue virus (DENV) serotypes could lead to more severe and life-threatening conditions.

➤ About:

- Dengue is a **mosquito-borne tropical disease** caused by the dengue virus (**Genus Flavivirus**), transmitted by several species of mosquito within the genus **Aedes**, principally **Aedes aegypti**.
 - This mosquito also transmits **chikungunya and Zika infection**.

➤ Serotypes of Dengue:

- There are 4 distinct, but closely related, serotypes (separate groups within a species of microorganisms that all share a similar characteristic) of the virus that cause dengue (**DEN-1, DEN-2, DEN-3 and DEN-4**).

➤ Symptoms:

- Sudden high fever, severe headaches, pain behind the eyes, severe bone, joint, and muscle pain, etc.

➤ Dengue Vaccine:

- Researchers at **India's National Centre for Biological Sciences**, in collaboration with nine other institutions in India, Africa, and the US, have developed **India's first and only DNA vaccine candidate for dengue fever**.
- The **dengue vaccine CYD-TDV or Dengvaxia** was approved by the US Food & Drug Administration in 2019, the **first dengue vaccine to get the regulatory nod in the US**.
 - **Dengvaxia** is basically a **live, attenuated dengue virus** that has to be administered in people of

Note:



ages 9 to 16 who have laboratory-confirmed previous dengue infection and who live in endemic areas.

Miyawaki Plantation Method

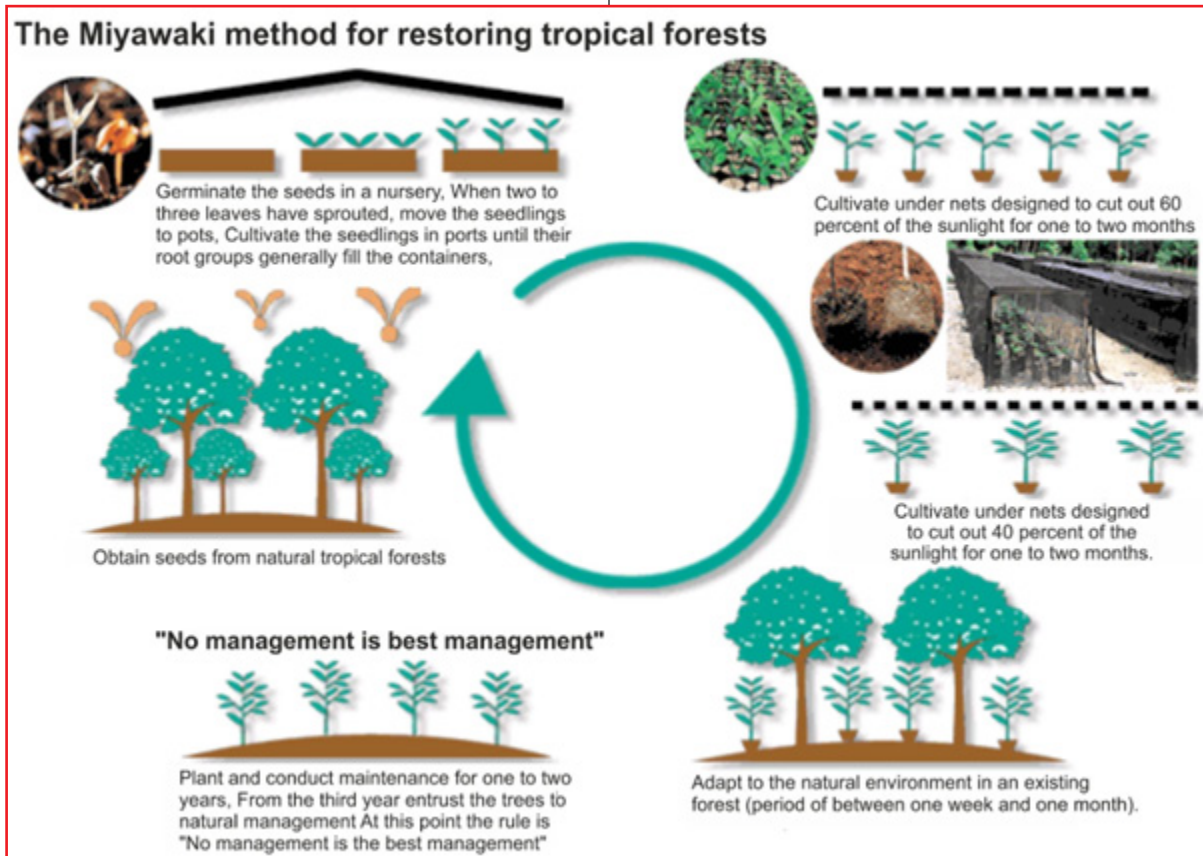
Why in News?

Prime Minister of India in his recent episode of 'Mann

What is the Miyawaki Plantation Method?

ki Baat', discussed the concept of **Miyawaki plantation**. He shed light on the Japanese technique of establishing dense **urban forests** in limited spaces.

- He also mentioned the inspiring story of Raafi Ramnath, a teacher from Kerala, who utilized the Miyawaki method to convert a barren piece of land into a miniature forest named Vidyavanam.



- **About:**
 - It was named after Japanese botanist Akira Miyawaki, this method involves planting two to four different types of indigenous trees within every square metre.
- The methodology was developed in the 1970s, with the basic objective to densify green cover within a small parcel of land.
- In this method, the trees become self-sustaining and they grow to their full length within three years.
 - The plants used in the Miyawaki method are

mostly self-sustaining and don't require regular maintenance like manuring and watering.

Solar Ultraviolet Imaging Telescope

Why in News?

The **Solar Ultraviolet Imaging Telescope (SUIT)**, developed by Pune's Inter-University Center for Astronomy and Astrophysics (IUCAA), has been delivered to the **Indian Space Research Organisation (ISRO)**.

Note:

- This unique space telescope will be **integrated with ISRO's ADITYA-L1 mission**, set to launch in mid-August 2023.

What is SUIT?

- **About:**
- SUIT aims to study the Sun's **ultraviolet (UV) emissions** and capture **high-resolution images of the Sun's atmosphere**, known as the **corona**, in various UV wavelengths.
- It will operate in the **far and near ultraviolet regions**, covering wavelengths of 200-400 nanometers.
- It will observe the **hotter and more dynamic regions of the Sun's atmosphere**, such as the **transition region and the corona**.

What is Aditya-L1 Mission?

- **About:**
- The ADITYA-L1 mission will be **dedicated to studying the Sun** and will fly **approximately 1.5 million kilometers from Earth to the Lagrange point 1 (L1)**, one of the **five favorable spots for observing the Sun**.
- The mission is expected to be launched **using a Polar Satellite Launch Vehicle (PSLV) rocket**.
- It will provide **regular images and updates on the Sun's surface phenomena and space weather**.

What are Brain Ventricles?

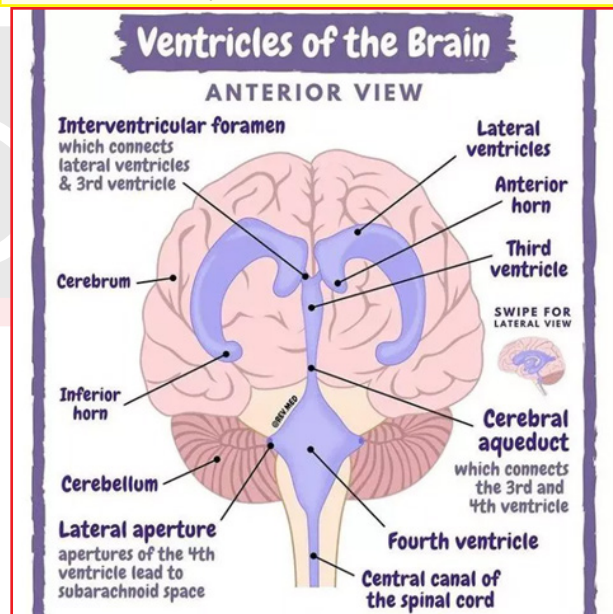
Why in News?

Recently, a study was published in Scientific Reports, which sheds light on the effects of Spaceflight on the Brain, particularly concerning Longer Missions and the recovery period between flights.

The study involved MRI (Magnetic Resonance Imaging) scans of 30 astronauts before and after spaceflight. These participants encompassed various mission durations, including two-week missions, six-month missions, and longer expeditions.

- **About:**
- Brain ventricles are cavities within the brain that produce and store **Cerebrospinal Fluid (CSF)**, which surrounds the brain and spinal cord, cushioning them and **protecting them from trauma**.

- They are also responsible for **removing waste and delivering nutrients** to your brain.
- **There are Four Brain Ventricles:**
 - The first and second ventricles are lateral ventricles. These C-shaped structures are located on each side of the cerebral cortex, the **wrinkly outer layer of Brain**.
 - The **third ventricle is a narrow, funnel-shaped structure** situated between the **right and left thalamus**, just above your brain stem.
 - The fourth ventricle is a **diamond-shaped structure that runs alongside** the brain stem.
 - It has four openings through which cerebrospinal fluid drains into an area surrounding the brain (subarachnoid space) and the central canal of the spinal cord.



What are Transgenic Crops?

Why in News?

Recently, Gujarat, Maharashtra and Telangana, have deferred a proposal, approved by the Centre's Genetic Engineering Appraisal Committee (GEAC), to test a new kind of Transgenic Cotton Seed that contains a gene, Cry2Ai.

- **About:**
 - Transgenic crops are plants that have been modified through genetic engineering techniques. These

Note:

crops have had **specific genes inserted into their DNA** to give them new characteristics or traits that are not naturally found in the species through traditional breeding methods.

○ **GMO vs Transgenic Organisms:**

- Genetically Modified Organism (GMO) and transgenic organism are two terms that are used interchangeably.
- However, there is a **slight difference** between GMO and transgenic organism. Although both have altered genomes, a transgenic organism is a GMO **containing a DNA sequence or a gene from a different species**. While a GMO is an animal, plant, or microbe **whose DNA has been altered** using genetic engineering techniques.
- Thus, all transgenic organisms are GMOs, but not all GMOs are transgenic.

➤ **Status in India:**

- In India, only **Cotton** is currently commercially cultivated as a **GM crop**. Trials are underway for other crops like brinjal, tomato, maize, and chickpea using transgenic technology.
- The GEAC approved the **environmental release of GM mustard hybrid DMH-11**, bringing it closer to full commercial cultivation.

What is Whole-Genome Sequencing?

Why in News?

Recently, the use of rapid whole-genome sequencing (WGS) in newborns, including healthy newborns, has emerged as a revolutionary approach to diagnose and treat genetic diseases.

By providing a comprehensive view of an infant's genetic makeup, this technology enables healthcare workers to make fast and effective diagnoses, leading to improved outcomes and reduced healthcare costs.

➤ **About:**

- All organisms have a unique **genetic code, or genome**, that is composed of **nucleotide bases- Adenine (A), Thymine (T), Cytosine (C) and Guanine (G)**.
- The unique **Deoxyribonucleic Acid (DNA) fingerprint, or pattern can be identified by knowing the sequence of the bases** in an organism.

- **Determining the order** of bases is called sequencing.
- **Whole genome sequencing** is a laboratory procedure that **determines the order of bases in the genome** of an organism in one process.

➤ **Importance of Sequencing Newborn Genomes:**

- Rapid, precise diagnosis of rare genetic diseases **not detected by standard screenings**.
- Detection of **treatable conditions, enabling early intervention or gene-based therapies**.
- Insight into **future health risks**, facilitating **informed choices and preventive measures**.
- Revelation of ancestry, traits, and carrier status for personal and social value.

CMV and ToMV Virus

Why in News?

Tomato growers in Maharashtra attribute crop decline to the **Cucumber Mosaic Virus (CMV)**, while growers in Karnataka and other **South Indian states blame the Tomato Mosaic Virus (ToMV)** for their crop losses.

- Over the last three years, **growers of tomato have complained of increased infestation with these two viruses**, leading to **partial to complete crop losses**.

What are ToMV and CMV?

➤ **ToMV:**

- **About:**
 - ToMV belongs to the **Virgaviridae family** and is closely related to the **Tobacco Mosaic Virus (TMV)**. It infects **tomato, tobacco, peppers**, and certain ornamental plants.
 - It was first identified in **tomato in 1935**.

➤ **Transmission:**

- ToMV mainly spreads through **infected seeds, saplings, agricultural tools, and human contact**.
- It can also be transmitted by some insect vectors, such as **thrips and whiteflies**.

CMV:

➤ **About:**

- CMV belongs to the **Bromoviridae family** and is one of the most widespread plant viruses. It has a broader host range, affecting **cucumber, melon, eggplant, tomato, carrot, lettuce, celery, cucurbits**, and some ornamentals.

Note:

- It was first identified in **cucumber in 1934**.
- **Transmission:**
 - CMV mainly spreads through **aphids**, which are **sap-sucking insects that can acquire and transmit the virus within minutes**.
 - It can also be transmitted by seeds, mechanical inoculation, and grafting.

Note:

- **Phloem** is a complex tissue found in vascular plants, responsible for the **transport of organic nutrients, primarily sugars**, throughout the plant.
- **Cytoplasm** is the gel-like substance that fills the interior of cells. It is a semifluid medium composed of **water, salts, proteins, and other molecules**.
- **RNA** is a genetic material composed of **ribonucleic acid (RNA)**. It carries genetic information in the form of **single-stranded nucleotide sequences**.

Guillain-Barre Syndrome

Why in News?

Peru has declared a 90-day national health emergency in response to a recent surge in **Guillain-Barre Syndrome (GBS)** cases, raising concerns about the potential connection between GBS and **Covid-19**.

What is Guillain-Barre Syndrome?

- **About:** GBS is a serious **autoimmune disorder** that affects the **peripheral nervous system**. It initially presents **weakness, tingling, and numbness in the limbs**, which can progress to **paralysis lasting 6-12 months or longer**.
- The syndrome **affects the nerves responsible for muscle movement**, pain, temperature, and touch sensations.
- While **more common in adults and males**, GBS can occur in individuals of all ages.
- **Cause:** The exact cause of GBS is unknown, but as per the **World Health Organisation (WHO)**, GBS is often preceded by an infection. This could be a **bacterial or viral infection**. This leads the immune system to **attack the body itself**.

Launch Vehicle Mark 3

Why in News?

Indian Space Research Organization (ISRO) will launch its **Chandrayaan-3 Mission** in **LVM (Launch Vehicle Mark) 3** on 14th July 2023.

What are the Launch Vehicles of ISRO?

- ISRO has **3 classes** of Launch Vehicles,
 - **PSLV (Polar Satellite Launch Vehicle):** It has a famous reputation as a workhorse with a very low failure rate, the PSLV can lift up to 3.8 tonnes of **Low Earth Orbit**.
 - **GSLV (Geostationary Launch Vehicle):** ISRO developed and uses the GSLV to launch heavier payloads and if required in higher orbits. Like the PSLV, GSLV also has multiple configurations.
 - The most Powerful **configuration is LVM-3**.
 - **SSLV (Small Satellite Launch Vehicle):** It is a 3 stage Launch Vehicle configured with three **Solid Propulsion Stages and liquid propulsion based Velocity Trimming Module (VTM)** as a terminal stage.

What is LVM 3?

- The LVM-3 has 3 stages,
 - **The first (or bottom most stage)** is in the form of 2 S200 boosters straps to the sides of the rocket body. They combust a solid fuel called hydroxyl-terminated polybutadiene,
 - **The second stage** is powered by Vikas Engines, which combust a **liquid fuel**, either nitrogen tetroxide or unsymmetrical dimethylhydrazine.
 - The **Uppermost final stage** is Powered by a cryogenic engine. It combusts **liquified hydrogen with liquified oxygen**.
- It can lift upto 8 tonnes in low earth orbit.
- **Some of the LVM 3 Missions launched are,**
 - **OneWeb India-2 Mission**
 - OneWeb India-1 Mission
 - **Chandrayaan-2 Mission**
 - **GSAT-29 Mission**
 - GSAT-19 Mission
 - **CARE Mission**

Note:

What is a Solar Flare?

Why in News?

Recently, the Sun emitted an X-class solar flare, disrupting radio communications over parts of the United States and the Pacific Ocean.

According to the National Aeronautics and Space Administration (NASA), the flare is classified as an X1.0 flare.

➤ About:

- A solar flare is a tremendous explosion on the Sun that happens when energy stored in 'twisted' magnetic fields (usually above sunspots) is suddenly released.
- They are seen as bright areas on the sun and they can last from minutes to hours.
- In a matter of just a few minutes, they heat the material to many millions of degrees and produce a burst of radiation across the electromagnetic spectrum, including from radio waves to x-rays and gamma rays.
- They can affect radio communications, power grids and navigation signals and endanger astronauts and spacecraft.

What are Quasars?

Why in News?

A recent study has utilized observations of Quasars, intense black holes to demonstrate time dilation in the early universe.

The researchers examined the brightness of 190 quasars across the universe, dating back approximately 1.5 billion years after the Big Bang. By comparing the brightness of these ancient quasars to those existing today, they discovered that certain fluctuations that occur in a specific duration today occurred five times more slowly in the earliest quasars.

➤ About:

- Quasars, which are incredibly bright objects, served as a "clock" in the study. They are supermassive black holes, millions to billions of times more massive than the sun, located at the centers of galaxies.
- These black holes draw matter towards them through strong gravitational forces, emitting powerful radiation and high-energy particle jets, while surrounded by a glowing disk of matter.

What is GMRT?

Why in News?

Recently, an international team of astronomers announced scientific evidence confirming the presence of gravitational waves using pulsar observations.

India's Giant Metrewave Radio Telescope (GMRT) was among the world's six large telescopes that played a vital role in providing this evidence.

What is GMRT?

- GMRT is a low-frequency radio telescope consisting of an array of 30 fully steerable parabolic radio telescopes of 45-meter diameter.
- It is located near Narayangaon, Pune in India, and operated by the National Centre for Radio Astrophysics (NCRA), a part of the Tata Institute of Fundamental Research, Mumbai.
- It is one of the largest and most sensitive radio telescope array in the world at low frequencies.
- GMRT has recently undergone significant upgrades in its receivers and electronics, which have improved its sensitivity and bandwidth. It is now known as the upgraded GMRT (uGMRT).



What are Gravitational Waves?

Why in News?

Recently, an international team of astronomers announced scientific evidence confirming the presence of gravitational waves using pulsar observations.

India's Giant Metrewave Radio Telescope (GMRT) was among the world's six large telescopes that played a vital role in providing this evidence.

Note:

- **About:**
 - Gravitational waves are **ripples in space-time caused by violent and energetic processes in the Universe.**
 - **Albert Einstein** predicted their existence in his **general theory of Relativity** in 1916.
- **Production of Gravitational Waves**
 - **Cataclysmic Events:** The strongest gravitational waves originate from **colliding black holes, supernovae, and colliding neutron stars.**
 - **Neutron Star Rotation:** Gravitational waves can also be produced by the **rotation of non-perfectly spherical neutron stars** and possibly remnants of gravitational radiation from the **Big Bang.**
- **Features and Detection**
 - Gravitational waves are challenging to detect due to their **weak interaction with matter.**
 - Gravitational waves were first detected in 2015 using an experiment involving **Laser Interferometer Gravitational Observatory (LIGO)** detectors.

What are Artemis Accords?

Why in News?

Recently, India's Prime Minister announced India's decision to join the Artemis Accords during the visit to the United States.

National Aeronautics and Space Administration (NASA) and Indian Space Research Organisation (ISRO) will collaborate to send Indian astronauts, trained at the Johnson Space Center in Houston, Texas, to the International Space Station (ISS) in 2024.

- **About:**
- **Artemis Accords** are established by the **U.S. State Department and NASA with seven other founding members: Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, and the United Kingdom** in 2020 for setting common principles to govern civil exploration and use of outer space, the moon, Mars, comets, and asteroids, for peaceful purposes.
- It builds upon the foundation of the **Outer Space Treaty of 1967.**
 - The Outer Space Treaty, a **multilateral pact under the United Nations**, serves as the foundation for international space law.

- The treaty emphasizes space as a **shared resource for humanity, prohibits national appropriation, and encourages the peaceful use of space.**

What are Battery Electric Vehicles?

Why in News?

As India strives to achieve its net-zero emissions target, battery electric vehicles (BEVs) have emerged as a centerpiece of the government's push for sustainable mobility.

However, while countries like Norway and China have seen success with BEVs, India faces unique challenges due to its specific conditions.

- **About:**
 - Battery Electric Vehicles (BEVs) are a type of electric vehicle that runs solely on **electric power stored in high-capacity batteries.**
 - They do not have an **internal combustion engine(ICE)** and **produce zero tailpipe emissions.**
 - BEVs use electric motors to drive the wheels, providing **instant torque** and smooth acceleration.
- **Battery Technology:**
 - BEVs rely on advanced battery technology, **primarily Lithium-ion (Li-ion) batteries.**
 - Li-ion batteries offer **high energy density, longer range,** and improved performance.
- **Charging Infrastructure:**
 - BEVs require a network of charging stations for recharging their batteries. Charging infrastructure includes various types of chargers:
 - **Level 1 (household outlets)**
 - **Level 2 (dedicated charging stations)**
 - **Level 3 (DC fast chargers).**
 - Public charging stations, workplaces, and residential buildings play a crucial role in expanding the charging infrastructure.

Note:



FOUR TYPES OF EVs

HEVs: Conventional hybrid electric vehicles (such as variants of the Toyota Hyryder Hybrid or Honda City e:HEV in India) combine a conventional ICE system with an electric propulsion system, resulting in a hybrid drivetrain that substantially lowers fuel usage. The onboard battery in a conventional hybrid is charged when the IC engine is powering the drivetrain.



BEVs: Vehicles like the Tata Nexon in India, or the Nissan Leaf and Tesla Model S, have no ICE or fuel tank, and run on a fully electric drivetrain powered by rechargeable batteries.

FCVs: Fuel cell vehicles (such as Toyota's Mirai and Honda's Clarity) use hydrogen to power an onboard electric motor. FCVs combine hydrogen and oxygen to produce electricity, which runs the motor, and the only residue of the chemical process is water. Since they're powered entirely by electricity, FCVs are considered EVs — but unlike BEVs, their range and refuelling processes are comparable to conventional cars and trucks.

PHEVs: Plug-in hybrid vehicles (such as the Chevrolet Volt) also have a hybrid drivetrain that uses both an ICE and electric power for motive power, backed by rechargeable batteries that can be, in this case, plugged into a power source.

Bharat 6G Alliance

Why in News?

Recently, the Department of Telecommunications (DoT) under the Ministry of Communications launched the **Bharat 6G Alliance (B6GA)** to foster innovation and leadership in **6G technology**, the next frontier of wireless communication.

What is the Bharat 6G Alliance (B6GA)?

➤ About:

- The B6GA is a collaborative platform comprising public and private companies, academia, research institutions, and standards development organizations.
- The alliance will **forge partnerships and synergies with other 6G global alliances** to facilitate international collaboration and knowledge exchange.

➤ Objective:

- Its primary objective is to understand the **business and societal needs of 6G technology**, foster consensus, and drive high-impact research and development initiatives.

➤ Importance:

- It will help **India to take a lead role in the development and adoption of 6G technology**, which will have a huge impact on the economy, society, and environment.
- It will also help India **leverage its strengths in software, hardware, and manufacturing**, as well as its large talent pool and market potential.

What is 6G Technology?

- **6G technology is the successor of 5G technology**, which is currently being deployed in various countries, including India.
- 6G technology is expected to offer speeds up to **100 times faster than 5G**, as well as **ultra-low latency, high reliability, and massive connectivity**.
- 6G technology is also envisioned to enable new applications and services such as **holographic communication, brain-computer interface, quantum internet, and artificial intelligence**.
- Holographic communication in 6G refers to the transmission and reception of **3D holographic images in real-time**, enabling immersive and lifelike communication experiences.
- Brain-computer interface in 6G is a futuristic technology that will enable users to **control computers and devices with their thoughts**.
- It seeks to utilize the **terahertz band of frequency** which is currently unutilized.
 - Terahertz waves fall between **infrared waves and microwaves on the electromagnetic spectrum**.
 - These waves are extremely tiny and fragile, but there's a huge amount of free spectrum up there that would allow for spectacular data rates.

What is Slaked Lime?

Why in News?

A new study sheds light on the major role played by “chuna” or slaked lime in causing ocular burns among children in the Indian subcontinent.

Most individuals with acute ocular burns were male, constituting over 80% among adults and over 60% among children.

➤ About:

- **Slaked lime (Ca(OH)₂)**, is obtained by **mixing quicklime (calcium oxide) with water**, resulting in a chemical reaction that **produces calcium hydroxide**.
- The process of slaking quicklime with water is **highly exothermic**, generating a significant amount of heat.
 - It has a **high pH value**, making it highly alkaline and caustic.

Note:

Note:

- **Alkali is the Base that dissolved in water.** Base refers to a type of chemical substance that has a high pH value, typically above 7 on the pH scale.
 - **Alkalis are also known as bases** and are characterized by their ability to neutralize acids, producing salts and water in the process.
 - Common examples of alkalis include **sodium hydroxide (NaOH) and potassium hydroxide (KOH).**
- **Acid is a type of chemical substance that has a low pH value, usually below 7 on the pH scale.** Acids are characterized by their ability to **release hydrogen ions (H+) in a solution.** They can react with metals, carbonates, and bases to form salts and water.
 - Common examples of acids include **hydrochloric acid (HCl) and sulfuric acid (H₂SO₄).**

Note:

- **General Theory of Relativity:** Albert Einstein's theory explains how objects move around massive ones. A fundamental consequence of the general theory of relativity is the existence of a black hole.
- **Quantum Theory:** The study of tiny particles' behavior, like atoms, at the smallest level.
- **Einstein's Principle of Equivalence:** The idea that nature's laws are the same in a small region with gravity as without it.
- **Hawking Radiation:** It is a theoretical concept proposed by Stephen Hawking, which suggests that **black holes can emit radiation due to quantum effects** near the event horizon known as Hawking radiation.

What are Fast Radio Bursts?

Why in News?

Recently, an international team of astronomers studied repeating Fast Radio Bursts (FRB), FRB 20190520B, using the Green Bank Telescope in the U.S. and the Parkes Observatory in Australia. The report was published in the journal Science.

- They are **mysterious emissions of radio light (or Radio Waves) that come from the far reaches of the universe.**

- FRBs reach Earth from **faraway galaxies**, emitting as much energy in a **millisecond** as the sun does over **weeks.**
- They are the **brightest radio bursts found in nature.**
- Astrophysicists have **only been able to 'see' FRBs momentarily using large radio telescopes**, but their precise origins and causes are unknown.
- Some **FRBs are 'one-off' phenomena**, while **others are repeaters**, flashing earth intermittently.

What is Steel Slag Road Technology?

Why in News?

The innovative Steel Slag Road technology developed by the Central Road Research Institute (CRRI), New Delhi in collaboration with the Ministry of Steel and major steel manufacturing companies is making significant strides towards the 'Waste to Wealth' mission.

This technology is revolutionizing road construction and addressing the environmental challenges of steel slag waste.

About:

- Steel slag road technology is a novel method of using steel slag, the **waste generated during steel production**, to build **more robust and more durable roads.**
- The technology involves **processing the steel slag to remove impurities and metal content** and then using it as an **aggregate for road base or sub-base layers.**
- The processed steel slag has **high strength, hardness, abrasion resistance, skid resistance, and drainage capacity**, making it suitable for road construction.
- It facilitates the **large-scale utilization of waste steel slag** generated by steel plants, effectively managing the approximately **19 million tonnes of steel slag produced in India.**

What is Duchenne Muscular Dystrophy?

Why in News?

A collaborative effort between doctors from Tamil

Note:

Nadu, India, and scientists from Japan has resulted in the development of a disease-modifying treatment for Duchenne Muscular Dystrophy (DMD).

➤ **About:**

- **Duchenne Muscular Dystrophy (DMD)** is a **rare genetic disease** characterized by the **inability of muscles to produce dystrophin**, an enzyme that aids in muscle wear and tear as well as its regeneration.
 - It affects only male children.
- The absence of dystrophin leads to **muscle damage, resulting in muscle weakness** and ultimately wheelchair-bound conditions in early teens and consequent premature deaths.

➤ **Common Symptoms:**

- Progressive muscle weakness and **atrophy (loss of muscle bulk)** that begins in the legs and pelvis and later affects the arms, neck and other areas of the body.
- Difficulty **walking, running, jumping, climbing stairs** and getting up from a lying or sitting position.
- Frequent falls, **waddling gait** (abnormal walking pattern) and toe walking.

What is the Perseverance Rover?

Why in News?

The United States National Aeronautics and Space Administration's (NASA) Perseverance rover has uncovered evidence of organic compounds in a Martian crater.

The rover's landing site in Jezero Crater shows a high possibility for past habitability. The presence of various minerals, including carbonates, clays, and sulphates, indicates its history as an ancient lake basin.

- **About:** Perseverance is a **car-sized Mars rover** designed to explore the **Jezero crater on Mars** as part of **NASA's Mars 2020 mission**.
 - It was manufactured by the **Jet Propulsion Laboratory** and launched on July 30, 2020.
 - It landed on **Mars on February 18, 2021**, after a seven-month journey.
- **Power Source:** A **Multi-Mission Radioisotope Thermoelectric Generator (MMRTG)** which converts heat from the natural **radioactive decay** of plutonium (Plutonium Dioxide) into electricity.

➤ **Major Objectives:**

- Seek signs of ancient life and collect samples of rock and soil for possible return to Earth.
- Study the geology and climate of Mars and how they have changed over time.
- Demonstrate technologies that could enable **future human exploration of Mars**, such as **producing oxygen from the Martian atmosphere** and testing a miniature helicopter.

Note:

- SHERLOC is the first instrument on Mars that can **perform fine-scale mapping and analysis of organic molecules**.
- It uses a **laser to illuminate the surface of rocks and soils**, and **measures the fluorescence** or glow emitted by organic compounds when exposed to ultraviolet light.
- SHERLOC can also **identify the minerals associated with organic compounds**, which can provide clues about their origin and preservation.

What are the Various Mars Missions?

- **India's Mars Orbiter Mission (MOM) or Mangalyaan (2013)**
- **ExoMars rover (2021)** (European Space Agency)
- **Tianwen-1: China's Mars Mission (2021)**
- **UAE's Hope Mars Mission** (UAE's first-ever interplanetary mission) (2021)
- **Mars 2 and Mars 3 (1971)** (Soviet Union)

What is Bird Flu?

Why in News?

The recent surge in bird flu outbreaks among mammals has alarmed international agencies, including the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the World Organisation for Animal Health (WOAH, founded as OIE).

The agencies express concern that as mammals are biologically closer to humans than birds, the virus could potentially adapt to infect humans more easily.

➤ **About:**

- **Bird flu** or Avian influenza refers to the disease caused by **infection with avian influenza Type A viruses**.

Note:

- Infrequently, the **virus can infect mammals from birds**, a phenomenon called **spillover**, and rarely can spread between mammals.
- **Outbreak in Wild Birds and Poultry:**
 - The most common type of bird flu virus is **H5N1**, which belongs to the **goose/Guangdong-lineage of H5N1 avian influenza viruses** that first emerged in 1996/1997.
 - Since 2020, this virus has caused an unprecedented number of deaths in wild birds and poultry in many countries in **Africa, Asia, Europe and the Americas**.
 - In 2022, WOAHA reported H5N1 high pathogenicity avian influenza outbreaks in poultry and wild birds in **67 countries across five continents**.

What is Space Debris?

Why in News?

Recently, ISRO's (Indian Space Research Organization) Rocket Debris was found on the shores of Western Australia.

In November 2022, large fragments of China's Long March 5B rocket plunged uncontrolled into the south-central Pacific Ocean. These fragments were stages of the rocket used to deliver the third and final module of the Tiangong space station.

In May 2021, a large chunk of a 25-tonne Chinese rocket fell into the Indian Ocean.

➤ About:

- Space debris refers to **man-made objects in Earth's orbit** that no longer serve a useful purpose.
- This includes **defunct satellites, spent rocket stages**, and fragments of debris from collisions or other events.

➤ Threats from Space Debris:

- **Threat to Marine Life:**
 - Even when falling into the oceans, which is more likely since 70% of the earth's surface is ocean, **large objects can be a threat to marine life**, and a source of pollution.
- **Threat for Operational Satellites:**
 - The floating space debris is a potential hazard for operational satellites and colliding with them can leave the satellites dysfunctional.
 - This overpopulation of space with objects and debris is referred to as **Kessler Syndrome**.

- **Reduction of Orbital Slots:**
 - The accumulation of space debris in specific orbital regions can limit the availability of desirable orbital slots for future missions.
- **Space Situational Awareness:**
 - The increasing amount of space debris makes it more challenging for satellite operators and space agencies to accurately track and predict the orbits of objects in space.

What is Akira Ransomware?

Why in News?

Recently, the Indian government's Computer Emergency Response Team (CERT-In) issued a warning about the Akira ransomware, which has emerged as a significant cybersecurity threat, targeting both Windows and Linux devices.

Ransomware is a type of malware that hijacks computer data and then demands payment (usually in bitcoins) in order to restore it.

➤ About:

- It is **malicious software** that poses a significant threat to **data security**.
- It targets **both Windows and Linux devices**, encrypting data and demanding a **ransom for decryption**.

➤ Key Characteristics of Akira Ransomware:

- Designed to **encrypt data and create a ransomware note** with a unique **“.akira” extension** appended to encrypted filenames.
- Capable of deleting Windows Shadow Volume copies and shutting down Windows services to prevent interference during encryption.
- Exploits **VPN services and malicious files** to infect devices, making it challenging to detect and prevent.

What is CERT-IN?

- Computer Emergency Response Team - India is an **organisation of the Ministry of Electronics and Information Technology** with the objective of securing Indian cyberspace.
- It is a **nodal agency which deals with cybersecurity threats** like hacking and phishing.

Note:

- It collects, analyses and disseminates information on cyber incidents, and also **issues alert on cybersecurity incidents**.
- CERT-IN provides **Incident Prevention and Response Services** as well as Security Quality Management Services.

What is Quantum Computing?

Why in News?

Computation has transformed various facets of human civilization, from banking to warfare, however, the emergence of Quantum Computing has raised concerns about its impact on Computer Security in the Future.

- **About:**
- Quantum computing is a **rapidly emerging technology** that harnesses the **laws of quantum mechanics** to solve problems that are too complex for classical computers.
- Quantum mechanics is a **subfield of physics that describes the behavior of particles** — atoms, electrons, photons, and almost everything in the molecular and sub molecular realm.
- It is an exciting new technology that will **shape our world tomorrow** by providing us with an edge and a myriad of possibilities.
- It is a fundamentally different way of processing information compared to today's classical computing systems.

Mars

Why in News?

NASA in collaboration with the United States Defense Advanced Research Projects Agency (DARPA) is seeking a nuclear propulsion system that could potentially cut down the travel time to Mars by half.

This ambitious initiative, known as the Demonstration Rocket for Agile Cislunar Operations (DRACO) and the launch is scheduled for late 2025 or early 2026.

- **About:** Mars is the fourth planet from the Sun in our solar system. It is often referred to as the **"Red Planet"**

due to its reddish appearance caused by **iron oxide (rust) on its surface**.

- **Atmosphere:** Mars has a thin atmosphere primarily composed of **carbon dioxide (95.3%), with traces of nitrogen and argon**.
- **Major Surface Features:**
 - **Olympus Mons:** The largest known volcano in the solar system.
 - **Valles Marineris:** A massive canyon system.
 - **Polar Ice Caps:** Ice caps made of water and frozen carbon dioxide (dry ice) at the poles.
 - **Dusty Surface:** The surface is covered in fine dust and rocks.
 - **Liquid Water:** Liquid water is rare, but evidence suggests past liquid flows.

What are the Major Mars Missions?

- [Perseverance Rover - NASA](#)
- [India's Mars Orbiter Mission \(MOM\)](#) or Mangalyaan (2013)
- ExoMars rover (2021) (European Space Agency)
- Tianwen-1: China's Mars Mission (2021)
- [UAE's Hope Mars Mission](#) (UAE's first-ever interplanetary mission) (2021)
- Mars 2 and Mars 3 (1971) (Soviet Union)

What is the Theory of Evolution by Charles Darwin?

Why in News?

Recently, a study published in the journal Royal Society Open Science, suggests a connection between Birds and Dinosaurs.

What is the Theory of Evolution by Charles Darwin?

- **About:**
 - Charles Darwin's theory of evolution is a **foundational concept in biology** that explains how **species change over time** and how new species arise.
 - Darwin's ideas revolutionized the **understanding of life on Earth** and provided a comprehensive explanation for the diversity of species.

Note:

➤ Key Elements:

- **Descent with Modification:** Darwin proposed that all species share common ancestors and that species **change gradually over time through a process called descent with modification**, meaning that new species arise from existing ones.
- **Natural Selection:** The central mechanism of Darwin's theory is **natural selection**. He observed that in every generation, more **offspring are produced** than can survive due to limited resources, leading to a struggle for survival.
- **Variation:** Within any population, there is **variation in traits among individuals**. Some of these variations are **heritable, meaning they can be passed down to offspring**.
- **Adaptation:** As natural selection acts on the variations in a population, individuals with traits that are **better suited to their environment become more successful** at surviving and reproducing.
- **Speciation:** Over long periods of time and **through the accumulation of gradual changes**, populations can become so different from each other that they can **no longer interbreed**. This leads to the **formation of new species**.

What is Computed Tomography (CT)?

- It is a medical imaging technique that **uses X-rays and advanced computer processing** to create detailed **cross-sectional images of the body**.
- Like an X-ray, it shows **structures inside the body**. But instead of creating a flat, 2D image, a **CT scan takes dozens to hundreds of images** of the body.
- Healthcare providers use CT scans to see things that regular X-rays can't show.
 - For example, body structures overlap on regular X-rays and many things aren't visible.
 - A CT shows the details of each of the organs for a clearer and more precise view.

What are Superconductors?

Why in News?

A group of South Korean scientists have recently claimed the discovery of a material they named LK-99.

According to their reports, LK-99 is a superconductor at room temperature and pressure.

This groundbreaking claim has piqued the interest of the scientific community and could potentially revolutionize the world of electrical conductivity and technology.

➤ About:

- Superconductors are **materials that exhibit zero electrical resistance** when cooled to extremely low temperatures. This property allows them to **conduct electricity with no loss of energy**.
 - **Example:** Lanthanum-Barium-Copper Oxide, Yttrium-Barium-Copper Oxide, Niobium-Tin etc.

➤ Discovery:

- In **1911 Kamerlingh Onnes** discovered that the electrical resistance of **mercury completely disappeared at temperatures a few degrees above absolute zero**.
 - The phenomenon became known as **superconductivity**.

➤ Applications of Superconductors:

- **Energy Transmission:** Superconducting cables can transmit electricity without losses, making them ideal for long-distance power transmission.
- **Magnetic Resonance Imaging (MRI):** Superconducting magnets are used in **MRI machines** to create strong and stable magnetic fields, enabling detailed medical imaging.
- **Particle Accelerators:** Superconducting magnets are crucial components in particle accelerators like the **Large Hadron Collider (LHC)**, allowing particles to reach high velocities.
- **Electric Motors and Generators:** Superconducting materials can enhance the efficiency and power density of electric motors and generators.
- **Maglev Trains:** Superconducting magnets enable **magnetic levitation (maglev) trains to float above tracks**, reducing friction and enabling high-speed travel.
- **Quantum Computing:** Some superconducting materials are being explored for their **potential in quantum computing** due to their ability to exhibit quantum states.

Note:

What is Lymphatic Filariasis?

Why in News?

Recently, the Union Health Minister inaugurated the second phase of the Annual Nationwide Mass Drug Administration (MDA) initiative for Lymphatic Filariasis.

India aims to eliminate Lymphatic Filariasis by 2027, three years ahead of the global target, through a mission-driven strategy.

➤ About:

- Lymphatic filariasis, commonly known as **elephantiasis**, is a **neglected tropical disease** caused by **parasitic infection** which is transmitted through the **bite of infected mosquitoes**.
- This impacts millions of individuals in tropical and subtropical regions across the globe.

➤ Causes and Transmission:

- **Lymphatic filariasis** is caused by **infection with parasites classified as nematodes (roundworms)** of the family Filarioididea.
- **There are 3 types of these thread-like filarial worms:**
- ***Wuchereriabancrofti***, which is responsible for 90% of the cases,
- ***Brugiamalayi***, which causes most of the remainder of the cases,
- ***Brugiatimori***, which also causes the disease.

➤ Symptoms:

- Lymphatic filariasis infection involves asymptomatic, acute, and chronic conditions.
 - In chronic conditions, it leads to **lymphoedema (tissue swelling) or elephantiasis (skin/tissue thickening) of limbs** and hydrocele (scrotal swelling).

➤ Treatment:

- The **World Health Organization (WHO)** recommends three drug treatments to accelerate the global elimination of lymphatic filariasis. The treatment, known as **IDA**, involves a combination of **ivermectin, diethylcarbamazine citrate and albendazole**.
 - The plan is to administer these drugs for two consecutive years. **The life of the adult worm is hardly four years, so it would die a natural death without causing any harm to the person.**

What is Cell-Free DNA (cfDNA)?

Why in News?

A notable advancement in medical science has emerged in recent years through the discovery of cell-free Deoxyribonucleic Acid (cfDNA), carrying significant implications for disease detection, diagnosis, and treatment.

cfDNA stands poised to reshape the entire landscape of medical science.

➤ About:

- cfDNA refers to **fragments of DNA that exist outside of cells**, specifically in various body fluids. Unlike the majority of **DNA which is enclosed within cells**.
- Scientists have been aware of **cfDNA since 1948**, but only in the last two decades have they figured out what to do with it.
- cfDNA is released into the **extracellular environment** under different circumstances, including **cell death or other cellular processes**.
- These cfDNA fragments contain **genetic information** and can offer insights into a person's health status, potential diseases, and genetic variations.

➤ Applications:

- **Non-Invasive Prenatal Testing (NIPT):**
 - Cell-free DNA serves as a valuable tool for **screening chromosomal abnormalities** in developing foetuses, such as **Down syndrome**.
 - NIPT replaces invasive procedures such as amniocentesis, minimizing risks for both expectant mothers and foetuses.
 - Analysis of **cfDNA in maternal blood** provides crucial information about the **foetus's genetic health**.
- **Early Cancer Detection:**
 - Identifying **cancers at their initial stages** for prompt treatment.
 - The '**GEMINI**' test utilizes **cfDNA sequencing to detect lung cancer with high accuracy**.
 - Combining cfDNA analysis with existing methods enhances overall cancer detection.

Note:

Chandrayaan-3 Successfully Lands on Moon's South Pole

Why in News?

Chandrayaan-3 has made history by becoming the **first mission to soft-land on the lunar south pole**, a region that has never been explored before. The mission aimed to demonstrate safe and soft lunar landing, rover mobility, and **in-situ scientific experiments**.

- India now joins the **United States, Russia, and China** as one of the few countries to successfully **land on the Moon**.

How did Chandrayaan-3 Prevail Over Obstacles Encountered in the Previous Mission?

- Chandrayaan-3's successful landing came after the **setback of the Chandrayaan-2 mission's landing failure in 2019**.
 - The Vikram lander of Chandrayaan-2 had lost control and communication during descent, leading to a crash on the lunar surface.
- Lessons from the Chandrayaan-2 mission were applied to Chandrayaan-3, focusing on a **"failure-based" design approach** to anticipate and mitigate potential issues.
 - Critical changes included strengthening the **lander's legs, increasing fuel reserves, and enhancing landing site flexibility**.

Why did Chandrayaan-3 Choose Moon's Near Side for Landing?

- Chandrayaan-3 aimed to investigate **"permanently shadowed regions"** near the **South Pole** for potential water-ice and resources.
 - The Vikram lander's controlled descent achieved **one of the closest approaches to the Moon's South Pole**.
- While a notable achievement, **Vikram's landing occurred on the Moon's near side, unlike China's Chang'e 4 on the far side**.
 - The near side, **visible from Earth due to synchronous rotation**, covers **60% of the Moon**.
 - The **far side, though not always in darkness**, remained hidden until the **Soviet spacecraft Luna 3 captured images in 1959**.

- Astronauts aboard the **Apollo 8 mission in 1968** became the first humans to observe the far side directly.

- The near side boasts smoother surfaces and numerous **'maria' (large volcanic plains)**, while the far side features massive craters from asteroid impacts.
 - The lunar crust on the near side is thinner, causing volcanic lava to flow and fill craters over time, creating flat terrains.
- The decision to land on the near side was **driven by the mission's primary goal of a controlled soft landing**.
 - Landing on the far side would require a **relay for communication due to the lack of direct line-of-sight with Earth**.

What are the Intended Actions for Chandrayaan-3 after its Landing?

- **Chandrayaan-3** is expected to **operate for at least one lunar day (14 Earth days)** on the lunar surface.
 - The **Pragyan rover will move around the landing site within a radius of 500 meters**, conducting experiments and sending data and images to the lander.
 - The **Vikram lander will relay the data and images to the orbiter**, which will then transmit them to Earth.
- **Lander and Rover modules** are collectively equipped with advanced scientific payloads.

What are ISRO's Future Expeditions?

- **Chandrayaan-4: Navigating the Path of Lunar Evolution**
 - Building upon past missions, **Chandrayaan-4 emerges as a potential candidate for a sample return mission**.
 - If successful, it could mark the next logical step after Chandrayaan-2 and 3, offering the capability to retrieve lunar surface samples.
 - The mission holds promise for advancing our understanding of the Moon's composition and history.
- **LUPEX: Lunar Polar Exploration (LUPEX) mission**, a collaborative effort between **ISRO and JAXA (Japan)**, **is poised to explore the Moon's polar regions**.
 - It will be specifically designed to venture into **permanently shaded areas**.

Note:

- Investigating the presence of water and assessing the potential for a sustainable long-term station are among LUPEX's objectives.
- **Aditya-L1: Aditya L1** will be the first space based Indian mission to study the Sun.
 - The spacecraft shall be placed 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.
 - Observing the sun's **corona, emissions, solar winds, flares, and coronal mass ejections** are the primary focus areas of **Aditya-L1**.
- **XPoSat (X-ray Polarimeter Satellite)**: It is India's **first dedicated polarimetry mission to study various dynamics of bright astronomical X-ray sources** in extreme conditions.
 - The spacecraft will carry two scientific payloads in a low earth orbit.
- **NISAR: NASA-ISRO SAR (NISAR)** is a **Low Earth Orbit (LEO)** observatory being jointly developed by NASA and ISRO.
 - NISAR will **map the entire globe in 12 days** and provide spatially and temporally consistent data for understanding **changes in Earth's ecosystems, ice mass, vegetation biomass, sea level rise, ground water and natural hazards** including earthquakes, tsunamis, volcanoes and landslides.
- **Gaganyaan: Gaganyaan** mission aims to send **humans to space and return them safely to Earth**. The mission will consist of **two unmanned flights and one manned flight**, using the **GSLV Mk III launch vehicle** and a **human-rated orbital module**.
 - The **manned flight will carry three astronauts, including a woman**, for up to seven days in low Earth orbit.
- **Shukrayaan 1**: It is a planned mission to send an **orbiter to Venus**, the second planet from the Sun. It is expected to **study Venus's geological and volcanic activity**, emissions on the ground, wind speed, cloud cover, and other planetary characteristics.

What is the Luna-25 Mission?

Why in News?

Recently, Russia's Luna-25 crashed on the Moon's

surface, ending its first mission to the lunar surface 47 years after the last landing by the former Soviet Union. This leaves India's Chandrayaan-3 on course to become the first spacecraft to land near the Lunar South Pole.

Russia's Luna-25 marked the resumption of lunar interest and plans to continue the Luna series.

➤ About:

- The Luna 25 mission, originally named **Luna-Glob**, underwent over two decades of development before joining the historic Luna series initiated in 1976.
- The mission aimed to **secure Russia's access to the Moon's surface** amid its significance in space exploration and geopolitical rivalry.
 - While Russia and China lead the **International Lunar Research Station (ILRS)**, the U.S. heads the Artemis Accords.

What are STEREO-A and STEREO-B?

Why in News?

In a significant development, NASA's (National Aeronautics and Space Administration) Solar Terrestrial Relations Observatory (STEREO-A) spacecraft has made its first Earth Flyby, nearly 17 years after its initial launch.

- **STEREO-A (A stands for Ahead)**, along with its twin **STEREO-B (B stands for Behind)**, was launched in 2006 to study the **Sun's Behavior** by charting Earth-like orbits around it.
 - Their primary goal was to provide a stereoscopic view of the Sun, **enabling researchers to study it from multiple perspectives**.
- In 2011, STEREO-A achieved a **pivotal milestone by reaching a 180-degree separation** in its orbit from STEREO-B. This spatial arrangement allowed humanity to **observe the Sun as a complete sphere** for the first time, offering **crucial insights into its complex structure** and activity.
 - STEREO-B broke contact with **mission control in 2014 after a planned reset (B's mission officially ended in 2018)**.

Note:

What is the Difference between DNA, Gene, and Chromosome?

Why in News?

- The new “long-read” sequencing technique has provided a reliable sequence from one end of the Y chromosome to the other.
- The findings published in Nature Journal provide information about the working of sex genes and sperm, the evolution of the Y chromosome, and its possible disappearance in a few million years.
- Earlier, some studies shed light on the role of the Y chromosome in colorectal and bladder cancer, revealing key genetic mechanisms that contribute to tumour progression, immune response, and clinical prognosis.

What is the Difference between DNA, Gene, and Chromosome?

- **DNA:**
 - DNA is a long molecule that contains our unique genetic code. DNA is composed of two strands that wrap around each other to form a double helix shape, like a spiral staircase.
 - Each strand of DNA is formed of four basic building blocks or ‘bases’: adenine (A), cytosine (C), guanine (G), and thymine (T).
- **Gene:**
 - Genes are sections of DNA that contain the set of instructions to produce one specific molecule in the body, usually a protein.
 - These proteins control how the body grows and works and are responsible for characteristics like eye colour, blood type, or height.
 - Each cell contains two sets of genes, one from your mother and one from your father. For ease of storage and access, the genes are packaged up into 46 parcels called chromosomes.
- **Chromosome:**
 - In the nucleus of each cell, the DNA molecule is packaged into thread-like structures called chromosomes.
 - Each chromosome is made up of DNA tightly coiled many times around proteins called histones that support its structure.
 - Chromosomes are not visible in the cell’s nucleus - not even under a microscope.

What are Somatic Genetic Variants?

Why in News?

Recent advances in genome sequencing unveil the impact of somatic genetic variants on human health, from cancer development to immune disorders, driving innovation in disease detection and treatment strategies.

- **About:**
 - Somatic genetic variants also known as somatic mutations refer to alterations in the DNA sequence that occur specifically within the cells of an individual’s body (somatic cells), excluding the germline cells (sperm and egg cells).
 - Somatic genetic mutations occur after birth during development and are not inherited from parents.
- **Somatic Mutation Progression:**
 - The human genome consists of 23 pairs of chromosomes, inherited from each parent, forming the blueprint of our genetic identity.
 - Following the fertilization of an egg cell by a sperm cell, the resultant single cell amalgamates genetic material from both parents.
 - Through subsequent rounds of division, this initial cell proliferates extensively, ultimately generating the countless trillions of cells constituting the human body.

What is a Demon Particle?

Why in News?

Recently, a team of researchers from the University of Illinois discovered a unique particle, known as a “demon particle,” within a metal called strontium ruthenate. This discovery has the potential to pave the way for the development of superconductors capable of operating at room temperature.

- The demon particle is a name given to a type of quasiparticle, which is not a real particle, but rather a collective excitation or vibration of many electrons in a solid.
 - Quasiparticles are useful for describing the complex behavior of electrons in solids, such as metals and semiconductors.

Note:

- The demon particle was **first predicted by theoretical physicist David Pines in 1956.**
 - He believed that electrons would behave strangely when passed through a solid. **Electric interactions make electrons combine to form collective units. This can make them lose individuality in solids.**
 - However, with such a large mass, **plasmons (collective oscillation of conduction electrons in metals)** cannot form with **energies available at room temperature.**
 - However, **demons do not contain mass**, they can form with **any energy and at room temperature as well.**
- The demon particle could have many applications in computing, medical imaging, transportation, and energy.

What are the Radio Thermoelectric Generators (RTGs)?

Why in News?

Recently, Indian Space Research Organisation (ISRO) in collaboration with the Bhabha Atomic Research Center (BARC), has embarked on the joint development of Radio thermoelectric generators (RTGs), an innovative approach aimed at surpassing the constraints of conventional chemical engines for interplanetary voyages.

Chemical engines work well for satellite thrusters, but they are inadequate for deep space travel due to fuel limitations and lack of solar power in distant regions.

RTGs have been successfully employed by US spacecraft such as the Voyager, Cassini and Curiosity, to power missions with exceptional achievements

- **About:**
 - RTGs are innovative power sources designed to **address challenges in deep space missions.**
 - RTGs utilize radioactive materials, such as **Plutonium-238 or Strontium-90, which emit heat as they decay over time.**
 - This **heat is harnessed and converted into electricity**, enabling the propulsion and power of spacecraft.
- **Components of RTGs:**
 - **Radioisotope Heater Unit (RHU):**
 - The RHU is responsible for **generating heat through the decay of radioactive materials.**

- It initiates the process by **releasing thermal energy**, which serves as the foundation for electricity generation.
- **RTG (Heat-to-Electricity Conversion):**
 - The RTG component transforms the **heat generated by the RHU into usable electricity.**
 - This conversion takes place through a **thermocouple**, a material that generates **voltage when subjected to a temperature gradient.**
 - The voltage produced by the thermocouple is utilized to **charge batteries onboard the spacecraft.**
 - These batteries, in turn, power various systems, including propulsion mechanisms, enabling interplanetary travel.
- **Advantages of RTGs for Space Missions:**
 - **Independence from Solar Proximity:**
 - Unlike solar-powered systems, RTGs operate effectively regardless of the **spacecraft's distance from the sun.**
 - This characteristic **eliminates constraints related to launch windows and planetary alignment.**
 - **Reliability and Consistency:**
 - RTGs offer a **consistent and reliable source of power**, essential for sustaining prolonged deep space missions.
 - The gradual decay of radioactive materials ensures a continuous supply of heat and electricity.

What is Project Worldcoin?

Why in News?

Recently, a project called Worldcoin has been launched by OpenAI, an Artificial intelligence company. The project claims to be building the world's largest identity and financial public network.

- **About:**
 - Worldcoin is an **initiative to create a digital network** in which everyone can claim some kind of stake, and join the digital economy.
- **Worldcoin Working Process:**
 - The initiative uses a **device called "Orb" to collect biometric (iris) data** and help participants get a World ID through the World app.

Note:

- With the app, participants can collect a **cryptocurrency** called **Worldcoin [WLD]**.
- Users need to be willing to scan irises and/or get their own irises scanned to make the Worldcoin network possible.

Aditya-L1 Mission

Why in News?

Recently, the **Indian Space Research Organisation (ISRO)** has accomplished the launch of **Aditya-L1**, its inaugural Solar Mission.

- The launch was conducted using the **PSLV-C57 rocket**. The PSLV's **fourth stage was fired twice**, a first in ISRO's history, to **precisely insert the spacecraft into its elliptical orbit**.

What is Aditya-L1 Mission?

- **About:**
 - **Aditya-L1** is the first space based observatory class Indian solar mission to study the Sun from a substantial distance of **1.5 million kilometers**. It will take approximately **125 days** to reach the L1 point.
 - Aditya-L1 is also ISRO's second astronomy observatory-class mission after **AstroSat (2015)**.
 - The mission's journey is notably shorter than India's previous **Mars orbiter mission, Mangalyaan**.
- The spacecraft is planned to be **placed in a halo orbit** around the **Lagrangian point 1 (L1)** of the Sun-Earth system.

What are Lagrange Points?

- **About:**
 - **Lagrange points** are special positions in space where the **gravitational forces of two large orbiting bodies**, such as the **Sun and the Earth**, balance each other out.
 - This means that a small object, such as a **spacecraft**, can stay at these points without using much fuel to maintain its orbit.
 - There are **five Lagrange Points**, each with distinct characteristics. These points enable a small mass to orbit in a stable pattern amid two larger masses.

➤ Lagrange Points in the Sun-Earth System:

- **L1:** L1 is considered the most significant of the Lagrange points for solar observations. A satellite placed in the **halo orbit around the L1 has the major advantage of continuously viewing the Sun** without any occultation/ eclipses.
 - It is currently home to the **Solar and Heliospheric Observatory Satellite (SOHO)**.
- **L2:** Positioned directly 'behind' Earth as viewed from the Sun, L2 is excellent for **observing the larger Universe without Earth's shadow interference**.
 - The **James Webb Space Telescope** orbits the Sun near L2.
- **L3:** Positioned behind the Sun, opposite Earth, and just beyond Earth's orbit, it offers **potential observations of the far side of the Sun**.
- **L4 and L5:** Objects at L4 and L5 maintain stable positions, forming an **equilateral triangle with the two larger bodies**.
 - They are often used for space observatories, such as those studying **asteroids**.

Shanti Swarup Bhatnagar Awards 2022

Why in News?

Recently, at the inaugural session of the **One Week One Lab (OWOL) program** of the **Council of Scientific and Industrial Research (CSIR)**-National Institute of Science Communication and Policy Research (CSIR-NIScPR), the CSIR announced the list of awardees for the **Shanti Swarup Bhatnagar (SSB) awards for 2022**.

- There were no female scientists chosen for the SSB Awards 2022.

What are the Key Facts About the Shanti Swarup Bhatnagar Awards?

- **About:**
 - The Shanti Swarup Bhatnagar Awards are the **highest multidisciplinary science awards in India**.
 - They are named after **Shanti Swarup Bhatnagar**, the **founder and director of the CSIR**, who was also a renowned chemist and visionary.

Note:

- **Purpose:**
 - Recognition of outstanding Indian work in science and technology.
- **Nature of the Prize:**
 - SSB Prizes, **each of the value of Rs 5,00,000 (Rupees five lakh only)**, are awarded annually for notable and outstanding research applied or fundamental, in the following disciplines: (i) Biological Sciences, (ii) Chemical Sciences, (iii) Earth, Atmosphere, Ocean and Planetary Sciences, (iv) Engineering Sciences, (v) Mathematical Sciences, (vi) Medical Sciences and (vii) Physical Sciences.
- **Eligibility:**
 - **Any citizen of India engaged in research in any field of science and technology up to the age of 45 years** as reckoned on 31st December of the year preceding the year of the Prize.
 - **Overseas citizens of India (OCI)** and **Persons of Indian Origin (PIO)** working in India are also eligible.
 - The Prize is awarded on the **basis of contributions made through work done primarily in India** during the five years preceding the year of the Prize.

Council of Scientific and Industrial Research (CSIR)

- **CSIR** is the **largest research and development (R&D) organization in India**, established in 1942, with its **headquarters in New Delhi**.
- CSIR has a dynamic network of 37 national laboratories, 39 outreach centers, 1 Innovation Complex, and three units with a pan-India presence.
- CSIR is **funded by the Ministry of Science and Technology** and it operates as an **autonomous body through the Societies Registration Act, 1860**.
- CSIR's organizational structure includes the **Prime Minister of India as President**, the **Union Minister of Science and Technology as Vice President**, with the Director-General heading the governing body along with the finance secretary (expenditures).

String of Pearls Supernova

Why in News?

The **James Webb Space Telescope (JWST)** captured an image of **SN1987A**, a **supernova** that **exploded decades ago**, offering new insights into its history and evolution.

What is SN1987A Supernova?

- **About:**
 - SN1987A exploded in **1987**, becoming the **nearest and brightest supernova** visible from earth in nearly four centuries.
 - SN1987A is situated **170,000 light-years away** from Earth in the **Large Magellanic Cloud**.
 - Now, the JWST is revealing intricate details of this cosmic event that have remained hidden until now.
- **Alias 'String of Pearls':**
 - SN1987A is often referred to as a **"string of pearls"** as it showcases a series of luminous rings composed of gases and dust expelled by the dying star in its various phases of collapse and explosion.
 - This string of pearls comprises material ejected about 20,000 years before the supernova event, offering insights into the star's history and evolution.

What is Hubble Constant?

Why in News?

Recently, some researchers from India and the US have proposed a novel method to determine the Hubble constant and the Rate of Expansion of the Universe.

- **About:**
 - In 1929, Edwin Hubble formulated Hubble's law, providing the **first mathematical description of the universe's expansion**.
 - The precise rate of this expansion, termed the Hubble constant, remains a contentious issue in cosmology.
- **Measurement:**
 - Two details are required to calculate the value of the Hubble constant:
 - The distance between the observer and astronomical objects,
 - The velocity at which these objects are moving away from the **observer as a result of the expansion of the universe**.

Super Blue Moon

Why in News?

On August 30, 2023, the night sky was illuminated by a **rare phenomenon: a super blue moon**. However,

Note:

despite its name, this **full moon was neither blue in colour nor super in size.**

- The last blue supermoon was in 2009, according to the **National Aeronautics and Space Administration (NASA)**, and the next is not expected until 2037.

What is a Super Blue Moon?

- A super blue moon combines a **supermoon and a blue moon.**
- A supermoon occurs when the **moon aligns closely with Earth during its orbit, making it appear larger and brighter.**
 - This alignment, called **perigee, contrasts with apogee, when the moon is farthest** in its elliptical orbit around earth. While the difference is subtle, near the horizon, an **optical illusion can make it seem larger.**
 - The term “**supermoon**” was coined in **1979 by astrologer Richard Nolle.**
- A blue moon is the **second full moon in a month.** Despite its name, **a blue moon isn't blue;** it's the traditional name for the second full moon in a month.
 - Sometimes, smoke or dust in the air can scatter red wavelengths of light, as a result of which the moon may, in certain places, appear more blue than usual, but this has **nothing to do with the name “blue” moon.**

Electrified Flex Fuel Vehicle

Why in News?

Recently, the Prototype of the world's 1st **Bharat Stage-6 (BS6) Stage-II, Electrified Flex fuel vehicle,** developed by Toyota Kirloskar Motor was unveiled.

- This vehicle is capable of **running on up to 85% ethanol blended petrol** and features an **electric powertrain.**
- The Ministry of Petroleum & Natural Gas has also highlighted flex-fuel vehicles' potential to substitute petrol with higher **ethanol blends beyond 20%.**

What are the Electrified Flex Fuel Vehicles?

- **About:**
 - Electrified Flex Fuel Vehicle integrates both a **Flex Fuel engine** and an **electric powertrain,** offering the dual benefit of **higher ethanol use and improved fuel efficiency.**

- Flex Fuel Strong Hybrid Electric Vehicles (FFV-SHEV): When FFV is integrated along with **strong hybrid electric technology, it is referred as FFV-SHEVs.**
 - Strong hybrid is another term for full hybrid vehicles, which have the capability to **run solely on either electric or petrol modes.**
 - In contrast, **mild hybrids cannot run purely on one of these modes and use the secondary mode merely as a supplement** to the main mode of propulsion.

Nipah Virus

Why in News?

The **Nipah Virus** has made a resurgence in Kerala, India, with two fatalities.

- This marks the first **Nipah Virus outbreak in India since 2021 when a case was reported in Kozhikode during the Covid-19 pandemic.**

What is Nipah Virus?

- **About:**
 - It is a **zoonotic virus** (it is transmitted from animals to humans).
 - The organism that causes Nipah Virus encephalitis is an RNA or **Ribonucleic acid virus** of the family Paramyxoviridae, genus Henipavirus, and is closely related to Hendra virus.
 - **Hendra virus (HeV) infection** is a rare emerging zoonosis that causes severe and often fatal diseases in both infected horses and humans.
 - It **first broke out in Malaysia and Singapore** in 1998 and 1999.
 - The disease is named after a village in Malaysia, Sungai Nipah, where it was first detected.
 - It **first appeared in domestic pigs** and has been found among several species of domestic animals including dogs, cats, goats, horses and sheep.
- **Transmission:**
 - The disease spreads through **fruit bats** or 'flying foxes,' of the genus Pteropus, who are natural reservoir hosts of the Nipah and Hendra viruses.
 - The **virus is present in bat urine** and potentially, bat faeces, saliva, and birthing fluids.

Note:

What is the World Organisation for Animal Health (WOAH)?

Why in News?

Recently, the World Organisation for Animal Health (WOAH) has released its 7th report on Antimicrobial use in animals, covering the period from 2017 to 2019.

157 participants submitted data to WOAH for the analysis, but only 121 provided quantitative data for at least one year. 74 participants reported specific amounts of antimicrobial products categorized by type of use and administration route.

The analysis is based on the data provided by the 80 countries that consistently updated on antimicrobial use in animals.

What is the World Organisation for Animal Health (WOAH)?

- **WOAH (founded as OIE)** is one of the **standard-setting bodies recognized by the Agreement** on the Application of Sanitary and Phytosanitary Measures.
- It is an intergovernmental organization responsible for improving animal health worldwide.
 - In 2018, it had a total of 182 Member Countries. India is one of the member countries.
- WOAH develops **normative documents relating to rules that Member Countries** can use to protect themselves from the introduction of diseases and pathogens. One of them is the Terrestrial Animal Health Code.
- WOAH standards are recognised by the **World Trade Organization (WTO)** as reference international sanitary rules.
- It is **headquartered in Paris, France**.

What are the Initiatives to Tackle Antimicrobial Resistance?

- **India:**
 - **National Programme on AMR Containment:** Launched in 2012. Under this programme, AMR Surveillance Network has been strengthened by establishing labs in State Medical College.

- **National Action Plan on AMR:** It focuses on **One Health approach** and was launched in April 2017 with the aim of involving various stakeholder ministries/departments.
- **AMR Surveillance and Research Network (AMRSN):** It was launched in 2013, to generate evidence and capture trends and patterns of drug resistant infections in the country.
- **AMR Research & International Collaboration:** **Indian Council of Medical Research (ICMR)** has taken initiatives to develop new drugs /medicines through international collaborations in order to strengthen medical research in AMR.
- **Antibiotic Stewardship Program:** ICMR has initiated antibiotic stewardship program (AMSP) on a pilot project across India to control misuse and overuse of antibiotics in hospital wards and ICUs.

➤ Global:

- **World Antimicrobial Awareness Week (WAAW):**
 - Held annually since 2015, WAAW is a global campaign that aims to raise awareness of antimicrobial resistance worldwide and encourage best practices among the general public, health workers and policy makers to slow the development and spread of drug-resistant infections.
- **The Global Antimicrobial Resistance and Use Surveillance System (GLASS):**
 - WHO launched the GLASS in 2015 to continue filling knowledge gaps and to inform strategies at all levels.
 - GLASS has been conceived to progressively incorporate data from surveillance of AMR in humans, surveillance of the use of antimicrobial medicines, AMR in the food chain and in the environment.
- **Global Database for ANImalantiMicrobial USE (ANIMUSE):**
 - It is an online platform facilitating data **accessibility to support evidence-based decision-making**.

Note:

- **Global High-Level Ministerial Conference:**
 - The Third Global High-Level Ministerial Conference on Antimicrobial Resistance in 2022 saw commitments from 47 countries to reduce antimicrobial use in animals and agriculture by 30-50% by 2030.

Geospatial Intelligence

Why in News?

The summer of 2023 has witnessed a series of **unprecedented natural disasters** across the **United States**, including record-breaking temperatures, **Canadian wildfires**, historic flooding, and a powerful hurricane where usage of geospatial intelligence can mitigate such crises.

- The technology facilitates decision making based on the importance and priority of scarce resources.

What is Geospatial Intelligence?

- Geospatial technology uses tools like **GIS (Geographic Information System)**, **GPS (Global Positioning System)** and **Remote Sensing** for geographic mapping and analysis.
- These tools capture **spatial information about objects, events and phenomena** (indexed to their geographical location on earth, geotag). The location data **may be Static or Dynamic**.
 - **Static location data** include position of a road, an earthquake event or malnutrition among children in a particular region while **dynamic location data** include data related to a moving vehicle or pedestrian, the spread of an infectious disease etc.
- The technology may be used to **create intelligent maps to help identify spatial patterns in large volumes of data**.

GEOSPATIAL TECHNOLOGY

GT facilitates the process of capturing/storing/processing/displaying/disseminating information tied to a location (static or dynamic)

TECHNOLOGIES UNDER GT

- **Remote sensing** – Detecting/monitoring the physical characteristics of an area typically from satellite or aircraft
- **Global Positioning System (GPS)** – A satellite navigation system to determine the ground position of an object
- **Geographic Information System (GIS)** – Computer system for capturing, storing and displaying data related to positions on Earth's surface
- **3-D Modelling** – Creating three-dimensional representations of an object or a surface

APPLICATIONS OF GT

- Climate Change and Disaster Management (Ex - Advance Warnings)
- Earth Observation Capabilities (Ex- Vegetation, water quality)
- Healthcare (Ex- Monitoring contact tracing)
- Societal Problems (Ex-Education, livelihood, financial inclusion)
- Logistics (Ex- Tracking goods)
- Real estate (Ex- Analyzing real estate objects remotely)

INDIA'S GEOSPATIAL SECTOR

- **GEOSPATIAL ECONOMY**
 - ◆ Expected to cross ₹63,000 crore by 2025
 - ◆ Growth rate of 12.8%
- **National Geospatial Policy 2022**
 - ◆ **Geospatial Data Promotion and Development Committee** (apex body to be formed)
 - ◆ **DST to be the nodal dept.** of GT; GDPDC will recommend DST
 - ◆ **Milestones to Achieve:**
 - By 2030 - High resolution topographical survey and mapping
 - By 2035 - National Digital Twin (virtual replica) of major cities/towns

The diagram shows a timeline with icons and text boxes for various milestones:

- 2015:** The Digital India vision aims to have a specific focus on leveraging Geospatial Information Systems (GIS) for decision support systems & development.
- 2017:** The Smart Cities and AMRUT (SOP cities) both have a prospective conceptual information system based on GIS that would integrate every aspect from conceptualisation, planning and development to implementation.
- 2018:** National Afforestation Programme emphasises use of Remote Sensing and Geographic Information Systems for planning and implementation project monitoring.
- 2019:** The National Mission for clean Ganga deals with extensive spatial data and analysis for the Ganga basin.
- 2020:** Geospatial technologies provide a holistic approach to understanding of rivers based on existing geomatics tools and techniques.
- 2021:** North Eastern Region Urban Development Programme emphasises use of Geospatial Technologies for planning & management of water supply, sewerage and sanitation as well as solid waste management.
- 2022:** Delhi Mumbai Industrial Corridor Project is implementing Remote Sensing, GIS and RS for perspective planning and nodal planning of the corridor.

Note:

What are the Hybrid Seeds?

Why in News?

Popularity of Hybrid Seeds has been increasing among farmers in India over a decades due to their quicker harvesting as compared to traditional or Open-Pollinated Variety (OPV) seeds.

OPV are usually more genetically diverse, causing an amazing variation within plant populations, which ultimately allows them to adapt to local growing conditions and climates every year.

➤ About:

- A hybrid seed is produced by **controlled Cross-Pollination** between **different varieties** of the same plant.
 - The transfer of pollen grains from the anther of one plant to the stigma of another different plant is called cross-pollination.
- These are **chosen to enhance the characteristics** of the resulting plants including – better yield, greater uniformity, and disease resistance.
- Since all hybrid seeds in a packet have the same parent plants, which means they will all grow into uniform plants.
- These are **often easier and faster to grow** than Heirloom Seeds.
 - **Heirloom Seeds** come from **open-pollinated plants**, meaning the plants were pollinated by natural mechanisms like wind, insects, or birds, rather than through controlled cross-breeding or hybridization.

Announcement of New Science Awards

Why in News?

The Central Government has decided to introduce **56 prizes under the category of Rashtriya Vigyan Puraskar** (3 Vigyan Ratna, 25 Vigyan Shri, 25 **Yuva Vigyan Shanti Swarup Bhatnagar**, 3 Vigyan Team Awards) to felicitate scientists.

- The **awards will be announced annually on National Technology Day**, May 11 and will be **awarded on National Space Day**, August 23 in 2024.

Note:

- Akin to prestigious **Padma awards**, these awards **will not include any cash component**.
- The **Rashtriya Vigyan Puraskar shall be given in the 13 science-related domains**.

What are the Key Highlights About these Awards?

➤ Included Awards:

- **Vigyan Ratna Awards:**
 - These awards will **recognise lifetime achievements & contributions made** in any field of science and technology.
- **Vigyan Shri Awards:**
 - These awards will **recognise distinguished contributions** to any field of science and technology.
- **Vigyan Team Awards:**
 - These awards are to be **given to a team comprising of three or more scientists/researchers/innovators** who have made an exceptional contribution working in a team in any field of science and technology.
- **Vigyan Yuva-Shanti Swarup Bhatnagar (VY-SSB):**
 - These awards are the **highest multidisciplinary science awards in India for the young scientists** (maximum 45 years).
 - They are named after **Shanti Swarup Bhatnagar**, the founder and director of the **Council of Scientific & Industrial Research (CSIR)**, who was also a renowned chemist and visionary.

➤ Awards Open to PIOs:

- **Persons of Indian origin (PIOs) will now be eligible for the new awards**, but only one PIO may receive the Vigyan Ratna.
- Three PIOs each can be selected for the Vigyan Shri and the VY-SSB.
 - However, **PIOs will not be eligible for the Vigyan Team awards**.

Reciprocity and Non Reciprocity

Why in News?

Scientists have developed devices which break the

Note:

Principles of Reciprocity tackling the challenges that arise out of the **Reciprocity Phenomenon**.

What is Reciprocity?

➤ About:

- Reciprocity means that **if a signal is sent** from one point to another, it is sent back from the second point to the first.
 - For Example: It's like when you shine a flashlight at a friend, they can shine it back at you because the light can go both ways through the air.
- However, there are **situations where reciprocity doesn't work as expected**.
 - For example, in some movies, a person being questioned can't see the police officers through a window, but the officers can see them.
 - Also, in the dark, one can see someone **under a streetlight**, but they can't see that person.

Note: Non-reciprocity: The physics of letting waves go one way but not the other.

Global Innovation Index 2023

Why in News?

India retains **40th rank out of 132 economies** in the **Global Innovation Index 2023** rankings published by the **World Intellectual Property Organization (WIPO)**.

Note: GII is a **leading reference for measuring an economy's innovation** ecosystem performance. Published annually, it is also a valuable benchmarking tool used by policymakers, business leaders, and other stakeholders to assess progress in innovation over time.

What is WIPO?

- WIPO is the global forum for **Intellectual Property (IP) services**, policy, information and cooperation.
- It is a self-funding agency of the **United Nations**, with 193 member states.
- Its aim is to lead the development of a balanced and effective international IP system that enables innovation and creativity for the benefit of all.
- Its mandate, governing bodies and procedures are set out in the WIPO Convention, which established WIPO in 1967.

Nobel Prize in Chemistry 2023

Why in News?

The **Royal Swedish Academy of Sciences** awarded the **Nobel Prize in Chemistry 2023** to **Moungi G Bawendi, Louis E Brus, and Alexei I Ekimov** for their groundbreaking discovery and synthesis of **quantum dots**.

How did Scientists Discover Quantum Dots?

➤ Background:

- Traditionally, **all pieces of a pure element**, regardless of size, were believed to have **identical properties** due to the uniform distribution of electrons.
 - However, about forty years ago, scientists discovered that nanoparticles on the nanoscale, **typically 1 to 100 billionths of a meter in size**, exhibited distinct behaviors different from their larger counterparts of the same element, **challenging this conventional belief**.

➤ The Nobel Laureates' Contributions:

- **Alexei Ekimov:** In around 1980, Alexei Ekimov was the first to observe the **anomalous behavior in Copper Chloride nanoparticles**.
 - He successfully manufactured these nanoparticles, **showcasing their distinctive properties**.
- **Louis Brus:** American scientist Louis Brus made a similar discovery involving **Cadmium Sulphide nanoparticles**.
 - Like Ekimov, he could create these **nanoparticles with altered properties**.
- **Moungi Bawendi:** Moungi Bawendi, who initially collaborated with Louis Brus, later played a pivotal role in **simplifying the production methods for nanoparticles with unique characteristics**.
 - His work paved the way for efficient and controlled manufacturing of nanoparticles displaying desired deviant behaviors.

R21 /Matrix-M Malaria Vaccine

Why in News?

Recently, the **World Health Organisation (WHO)** has recommended the use of the **R21/Matrix-M malaria**

Note:

vaccine, co-developed by the **University of Oxford and the Serum Institute of India**.

- The **Matrix-M component** is a proprietary **saponin-based adjuvant** developed by Novavax and licensed to the Serum Institute for use in endemic countries.
- As of now, the vaccine has been licensed for use in **Ghana, Nigeria and Burkina Faso**.

What is Adjuvant?

- An adjuvant is an **ingredient in a vaccine that enhances the immune system's response to that vaccine**.
 - Adjuvants help the immune system better recognize what's in a vaccine and remember it longer, increasing the amount of time that a vaccine may offer protection.
- **Matrix-M adjuvant** is derived from **saponins**, naturally occurring compounds found in the bark of the **Quillaja saponaria tree in Chile**. Saponins have a history of medicinal use.

What is Malaria?

- **About:**
 - Malaria is a life-threatening disease caused by the **Plasmodium parasite**.
 - This parasite is transmitted to humans through the bites of **infected female Anopheles mosquitoes**.

➤ Plasmodium Parasite:

- There are **5 Plasmodium parasite species** that cause malaria in humans and 2 of these species, ***P. falciparum* and *P. vivax***, pose the greatest threat.
 - ***P. falciparum*** is the **deadliest** malaria parasite and the most prevalent on the African continent.
 - ***P. vivax*** is the **dominant malaria parasite** in most countries outside of sub-Saharan Africa.
 - The other malaria species which can infect humans are ***P. malariae*, *P. ovale* and *P. knowlesi***.
- **Symptoms:**
 - Mild symptoms are **fever, chills and headache**. Severe symptoms include **fatigue, confusion, seizures, and difficulty breathing**.

Nobel Prize in Physics 2023

Why in News?

The **2023 Nobel Prize for Physics** has been awarded to three distinguished scientists: **Pierre Agostini, Ferenc Krausz, and Anne L'Huillier**.



- Their groundbreaking work in the field of experimental physics has led to the development of **attosecond pulses**, enabling scientists to directly observe and study the **rapid dynamics of electrons within matter**.

Note:

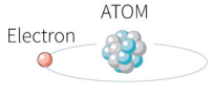


Nobel Prize for physics 2023

France's Pierre Agostini, Hungarian-Austrian Ferenc Krausz and French-Swedish Anne L'Huillier
for research into tools for exploring electrons inside atoms and molecules


x 1 billionth
of a billionth



1 attosecond

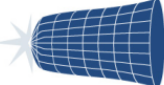
Electrons move or change energy rapidly, in the magnitude of attoseconds, which makes them difficult to study

x 1 billionth
of a billionth



1 second

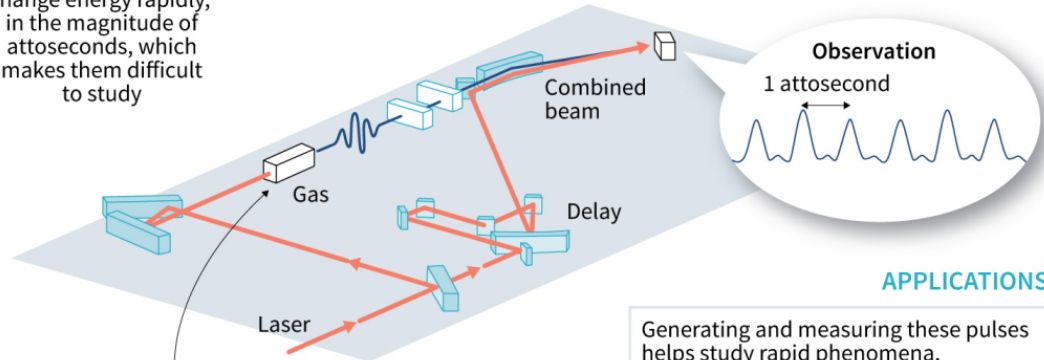
x 1 billionth
of a billionth



Age of the universe

DISCOVERY

The three physicists recreated attosecond light pulses by shining laser light through a gas, making it possible to study such rapid movements



Observation
1 attosecond

APPLICATIONS

Generating and measuring these pulses helps study rapid phenomena, used for

- observing the movement of electrons
- rapidly transforming insulators into conductors
- identifying molecules, such as in medical diagnostics

Source: nobelprize.org

AFP

World Health Organization's Specs 2030

Why in News?

Millions around the world suffer from **vision problems**, with a significant portion in need of spectacles. However, **access to eye care remains a challenge**, particularly in **low- and middle-income countries**.

- In response to this crisis, the **74th World Health Assembly, 2021** has embarked on an initiative called "**Specs 2030**" to provide integrated and **people-centered eye care**.

What is Specs 2030?

➤ About:

- The **World Health Organization (WHO)** is set to launch the SPECS 2030. The initiative's goal is to assist **member states in addressing the unmet need for spectacles** while ensuring the delivery of quality eye care.

➤ Vision:

- It envisions a world in which everyone who needs a **refractive error** intervention has access to **quality, affordable and people-centred refractive error services**.

Note:

➤ Mission:

- It has the mission to support Member States with the achievement of the 74th World Health Assembly endorsed **2030 target on effective refractive error coverage**.
- The initiative calls for coordinated global action amongst all stakeholders across 5 strategic pillars, in line with the letters of SPECS, to address the key challenges to improving refractive error coverage.

Nobel Prize in Medicine 2023

Why in News?

The **Nobel Prize in Medicine or Physiology** for 2023 has been awarded to **Katalin Karikó and Drew Weissman** for their groundbreaking work on **nucleoside base modification** of **messenger Ribonucleic Acid (mRNA)**.

- The discoveries by the two Nobel Laureates were critical for developing effective **mRNA vaccines against Covid-19** during the pandemic that began in early 2020.

What Did Katalin Karikó and Drew Weissman Discover?

➤ Understanding the Challenge:

- Cells possess an inherent capability to **detect foreign materials**. **Dendritic cells**, which play a crucial role in our immune system, had the ability to recognize **in vitro transcribed mRNA as foreign**, setting off an **inflammatory response**.
 - This reaction could potentially lead to harmful side effects and **undermine the vaccine's efficacy**.
- Furthermore, another challenge stemmed from the fact that in vitro transcribed mRNA was highly unstable and susceptible to degradation by enzymes within the body.

Note:

- **In vitro transcribed mRNA** is a type of synthetic RNA that is **produced in the laboratory** by using a DNA template and an RNA polymerase.
- It can be used for various purposes, such as **making RNA probes, vaccines, or proteins**.

Cholera

Why in News?

According to the **World Health Organization (WHO)**'s weekly Epidemiological Record, the World reported more than twice as many cholera cases in 2022 as it did in 2021.

- This escalation presents a substantial challenge to the WHO ambitious goal set in 2017 to **reduce global cholera deaths by 90% by 2030**.

What is Cholera?

➤ About:

- Cholera, a water-borne disease primarily caused by the **bacteria Vibrio cholerae strains O1 and O139**, poses a significant public health challenge worldwide.
 - Strain O1 is the predominant cause of outbreaks, with O139 occurrences being rare and mostly confined to Asia.
- It is an acute diarrheal illness caused by infection of the intestine.
- The infection is often mild or without symptoms, but sometimes can be severe.

➤ Symptoms:

- Profuse watery diarrhoea, Vomiting, Leg cramps

➤ Transmission:

- A person may get cholera by drinking water or eating food **contaminated with the cholera bacterium**.
- The disease can spread rapidly in areas with inadequate treatment of sewage and drinking water.

What are the Initiatives to Curb Cholera?

- **A global strategy on cholera control, Ending Cholera:** A global roadmap to 2030, with a target to reduce cholera deaths by 90% was launched in 2017.
- **Global Task Force for Cholera Control (GTFCC):** WHO revitalized the Global Task Force for Cholera Control (GTFCC) to strengthen WHO's work in eradicating cholera.
 - The purpose of the GTFCC is to support increased implementation of evidence-based strategies to control cholera.

Note:

What is Measles?

Why in News?

Recently, there has been a significant spike in measles cases and fatalities in Delhi, attributed to under-reporting of cases during the Covid-19 lockdowns in the previous years.

The Covid-19 lockdowns in 2020 and 2021, the focus and resources were primarily directed towards managing the pandemic, leading to weakened surveillance for measles and other diseases, contributing to measles cases, along with challenges related to vaccine acceptance, even among some affluent segments of society.

➤ About:

- Measles virus is an enveloped, **ribonucleic acid virus** of the **genus Morbillivirus**.
- Measles is highly contagious, and an infected person will often transmit the virus to over 90% of unprotected close contacts.
- The virus infects the respiratory tract, then spreads throughout the body. Measles is a human disease and is not known to occur in animals.
- Measles can be entirely prevented through a **two-dose vaccine and has been officially eliminated in many countries** with advanced healthcare systems.

➤ Treatment:

- **No specific antiviral treatment** exists for measles virus.
- Severe complications from measles can be avoided through medical care that ensures good nutrition, adequate fluid intake, and treatment of dehydration.

What is Venus?

Why in News?

According to a new study, Venus, often referred to as Earth's sister planet, may have experienced tectonic activity about 4.5 billion to 3.5 billion years ago.

➤ About:

- It is named after the Roman goddess of love and beauty. It is the **second planet from the Sun** and **sixth in the solar system in size and mass**.
 - It is the **second brightest** natural object in the night sky **after the Moon**, probably that is the

reason why it was the **first planet to have its motions plotted across the sky**, as early as the second millennium BC.

➤ Characteristics:

- Unlike the other planets in our solar system, **Venus and Uranus spin clockwise** on their axis.
- It is the **hottest planet** in the solar system because of the **high concentration of carbon dioxide** which works to produce an intense **greenhouse effect**.
- A **day on Venus is longer than a year**. It takes Venus **longer to rotate once on its axis than to complete one orbit of the Sun**.
 - That's **243 Earth days to rotate once** - the longest rotation of any planet in the Solar System - and only **224.7 Earth days to complete one orbit of the Sun**.

➤ Comparison With Earth:

- Venus has been called **Earth's twin** because of the **similarities in their masses, sizes, and densities and their similar relative locations** in the solar system.
- No planet approaches closer to Earth than Venus; at its nearest it is the **closest large body to Earth other than the Moon**.
- Venus has **90 times the atmospheric pressure of Earth**.

What is InSights Mars Lander?

Why in News?

According to a pair of recent studies published in Nature, Mars's liquid iron core is likely to be surrounded by a fully molten silicate layer.

Data from three years of quakes in Mars, including two seismic events caused by meteorite impacts, were used for the study.

NASA's InSight Mars Lander used an instrument called the Seismic Experiment for Interior Structure (SEIS) to record seismic waves passing through Mars's interior.

Note:

What is InSights Mars Lander?

- **About:**
 - **InSight** (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) was sent on a **24-month mission in 2018**.
 - InSight will study the **interior of Mars**.
 - The landing site is **Elysium Planitia** (a flat-smooth plain just north of the equator considered to be the perfect location from which to study the deep Martian interior), where InSight can stay still and quiet all through.
- **Functions:**
 - Mars InSight's goal is to **listen for quakes and tremors** as a way to unveil the Red Planet's inner mysteries.
 - The mission seeks to **answer critical questions about rocky planet formation** in the early days of the solar system.

What are the Various Mars Missions?

- NASA has a lander (Mars Insight), two rovers (Curiosity and Perseverance), and three orbiters (Mars Reconnaissance Orbiter, Mars Odyssey, MAVEN)
- ExoMars rover (2021) (European Space Agency)
- Tianwen-1: China's Mars Mission (2021)
- UAE's Hope Mars Mission (UAE's first-ever interplanetary mission) (2021)
- India's Mars Orbiter Mission (MOM) or Mangalyaan (2013)

Thallium Poisoning

Why in News?

Recently multiple family members in Mahagaon village, Maharashtra fell victim to **thallium poisoning**, a chemical that operates in silence, evading detection.

What are the Key Facts about Thallium?

- **About:**
 - Thallium(Tl) is a chemical element with the **atomic number 81**, was discovered by **Sir William Crookes in 1861**.
 - It is a soft, heavy, inelastic metal.
 - Thallium is **tasteless and odourless** and has been used by murderers as a difficult-to-detect poison.

- **Appearance:**
 - A soft, silvery-white metal that tarnishes easily.
- **Sources:**
 - It is found in trace amounts in the **earth's crust**.
 - It is found in **several ores**. One of these is pyrites, which is used to produce sulfuric acid. Some thallium is obtained from pyrites, but it is mainly obtained as a by-product of copper, zinc and lead refining.
- **Uses:**
 - Thallium's utilization is **restricted due to its toxic nature**.
 - Thallium sulfate, once a **rodent killer**, is now banned for household use in many developed nations.
 - It finds application in the electronics industry for **photoelectric cells**.
 - Thallium oxide is used to create high-refraction glass and low-melting glass.
 - It is also used in the manufacturing of low temperature thermometers, and imitation jewels.

DNA and Face Matching Systems At Police Stations

Why in News?

Over a year after Parliament passed the **Criminal Procedure Identification Act (CrPI), 2022**; the Centre is preparing to introduce '**DNA and Face Matching' systems** in 1,300 police stations nationwide, despite the Act's provisions not yet being fully implemented.

What is the Context of 'DNA and Face Matching Systems' under CrPI Act, 2022 ?

- **Introduction to the Act and Rules:**
 - In 2022, the Indian Parliament passed CrPI Act that grants police and **central investigating agencies the authority to collect, store, and analyze physical and biological samples**, which even include retina and iris scans, of arrested individuals.
 - This legislative move **aimed to enhance law enforcement capabilities and ushered in a new era in criminal identification** and data management.
- **Rollout of the Act and Rules:**
 - The **responsibility for implementing the Act** and establishing the Standard Operating Procedure (SOP) for the measurement collection process **was**

Note:

entrusted to the **National Crime Records Bureau (NCRB)**, a central organization.

- The NCRB played a pivotal role in guiding police officials on the proper protocol for recording these measurements.
- **Expanding Measures and Committees for Implementation:**
 - The Act and rules did not directly mention DNA sample collection and face matching procedures, but the **NCRB conveyed plans** to implement these measures in discussions with **State police officials**.
 - Additionally, the Ministry of Home Affairs formed a **Domain Committee comprising State police and central law enforcement** representatives for recording DNA data.

What is the 'DNA and Face Matching Systems' Technology?

- **Face Matching System:**
 - Face Matching System is an **algorithm-based technology which creates a digital map of the face** by identifying and mapping an individual's facial features, which it then matches against the database to which it has access.
 - In the **Automated Facial Recognition System (AFRS)**, the large database (containing photos and videos of peoples' faces) is used to match and identify the person.
 - Image of an unidentified person, taken from CCTV footage, is compared to the existing database using **Artificial Intelligence** technology, for pattern-finding and matching.
- **DNA Matching Systems:**
 - DNA matching systems, also known as **DNA profiling or DNA fingerprinting**, are techniques used to compare and identify individuals based on their unique genetic characteristics.
 - These systems **analyze specific regions of an individual's DNA**, which are highly variable among people, to create a unique genetic profile for each individual.
 - DNA matching is commonly used in criminal investigations to link suspects to crime scenes or victims. DNA evidence found at a crime scene, **such as blood, hair, or bodily fluids, can be compared to the DNA profiles of potential suspects**.

SIM Cards

Why in News?

In contemporary times, the usage of smartphones have outgrown other electronic devices so much that an important component of smartphones, i.e. **Subscriber Identification Module (SIM) Cards** need apt description.

What is a SIM Card?

- **About:**
 - A SIM card is a tiny **integrated circuit or microchip** that plays a **vital role in identifying subscribers on a cellular network**. It can be thought of as an individual's ID card within the vast city of a cellular network.
 - This ID card carries a unique identification number known as the **international mobile subscriber identity (IMSI)**, which is used to locate and confirm the identity of the subscriber when others try to reach them on the network.
- **Essential Role in Network Access:**
 - When it comes to connecting a mobile phone to a cellular network adhering to the **Global System for Mobile Communications (GSM)** standard, a SIM card is mandatory. This connection relies on a **special authentication key (SAK)** that serves as a digital lock and key mechanism.
 - Each SIM card stores SAK, but **it's inaccessible through the user's phone**. Instead, when the phone communicates with the network, it 'signs' the signals using this key, allowing the network to verify the legitimacy of the connection.
 - It's important to note that **duplicating a SIM card is feasible by accessing and copying this authentication key** onto multiple cards.

Marsquake

Why in News?

Recently, scientists have revealed the causes of the **largest recorded marsquake**. This finding holds scientific importance and carries **implications for forthcoming Mars exploration** by providing fresh insights into the **geology and seismic events of the Red Planet**.

Note:

What are the Recent Findings Related to Marsquake?

- A **Marsquake**, or Martian **earthquake**, is a seismic event **occurring on Mars**. In **2022**, a significant marsquake with a magnitude of **4.7** was recorded.
 - Initial suspicion was a **meteoroid impact** due to **similar seismic signals from past meteoroid-caused quakes**.
- Space agencies like **Indian Space Research Organisation (ISRO)**, **European Space Agency**, **China National Space Administration**, and the **UAE Space Agency** collaborated on a groundbreaking project to search for a crater on Mars.
 - The **search found no impact crater**, leading to the conclusion that the **marsquake resulted from internal tectonic forces**, indicating increased seismic activity.
 - The cause was attributed to the **accumulated stresses within Mars' crust**, evolving over billions of years due to differential cooling and shrinking rates in different regions.

Test on Crew Escape System

Why in News?

Recently, **Indian Space Research Organisation (ISRO)** carried out the first of a series of tests of systems and procedures called the **Flight Test Vehicle Abort Mission-1 (TV-D1)** with the aim to ultimately fulfill the objectives of **Gaganyaan Mission** perhaps by 2025.

What is the TV-D1 Test?

- **About:**
 - The **Flight Test Vehicle Abort Mission-1 (TV-D1)** demonstrates the performance of the Crew Escape System of the Gaganyaan project.
 - The flight is the **first of two abort missions** to test the safety mechanisms that will allow the Gaganyaan crew to leave the spacecraft in an emergency.
 - The Test Vehicle is a single-stage liquid rocket developed for this abort mission. The payloads consist of the **Crew Module (CM)** and **Crew Escape Systems (CES)** with their fast-acting solid motors, along with CM fairing (CMF) and Interface Adapters.

➤ Mechanism:

- The test exercise will see the rocket rise to an **altitude of almost 17 km** before an abort signal is triggered, leading to the separation of the crew module, which will descend using a parachute for a splashdown in the **Bay of Bengal**.
- The rocket, **ISRO's new, low-cost Test Vehicle**, will reach a **peak relative velocity of 363 metres/second (about 1307 km/ hr)** during the flight and the crew module will be empty for the test.

White Phosphorus Munitions

Why in News?

Recently, global human rights organizations, **Amnesty International** and **Human Rights Watch** have accused the Israel Defense Forces (IDF) of using **white phosphorus munitions** in **Gaza** and Lebanon, in violation of **International Humanitarian Law (IHL)**.

What is the White Phosphorus?

➤ 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 which ignite spontaneously or very quickly (under five minutes) when in contact with air.

➤ Global Status:

- Under the **Globally Harmonized System of Classification and Labeling of Chemicals**, the internationally agreed-upon system to standardize chemical hazard classification and communication, **white phosphorus falls under "Pyrophoric solids, category 1"**, which includes chemicals that catch fire "spontaneously" when exposed to air. It is among the most unstable of pyrophoric substances.

What is Deep Tech?

Why in News?

As per Principal Scientific Advisor, India will set up a "high powered committee" to explore the development of Large Language Models (LLMs), tools that harness Artificial Intelligence to create applications that can understand and process human language.

Note:

- **About:**
 - Deep tech or deep technology refers to a **class of startup businesses that develop new offerings** based on tangible engineering innovation or scientific discoveries and advances.
 - Usually, such startups operate on, but are **not limited to, agriculture, life sciences, chemistry, aerospace and green energy.**
 - Deep tech fields like Artificial Intelligence, advanced materials, **blockchain, biotechnology**, robotics, **drones**, photonics, and **quantum computing** are moving more and more quickly from early research to market applications.
- **Characteristics of Deep Tech:**
 - **Impact:** The deep tech innovations are **very radical and disrupt an existing market** or develop a new one. Innovations based on deep tech often change lives, economies, and societies.
 - **Time & Scale:** The time required for deep technology to develop the technology and reach the market-ready maturity is **way more than shallow technology development (like mobile apps and websites)**. It took decades for artificial intelligence to develop and it is still not perfect.
 - **Capital:** Deep tech often requires a **lot of early-stage funding for research and development**, prototyping, validating hypotheses, and technology development.

What is Marine Microalgae?

Why in News?

Recently, Scientists from the University of East Anglia (UEA), England have found that eukaryotic phytoplankton, also known as Microalgae, have adapted to cope with Global Warming and changing ocean conditions.

- Microalgae are **photosynthetic microorganisms** that can be found in diverse natural environments, such as water, rocks, and soil. They present **higher photosynthetic efficiency** than terrestrial plants, and are responsible for a **significant fraction of the world's oxygen production.**
- Marine microalgae play a pivotal role in the **oceanic food chain** and carbon dioxide absorption.
 - However, as climate change continues, **global warming is causing surface ocean waters** to

warm, resulting in reduced nutrient availability due to **less mixing between the surface waters and nutrient-rich deeper waters.**

- So nutrients become scarce at the surface, impacting **the primary producers such as microalgae** that are present in the top layer.
- This scarcity of nutrients, including iron, impacts the **primary producers like microalgae, causing them to produce less food** and capture less carbon dioxide from the atmosphere.
- Examples of Microalgae: **Diatoms, Dinoflagellate, Chlorella, etc.**

What are Quantum States and Quantum Engines?

Why in News?

Researchers have made a groundbreaking discovery by developing a quantum engine, referred to as the 'Pauli engine,' which can convert the energy difference between two quantum states of a group of atoms into useful work.

This innovation has the potential to advance our understanding of quantum thermodynamics and could have applications in the development of more efficient quantum computers.

- **Quantum State:**
 - A **Quantum state** is a mathematical description of the **physical properties of a quantum system.**
 - In quantum mechanics, the **fundamental theory that describes the behavior of matter and energy at the smallest scales**, quantum states provide a complete specification of a system's properties, including its **position, momentum, energy, spin, and other observable quantities.**
 - Quantum phenomena often defy our common sense and challenge our classical understanding of the world.
 - One of these phenomena is the difference between two types of quantum particles: **bosons and fermions.**
 - **Fermions are the building blocks of matter**, bosons are particles that carry the forces acting between them.
 - **Bosons are particles that can share the same quantum state**, while fermions are particles that

Note:



obey the Pauli exclusion principle, which forbids them from occupying the same quantum state.

- At low temperatures, **bosons can behave very differently than fermions** because an **unlimited number of them can occupy the same lowest energy level**, while fermions have to fill up **higher energy states**.
- This energy difference between bosons and fermions has inspired researchers to design and build a **novel quantum engine** that can **convert this difference into useful work**.
- Quantum Engine:
 - The **quantum engine or Pauli's engine** consists of a **gas of lithium-6 atoms** that are trapped in a combined **optical and magnetic trap**.
 - The gas can be tuned to **behave like bosons or fermions** by changing the magnetic field around it.
 - This is possible because the atoms can pair up into bosonic molecules or dissociate into individual fermionic atoms depending on the strength of the magnetic field.
 - The engine operates in a four-step cycle and it opens up new possibilities for studying **quantum thermodynamics** and its implications for other fields of physics.

FSSAI Lacks Data on Genetically Modified Organisms

Why in News?

Recently, an **RTI (Right to Information)** investigation has found that the **Food Safety and Standards Authority of India (FSSAI)** lacks data on **Genetically Modified Organism (GMO)** in produce imported **over the past 5 years**, raising concerns about the presence of GM varieties in sold fruits and vegetables.

What is Genetically Modified Organism (GMO)?

- **About:**
 - A GMO refers to an entity, whether it's an animal, plant, or **Microorganism**, that has undergone modifications **to its DNA using genetic engineering methods**.

- Across generations, specific traits have been cultivated in crops like corn, animals like cattle, and even domestic companions like dogs through selective breeding. Yet, in recent decades, the progress of biotechnology has enabled researchers to directly manipulate the genetic makeup of microorganisms, plants, and animals.

What is FSSAI?

➤ About:

- FSSAI is an autonomous statutory body established under the Food Safety and Standards Act, 2006 (FSS Act).
- The Ministry of Health & Family Welfare, Government of India is the administrative Ministry of FSSAI.
- The Chairperson and Chief Executive Officer of FSSAI have already been appointed by Government of India. The Chairperson is in the rank of Secretary to Government of India.

➤ Headquarters: Delhi.

Global Positioning System Tracker Anklet

Why in News?

Recently, a prisoner in Jammu and Kashmir was released on bail after he was tagged with a **Global Positioning System (GPS) tracker ankleton his foot** to monitor his movements.

- This is the first time in the country that a GPS tracker has been put to such use.

What are GPS Tracker Anklets?

➤ About:

- GPS anklets are **small, wearable devices** that are attached to the ankles of individuals who are under some form of **legal supervision, such as parole, probation, house arrest, or bail**.
 - The tracker can be put on the ankle or arm of a person. Thus, there are **GPS anklets and GPS bracelets**.
- GPS anklets are tamper-proof, and any attempt to remove or damage them triggers an alarm.

Note:



- They also have a battery life of several days and can be recharged by the wearer.

➤ Working Procedure:

- GPS anklets use the **GPS technology** to provide the **exact location** of the wearer at all times, and allow law enforcement and security agencies to monitor their movements in real-time.

What is a Global Positioning System?

- GPS is a satellite navigation system, used to determine the **ground position of an object**. It is a **US-owned utility** that provides users with **Positioning, Navigation, and Timing (PNT)** services.
- It provides service to civilian and military users. The civilian service is freely available to all users on a continuous, worldwide basis. The military service is available to US and allied armed forces as well as approved Government agencies.

Sixth Assembly of International Solar Alliance

Why in News?

Recently, the **Sixth Assembly of the International Solar Alliance (ISA)** was convened at **Bharat Mandapam in New Delhi**.

What is the International Solar Alliance?

- The **International Solar Alliance** is an **action-oriented, member-driven, collaborative platform** for increased deployment of solar energy technologies as a means for bringing **energy access, ensuring energy security, and driving energy transition in its member countries**.
- Initially conceived as a **joint effort by India and France**, ISA was conceptualized during the **21st Conference of Parties (COP21) in 2015**.
 - With its framework Agreement amended in 2020, all UN member states are eligible to join ISA.
 - Currently, **116 countries are signatories**, with 94 having completed the necessary ratification to become full members.
- The ISA is guided by its **'Towards 1000'** strategy which aims to **mobilize USD 1,000 billion** of investments in solar energy solutions by **2030**, while delivering energy access to **1,000 million** people using clean

energy solutions and resulting in **installation of 1,000 GW** of solar energy capacity.

- This would help mitigate global solar emissions to the tune of **1,000 million tonnes of CO₂ every year**.
- The **Assembly is the apex decision-making body of ISA**, in which each Member Country is represented.
 - This body makes decisions concerning the implementation of the ISA's Framework Agreement and coordinated actions to be taken to achieve its objective.

Genetically Engineered Insects

Why in News?

India aims to increase the Bioeconomy's contribution to **GDP (Gross Domestic Product)** from **2.6% to 5% by 2030**, as outlined in the **'Bioeconomy Report 2022'** by the Department of Biotechnology (DBT).

What is Bioeconomy?

- According to the **United Nations Food and Agriculture Organisation (FAO)**, the bioeconomy is **"the production, use and conservation of biological resources**, including related knowledge, science, technology, and innovation to provide information, products, processes and services to all economic sectors with the aim of moving towards a sustainable economy".
- The term bioeconomy became popular in the first decade of the 21st century following its adoption by the **European Union (EU)** and the **Organisation for Economic Co-operation and Development (OECD)** as a framework for promoting the use of **biotechnology to develop new products and markets**. Since then, both the EU and the OECD have implemented specific bioeconomy policies.

Kavach System

Why in News?

The recent collision between two passenger trains in **Andhra Pradesh's Vizianagaram district** drew attention to the absence of the **Traffic Collision Avoidance Systems**

Note:

(TCAS), specifically the indigenously developed system called '**Kavach**,' which, if installed, could have averted the tragic incident.

What is Kavach?

➤ About:

- Kavach is a **cab signaling train control system with anti-collision features** developed by the **Research Design and Standards Organisation (RDSO)** in association with three Indian vendors.
 - It has been adopted as our **National Automatic Train Protection (ATP) System**.
- It adheres to **Safety Integrity Level-4 (SIL-4)** standards and acts as a vigilant watchdog over the existing signaling system, **alerting the loco pilot when approaching a 'red signal'** and applying automatic brakes if necessary to prevent overshooting the signal.
 - The system also relays **SoS messages** during emergency situations.
- It features centralized live monitoring of train movements through the **Network Monitor System**.
 - The **Indian Railways Institute of Signal Engineering & Telecommunications (IRISET)** in **Secunderabad, Telangana** hosts the 'Centre of Excellence' for Kavach.

➤ Components of Kavach:

- Within the **Kavach setup**, designated railway stations along the intended route for deployment consist of **three essential components**.
 - **First Component:** The first component involves the **incorporation of Radio Frequency Identification (RFID) technology into the tracks**.
 - RFID employs **radio waves to identify objects or individuals and utilizes electromagnetic fields** to automatically read wireless device information from a distance without physical contact or line of sight.
 - **Second Component:** The **locomotive**, serving as the driver's cabin, **is equipped with RFID readers, a computer, and brake interface equipment**, comprising the second component.
 - **Third Component:** It encompasses radio infrastructure, **such as towers and modems**, strategically installed at railway stations to support the system's functionality.

Deepfakes

Why in News?

A **Deepfake video** showing an Indian actress has sparked **outrage and concern over the misuse of artificial intelligence (AI)** to create realistic but fake videos, also known as deepfakes.

What are Deepfakes?

➤ About:

- Deepfakes are **synthetic media that use AI** to manipulate or generate visual and audio content, usually with the intention of deceiving or misleading someone.

➤ Deepfake Creation:

- Deepfakes are created using a **technique called generative adversarial networks (GANs)**, which involve two competing neural networks: a **generator and a discriminator**.
 - The generator tries to **create fake images or videos that look realistic**, while the discriminator tries to **distinguish between the real and the fake ones**.
 - The generator learns from the **feedback of the discriminator** and improves its output until it can fool the discriminator.
 - Deepfakes require a large amount of data, such as photos or videos, of the source and the target person, which are often collected from the internet or social media without their consent or knowledge.
- Deepfakes are a part of **Deep Synthesis**, which uses technologies, including **deep learning and augmented reality**, to generate text, images, audio and video to create virtual scenes.

Zika Virus

Why in News?

Recently, the **Karnataka State Health Department** issued an alert following **Zika virus detection** in mosquito samples from **Talakayalabetta, Chikkaballapura village**.

- The **Zika virus**, a **mosquito-borne flavivirus**, and its impacts on public health have been a matter of significant concern.

Note:

What is Zika Virus?

- **About:** The Zika virus, a **mosquito-borne flavivirus**, that is primarily spread by Aedes mosquitoes, particularly **Aedes aegypti**.
 - Also, it can also be **transmitted from mother to fetus during pregnancy, as well as through sexual contact, transfusion of blood** and blood products.
 - The Zika virus has an **RNA genome**, and thus a very high potential to accumulate mutations.
 - Genomic studies have suggested that the Zika virus has two lineages: **African and Asian**.
- **History:** Discovered in 1947 in the **Zika forest in Uganda** from infected monkeys, the **first human cases were recorded in 1952 in Uganda and Tanzania**.
 - Outbreaks have occurred across Africa, the Americas, Asia, and the Pacific since 2007.
 - Notable outbreaks have occurred in Indian states like **Kerala and Karnataka** in recent years.
- **Symptoms:** Often asymptomatic; when present, **common symptoms include fever, joint pain, muscle pain**, and headache lasting 2-7 days.
- **Association with Other Conditions:** Linked with **Guillain-Barre syndrome, neuropathy, and myelitis** in adults and children.
 - Also, the **interaction between Zika and dengue viruses significantly impacts disease severity**.
 - Exposure to one can worsen the impact of the other, posing challenges in vaccine development and public health management.
- **Complications:** Infection during pregnancy causes **congenital malformations, such as microcephaly** and other associated conditions.

Note:

Guillain-Barre syndrome is a serious autoimmune disorder that affects the peripheral nervous system. The syndrome affects the nerves responsible for muscle movement, pain, temperature, and touch sensations.

- **Microcephaly** is a **birth defect in which babies are born with a smaller than usual head and underdeveloped brain**.

CO₂ to CO Conversion Technology

Why in News?

The **National Centre of Excellence in Carbon Capture**

and Utilisation (NCoE-CCU) at IIT Bombay has developed a new technology for converting **carbon dioxide (CO₂) to carbon monoxide (CO)**.

- The technology is energy-efficient and can be used in the steel sector. It aligns with India's goal for **net-zero emissions by 2070**.

How Does the CO₂ to CO Conversion Technology Work?

Working Process:

- The CO₂ to CO conversion technology operates through an **electrocatalytic process**.
- Unlike traditional methods that **require high temperatures (400-750 °C)**, and the presence of the equivalent amount of hydrogen, this process can operate at **ambient temperatures (25-40 °C)** in the presence of water, **eliminating the need for high-temperature conditions**.
 - The energy for this electrocatalysis reaction can be sourced directly from **renewable energy, such as solar panels or windmills**, ensuring a carbon-neutral operation. Making it highly energy-efficient process and environmentally friendly and sustainable.
- **Significance for the Steel Industry:**
 - CO is a crucial chemical in the steel industry, used in the **conversion of iron ores to metallic iron in blast furnaces**.
 - CO is a widely used chemical in the industry especially in the form of syngas.
 - Traditionally, CO is produced through the **partial oxidation of coke/coal, resulting in significant CO₂ emissions**.
 - The new CO₂ to CO conversion technology presents an opportunity to establish a **circular economy**, reducing **carbon footprint and associated costs in steel production**.

Electrocatalytic Process

- It is a catalytic process that involves the **direct transfer of electrons between an electrode and reactants**.
- This process is environmentally friendly, efficient, and inexpensive. It can be used in many sustainable energy technologies.

Note:

Carbon monoxide (CO)

- It is a **colorless, odorless, and tasteless** gas that is slightly less dense than air.
- **Sources of CO:** CO is a byproduct of the **incomplete combustion of hydrocarbons**. Common sources include burning fossil fuels like natural gas, petrol, coal and oil, wood smoke, car and truck exhausts etc.
- It is toxic to humans insofar as it forms a complex thereby displacing oxygen from the hemoglobin of the blood.
- In the atmosphere CO is short lived because of the role it plays in the formation of **ground-level ozone**.

India's Deep Ocean Mission

Why in News?

India is gearing up for a **historic Deep Ocean Mission to explore and harness the depths of the ocean**, a frontier that remains largely uncharted and holds immense potential for scientific and economic benefits.

- Countries such as the **U.S.A., Russia, China, France, and Japan** have already achieved successful deep-ocean crewed missions.

What is the Deep Ocean Mission?

➤ About:

- **Deep Ocean Mission (DOM)** is an ambitious initiative of the **Ministry of Earth Sciences (MoES)** which aims to develop technologies and capabilities for **deep sea exploration**.
 - Also, DOM is one of nine missions under the **Prime Minister's Science, Technology, and Innovation Advisory Council (PMSTIAC)**.

➤ Key Pillars of the Mission:

- Technological Advancements for **Deep-Sea Mining and Crewed Submersibles**
- Ocean Climate Change Advisory Services
- Innovations for **Deep-Sea Biodiversity Exploration and Conservation**
- **Survey and Exploration** of Deep-Ocean Minerals
- **Harvesting Energy and Freshwater** from the Ocean
- Establishment of an **Advanced Marine Station for Ocean Biology**

➤ Major Advancement in DOM Objectives:

- **Samudryaan and Matsya6000:** As a part of DOM, India's flagship deep ocean mission, **Samudrayaan**, was initiated in 2021 by the Minister of Earth Sciences.
 - With Samudrayaan, India is embarking on a groundbreaking crewed expedition to reach a depth of **6,000 m to the ocean bed in the Central Indian Ocean**.
 - This historic journey will be accomplished by **Matsya6000**, a **deep-ocean submersible** designed to accommodate a crew of three members.
 - It is constructed from a titanium alloy, the sphere is engineered to withstand pressures of up to 6,000 bar.

CAR-T Cell Therapy

Why in News?

Recently, The **Central Drugs Standard Control Organisation (CDSCO)** has granted market authorisation for **NexCAR19**, India's first indigenously-developed **Chimeric Antigen Receptor T cell (CAR-T cell) Therapy**.

- India is now one of the first developing countries to **have its indigenous CAR-T and gene therapy platform**.

What is NexCAR19?

➤ About:

- NexCar19 is a **type of CAR-T and gene therapy** developed indigenously in India by ImmunoACT, which is a **company incubated at IIT Bombay**.
- It is designed to target **cancer cells that carry the CD19 protein**.
 - This protein acts like a flag on cancer cells, which allows **CAR-T cells to recognise and attach themselves to the cancer cells** and start the process of elimination.
- Even some developed nations don't have their own CAR-T therapies; they import them from the **United States or Europe**.

Note:

TREATMENT FOR SPECIFIC B-CELL CANCERS

NexCAR19 is a prescription drug for B-cell lymphomas, lymphoblastic leukaemias when other treatments have been unsuccessful

PATIENT'S WHITE blood cells are extracted by a machine through a process called leukapheresis and genetically modified, equipping them with the tools to identify and destroy the cancer cells.



NEXCAR19 IS manufactured to an optimal dose for the patient, and typically administered as a single intravenous infusion. Prior to this, the patient is put through chemotherapy to prime the body for the therapy.

HOW NEXCAR19 WORKS



T-cells are naturally made by the body as an advanced defence against viruses and cancer cells.

As T-cells mature, they develop specific connectors (receptors) to target key signals on cancer cells.



However, cancers can limit the inbuilt extent and efficiency with which T-cells are able to seek and fight them. This results in an increase in cancer burden.

Source: ImmunoACT



Scientists have identified certain proteins that are abnormally expressed on the surfaces of specific types of cancer cells. Specially designed receptors can find and bind to these cells.



A safe shell of a virus is used to genetically engineer T-cells so they express Chimeric Antigen Receptors — connectors that target a protein called CD19 on B-cell cancer.

Carbon Nanoflorets

Why in News?

Recently, researchers at IIT Bombay have created **carbon nanoflorets** capable of converting **sunlight into heat** with unmatched efficiency.

What are Carbon Nanoflorets?

➤ About:

- The carbon nanoflorets, developed by researchers from IIT Bombay, demonstrate an impressive **light absorption efficiency of 87%**.
- They can absorb multiple frequencies of sunlight, including infrared, visible light, and ultraviolet, in stark contrast to **traditional solar-thermal materials** that typically **absorb only visible and ultraviolet light**.

Note:



drishti

Casgevy Therapy for Sickle Cell Disease and Thalassaemia

Why in News?

Recently, the UK Drug Regulator sanctioned a **gene therapy** called **Casgevy** heralded as a significant breakthrough for **treating sickle cell disease** and **thalassaemia**.

- Notably, this marks the **world's inaugural licensed therapy leveraging the CRISPR-Cas9 gene editing technology** that earned its innovators a **Nobel Prize in Chemistry 2020**.

How does the Casgevy Therapy Work?

- Both **sickle cell disease** and **thalassaemia** are caused by **errors in the gene for haemoglobin (Hb)**, a protein in the red blood cells that carry oxygen to organs and tissues.
 - The therapy **uses the patient's own blood stem cells**, which are precisely **edited using CRISPR-Cas9**.
 - A gene called **BCL11A**, which is crucial for switching from **foetal to adult haemoglobin**, is targeted by the therapy.
- **Foetalhaemoglobin**, which is naturally present in everyone at birth, does not carry the same abnormalities as adult haemoglobin.
 - The therapy **uses the body's own mechanisms to start producing more of this foetalhaemoglobin**, alleviating the symptoms of the two conditions.
- Casgevy involves a single treatment wherein **blood stem cells are extracted via apheresis** and then edited over approximately six months before being reintroduced into the patient.
 - Apheresis is a medical procedure that involves removing specific components from blood and returning the rest to the body.

What are Sickle Cell Disease and Thalassaemia?

- **Sickle Cell Disease:**
 - **About:** Sickle cell disease is a genetic blood disorder characterized by an abnormality in hemoglobin, the **protein responsible for carrying oxygen in red blood cells**.

- It causes **red blood cells to adopt a sickle or crescent shape**, hindering their movement through vessels, leading to potential complications like **severe pain, infections, anaemia, and strokes**.
- In India alone, an estimated **30,000-40,000 children** are born with sickle cell disease annually.
- **Types:** It encompasses various types, each dependent on the **inherited genes from parents**, all encoding abnormal hemoglobin. The most prevalent forms of SCD include:
 - **HbSS (Sickle Cell Anemia):** Individuals **inherit two "S" genes**, one from each parent, resulting in **abnormal hemoglobin "S."**
- This type often leads to severe manifestations characterized by **rigid, sickle-shaped red blood cells**.
 - **HbSC:** Inheriting an **"S" gene from one parent and a different abnormal hemoglobin, "C,"** from the other, leads to this milder variant of SCD.
 - **HbS Beta Thalassaemia:** This form arises from **inheriting an "S" gene from one parent and a beta thalassaemia gene from the other**.
- The severity varies based on the type of beta thalassaemia inherited either **"zero" (HbS beta0) or "plus" (HbS beta+)**, with the former typically resulting in a severe form and the latter in a milder manifestation.
- **Thalassaemia:** Similar to **sickle cell disease**, individuals with **thalassaemia experience severe anaemia due to low haemoglobin levels**, necessitating lifelong blood transfusions and **chelation therapy** to manage iron accumulation.
 - Major symptoms include **fatigue, paleness or jaundice, shortness of breath, delayed growth, facial bone deformities (in severe cases)** among others.

What is CRISPR-Cas9 Technology?

- **CRISPR-Cas9** is a groundbreaking technology that empowers geneticists and medical researchers to modify specific portions of the genome.
 - This is achieved through the **precise removal, addition, or modification of segments within the DNA sequence**.

Note:

- It involves two essential parts for editing DNA. First, there is **Cas9**, which acts like **molecular scissors**, cutting DNA at specific spots.
 - Then, there is **guide RNA (gRNA)**, containing a designed sequence. This sequence guides Cas9 to the exact spot in the genome to make the cut.
 - This **precise guidance ensures Cas9 works accurately where needed**, allowing for specific changes in the DNA.

Night Sky Sanctuary in Ladakh

Why in News?

The **Government of India**, recently announced the upcoming establishment of South East Asia's first **Night Sky Sanctuary in Ladakh**.

What are the Key Points Related to Night Sky Sanctuary in Ladakh?

- It will be located at **Hanle village in Eastern Ladakh** as a part of **Changthang Wildlife Sanctuary**.
- It is being set up with the help of **Indian Institute of Astrophysics Bengaluru**, which is affiliated to the **Department of Science & Technology, Govt of India**.
 - Spread over **1,073 square kilometers**, it is adjacent to the **Indian Astronomical Observatory**, the second-highest optical telescope in the world.
- It will boost **Astro-tourism in India** and will be one of the **world's highest-located sites for optical, infra-red, and gamma-ray telescopes**.

Fibre Optic Cables

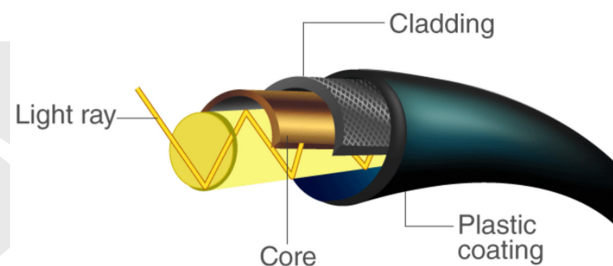
Why in News?

With the increasing demand for high-speed internet connections **Optical Fibres** have been materialized into the present-day reality of high-speed data transmission.

What is an Optical Fibre?

- **About:**
 - Optical Fibres are thin, cylindrical strands composed of glass, with a diameter typically comparable to that of a human hair.

- These fibres possess the **remarkable ability to transmit various forms of information**, including text, images, audio, video, phone calls, and any data that can be digitized, across vast distances at **speeds approaching that of light**.
- They are **strong, lightweight, and remarkably flexible**, making them suitable for burial underground, submersion underwater, or coiling around a spool.
- Almost 60 years ago, physicist **Charles Kao proposed the concept of using glass Fibres** as a superior medium for telecommunications, superseding the prevalent copper wires.
 - His groundbreaking contributions to Fibre optic communication earned him a share of the 2009 Nobel Prize in Physics.



Working:

- **Principle of Total Internal Reflection:** The phenomenon of Total Internal Reflection (TIR) **forms the basis for guiding light within optical Fibres**.
 - If light travels from a higher refractive index medium (like glass) to a lower one (such as air) at a specific angle, it may not exit the medium **but be entirely reflected back within it**. This phenomenon is called TIR.
- **Signal Encoding:** Information is encoded into optical signals as **rapidly blinking light pulses**, typically representing binary digits (zeros and ones).
 - These optical signals are fed into one end of an optical Fibre, where they travel by reflecting and bouncing between the glass walls due to total internal reflection.
- **Signal Transport:** The optical Fibre carries the encoded signals across several kilometers without significant loss of signal integrity.
 - At the destination, a receiver reproduces the encoded information from the transmitted optical signal.

Note:

➤ Benefits:

- **High Speed:** Fibre provides more bandwidth and has standardized performance up to 10 Gbps and beyond, something that it is impossible to achieve when using copper.
 - More bandwidth means that Fibre can carry more information with far greater efficiency than copper wire.
- **Range of Transmission:** Since data travels in the form of light in Fibre-optic cables, very little signal loss occurs during transmission and data can move at higher speeds and greater distances.

Ixchiq Vaccine for Chikungunya

Why in News?

Recently, the **Food and Drug Administration (FDA) in the United States** approved the world's inaugural vaccine for **chikungunya**.

- This novel vaccine, named **Ixchiq** and developed by **European vaccine manufacturer Valneva**, marks a significant leap in combating the **chikungunya virus (CHIKV)**.

What are the Key Features of Ixchiq Vaccine?

- It is administered as a single dose via injection into the muscle. It contains a **live, weakened version of the chikungunya virus**, potentially causing symptoms akin to the disease in vaccine recipients.
- The vaccine has been approved for administration in **people who are 18 years or older**, and are at increased risk of exposure to the virus.

What is Chikungunya?

- **About:** Chikungunya is a **mosquito-borne viral disease**. It was **first recognized in 1952** during an outbreak in southern Tanzania.
 - It is a **ribonucleic acid (RNA) virus** that belongs to the **alphavirus genus of the family Togaviridae**.
- **Symptoms:** Chikungunya causes **fever and severe joint pain**, which is often debilitating and varies in duration.
 - **Dengue and Zika have similar symptoms to chikungunya**, making chikungunya easy to misdiagnose.

NASA's Psyche Spacecraft

Why in News?

NASA's Psyche spacecraft, currently journeying over **16 million kilometers away in space**, recently achieved a groundbreaking feat by **successfully firing a laser signal at Earth**.

- It took off on **13th October, 2023**, launching from the **Kennedy Space Center** via a **SpaceX Falcon Heavy rocket**.

What is NASA's Psyche Mission?

- **About:** The Psyche mission aims to explore the **asteroid Psyche**, located between **Mars and Jupiter**.
 - Psyche is a **rare metallic asteroid** believed to be the exposed **nickel-iron core of an early planet**.
 - This mission offers a unique opportunity to **directly study a planetary core**, providing invaluable insights into the formation of terrestrial planets like Earth.

Decentralised Autonomous Organisations

Why in News?

Decentralised Autonomous Organisations (DAOs) represent a groundbreaking innovation at the intersection of **Blockchain Technology** and governance.

What are Decentralised Autonomous Organisations (DAOs)?

- **About:**
 - DAOs are the digital entities that operate without centralised control and are governed by smart contracts and the consensus of their members, often utilising **Cryptocurrencies** as a means of decision-making and resource allocation.
 - DAOs have garnered attention for their potential to change various industries, including finance, art, and governance, **by fostering transparent, democratic, and self-executing systems**.
 - These entities are not only reshaping traditional business structures but also challenging the way we perceive trust, governance, and collaboration in the digital world.

Note:

- The idea behind DAOs is to create self-sustaining, community-driven entities governed by smart contracts on blockchain networks.
- **Various Use Cases:**
 - **Global Financial Ecosystem:** In the realm of decentralized finance, platforms like Compound and Maker DAOs have introduced lending and borrowing services, enabling users to participate in the global financial ecosystem without relying on traditional banks.
 - **In the Art World:** In the art world, artists are tokenising their creations and utilising DAOs to manage royalties and maintain control over their intellectual property.
 - **Supply Chain Management:** Supply chain management is another arena where DAOs are gaining traction, as they offer transparency and traceability in global supply chains, ensuring the authenticity and quality of products.
 - **Governance of Online Communities:** Even in the governance of online communities, DAOs have emerged as tools for decision-making, with platforms like DAOstack facilitating decentralised governance structures for internet communities.

NASA's Atmospheric Waves Experiment

Why in News?

NASA's unveiling of the **Atmospheric Waves Experiment (AWE)** emerges amidst escalating disruptions in satellite communication and **GPS systems**, spotlighting the critical need to comprehend **space weather**.

- With Earth's extreme weather events influencing space phenomena via **Atmospheric Gravity Waves (AGWs)**, AWE's imminent launch promises groundbreaking insights into these interconnected dynamics.

What are Atmospheric Gravity Waves (AGWs)?

- **Gravity Waves:** In a stable atmosphere, **gravity waves** are created when temperature contrasts between **rising air and the surrounding atmosphere** generate a force that pushes the air back to its initial location.

- **Atmospheric Gravity Waves:** AGWs are waves that travel within a stable atmospheric layer, particularly thriving in regions where air is moving upward, facilitating the creation of distinctive cloud formations.
 - Remarkably, **these AGWs extend into space**, playing a role in shaping space weather.
 - They are mostly generated by **extreme weather events or disturbances** causing **vertical displacement** of stable air.
 - **Thunderstorms, hurricanes, and regional topography** contribute to the **generation of AGWs** in the lower atmosphere.

What is NASA's Atmospheric Waves Experiment?

- **About:** As a pioneering NASA experiment under the **Heliophysics Explorers Program**, AWE aims to study the connections between **lower atmospheric waves and space weather**.
- **Operational Mechanism:** Mounted on the **International Space Station (ISS)**, AWE will observe the **colorful air glows in the Earth's atmosphere**, specifically at the **mesopause** (about 85 to 87 km above the Earth's surface).
 - Equipped with an **Advanced Mesospheric Temperature Mapper (ATMT)**, AWE will scan the mesopause using imaging radiometers to capture specific wavelengths' brightness.
- **Mission Objective:** Understanding the **forces driving space weather** and investigating the potential impact of **terrestrial weather** on it.
 - Data obtained by AWE will **contribute as inputs for weather models**, improving weather forecasts.

E Prime Layer

Why in News?

According to a research conducted at the Advanced Photon Source of Argonne National Lab and PETRA III of Deutsches Elektronen-Synchrotron in Germany, a new mysterious layer called the **E prime layer** has formed on the outer part of the **Earth's core**.

- This happened because **surface water penetrated deep into the planet**, changing the composition of the outer region of the **liquid metal core**.

Note:

How Did E Prime Layer Develop Over Time?

- Tectonic Plates Transporting Water to Earth's Core:
 - New research reveals a fascinating process where **tectonic plates**, carrying surface water, have been transporting it deep into the Earth's interior over billions of years.
 - As this water reaches the core-mantle boundary, located approximately 1,800 miles beneath the Earth's surface, **it instigates significant chemical changes that directly influence the structure of the Earth's core.**
- Chemical Reactions and Structural Impact on Earth's Core:
 - Observations by scientists highlight the chemical reactions occurring **when subducted water interacts with core materials** under high pressure.
 - This interaction results in the creation of a distinct layer in the outer core **characterized by high hydrogen content and low silicon levels**, forming a film-like structure.
 - Additionally, **the process generates silica crystals that ascend into the mantle**, causing compositional changes.
 - These alterations in the liquid metallic layer have potential implications, including reduced density and modified seismic characteristics.

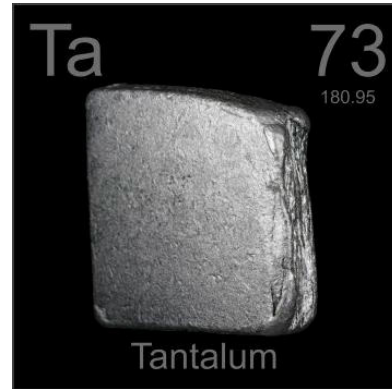
Tantalum

Why in News?

Tantalum, a rare metal with remarkable properties, has been discovered in the sands of the **Sutlej River in Punjab** by a team of researchers from the Indian Institute of Technology (IIT), Ropar.

What are the Key Facts About Tantalum?

- **Discovery:**
 - Tantalum is a rare metal with the **atomic number 73**. It was first discovered in 1802 by Swedish chemist **Anders Gustaf Ekenberg**.



- **Properties:**
 - It is **grey, heavy, and highly corrosion-resistant**, forming an oxide layer when exposed to air.
 - **Pure tantalum is ductile**, allowing it to be stretched into **thin wires without breaking**.
 - Extremely **resistant to chemical attack** at temperatures below 150°C, it is affected only by hydrofluoric acid, acidic solutions with fluoride ions, and free sulphur trioxide.
 - Tantalum also has an **extremely high melting point**.
- **Uses of Tantalum:**
 - **Electronic Sector:**
 - **Capacitors** made from tantalum are vital for storing more electricity in smaller sizes, ideal for portable electronic devices.
 - A committee of experts within the Ministry of Mines has recognized a collection of **30 critical minerals for India**, with **Tantalum** being among them.
 - It is also used to make components for chemical plants, nuclear power plants, aeroplanes and missiles.
 - **Substitute for Platinum:**
 - It has a high melting point, and is frequently used as a **substitute for platinum**, which is more expensive.

What is a Gamma Ray Burst?

Why in News?

According to recent researchers, gamma-ray burst

Note:

(GRB) triggered by a supernova explosion in a galaxy situated nearly two billion light-years from earth, induced a notable disruption in the ionosphere of Earth.

➤ **About:**

- **Gamma-ray bursts** are **short-lived explosions of gamma rays**, the most energetic form of light.
- Lasting from a **few milliseconds to several hours**, they shine hundreds of times brighter than a typical supernova and about a million trillion times as bright as the Sun.
- Observed in distant galaxies, they are the **brightest electromagnetic events known to exist in the universe**.

➤ **Types:**

- Astronomers classify gamma-ray bursts into **long- and short-duration events**. While the two types of events are likely created by different processes, both result in the **creation of a new black hole**.
 - **Long-duration bursts** last anywhere from **2 seconds to several hours**. Although they are associated with the deaths of massive stars in supernovas, **not every supernova results in a gamma-ray burst**.
 - **Short-duration bursts** last **less than 2 seconds**. They appear to result from the **merger of two neutron stars into a new black hole**, or the merger of a neutron star and a black hole to form a larger black hole.

Rashtriya Vigyan Puraskar Awards

Why in News?

Recently, the Ministry of Science and Technology has announced 'Rashtriya Vigyan Puraskar' (RVP) at par with the **Padma** and other national awards.

What is Rashtriya Vigyan Puraskar (RVP)?

➤ **Included Awards:**

- **Vigyan Ratna Awards:** These awards will recognise lifetime achievements & contributions made in any field of science and technology.
- **Vigyan Shri Awards:** These awards will recognise distinguished contributions to any field of science and technology.

- **Vigyan Team Awards:** These awards are to be given to a team comprising three or more scientists/researchers/innovators who have made an exceptional contribution working in a team in any field of science and technology.
- **Vigyan Yuva-Shanti Swarup Bhatnagar (VY-SSB):** These awards are the highest multidisciplinary science awards in India for the young scientists (maximum 45 years).
 - They are named after **Shanti Swarup Bhatnagar**, the founder and director of the **Council of Scientific & Industrial Research (CSIR)**, who was also a renowned chemist and visionary.

Euclid Mission for Dark Matter and Dark Energy

Why in News?

The Euclid mission by the **European Space Agency (ESA)** launched in July 2023, to study **dark matter** and **dark energy** has shared its initial five science images which include pictures of expansive **galaxy clusters**, detailed shots of two nearby galaxies, a **nebula**, and a gravitationally connected group of stars known as a **globular cluster**.

Euclid Mission:

- ESA's Euclid mission is a **space telescope** designed to **explore the composition and evolution of the dark Universe**.
 - Euclid will **explore how the Universe has expanded** and how structure has formed over cosmic history, revealing more about the **role of gravity and the nature of dark energy and dark matter**.
- **Launch Vehicle:** SpaceX Falcon 9
- **Destination:** Sun-Earth Lagrange point 2

What is Dark Matter?

➤ **About:**

- Dark matter, though never detected, **is believed to be present in the entire universe**, its existence presumed because a number of observable celestial phenomena could not be possible if the universe did not have much more matter in it than is seen.
 - It is believed to make up **more than 95% of all the universe**.

Note:

➤ Characteristics:

- The material is considered to be a 'matter' since it has **gravitational attraction** and it is 'dark' because it **does not seem to interact with light** (or any part of the electromagnetic spectrum).
 - Its gravitational force **prevents stars in our Milky Way from flying apart**.
- However, attempts to detect such dark matter particles using underground experiments, or accelerator experiments including the world's largest accelerator, the **Large Hadron Collider (LHC)**, have failed so far.

Dark Energy

- **Dark energy is a hypothetical form of energy** that is thought to permeate all of space and drive the accelerated expansion of the universe.
- It's a term used in cosmology to explain the observed phenomenon that galaxies are moving away from each other at an accelerating rate.

Web Browsers

Why in News?

Web browsers are our digital passports to the vast universe of the internet, making it easy for us to explore and **access web pages with just a click**.

What are Web Browsers?

➤ About:

- The web browser is an application software to explore **www (World Wide Web)**. It provides an **interface between the server and the client and requests to the server** for web documents and services.
- It works as a compiler to render HTML (Hypertext Markup Language) which is used to design a webpage.
- Whenever we search for anything on the internet, the browser loads a web page written in **HTML, including text, links, images**, and other items such as stylesheet and JavaScript functions.
 - Google Chrome, Microsoft Edge, Mozilla Firefox, and Safari are examples of web browsers.

➤ Origin:

- In the nascent days of the internet, browsing was a **text-based venture until Tim Berners-Lee** introduced the **World Wide Web in 1990**, alongside the inaugural web browser, '**WorldWideWeb**'.
- The transformative **Mosaic browser in 1993** brought images into the web landscape, **revolutionizing user interaction**.
- Netscape Navigator's advent further **enhanced browsing by introducing bookmarks and user-friendly features**, sparking the 'Browser Wars' between it and Internet Explorer.

➤ The Evolutionary Leaps:

- The monotony of **Internet Explorer's dominance was broken by Mozilla Firefox** in 2004-2005, propelling innovation with tabbed browsing and add-ons, setting new standards.
- Google's Chrome, with its speed and minimalism, emerged in 2008, triggering a revitalization of the browser market.
- Other contenders such as Apple's Safari and Microsoft Edge (a successor to Internet Explorer) evolved, providing diverse options tailored to user preferences.

Chandrayaan-3 Propulsion Module Returns to Earth's Orbit

Why in News?

- Recently, scientists successfully brought the **Propulsion Module (PM)** of the **Chandrayaan-3 mission**, which brought the **Vikram lander** within **100 km** of the **Moon's surface** before detaching.
 - This historic event involved a controlled descent to the **lunar surface** and a successful return to **Earth orbit**.

What is Mission Chandrayaan?

- India has launched a total of three Chandrayaan Missions i.e., **Chandrayaan-1, Chandrayaan-2 and Chandrayaan-3**.

Note:

- **Chandrayaan-1:**
 - India's **first mission to the Moon** was **Chandrayaan-1** launched successfully in **2008**. It was designed to orbit the Moon and make observations with instruments on board.
 - Key Findings of Chandrayaan-1:
 - Confirmed presence of **lunar water**.
 - Evidence of **lunar caves** formed by an ancient lunar lava flow.
 - **Past tectonic activity** was found on the **lunar surface**.
 - The faults and fractures discovered could be features of **past interior tectonic activity** coupled with meteorite impacts.
- **Chandrayaan-2:**
 - **Chandrayaan-2** is an integrated **3-in-1 spacecraft** consisting of an orbiter of the **Moon, Vikram (after Vikram Sarabhai)** the lander and **Pragyan (wisdom)** the rover, all equipped with scientific instruments to study the moon.
 - Launched: 22th July 2019
 - **Lander Vikram:** It remains stationary after touching down, and mainly studies the moon's atmosphere and seismic activity.
 - **Rover Pragyan:** The Rover, a **six-wheeled solar-powered vehicle**, detaches itself and slowly crawls on the surface, making observations and collecting data.
 - Chandrayaan-2's lander had **crashed**, or made a **hard landing**, on the **Moon's surface** because of its **high velocity**.
 - However, its **orbiter** is functioning very well and this will communicate with **Chandrayaan-3 lander**.
- **Chandrayaan-3:**
 - It was **India's third lunar mission** and second attempt at achieving a **soft landing** on the **moon's surface**.
 - **Launched:** July 14, 2023.
 - Objectives:
 - To demonstrate Safe and Soft Landing on Lunar Surface
 - To demonstrate Rover roving on the moon
 - To conduct In-situ scientific experiments.
 - It consists of an indigenous **Lander module (LM), Propulsion module (PM)** and a **Rover** with an objective of developing and demonstrating new technologies required for Interplanetary missions.

What is the Chandrayaan-3 Propulsion Module?

- **Chandrayaan-3:** It utilized a lightweight **Propulsion Module** for the **lander's journey** to the Moon instead of a complete orbiter.
- **SpectroPolarimetry of Habitable Planet Earth (SHAPE):** The **Chandrayaan-3 propulsion module** carried a single instrument called **SHAPE**.
 - It was an experimental payload designed to study **Earth's characteristics** that make it habitable, aiming to identify habitable exoplanets.
- **Pragyaan Rover:** The **propulsion module** separated from the **lander**, which carried the **Pragyaan rover**. It was anticipated to orbit the Moon for an additional **six months**, with **SHAPE** observing Earth.

Six Exoplanets Found Orbiting Around HD 110067

Why in News?

A recent study published in *Nature* has unveiled the discovery of **six exoplanets** orbiting a nearby **bright star, HD 110067**, located in the **Coma Berenices constellation**.

- These planets referred to as 'sub-Neptunes', were detected and characterized by using data from two space telescopes: **National Aeronautics and Space Administration's (NASA) Transiting Exoplanet Survey Satellite (TESS)** and **European Space Agency's (ESA) Characterising Exoplanet Satellite (CHEOPS)**.

Note: CHEOPS is ESA's first space mission dedicated to studying bright, **nearby stars that are already known to host exoplanets**, in order to make high-precision observations of the planet's size as it passes in front of its host star.

What are the Key Facts about Sub-Neptunes?

- The six exoplanets in the HD 110067 system are classified as '**sub-Neptunes**.'
 - Planets with radii between that of the Earth and Neptune are referred to as 'sub-Neptunes'.
 - Calculations of their masses and densities indicate the presence of relatively low-density atmospheres, **potentially rich in hydrogen**.

Note:

- All six planets are in **resonant orbits**, in which the planets exert regular forces on each other as they orbit.
 - This feature suggests that the system remains practically unchanged since its birth, at least four billion years ago.
- The planets are named **HD 110067 b, c, d, e, f, and g**, in order of increasing distance from the star.

HD 110067

- The star is called HD 110067, and it is located about 100 light-years away from Earth, located in the Coma Berenices constellation.
- It is visible from the Northern Hemisphere, and it is the brightest star found to host more than four transiting exoplanets to date.
 - The Coma Berenices constellation, also known as Berenice's Hair, is a medium-sized constellation in the **northern celestial hemisphere**. It's visible in both hemispheres, but is most easily seen in the northern hemisphere during spring and summer.

What is an Exoplanet?

- Exoplanets are **planets that orbit other stars and are beyond our solar system**.
 - The first confirmation of detection of exoplanets occurred in 1992.
- According to NASA, to date, more than 5,000 exoplanets have been discovered.

Global Positioning System

Why in News?

Global Positioning System (GPS) is one of few everyday technologies that have had the kind of revolutionary impact on civilian, military, scientific, and urban realms, redefining our sense of location and impacting diverse sectors globally.

What is the Global Positioning System?

- **About:**
 - The GPS, initiated by the U.S. Department of Defense in 1973, comprises three main segments,
 - **Space:** Detailing the space segment, the **24 satellites in six orbits** ensure global coverage, allowing receivers to access signals from at least

four satellites simultaneously—a fundamental necessity for accurate positioning.

- All six orbits are positioned at an **altitude of 20,200 km** above the Earth, and **each orbit has four satellites at all times**. Each satellite completes two orbits in a single day.
 - **Control:** The control segment, managed by ground-based stations, ensures satellite performance and signal accuracy, adhering to the **Standard Positioning Service (SPS)** standards published in 2020. Key stations across the globe manage and monitor the system's integrity.
- The **SPS standard** tells application developers and users anywhere in **the world what they can expect from the GPS system**.
 - **User:** User segment encompasses diverse sectors from agriculture to military operations, with an estimated 6.5 billion **GNSS (Global Navigation Satellite System)** devices worldwide in 2021, expected to surge to 10 billion by 2031, underscoring its pervasive influence.
- **Functionality of GPS:**
 - GPS operates through **satellite-transmitted radio signals** at specific frequencies (L1 and the L2 frequencies at 50 bits/second), received and triangulated by GPS receivers, enabling precise location determination in three dimensions of space and one of time.
- **Precision and Adjustments:**
 - Error adjustments, including relativistic effects on satellite clocks and relative velocities, are factored in to enhance accuracy, highlighting the meticulousness of GPS calculations.
 - Satellites maintain precise time for GPS by using atomic clocks. These clocks are critical because even tiny timing differences **could lead to substantial location errors**.

Fast Radio Bursts

Why in the News?

Recently, scientists are trying to understand a new aspect of **Fast Radio Bursts (FRBs)**, which are **mysterious radio signals** coming from **distant galaxies**.

- **Laser Interferometer Space Antenna (LISA)**, which is scheduled to launch in the early 2030s, will aid in studying **FRBs and mysterious radio signals**.

Note:

What are Fast Radio Bursts (FRBs)?

- **Fast Radio Bursts (FRBs)** are powerful and brief bursts of **radio frequency emissions** originating from **deep space**. These mysterious and intense signals last **only milliseconds** but release an amount of energy comparable to **hundreds of millions of suns**.
- **Astronomers** have proposed that **magnetars**, a type of **neutron star** formed from the remnants of **exploding stars**, could be a probable origin for **FRBs**.
- The **rotation of magnetars** is **comparatively slower** than that of other **neutron stars**.
- **Neutron stars** are formed when a **massive star** collapses. The very central region of the **core collapses**, **crushing** together every **proton** and **electron** into a **neutron**. These newly-created **neutrons** can stop the **collapse**, **leaving behind a neutron star**.
- A **magnetar** possesses a **magnetic field** over a **thousand times stronger** than that of other **neutron stars**, and it is a **trillion times** more powerful than **Earth's magnetic field**.

What is Laser Interferometer Space Antenna (LISA)?

Why in the News?

Recently, scientists are trying to understand a new aspect of Fast Radio Bursts (FRBs), which are mysterious radio signals coming from distant galaxies.

Laser Interferometer Space Antenna (LISA), which is scheduled to launch in the early 2030s, will aid in studying FRBs and mysterious radio signals.

- LISA is a planned **space-based gravitational wave observatory** led by the **European Space Agency (ESA)** and **National Aeronautics and Space Administration (NASA)**.
- LISA is designed to **detect and observe gravitational waves** by measuring the minute changes in the distance between **three spacecraft** in a **triangular formation**, caused by the **passage of gravitational waves** through space.
- This **space-based observatory** is anticipated to provide valuable insights into cosmic events, such as the **mergers of massive black holes** and other astrophysical phenomena, contributing to our understanding of the universe.

Tree Ambulance

Why in News?

Recently, the **Horticulture Department** of the **Municipal Corporation of Delhi (MCD)** plans to expand its **tree ambulance fleet** in Delhi, aiming to **triple** the current number to **12** by 2024.

- Each of the **12 administrative zones** will be assigned **one tree ambulance**, enhancing the city's capacity for timely and efficient tree care.

What is the Tree Ambulance?

About:

- **Tree Ambulance** is an initiative that has been initiated to support **"save trees"** with the **"vision to save the Earth"**.
- The **first phase** of **Tree Ambulance** was flagged off and inaugurated in **Chennai** on the occasion of **International Day for Biological Diversity, 2019** (celebrated on **22nd May**) by the **Vice President of India**.
- **Tree Ambulances** are **run by botanists, forestry experts, gardeners, volunteers and tree surgeons** and **provide free services** to people who call its helpline requesting help rescuing ailing trees and plants.

Aim:

- The initiative was proposed by the Chennai-based environmentalist **K Abdul Ghani**, well known as the **"Green Man of India"**.
- The initiative was launched for the purpose of providing a platform to **battle climate change** by replanting the trees that were uprooted due to **Cyclone Vardah** and **Cyclone Gaja**.
- **Tree Ambulance** is also tasked to provide services such as **"first aid treatment, seed banking, seed ball distribution, uprooted tree planting, plant distribution, aiding tree plantation, shifting trees, and surveying of trees and removal of dead trees"**.

Electronic Soil

Why in News?

Recently, researchers from **Linköping University in Sweden** have developed 'Electronic Soil' that can **speed up the growth of plants** in **Hydroponic** spaces.

Note:

What is Electronic Soil?

- **About:**
 - The electronic soil (eSoil) developed is a **novel conductive cultivation substrate** tailored specifically for hydroponic systems.
 - Unlike traditional substrates like mineral wool, which are non-biodegradable and manufactured using energy-intensive processes, **eSoil is composed of cellulose**, a biopolymer, blended with a conductive polymer known as PEDOT (Poly(3,4-ethylenedioxythiophene)).
 - This innovative blend of **materials allows for the stimulation of root systems in plants** through low-power electrical currents.

What is Hydroponics?

- **Hydroponics:**
 - Hydroponics is a method of growing plants in a **water based, nutrient rich solution in a soilless media**.
 - It does not use soil, instead the root system is supported **using an inert medium such as perlite, rockwool, clay pellets, peat moss, or vermiculite**.
 - The fundamental is to allow the plants roots to come **in direct contact with the nutrient solution**, while also having access to oxygen, which is essential for proper growth.
- **Advantages:**
 - **Land and Water Efficient:** The hydroponic farming technology with closed water loop systems is a viable option for farmers with limited access to land and water.
 - **Suitable for Urban Areas:** The significance of soilless systems increases many folds when it comes to urban and peri-urban areas where the arable land is polluted.
 - **Lower Resource Consumption:** Lower and more efficient resource consumption allows this alternative farming technique to be adopted by a variety of stakeholders.
 - **Higher Yield:** According to the **Food and Agricultural Organisation (FAO)**, the vegetable yield of soilless systems is 20-25% higher than in traditional systems as the number of plants per square metre is higher.

Pesticide Poisoning

Why in News?

Recently, in **Maharashtra** which is prone to **droughts** and **crop failures, pesticide poisoning** has claimed the lives of many farmers and farm workers in recent years.

- Many others have suffered from **respiratory problems, skin rashes, eye irritation, neurological disorders, reproductive issues, cancer**, and even death.

What are Pesticides?

- **About:**
 - Pesticide is any **chemical or biological substance** intended to **prevent, destroy or control damage** from pests which has both **agricultural and non-agricultural** uses.
 - They also pose serious risks to **human health** and the **environment**, especially when they are **misused, overused, or sold illegally**.
- **Types:**
 - **Insecticides:** The chemicals that are used to protect plants from insects and pests are known as Insecticides.
 - **Fungicides:** This class of crop protection chemicals is used to control the spread of fungal diseases in plants.
 - **Herbicides:** Herbicides are chemicals that kill or control the growth of weeds in the cultivation area.
 - **Bio-Pesticides:** They are Pesticides of biological origin, i.e., derived from animals, plants, bacteria etc.
 - **Others:** This includes plant growth regulators, nematicides, rodenticides and fumigants.
- **Pesticide Poisoning:**
 - **Pesticide poisoning** is a term that refers to the **adverse effects of exposure to pesticides** on **humans or animals**.
 - According to the **World Health Organization (WHO)**, **pesticide poisoning** is one of the leading causes of **death** among **agricultural workers** worldwide.
 - Pesticides can be classified into two types, **Acute (short-term)** and **chronic (long-term)**.
 - **Acute poisoning** occurs when a person **ingests, inhales, or comes into contact** with a large amount of pesticide in a **short period of time**.

Note:

- **Chronic poisoning** occurs when a person is exposed to **low doses** of pesticide over a **long period of time**, which can cause damage to various organs and systems in the body.

➤ Recently Banned Pesticides:

- The government has banned three more insecticides in **2023**: **Dicofol**, **Dinocap**, and **Methomyl**, in addition to **monocrotophos**.

How Pesticides are Regulated in India?

- Pesticides are regulated under the **Insecticides Act, 1968** and the **Insecticides Rules, 1971**.
- The **Insecticides Act of 1968** covers the **registration, manufacture** and **sale of pesticides** in India.
- The Act is administered by the **Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare**.

Note: The **Pesticide Management Bill, 2020** was introduced in **Rajya Sabha** in 2020. It seeks to regulate the **manufacture, import, sale, storage, distribution, use, and disposal of pesticides**, in order to ensure the availability of safe pesticides and minimize the risk to humans, animals, and environment. The Bill seeks to replace the **Insecticides Act, 1968**.

Breakthrough Prizes

Why in News?

The **2024 Breakthrough Prizes in the Life Sciences** category recognised groundbreaking research set to change the lives of those suffering from three **Rare Diseases**: **Parkinson's disease**, **Cystic fibrosis** and **Cancer**.

- Awards were also given in the categories of **Fundamental Physics** and **Mathematics**.

What are Rare Diseases?

➤ About:

- A rare disease is a **health condition of low prevalence that affects a small number of people** compared with other prevalent diseases in the general population.
- There is **no universally accepted definition of rare diseases** and the definitions usually vary across different countries.

➤ Prevalence:

- There are about **7,000 known rare diseases**, affecting around 8% of the world's population" and "75% of rare disease patients are children.
- **India** has close to **50-100 million people affected by rare diseases or disorders**.

➤ Examples:

- **Lysosomal Storage Disorders (LSD)**
- **Cystic fibrosis**
- **Haemophilia**
- **Parkinson's Disease**

Sensor for Formalin Detection in Fish

Why in News?

A team of researchers from Guwahati University, Assam, has developed a new sensor made of a **metal oxide-reduced graphene oxide(metal oxide- rGO) composite** that can detect **formalin adulteration in fishes** at room temperature in a non-invasive way.

Note:

- **Food adulteration** is the practice of **adding illegal or harmful substances to food** to make it appear **more appealing or to increase its shelf life**.
- Formaldehyde is a **colourless, pungent gas** that is used in a variety of industrial processes, including as a **preservative in some foods**, commonly in fish in developing countries.
 - However, the use of formaldehyde in food is illegal in many countries, as it is a known **carcinogen**.

What are the Key Facts of the Metal oxide- rGO Sensor?

➤ About:

- The sensor used Graphene(material that is extracted from graphite) oxide (GO) and tin oxide-reduced graphene oxide composite (rGO-SnO₂) to detect formalin in adulterated fishes.
- The sensor is **low-cost, non-invasive, and selective**, and can be used to prevent food adulteration and protect consumers.

Note:

➤ **Need:**

- Traditional formalin sensors for fish are **either expensive electrochemical-based** or less costly but **invasive colorimetric-based** methods.
 - Both face issues of low-level and selective detection.

➤ **Working Procedure:**

- GO, the oxidized form of graphene, initially poses a challenge due to low **electrical conductivity**.
 - To overcome GO's limitations, scientists developed a composite called **tin oxide-reduced graphene oxide (rGO-SnO₂)** with enhanced properties.
- The reduced graphene oxide provides **high solution processability** and ease of chemical modification with other materials, while the tin oxide offers **high stability and sensitivity** to low concentrations of formaldehyde.
- The sensor, crafted from tin oxide (SnO₂) decorated Reduced graphene oxide (rGO), demonstrates effective **sensing of formaldehyde vapour at room temperature**.
 - rGO is known for **detecting toxic gasses**, while SnO₂ **excels in formaldehyde detection**. The combination maximizes their strengths.
- The **designing of the prototype is in process in the lab** which may be **regarded as a breakthrough** in the field of food adulteration.

Dark Energy

Why in News?

The universe's energy makeup involves a **delicate balance** between different forms of matter and radiation.

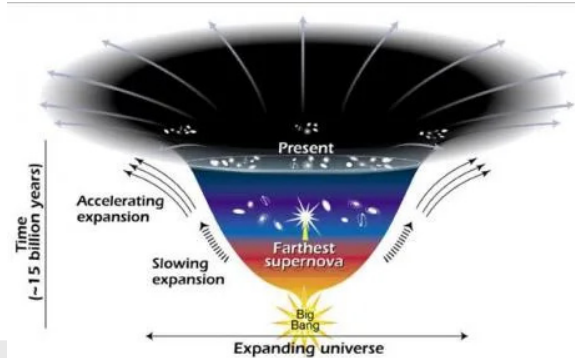
- **Dark energy**, constituting a significant **68%**, plays a dominant role in dictating the **universe's expansion**.

What is Dark Energy in the Universe?

➤ **About:**

- **Dark energy** is a mysterious and elusive form of energy that makes up a significant portion of the **total energy content of the universe**.
- It is thought to be responsible for the **observed accelerated expansion** of the cosmos.

- Roughly **68%** of the universe is **dark energy** and **dark matter** makes up about **27%**.
 - The rest of everything on Earth, everything ever observed with all of our instruments, all normal matter adds up to less than **5%** of the universe.



Pantoea Tagorei

Why in News?

Researchers at **Visva-Bharati University** have discovered a **new species of bacteria** that could transform agricultural practices. They named it **Pantoea Tagorei** after the famous Nobel laureate **Rabindranath Tagore**.

What are the Key Facts About Pantoea Tagorei?

- Pantoea Tagorei bacteria belong to the **genus Pantoea**, which is part of the **Enterobacteriaceae family**.
 - Pantoea bacteria can be isolated from various environments including Water, Soil, Humans, Animals, and Plants.
- It is described as a **plant growth-promoting bacteria**, Pantoea Tagorei has demonstrated remarkable capabilities in **boosting the cultivation of crops** like paddy, pea, and chilli.
- The bacteria efficiently extracts potassium from the soil, enhancing plant growth. Additionally, it facilitates the **solubilization of both potassium and phosphorus, nitrogen fixation**, and enhances overall nutrient availability for plants.

Note:

Magnetars and Related AstroSat's Discovery

Why in News?

AstroSat, India's first multi-wavelength space-based observatory, has detected bright sub-second X-ray bursts from a new and unique **neutron star** with an ultrahigh magnetic field (magnetar).

- Scientists performed the timing and spectral analysis of this magnetar using two instruments onboard AstroSat: the **Large Area X-Ray Proportional Counter (LAXPC)** and **Soft X-Ray telescope (SXT)**.

What are Magnetars?

- **Magnetars** are neutron stars having an ultrahigh magnetic field that are much **stronger than the terrestrial magnetic field** (over one quadrillion times stronger than the magnetic field of Earth).
 - High-energy electromagnetic radiation emitted by magnetars results from the decay of their powerful magnetic fields.
- They display strong **temporal variability**, typically including a slow rotation, a **rapid spin-down**, **bright but short bursts** going on up to months-long outbursts.
- One such magnetar, called **SGR J1830-0645**, was discovered in **October 2020** by **NASA's Swift spacecraft**.
 - It is relatively young (about 24,000 years) and an isolated neutron star.

Note: Note: A neutron star is a dense and compact stellar object that forms from the remnants of a massive star's core after a supernova explosion. These stars are among the densest objects known in the universe, packing an immense mass into a relatively small size.

- The **discovery of pulsars in 1967** provided the first evidence of the existence of neutron stars. Pulsars are neutron stars that emit pulses of radiation once per rotation

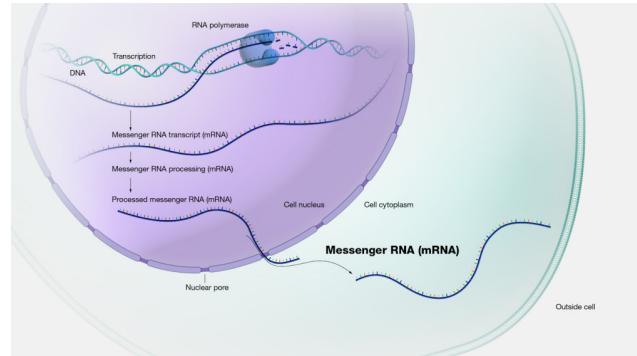
mRNA-Based Medicines

Why in News?

The cells in our body **create mRNAs that serve as instructions** to make specific proteins we need to function.

Researchers can create new mRNAs to correct those instructions when they aren't working.

- While most scientists **studying mRNAs are not creating new drugs**, this fundamental understanding of how mRNA works **laid the foundation for other scientists to create effective mRNA medicines like Covid-19 vaccines**.



What does mRNA do?

- **mRNA (Messenger RNA)** carries important messages from our **DNA (Deoxyribonucleic acid)**, to the cell's machinery, telling it how to make specific proteins.
 - Imagine DNA as a library of **cookbooks filled with recipes (genes) to create different proteins**.
- Our bodies need around **100,000 proteins to work properly**, helping with tasks like breaking down food and performing vital chemical reactions.
- When a cell needs a specific protein, it doesn't directly read the recipe from DNA. Instead, **it makes a copy called mRNA**.
- This mRNA serves as a messenger, carrying the protein-making instructions. It's made up of **four building blocks (A, U, C, G)**, forming words of only three letters.
- By reading this mRNA recipe, **cells easily know how to create the required protein**.
- Cells are quite good at recognizing, using, and then getting rid of mRNA once it's done its job.
- However, changes or mistakes in the DNA's recipe book (mutations) can mess **up the mRNA instructions, leading to errors in making essential proteins**, which can cause diseases.

Note:

Kakrapar Atomic Power Project

Why in News?

Recently, the fourth unit of **Kakrapar Atomic Power Station (KAPS)**, Gujarat has achieved its **first Criticality** — the beginning of the regulated fission reaction — paving the way for its eventual transition to generating power for commercial use.

What is Criticality?

- Criticality is the **first step towards power production**. A nuclear reactor is said to be critical when the nuclear fuel inside a reactor sustains a fission chain reaction.
- Each fission reaction releases a sufficient number of neutrons to **sustain a series of reactions**. Heat is produced in the event, which is used to generate steam that spins a turbine to create electricity.
 - **Fission is a process** in which the nucleus of an atom splits into two or more smaller nuclei, and some byproducts.
 - When the nucleus splits, the **kinetic energy of the fission fragments (primary nuclei) is transferred** to other atoms in the fuel as heat energy, which is eventually used to produce steam to drive the turbines.

Ketamine Drug

Why in News?

In recent times, drug **Ketamine** has surged into the spotlight, triggering debates and discussions surrounding its application, effects, and safety concerns.

What are the Key Facts about Ketamine?

- **About:**
 - Ketamine is a dissociative anaesthetic. Doctors use it to **induce general anesthesia** that does not require muscle relaxation.
 - General anesthesia denotes a **sleep-like state**, while dissociative refers to the state of **detachment from the body and the outside world**.

- Developed as an **animal anesthetic in the 1960s**, later approved by the United States Food and Drug Administration (FDA) for **human use**.
- Recently used to **treat depression and mental illnesses**, also used recreationally.
 - Recreational use **involves snorting, injecting, or smoking**.
- Administered through intravenous (IV), nasal spray, or tablet for mental illness treatment.

➤ **Effects of Ketamine:**

- Ketamine works by blocking the **N-methyl-D-aspartate (NMDA) receptor** in the brain.
 - This receptor is involved in the **transmission of pain signals and in the regulation of mood**. By blocking the NMDA receptor, ketamine can produce analgesia (pain relief) and euphoria.
- It can create pleasant visualizations and a sense of detachment
- Ketamine can produce **hallucinations** similarly to other drugs such as Lysergic acid diethylamide (LSD) and angel dust.
 - Hallucinations are distorted perceptions of sounds and sights.

Global Partnership on Artificial Intelligence (GPAI) Summit

Why in News?

The Prime Minister of India inaugurated the **Global Partnership on Artificial Intelligence (GPAI) Summit**.

- **India is the lead chair of GPAI in 2024**. The GPAI is an alliance of 28 countries; the European Union adopted the 'New Delhi Declaration' of the GPAI.

What are the Key Highlights of the GPAI Summit?

- The Prime Minister of India discussed the national AI portal, highlighting the **AIRAWAT** initiative and raising concerns over the potential misuse of **deep fake technology**.
- **YUVAi** was prominently featured at the **GPAI Summit**, and the winners of the **YUVAi** initiative and start-ups showcased their **AI models and solutions**.

Note:

- The Prime Minister suggested using AI to make digital services available in **local languages** to increase **digital inclusion**.

What is the YUVA Ai initiative?

Why in News?

The Prime Minister of India inaugurated the Global Partnership on Artificial Intelligence (GPAI) Summit.

India is the lead chair of GPAI in 2024. The GPAI is an alliance of 28 countries; the European Union adopted the 'New Delhi Declaration' of the GPAI.

➤ About:

- The **National e-Governance Division (NeGD)** partnered with **Intel India** to launch '**YUVAi- Youth for Unnati and Vikas with AI**' program.

➤ Aims:

- To foster a deeper understanding of **AI**, equip school students from **classes 8 to 12** across the nation with relevant mindset and skill sets, and empower them to become human-centric designers and users of AI.
- The program offers an applied learning experience for students to understand and identify how **AI technology** can be used to tackle critical problems and lead to inclusive development of the nation.
- The program will be ongoing throughout the year to give a maximum number of students a chance to empower themselves to be future-ready.

Heat-Tolerant Covid-19 Vaccine by IISc

Why in News?

A heat-tolerant vaccine developed by the **Indian Institute of Science (IISc)** researchers is **said to be** effective against all **current strains of SARS-CoV-2** besides having the potential to be quickly adapted for future variants as well.

Note: A **receptor-binding domain** is a key part of a virus located on its 'spike' domain that allows it to dock to body receptors to gain entry into cells and lead to infection.

- The **spike (S) protein of SARS-CoV-2**, which plays a key role in the receptor recognition and cell membrane fusion process, is composed of two subunits, **S1 and S2**.

ISRO Tests Polymer Electrolyte Membrane Fuel Cell

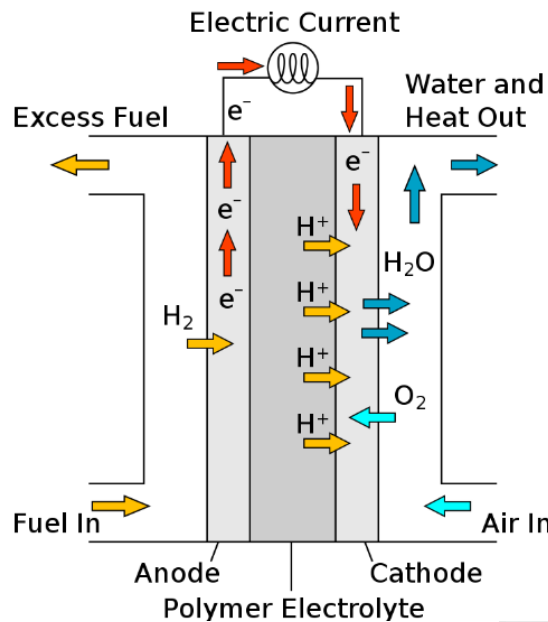
Why in News?

The **Indian Space Research Organisation (ISRO)** successfully tested a **100 W class Polymer Electrolyte Membrane Fuel Cell (PEMFC)** based Power System aboard the orbital platform, **POEM3**.

What is a Fuel Cell?

- **About:** A **fuel cell** is an **electrochemical device** that converts the chemical energy of a **fuel (like hydrogen) and an oxidant (like oxygen)** directly into electricity.
 - Unlike batteries, which store chemical energy that gets converted to electrical energy, fuel cells continuously **produce electricity as long as they are supplied with fuel and oxidant**.
- **Major Types of Fuel Cells:**
 - **Polymer Electrolyte Membrane Fuel Cells:** They use a **thin, solid polymer membrane as the electrolyte** and are well-suited for portable applications.
 - **Solid Oxide Fuel Cells (SOFCs):** SOFCs use a **ceramic electrolyte** that can operate at high temperatures. They are highly efficient but are more expensive and complex than PEMFCs.
 - **Alkaline Fuel Cells (AFCs):** AFCs use a **liquid electrolyte made of potassium hydroxide (KOH)**. They are less efficient than PEMFCs and SOFCs but are less expensive and can be more tolerant of impurities in the fuel.

Note:



➤ Applications of Fuel Cells:

- **Transportation:** Fuel cells can be used to power **electric vehicles, boats, and even airplanes.**
 - Fuel cells can also power space missions, providing electrical power for spacecraft, and a dependable energy source for long-duration missions.
 - Highly efficient with **zero emissions**, making them ideal for space missions
- **Portable Power:** Fuel cells can be used to power laptop computers, cell phones, and other portable devices.
- **Stationary Power:** Fuel cells can be used to power homes, businesses, and even entire cities.

Counter-Drone Technology and UAV Development

Why in News?

The **Defence Research and Development Organisation (DRDO)** has made substantial strides in developing a **comprehensive counter-drone system**, as well as focusing on the advancement of **high-endurance Unmanned Aerial Vehicles (UAVs)**.

What are the Recent Developments in Counter-Drone Technology and UAV Development?

➤ Counter-Drone Technology Development:

- DRDO has developed a comprehensive anti-drone system encompassing **detection, identification, and neutralization of drones.**
 - The technology is capable of **countering attacks, soft kill and hard kill of all types of drones**, including micro drones.
- Also, the technology has been transferred to private companies like **BEL, L&T, and Icom** for mass production

➤ UAV Development:

- **Tapas MALE UAV:** The **Tapas Medium Altitude Long Endurance (MALE) UAV** developed for **Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR) applications** is in an advanced stage of developmental trials.
 - **Lithium Ion-based battery** with indigenous battery management system has been developed by the DRDO in association with a private vendor and is **being used on Tapas UAV.**

What is the Defence Research and Development Organization?

- **About:** DRDO is the **R&D wing of the Ministry of Defence, Govt of India**, with a vision to empower India with **cutting-edge defense technologies and a mission to achieve self-reliance in critical defense technologies.**
 - **Core Principle:** "**Balasya Mulam Vigyanam**" (Science is the source of strength)
- **Foundation:** Established in **1958** by amalgamating existing establishments from the **Indian Army and Directorate of Technical Development & Production.**
- **Significant Contributions:** Developed strategic systems and platforms like **Agni and Prithvi series of missiles, Tejas (Light Combat Aircraft), Pinaka (Multi-barrel Rocket Launcher), Akash (Air Defence System), radars, and electronic warfare systems.**

Antimicrobial Resistance

Why in News?

Recently, a survey conducted by the **National Centre for Disease Control (NCDC)** highlighted several key findings regarding the prescription and use of antibiotics

Note:

in hospitals amidst growing concerns about **Antimicrobial Resistance (AMR)**.

What is Antimicrobial Resistance (AMR)?

➤ About:

- Antimicrobial resistance is the **resistance acquired by any microorganism (bacteria, viruses, fungi, parasites, etc.)** against antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics) that are used to treat infections.
 - As a result, standard treatments become ineffective, infections persist, and may spread to others.
- It is a **natural phenomenon** as bacteria evolve, making drugs used to treat infections less effective.
- Microorganisms that develop antimicrobial resistance are sometimes referred to as “**superbugs**”.
 - The **World Health Organization (WHO)** has identified AMR as one of the top ten threats to global health.

GSAT-20 (GSAT-N2) Aboard SpaceX's Falcon-9

Why in News?

The commercial arm of the **Indian Space Research Organisation (ISRO)**, **NewSpace India Limited (NSIL)** is set to launch **GSAT-20 (GSAT-N2)**, aboard **SpaceX's Falcon-9** in 2024.

- Falcon 9 is the world's first orbital class **reusable, two-stage rocket** designed and manufactured by **SpaceX** for the reliable and safe transport of people and payloads into Earth orbit and beyond.

What is GSAT-20?

- GSAT-20 is a **high throughput Ka-band satellite** that provides **high-speed broadband internet connectivity**, digital video transmission, and audio transmission.
 - It is being launched to address the growing broadband communication needs of India. It is designed to provide comprehensive coverage across India, including remote regions like **Andaman and Nicobar Islands** and **Lakshadweep Islands**.
- This satellite offers an impressive **HTS (High Throughput Satellite) capacity** of nearly 48Gbps. Notably, it

comprises **32 beams specifically designed to meet the demanding service** needs of underserved areas, aiming to bridge the connectivity gap.

Note: The Ka-band refers to radio frequencies ranging from **27 to 40 GHz**. It allows high-speed satellite data transfers with wide coverage through focused spot beams.

What is NewSpace India Limited (NSIL)?

- NSIL, incorporated on 6th March **2019 (under the Companies Act, 2013)**, is a wholly owned **Government of India company**, under the administrative control of **Department of Space (DOS)**.
 - Its primary responsibility is **enabling Indian industries to take up high technology space related activities** and is also responsible for promotion and commercial exploitation of the products and services emanating from the Indian space programme.

India to Join SKAO as a Full Member

Why in News?

India will also be part of the **world's largest radio telescope project** called the **Square Kilometre Array Observatory (SKAO)**.

- Countries have to **sign, and ratify, the SKAO convention** to formally become members. The **Government of India's** approval for joining the project, with a financial sanction of Rs **1,250 crore**, is the first step towards the ratification.

What is the SKAO?

- **About:** SKAO is an intergovernmental organization that aims to build and operate **cutting-edge radio telescopes**. Its global headquarters is located in the **Jodrell Bank Observatory, United Kingdom**.
 - The project will not have a single telescope but an **array of thousands of antennas**, to be installed in **remote radio-quiet locations in South Africa and Australia**, that will operate as one large unit meant to observe and study celestial phenomena.
 - SKAO objectives also include study of **gravitational waves**.

Note:

- Some of the countries taking part in building the SKA include the **UK, Australia, South Africa, Canada, China, France, India, Italy and Germany.**

What is a Radio Telescope?

- **About:** A **radio telescope** is a specialized type of **antenna and receiver system** used to detect and collect radio waves emitted by celestial objects.
 - Radio waves are **EM (Electromagnetic)** waves that have wavelengths between **1 millimeter and 100 kilometers.**
 - Unlike optical telescopes, **radio telescopes can be used in the daytime as well as at night.**
- **Applications:** Radio telescopes are used to study a wide range of astronomical phenomena, including:
 - The formation and evolution of stars and galaxies
 - Black holes and other active galactic nuclei
 - The interstellar medium
 - Planets and moons in our solar system
 - The search for extraterrestrial life
- **Major Radio Telescopes:**
 - **Giant Metrewave Radio Telescope (India)**
 - In **June 2023**, GMRT (near Pune) played a crucial role in the **first-ever detection of nano-hertz gravitational waves**, showcasing its vital role in cutting-edge astronomical research.
 - **SARAS 3 (India)**
 - **Atacama Large Millimetre/submillimetre Array (ALMA)** (Atacama Desert, Chile)
 - Five-hundred-metre Aperture Spherical Telescope (FAST) (China)

What are Gravitational Waves?

- **About:** **Gravitational waves** are ripples or vibrations in the very fabric of spacetime. For instance, when a pebble is dropped in a pond, the resulting ripples are analogous to gravitational waves, but instead of water, **they propagate through the fundamental structure of the universe.**
 - In 1916, Albert Einstein forecasted the presence of gravitational waves within his theory of general relativity.

- **Prominence:** Gravitational wave research, as evidenced by the **2017 Nobel Prize awarded for the first detection using Laser Interferometer Gravitational Wave Observatory (LIGO)**, holds immense potential for scientific breakthroughs.
 - Recently, India gave its go-ahead to construct the third node of the LIGO in **Hingoli district of Maharashtra.**

Space Missions in 2024

Why in News?

The year 2023 proved to be an **important one for space missions**, with **NASA's OSIRIS-REx mission** returning a **sample from an asteroid** and **India's Chandrayaan-3 mission**, and 2024 is shaping up to be **another exciting year for space exploration.**

- Several new missions under **NASA's Artemis plan** and Commercial Lunar Payload Services initiative will target the moon.

What are the Space Missions Planned for 2024?

- **Europa Clipper:**
 - NASA will launch **Europa Clipper**, which will explore one of Jupiter's largest moons, Europa.
 - Europa is **slightly smaller than the earth's moon**, with a surface made of ice. Beneath its icy shell, Europa likely harbours a saltwater ocean, which scientists expect contains over twice as **much water as all the oceans here on Earth combined.**
 - With Europa Clipper, scientists want to **investigate whether Europa's ocean** could be a suitable habitat for extraterrestrial life.
 - The mission plans to do this by **flying past Europa nearly 50 times** to study the moon's icy shell, its surface's geology and its subsurface ocean.
 - The mission will also **look for active geysers spewing out from Europa.**
- **Artemis II launch:**
 - Artemis II, part of NASA's Artemis program, is a **crewed lunar mission set to orbit the Moon, marking humanity's return since 1972.**
 - The Artemis programme is named after **Apollo's twin sister in Greek mythology.**

Note:

- Planned for a 10-day journey, it aims to validate systems for sustained lunar presence.
- This pivotal mission, including the **first woman and person of color**, follows Artemis I's success, testing an uncrewed lunar capsule in late 2022.
 - Artemis II underscores NASA's **commitment to lunar exploration**, preparing for extended space habitation, and laying the groundwork for future missions to Mars.
- **VIPER to Search for Water on the Moon:**
 - VIPER (Volatiles Investigating Polar Exploration Rover), is a **robot the size of a golf cart that NASA** will use to explore the moon's south pole in late 2024.
 - This robotic **mission is designed to search for volatiles**, which are molecules that easily vaporize, like water and carbon dioxide, at lunar temperatures.
 - These materials could provide resources for future human exploration on the moon.
 - The VIPER robot will **rely on batteries, heat pipes and radiators throughout its 100-day mission**, as it navigates everything from the extreme heat of lunar daylight – when temperatures can reach 224°F (107 °C) – to the moon's frigid shadowed regions that can reach as low as -240°C.
- **Lunar Trailblazer and PRIME-1 Missions:**
 - NASA has **recently invested in a class of small, low-cost planetary** missions called **SIMPLEX**, which stands for **Small, Innovative Missions for Planetary Exploration**.
 - These missions save **costs by tagging along on other launches** as what is called a rideshare, or secondary payload.
 - One example is the **Lunar Trailblazer**. Like VIPER, Lunar Trailblazer will look for water on the moon.
 - But while VIPER will land on the moon's surface, studying a specific area near the south pole in detail.
 - Lunar Trailblazer will orbit the moon, measuring the temperature of the surface and mapping out the locations of water molecules across the globe.
 - Lunar Trailblazer's launch timing depends on **the primary payload's launch readiness**.
 - The PRIME-1 mission, scheduled for a mid-2024 launch, is Lunar Trailblazer's ride. PRIME-1 will

drill into the moon – it's a test run for the kind of drill that VIPER will use.

➤ **JAXA's Martian Moon eXploration Mission:**

- The JAXA MMX mission concept to study Mars' moons - Phobos and Deimos.
- The Japanese Aerospace Exploration Agency, or JAXA, has a robotic mission in development called the Martian Moon eXploration, or MMX, planned for launch around September 2024.
 - The mission's **main science objective is to determine the origin of Mars' moons**.
- Scientists aren't sure whether Phobos and Deimos are former asteroids that Mars captured into orbit with its gravity or if they formed out of debris that was already in orbit around Mars.
- The spacecraft will **spend three years around Mars** conducting science operations to observe Phobos and Deimos. MMX will also land on Phobos' surface and collect a sample before returning to Earth.

➤ **ESA's Hera Mission:**

- It is a **mission by the European Space Agency** to return to the Didymos-Dimorphos asteroid system that **NASA's DART mission** visited in 2022.
 - But DART didn't just visit these asteroids, it collided with one of them to test a planetary defence technique called "**kinetic impact**".
 - DART hit Dimorphos with such force that it actually changed its orbit.
- The kinetic impact technique smashes something into an object in order to alter its path. This could prove useful if humanity ever finds a potentially hazardous object on a collision course with Earth and needs to redirect it.
- Hera will launch in October 2024, making its way in late 2026 to Didymos and Dimorphos, where it will study the physical properties of the asteroids.

Efficacy of Liquid Nano Urea

Why in News?

A two-year field experiment on the efficacy of **Liquid Nano Urea** by scientists from **Punjab Agricultural University (PAU)** has found a **substantial decrease in rice and wheat yields** when compared to conventional nitrogen (N) fertiliser application.

Note:

What are the Key Findings about the Efficacy of Liquid Nano Urea?

- **Yield Reduction:**
 - There is a significant decrease in crop yields when nano urea was used compared to conventional nitrogen fertilizers.
 - Specifically, there was a **21.6% decrease in wheat yield and a 13% decrease** in rice yield.
- **Grain Nitrogen Content:**
 - The application of nano urea **resulted in a decline in grain nitrogen content** in both rice and wheat crops.
 - There is a 17 and 11.5% **decrease in grain N content of rice** and wheat, respectively.
 - The lowered grain nitrogen content implies reduced protein levels in the harvested crops.
 - This is a concern in a country like India, where rice and wheat are staple foods providing protein and carbohydrates. Low protein content could impact the population's protein energy requirements.
- **Cost Considerations:**
 - The cost of nano urea formulation was 10 times higher than that of granular urea and will add to the cost of cultivation for farmers.
- **Crop Biomass and Root Volume:**
 - The application of nano urea led to a **reduction in above-ground biomass** and root volume. This decrease in root volume resulted in decreased root-surface area, **impacting nutrient uptake processes by the roots.**

What is Liquid Nano Urea?

- **About:**
 - It is urea in the **form of a nanoparticle**. It is a **nutrient (liquid) to provide nitrogen to plants** as an alternative to the conventional urea.
 - Urea is a chemical nitrogen fertilizer, white in colour, which artificially provides nitrogen, a major nutrient required by plants.
 - It is developed to **replace conventional urea** and it can **curtail the requirement** of the same by at **least 50%**.
 - It contains **40,000 mg/L of nitrogen in a 500 ml bottle** which is equivalent to the impact of nitrogen nutrient provided by one bag of conventional urea.

- Nano liquid urea was launched in June 2021 by the **Indian Farmers and Fertiliser Cooperative (IFFCO)**.

- **Developed At:**

- It has been indigenously developed at IFFCO-**Nano Biotechnology Research Centre, Kalol, Gujrat in line with Atmanirbhar Bharat** and Atmanirbhar Krishi.

- India is dependent on imports to meet its **urea requirements**.

- **Application:**

- This fertiliser is a **foliar spray**, meaning it should **only be used once leaves arrive** on the crops.

Lithium-Deal with Argentina

Why in News?

The **Ministry of Mines**, Government of India through the **state-owned Khanij Bidesh India Ltd (KABIL)**, has entered into a draft exploration and development agreement with **Argentinan miner CAMYEN** for possible acquisition and development of **five-odd lithium blocks**.

What is Lithium?

- **About:**

- Lithium is an alkali mineral, also called '**white gold**'. It is soft, silvery-white metal, the lightest metal of the periodic table.

- **Major Properties:**

- High Reactivity
- Low Density
- Excellent Electrochemical Properties

- **Occurrence and Top Producers:**

- Lithium is found naturally in various minerals, including **spodumene, petalite, and lepidolite**.
 - It is extracted from these minerals and refined into lithium metal or its compounds.
- The top producers of lithium are **Australia, Chile, China, and Argentina**.
 - In 2022, **Australia** was the world leader in terms of lithium mine production. **Chile and China** ranked second and third.
- Recently, a massive lithium deposit beneath **California's Salton Sea (US)**, holding an estimated **18 million tons of lithium**, was discovered.

Note:

Note: Lithium triangle made up of **Argentina, Chile, and Bolivia**—contain roughly half the world's known lithium.

Pegasus Spyware

Why in News?

The **Pegasus spyware** has once again ignited a debate on **privacy and security**. Recent reports by **Amnesty International** point to its utilization in targeting the **phones of two prominent Indian journalists**, prompting inquiries into potential government involvement.

What is Pegasus Spyware?

➤ About:

- Pegasus spyware is a **highly invasive mobile surveillance tool** that can secretly infiltrate and monitor smartphones, collecting data and information from various apps and sources.
- It was developed by the **Israeli cyber-intelligence firm NSO Group**, which claims to sell it only to government agencies for fighting crime and terrorism.
 - NSO emphasizes mechanisms in place to avoid targeting journalists, lawyers, and human rights defenders not involved in terror or serious crimes.

➤ Operating Procedure:

- Pegasus uses **“zero-click”** methods to infect devices; it is a malicious software that allows spyware to be installed on a device **without the device owner's consent**.
 - The spyware doesn't necessitate any **user actions for installation**, distinguishing it from **regular apps that require explicit user confirmation**.
 - It can exploit vulnerabilities in apps such as WhatsApp, iMessage, or FaceTime, and send a message or a call that triggers the installation of the spyware, even if the user does not open or answer it.
- Pegasus is a spyware that can **exploit zero-day vulnerabilities** to deploy spyware on Apple products.
 - A zero-day vulnerability is an **undiscovered flaw or bug** in an operating system that the mobile phone's manufacturer does not yet know about and so has **not been able to fix**.

X-ray Polarimeter Satellite: ISRO

Why in News?

Recently, the **Indian Space Research Organisation (ISRO)** has launched its **first X-ray Polarimeter Satellite (XpoSat)** to study **X-ray polarisation and its cosmic sources**, like **Black holes, Neutron stars, and Magnetars**.

- The mission is propelled by the PSLV-C58 rocket in **Low Earth Orbit**.

What is an X-ray Polarimeter Satellite (XpoSat)?

➤ Purpose:

- XPoSat is designed to study X-ray polarization in the medium X-ray band, offering insights into celestial sources' radiation mechanisms and geometry.
- This study is crucial for **understanding the physics behind these celestial bodies**.

➤ Payloads:

- The satellite carries two main payloads, **POLIX (Polarimeter Instrument in X-rays)** and **XSPECT (X-ray Spectroscopy and Timing)**.
- POLIX will observe **about 40 bright astronomical sources**, while XSPECT will study the electromagnetic spectrum generated by different matter.

➤ Development:

- Entirely **built by two Bengaluru-based institutes**—ISRO's UR Rao Satellite Centre and Raman Research Institute—XPoSat's development began in 2008, with a formal agreement signed with ISRO in 2015.

➤ Global Context:

- XPoSat is **only the world's second mission dedicated to X-ray polarization** in the medium X-ray band. **NASA's Imaging X-ray Polarimetry Explorer (IXPE)**, launched in 2021, was the first such mission by a space agency.

➤ National Contribution:

- XPoSat will be India's third space-based observatory, following the recently launched solar mission **Aditya-L1** and **AstroSat**, which was launched in 2015. Its launch is seen as a significant stride for Indian astronomy and space research.

Note:

High Altitude Pseudo-Satellite (HAPS)

Why in News?

The **Council of Scientific and Industrial Research (CSIR) - National Aerospace Laboratories (NAL)** recently conducted successful tests on a **High Altitude Pseudo-Satellite (HAPS)**, marking a significant milestone in **unmanned aerial vehicle (UAV) technology**.

What is High Altitude Pseudo-Satellite (HAPS)?

➤ About:

- HAPS is a solar-powered UAV. It can generate **solar energy** and remain in the air for months or years.
 - HAPS operates in the **stratosphere** (which extends from 6-50 km above the earth's surface), flying at altitudes of **18-20 km**, nearly double the heights of commercial aeroplanes. This altitude allows them to provide **surveillance capabilities akin to satellites**.
- HAPS is designed for persistent surveillance, communications, and specialist science missions.
- HAPS is a **still-developing technology**, and the successful test flight puts India among a very small group of countries currently experimenting with this technology.

➤ Need:

- The need for development of HAPS arose from the desire to have continuous surveillance of border areas to detect changes or movements, particularly in the wake of the **Doklam standoff in 2017**.
- Previous **limitations with battery-powered UAVs** and satellites led to the development of solar-powered UAVs.
- The **cost** of operating HAPS is significantly **lower than traditional satellites** as it doesn't require rocket launches.

CAR-T Cell Therapy

Why in News?

Following **India's approval of CAR-T cell therapy**, a pioneering treatment for cancer, a patient recently underwent the procedure, achieving freedom from cancer

cells, marking a significant advancement in cancer treatment accessibility in the country.

What is CAR-T Cell Therapy?

- **About:** CAR-T cell therapy, also known as **chimeric antigen receptor T-cell therapy**, is a type of immunotherapy that uses a patient's own immune system to fight cancer.
 - CAR T-cell therapy has been approved for **leukaemias** (cancers arising from the cells that produce white blood cells) and **lymphomas** (arising from the lymphatic system).
 - CAR-T cell therapies, often referred to as **'living drugs'**.
- **Procedure:** It is a complex and personalised treatment process that involves:
 - **Collecting T cells:** T cells, a type of **white blood cell** that helps fight infection, are extracted from the patient's blood through a process known as **Apheresis**.
 - **Genetic Engineering:** In the laboratory, the T cells are genetically modified to express a special protein called a **chimeric antigen receptor (CAR)** on their surface.
 - This CAR is designed to recognize and bind to a specific **antigen (marker)** found on cancer cells.
 - **Expansion:** The engineered T cells are multiplied in large numbers in the lab.
 - **Infusion:** The expanded **CAR-T cells** are then infused back into the patient's bloodstream, where they can identify and attack cancer cells that express the targeted antigen.

India's Ambitious Push for Deep Tech

Why in News?

During her **Interim Budget** address, the Finance Minister unveiled a **Rs 1 lakh crore fund** aimed at offering **long-term, low-cost, or zero-interest loans** for **research and development** initiatives.

- She also pledged to introduce a new program to enhance **deep-tech capabilities** in **defense**, hinting at a **broader policy** to support deep-tech startups across various sectors, expected later this year.

Note:

What is Deep Tech?

- **About:**
 - **Deep tech** or deep technology refers to a class of startup businesses that develop **new offerings** based on tangible engineering innovation or scientific discoveries and advances.
 - Deep tech fields like **Artificial Intelligence**, advanced materials, **blockchain**, biotechnology, **robotics**, **drones**, photonics, and **quantum computing** are moving more and more quickly from early research to market applications.
- **Characteristics of Deep Tech:**
 - **Impact:** The deep tech innovations are **very radical** and disrupt an existing market or develop a new one. Innovations based on deep tech often change lives, economies, and societies.
 - **Time & Scale:** The time required for deep technology to develop the technology and reach market-ready maturity is way more than shallow technology development (like mobile apps and websites).
 - **Capital:** Deep tech often requires a lot of early-stage funding for research and development, prototyping, validating hypothesis, and technology development.

Typbar Typhoid Vaccine

Why in News?

Recently, phase-3 trial conducted in **Malawi, Africa**, a region endemic for **typhoid fever**, has demonstrated the long-term efficacy of **Bharat Biotech's** Typhoid conjugate vaccine (TCV), **Typbar**. The efficacy of the vaccine was seen in children of **all age groups studied**.

- Typbar TCV is the **world's first clinically proven conjugate Typhoid vaccine**.

Note:

- A conjugate vaccine is a type of vaccine that **combines a weak antigen with a strong antigen**, also known as a **carrier protein**. This combination helps the immune system to develop a stronger and more effective immune response to the weak antigen.
- This stronger immune response helps to protect against infection from the pathogen that the weak antigen originated from.

What is Typhoid?

- **About:** Typhoid fever is a life-threatening infection caused by the **bacterium Salmonella Typhi**. It is usually spread through contaminated food or water.
 - It is transmitted by the **faecal-oral route**, through ingestion of contaminated food or water.
 - Once the bacteria is ingested, it multiplies and spreads into the bloodstream.
 - Urbanisation and climate change have the potential to increase the global burden of typhoid.
- **Symptoms:** It encompasses **fever, fatigue, gastrointestinal problems**, headache, and occasionally a rash.
 - Severe cases can result in complications or death, confirmed through blood testing.
- **Treatment:** **Antibiotics** are the mainstay of treatment, but **increasing resistance to antibiotic treatment** is making it easier for typhoid to spread in communities that lack access to safe drinking water or adequate sanitation.
 - The existence of **resistant strains of bacteria** means antibiotics or drugs designed to kill them no longer work, allowing them to spread rapidly, posing a risk to public health.
- **Prevention:** Prevention strategies include **access to safe water, sanitation, and hygiene**.
 - WHO recommends integrating **typhoid conjugate vaccines** to routine childhood immunisation programmes in typhoid endemic countries.
 - **Gavi** supports vaccine implementation in eligible nations.
 - The **Vaccine Alliance (GAVI)** was set up as a **Global Health Partnership in 2000** with the goal of creating equal access to new and underused vaccines for children living in the world's poorest countries.
 - At the **Global Vaccines Summit** in June 2020, India pledged **USD 15 million** for Gavi's 2021–2025 programme.

Green Propulsion System

Why in News?

A **Green Propulsion System**, developed under the

Note:

Technology Development Fund (TDF) scheme of the **Defence Research and Development Organisation (DRDO)**, has successfully demonstrated in-orbit functionality on a payload launched by the **Polar Satellite Launch Vehicle (PSLV) - C58 Mission**.

- This is a major achievement for the Indian space sector, as it showcases the **potential of green and indigenous technologies** for enhancing the country's defence capabilities.

Note:

- The TDF is a flagship programme of the Ministry of Defence which is being executed by the DRDO under the **"Make in India" initiative** for funding **innovation in defence and aerospace**, especially to startups and MSMEs.

What is the Green Propulsion System?

- The Green Propulsion System was developed by a Bengaluru-based start-up Bellatrix Aerospace Pvt Ltd (Development Agency).
- This project uses a **1N Class Green Monopropellant** for altitude control and orbit keeping of microsatellites.
- The system consists of **indigenously-developed propellant**, fill and drain valves, latch valve, solenoid valve, catalyst bed, drive electronics, etc.
- This innovative technology has resulted in a **non-toxic and environment-friendly propulsion system** for low orbit space, unlike the conventional **hydrazine-based propulsion systems** that are hazardous and polluting.
 - The system is ideal for space missions with **high thrust requirements**.

Propulsion System:

- Propulsion means to **push forward or drive an object forward**. A propulsion system is a machine that produces thrust to push an object forward.
- A propellant is a substance that is expelled or expanded **to create thrust**. Propellants can be gases, liquids, or solids.
 - In rockets, propellants are **chemical mixtures that produce thrust**. They consist of fuel and an oxidizer.

- **The Indian Space Research Organisation (ISRO)** is developing green propellants for use in future rocket & satellite propulsion systems.
 - ISRO has made a beginning by developing an **eco-friendly solid propellant based on Glycidyl Azide Polymer (GAP)** as fuel and **Ammonium Di-Nitramide (ADN)** as oxidizer at the laboratory level, which will eliminate the emission of chlorinated exhaust products from rocket motors.

What is the PSLV-C58 Mission?

- ISRO's PSLV-C58 launched an **X-ray Polarimeter Satellite (XPOSAT)** into an Eastward low inclination orbit on 1st January 2024.
- XPoSat is the first dedicated scientific satellite from ISRO to carry out research in **space-based polarisation measurements of X-ray emission** from celestial sources.
 - This mission aims to investigate the polarization of intense X-ray sources.
 - **X-rays, with wavelengths of 0.01-10 nanometers**, are **electromagnetic radiation** characterized by perpendicular electric and magnetic fields.
 - Measuring X-ray polarization, aids astronomers in studying **magnetic field orientations and strengths in celestial bodies**, crucial for understanding pulsars, **black hole regions**, and other X-ray-emitting cosmic phenomena.

Nano DAP

Why in News?

Recently, the Finance Minister in the **Interim Budget 2024-25** has announced the expansion of the application of **Nano DAP (Di-Ammonium Phosphate)** as a **Fertilizer** on various crops in all agro-climatic zones.

- Nano fertilisers are **highly efficient types of fertilisers** that provide nutrients like nitrogen to crops through fine granules.

What is Nano DAP?

- **DAP (Di-Ammonium Phosphate):**
 - DAP is the second most commonly used fertilizer in India after urea.
 - DAP is a preferred fertilizer in India because it contains both **Nitrogen and Phosphorus** which are primary macro-nutrients and **part of 18 essential plant nutrients**.

Note:

- Fertilizer grade DAP **contains 18% Nitrogen and 46% Phosphorus**. It is manufactured by **reacting Ammonia with Phosphoric acid** under controlled conditions in fertilizer plants.
- **Nano DAP:**
 - **Nano DAP is a specialised form of DAP** designed with the goal of improving the fertiliser's effectiveness in promoting plant growth and development.
 - In 2023 **Indian Farmers Fertiliser Cooperative (IFFCO)** launched its Nano DAP, containing **8% Nitrogen and 16% Phosphorus by volume**.
 - Unlike conventional DAP, which comes in granular form, IFFCO's Nano DAP is in **liquid form**.

What is Nano Urea?

- **About:**
 - **Nano Urea** is urea in the form of a nanoparticle. It is a **nutrient (liquid)** to **provides nitrogen to plants as an alternative** to the conventional urea.
 - Urea is a chemical nitrogen fertiliser, white in colour, which artificially provides nitrogen, a major nutrient required by plants.
 - It is **developed to replace conventional urea** and it can curtail the requirement of the same by at least 50%.
 - It **contains 40,000 mg/L of nitrogen in a 500 ml bottle** which is **equivalent to** the impact of nitrogen nutrient provided by **one bag of conventional urea**.
- **Developed at:**
 - It has been indigenously developed at **Nano Biotechnology Research Centre, Kalol, Gujrat in line with Atmanirbhar Bharat** and Atmanirbhar Krishi.
 - India is dependent on imports to meet its **urea requirements**.
- **Objective:**
 - It is aimed at **reducing the unbalanced and indiscriminate use of conventional urea**, increasing crop productivity, and reducing soil, water, and air pollution.

Conserving Northern White Rhino Through Surrogacy

Why in News?

The **northern white rhino (NWR)** is one of the most

endangered animals on the planet, **with only two females left alive**. In a bid to rescue this species, scientists embarked on an ambitious project named **BioRescue in 2015**, employing reproductive technologies like **in-vitro fertilization (IVF)** and **stem cell techniques**.

- Recently, the international consortium, BioRescue, announced the **first-ever rhino pregnancy** through a lab-made embryo transferred to a **southern white rhino**.
- This endeavour represents a beacon of hope for the survival of the northern white rhino.

What are the Key Facts Regarding the Northern White Rhino?

- **About:**
 - The **NWR is a subspecies of the white rhino (Ceratotherium simum)**, which is native to **central and eastern Africa**.
 - White rhinos are the second largest land mammal after the elephant. They are known as the **square-lipped rhinoceros**, white rhinos have a square upper lip with almost no hair.
 - The **northern and southern white rhino are two genetically distinct subspecies** of the white rhino.
- **Current Status:**
 - The **IUCN Red List Status** of White Rhino is Near Threatened. The IUCN status of its subspecies is as follows:
 - Northern White Rhino: **Critically Endangered**.
 - Southern White Rhino: **Near Threatened**.
 - The NWR population has declined dramatically due to **poaching, habitat loss, civil war, and disease**.
 - In the 1960s, there were about 2,000 NWRs in the wild. By 2008, only four remained.
- The last male NWR, named Sudan, died in 2018, leaving only **two females, Najin and Fatu**, who live in a conservancy in Kenya.
 - The majority (98.8%) of the southern white rhinos occur in just four countries: South Africa, Namibia, Zimbabwe, and Kenya.
 - Southern white rhinos are around 18,000 animals that exist in protected areas and private game reserves.

Note:

Note:

- The **Indian rhinoceros** (also known as the greater one-horned rhinoceros) is different from the African rhinos and it is listed as **vulnerable on the IUCN Red List**.

End-to-end Encryption

Why in News?

End-to-end encryption is crucial for **cybersecurity**, ensuring secure transmission of sensitive data by **encoding** it exclusively for the sender and recipient.

- It protects against unauthorised access, theft, surveillance, and tampering, especially in the face of rising **cyber threats**.

What is Encryption?

- **About: Encryption** involves **transforming** consumable information into an unconsumable form according to various rules, fundamentally encompassing different rule sets.
 - In this context, the **key** is a set of data that enables a computer to **decrypt** encrypted text by understanding the specific rules used to encrypt it.
- **E2E Encryption: E2E encryption** involves securing specific points through which data is transmitted.
 - When communicating with a friend on a messaging app, messages are encrypted during transit to **prevent unauthorized access**, employing both encryption-in-transit, which secures messages during relay between the server and the user, and **end-to-end encryption (E2E)**, which ensures encryption both during **transit** and while stored on the server until the recipient decrypts it.

What is the Role of Hash Function?

- There are different symmetric and asymmetric schemes that encrypt messages in different ways, i.e. using different **hash functions**.
 - The role of a hash function is to encrypt a message while ensuring certain properties:
 - **Message Concealment:** The hash function should take an input message and generate an **encrypted version** known as the **digest**. Importantly, given the digest, it should not reveal information about the original message.

Brainoware

Why in News?

Recently, scientists have seamlessly integrated **brain-like tissue with electronics** to create **Brainoware**, an '**organoid neural network (ONN)**' capable of recognising voices and solving complex mathematical problems.

- This innovative system extends **neuromorphic computing**, to a new level by directly integrating brain tissue into a computer.

What is Brainoware?

➤ About:

- Brainoware is an innovative computing system that **melds brain-like tissue with electronics**.
- Brainoware integrates **brain organoids** with microelectrodes, forming an '**organoid neural network (ONN)**' that directly incorporates living brain tissue into the computing process.
 - Brain organoids are 3D tissues that simulate the **structure and function of the human brain**. They are derived from **human embryonic stem cells**, and are able to self-organize.
 - Brain organoids are similar to the **brain's cell composition and structure, and can reflect the brain's developmental process**. They are used as models to study human brain development and brain-related diseases.
- ONNs are different from **artificial neural networks**, which are made of **silicon chips** because they use **biological neurons that can adapt and learn** from their environment.

Google DeepMind's Genie

Why in News?

Recently, **Google DeepMind** has introduced **Genie AI (Artificial Intelligence)**, a new model that can generate interactive video games from just a text or image prompt.

What is Genie?

➤ About:

- **Generative Interactive Environments (Genie)** is a foundation **world model that is trained on videos sourced** from the Internet.

Note:

- The model can “generate an endless variety of **playable (action-controllable) worlds** from synthetic images, photographs, and even sketches”.
- It is the first generative interactive environment that has been trained in an unsupervised **manner from unlabelled internet videos**.

What is Generative Artificial Intelligence (GAI)?

➤ About:

- GAI is a rapidly growing branch of AI that focuses on generating new content (such as images, audio, text, etc.) based on patterns and rules learned from data.
- The rise of GAI can be attributed to the development of advanced generative models, such as **Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs)**.
 - These models are trained on large amounts of data and are able to generate new outputs that are similar to the training data. For example, a GAN trained on images of faces can generate new, synthetic images of faces that look realistic.
- While GAI is often associated with **ChatGPT and deep fakes**, the technology was **initially used to automate the repetitive processes** used in digital image correction and digital audio correction.
- Arguably, because **machine learning** and deep learning are inherently focused on generative processes, they can be considered types of GAI, too.

Large Language Models

Why in News?

In the era of advanced **artificial intelligence (AI)**, the emergence of **Large Language Models (LLMs)** has revolutionized the way computers interact with humans and process language. From enhancing virtual conversations to powering creative tasks, LLMs have paved the way for a new frontier in the realm of AI technology.

What are Large Language Models (LLMs)?

➤ Definition:

- LLMs are large general-purpose language models capable of solving common language problems such as text classification, question answering, and text generation.

- These models are **trained on massive datasets to understand patterns**, structures, and relationships within human language.

➤ Types of Large Language Models (LLMs)

○ Based on Architecture:

- **Autoregressive Models:** Predict the **next word in a sequence** based on previous words. Example: GPT-3.
- **Transformer-based Models:** Utilise a specific **artificial neural network architecture** for language processing. Examples: **LaMDA, Gemini (formerly Bard)**.
- **Encoder-decoder Models:** Encode input text into a representation and then decode it into another language or format.

○ Based on Size and Availability:

- **Size:** Large models require more computational resources but offer better performance.
- **Availability:** Open-source models are freely available, while closed-source models are proprietary.

➤ Examples of open-source LLMs: LLaMA2, BLOOM, Google BERT, Falcon 180B, OPT-175 B.

➤ Examples of closed-source LLMs: [GPT 3.5 by OpenAI](#), [Gemini by Google](#).

What are Large Action Models (LAMs)?

➤ LAMs are **specialized AI models** built to perform specific **tasks or sequences of actions**, often beyond just understanding and generating text.

- **LAMs** can understand human intention and predict actions. LAMs are designed to help with repetitive tasks.

➤ They are designed to execute **actions based on inputs, which may include text, images, or other forms of data**.

➤ LAMs can be used in various applications such as **virtual assistants, robotic systems, automated customer service**, and more.

- Example of LAM: [Rabbit r1](#).

➤ These models are trained on **datasets that include both linguistic information and action-oriented data** to learn how to perform tasks based on given contexts.

Note:



Neurovascular Tissues/ Organoids

Why in News?

Recently, researchers at the Post Graduate Institute of Medical Education & Research (PGIMER) in Chandigarh, have developed a groundbreaking prototype model for **generating neurovascular organoids (NVOEs) from autologous blood**, representing a novel approach to generating **neurovascular tissues**.

- These innovative NVOEs hold the key to transforming our understanding of brain function and neurological diseases.

Neural Organoids

- Neural organoids, also known as **cerebral organoids**, are **human pluripotent stem cells (hPSCs)**-derived **3D in vitro culture systems** that recapitulate the developmental processes and organisation of the **developing human brain**.
 - These provide a physiologically relevant in vitro 3D brain model for the study of **neurological development and disease processes** that are unique to the human nervous system.
- They have important applications in studying human brain development and neurological disorders such as **schizophrenia**.

Astronomers Uncover Hot Helium Stars

Why in News?

Astronomers have recently identified a group of **hot, helium-covered stars found in binary systems**, potentially deepening our understanding of stellar dynamics and evolution.

What is the Binary System of Stars?

- **About:** It refers to the pair of **stars** that are **gravitationally bound to each other** and orbit around a **common centre of mass**.
 - An estimated 85% or more of stars are actually part of binary or even multiple-star systems.

Classification:

- **Visual Binaries:** These are the **easiest to identify and consist of two stars** that can be directly resolved and separated using a telescope.
- **Spectroscopic binaries:** These stars are too close together to be resolved visually even with powerful telescopes.
 - However, their presence can be detected by observing periodic shifts in their spectral lines.
- **Eclipsing Binaries:** These binary systems are aligned in a way that one star periodically passes in front of the other from our perspective.
 - This event creates a **temporary dip in the brightness of the combined system**, allowing astronomers to confirm the presence of the unseen companion and study its properties.
- **Astrometric Binaries:** These binary systems are detected indirectly by measuring the **wobbling motion** of a single star.
 - This wobbling is caused by the gravitational pull of the unseen companion star.
- **Confirmation of Binary Systems:** When a star exhausts its fuel, gravity takes over, leading to a **supernova explosion** that strips its outer layers.
 - Some supernova lack **hydrogen**, suggesting pre-explosion stripping of the outer layer.
 - This can happen in binary systems, where **one star's gravity removes the outer hydrogen layer from its companion**, leaving behind a helium-rich star.

The iOncology-AI Project

Why in News?

At the forefront of medical innovation, researchers at the **All India Institute of Medical Sciences (AIIMS)** in Delhi have developed an **artificial intelligence (AI)**-powered model named iOncology-AI Project, integrated with a **supercomputer**, to aid oncologists in making informed decisions regarding **cancer treatment**.

What are the Key Highlights of the iOncology-AI Project?

- **About:**
 - The iOncology-AI project emerges from a collaborative effort between the AIIMS in Delhi

Note:

and Pune's **Centre for Development of Advanced Computing (C-DAC)**, and the Ministry of Electronics & Information Technology. This partnership brings together expertise in medical research and computational science to revolutionize cancer care.

- It aims to leverage **AI** to enhance the precision and efficacy of cancer treatment. By analysing **vast datasets encompassing genetic profiles, clinical histories, and treatment outcomes**, the project seeks to unravel the complex interplay **between genetics and cancer therapy**.

➤ Working Procedure:

- The platform, developed with C-DAC, stores and analyses various cancer-related data, including blood tests, lab reports, scans, and patient histories.
- Utilising advanced algorithms, the AI-enabled platform assists doctors in making treatment decisions **based on comprehensive genomic data analysis**, helping to tailor treatment plans to individual patients.
 - By studying the clinical data and genomic makeup of thousands of cancer patients, the platform can provide **personalised treatment recommendations, improving therapeutic outcomes**.
- Particularly beneficial in resource-constrained settings, the tool aids doctors in making targeted treatment decisions and optimising healthcare delivery.
 - While not replacing doctors, the platform serves as a valuable guide by **automatically flagging abnormalities in scans and reports**, enhancing clinical decision-making.

Stem Cells in Menstrual Blood

Why in News?

Recently, researchers have unveiled the **regenerative potential of stem cells in menstrual blood**, stemming from studies conducted roughly two decades ago.

- This discovery has opened new avenues for understanding the complex interplay between the **female reproductive system and regenerative processes**.

What are Menstrual Blood Stem Cells?

➤ About:

- Menstrual blood-derived stem cells (MenSCs), known as **endometrial stromal mesenchymal stem cells**, possess multipotent properties, meaning they can differentiate into various tissue types such as **fat cells, bone cells, and smooth muscle cells**.
- MenSCs are an ethical source of adult stem cells that can be collected painlessly from women.
 - MenSCs can be collected through a **menstrual cup**, providing a less **invasive alternative** to surgical biopsies.
- MenSCs can be obtained from women's menstrual blood derived from the **endometrium** (lines the inside of the uterus).

➤ Role in Women's Health:

- Regenerative Potential:
 - MenSCs exhibit multipotent characteristics. This means they can differentiate into various cell types, including neurons, cartilage, fat, bone, heart, liver, and skin cells.
- Treating Endometriosis:
 - MenSCs offer potential avenues for treating gynaecological disorders such as endometriosis and infertility.

- **Endometriosis** is a disease in which tissue similar to the lining of the uterus (endometrium) **grows outside the uterus**. It can cause severe pain in the pelvis and make it **harder to get pregnant**.

- Endometriosis can start at a person's first menstrual period and last until menopause (end of menstrual cycles).

- Common symptoms of endometriosis include **pelvic pain**, especially during menstruation, painful intercourse, infertility, heavy menstrual bleeding, and gastrointestinal issues such as diarrhoea or constipation.

Endometriosis and Fusobacterium bacteria

- There is a significant **association between Fusobacterium bacteria and endometriosis**.
 - Fusobacterium was found in **64% of endometriosis patients compared to only 7% in healthy individuals**. Studies suggest that **Fusobacterium exacerbates endometrial lesions**.

Note:

- A 2022 research paper found that people with endometriosis had an imbalance of microbe populations in the gut, known as **gut dysbiosis**.
 - This altered microbiota could contribute to the **progression of endometriosis**.

What are Stem Cells?

- **About:**
 - Stem cells are special human cells with the ability to develop into various cell types, such as muscle cells or brain cells.
 - They have the potential to repair damaged tissues, offering hope for treating serious illnesses like **paralysis** and **Alzheimer's disease**.
- **Types of Stem Cells:**
 - Stem cells are usually categorized as **multipotent** (able to give rise to multiple cells within a lineage), **pluripotent** (able to give rise to all cell types in an adult) and **totipotent** (able to give rise to all embryonic and adult lineages).

GSLV-F14/INSAT-3DS Mission

Why in News?

The **Indian Space and Research Organisation (ISRO)** is all set to launch its **GSLV-F14/INSAT-3DS mission** on 17th February 2024, with the aim of enhancing weather forecasting and disaster warning capabilities.

What are the Key Highlights of the GSLV-F14/INSAT-3DS Mission?

- INSAT-3DS will be launched aboard the **Geosynchronous Satellite Launch Vehicle F14 (GSLV F14)**.
 - GSLV-F14 is a **three-stage launch vehicle**.
 - The first stage (GS1) has a solid propellant motor and four **earth-storable propellant stages (EPS)**.
- EPS includes a supporting structure, propellant tanks, and an engine.
 - The second stage (GS2) is also an earth-storable propellant stage
 - The third stage (GS3) is a **cryogenic stage**, with propellant loading of liquid oxygen (LOX) and liquid hydrogen (LH₂).
 - The GSLV-F14 is the 16th flight of the GSLV, and the 10th flight with the indigenous cryo stage.

- INSAT-3DS comprises **four payloads**, including an Imager, a sounder, a data relay transponder, and a satellite-aided search and rescue transponder.
 - **Imager Payload:**
 - INSAT-3DS carries a multi-spectral Imager capable of generating **Earth images in six wavelength bands**.
 - **Sounder Payload:**
 - It features a 19-channel Sounder payload, offering data on atmospheric vertical profiles like temperature and humidity.
 - **Data Relay Transponder (DRT):**
 - INSAT-3DS through DRT receives global meteorological, hydrological, and oceanographic data from automatic weather stations and data collection platforms, relaying it back to user terminals.
 - **Satellite aided Search and Rescue (SA&SR) Transponder:**
 - INSAT-3DS through SA&SR relays distress signals for global search and rescue operations, covering the **Ultra high frequency band**.

New Satellite-Based Toll Collection System

Why in News?

Recently, the Ministry of Road Transport and Highways of India announced in **Parliament** that the government intends to roll out a **new highway toll collection system** based on the **global navigation satellite system (GNSS)** before the **model code of conduct** for the 2024 **election** becomes effective.

What is the New Proposed Highway Tolling System?

- **Salient Features:**
 - The proposed highway tolling system utilises the **GNSS**, including the **Indian satellite navigation system GAGAN (GPS Aided GEO Augmented Navigation)** for accurate location tracking.
 - The GNSS is a term used to refer to any satellite-based navigation system, including the US' **Global Positioning System (GPS)**.

Note:

- It uses a large constellation of satellites to provide more accurate location and navigation information to users globally as compared to the GPS alone.
- Implementation involves fitting vehicles with an **On-Board Unit (OBU)**, or tracking device, which communicates with **satellites to determine location**.
- Coordinates of national highways are logged using **digital image processing**, allowing software to calculate toll rates based on distance travelled.
 - Toll amounts are deducted from a digital wallet linked to the OBU, ensuring seamless and cashless transactions.
- Enforcement measures including gantries equipped with CCTV cameras along highways to monitor compliance and deter evasion tactics.
- The new system will likely **coexist with the existing FASTag-based toll collection initially**. A decision on mandating OBUs for all vehicles is yet to be made.

FASTag

- **FASTag** is a device that employs **Radio Frequency Identification (RFID)** technology for making toll payments directly while the vehicle is in motion.
- FASTag (RFID Tag) is affixed on the windscreen of the vehicle and enables a **customer to make toll payments directly from the account** which is linked to FASTag.
 - It is operated by the **National Highway Authority of India (NHAI)** under the supervision of the Ministry of Road Transport and Highways.

GAGAN

- **GPS Aided GEO Augmented Navigation (GAGAN)** is an initiative by the Indian Government for Satellite-based Navigation Services in India.
- It aims to enhance the accuracy of global navigation satellite system (GNSS) receivers through reference signals.
- The **Airports Authority of India (AAI)** and the **Indian Space Research Organization (ISRO)** have collaborated to develop the GAGAN as a regional **Satellite Based Augmentation System (SBAS)**.
- The GAGAN's goal is to provide a navigation system to assist aircraft in accurate landing over the Indian airspace and the adjoining area and applicable to safety-to-life civil operations. **GAGAN is interoperable with other international SBAS systems.**

India's 5G Fighter Aircraft and LCA Tejas

Why in News?

The **Cabinet Committee on Security (CCS)** approved a Rs 15,000 crore project to design and develop India's **fifth-generation fighter** multirole jet, the **Advanced Medium Combat Aircraft (AMCA)**.

- In a related incident, a Court of Inquiry has been initiated to investigate the cause of an Indian Air Force Light Combat Aircraft (LCA) Tejas crash during an operational training sortie in Rajasthan.

What are the Fifth-generation Fighter Jets?

➤ About:

- **Fifth-generation (5G) fighters** are aircraft capable of operating in **heavily contested combat zones**, characterised by the presence of the most advanced air and ground threats, both current and anticipated.
- 5G fighter jets have **stealth capabilities** and can **cruise** at **supersonic speeds** without engaging afterburners.
- It stands out from fourth-generation (4G) peers due to its **multi-spectral low-observable design**, self-protection, radar jamming capabilities, and integrated avionics.
- **5G jets** are possessed by **Russia (Sukhoi Su-57)**, **China (Chengdu J-20)**, and the **US (F-35)**.

What are the Features of Light Combat Aircraft (LCA) Tejas?

➤ About:

- The **Light Combat Aircraft (LCA) programme** was started by the Government of India in 1984 when they established the ADA to manage the LCA programme.
 - It replaced the ageing Mig 21 fighter planes.

➤ Designed by:

- ADA under the **Department of Defence Research and Development**.

➤ Manufactured by:

- State-owned Hindustan Aeronautics Limited (HAL).

➤ Features:

- The **lightest, smallest, and tailless** multi-role supersonic fighter aircraft in its class.

Note:

- Designed to carry a range of **air-to-air, air-to-surface**, precision-guided, weapons.
- Air-to-air refueling capability.
- Maximum payload capacity of 4000 kg.
- It can attend the **maximum speed of Mach 1.8**.
- The range of the aircraft is 3,000km
- **Variants of Tejas:**
 - **Tejas Trainer:** 2-seater operational conversion trainer for training air force pilots.
 - **LCA Navy:** Twin- and single-seat carrier-capable for the Indian Navy.
 - **LCA Tejas Navy MK2:** This is phase 2 of the LCA Navy variant.
 - **LCA Tejas Mk-1A:** This is an improvement over the LCA Tejas Mk1 with a higher thrust engine.

Multiple Independently Targetable Re-entry Vehicle Technology

Why in News?

India has recently made a significant advancement in missile technology, joining the select group of nations possessing **Multiple Independently Targetable Re-entry Vehicle (MIRV) capabilities**.

- This milestone was achieved through the successful **flight test named Mission Divyastra**, conducted by the **Defence Research and Development Organisation (DRDO)**. It marked the first time the indigenously developed **Agni-5 missile** integrated MIRV technology.

What are the Key Facts About MIRV Technology?

- **Inception:**
 - MIRV technology originated in the **United States**, with the deployment of a **MIRVed Intercontinental Ballistic Missile (ICBM)** in 1970.
 - MIRV allows a **single missile to carry multiple warheads (3-4)**, each capable of targeting different locations independently.
 - MIRV technology enhances the **missile's effectiveness by increasing the number of potential targets** it can engage.

- MIRVs can be launched from both land-based platforms and sea-based platforms, such as submarines, expanding their operational flexibility and range.

➤ Global Adoption and Proliferation:

- Nations possessing MIRV technology include major nuclear powers such as the **United States, the United Kingdom, France, Russia, China, and India**, while Pakistan tested the technology (Ababeel Missile) in 2017.
- The test flight of **Agni-5** marked the **first time that the MIRV technology was tested in India**, which aims to deploy multiple warheads at different locations in a single launch.
 - The Agni-5 weapon system is equipped with indigenous avionics systems and high-accuracy sensor packages, which ensured that the re-entry vehicles reached the target points within the desired accuracy.

Agni-5 Missile

- Agni is an **Inter-continental ballistic missile (ICBM) developed indigenously** by the DRDO.
- It is capable of carrying nuclear warheads and has a target range of more than 5,000 km. It uses a three-stage solid-fuelled engine.
 - Agni-5 has been successfully tested several times since 2012. In December 2022, DRDO also tested the night-time capabilities of Agni-5.
- **Missiles in Agni Family:**
 - **Agni I:** Short-range ballistic missile (Range more than 700 km).
 - **Agni II:** Medium-range ballistic missile (Range more than 2000 to 3500 km).
 - **Agni III:** Intermediate-range ballistic missile (Range more than 3000 km).
 - **Agni IV:** Intermediate-range ballistic missile (Range more than 3500 km).
 - **Agni-P (Agni Prime):** A **nuclear-capable, two-stage canisterised solid propellant ballistic missile** (Range 1,000 to 2,000 km).
- The next upgrade of the Agni missile, **Agni-6**, is expected to be a full-fledged **intercontinental ballistic missile with a range well over 7,000 km**.

Note:

Carbon Footprint of Artificial Intelligence

Why in News?

As **artificial intelligence (AI) technology** grows, its **energy-intensive operations** pose **significant environmental concerns**. Despite challenges, advancements like **Spiking Neural Networks (SNNs)** and **lifelong learning** offer promising avenues to **reduce AI's carbon footprint** while leveraging its **potential to address climate change**.

What are the Spiking Neural Networks and Lifelong Learning?

- **Spiking Neural Networks (SNNs):**
 - SNNs are a type of **artificial neural network (ANNs)** inspired by the human brain's neural structure.
 - Unlike traditional ANNs, which use continuous numerical values for processing data, SNNs operate based on **discrete spikes or pulses of activity**.
 - Just as **Morse code** uses specific sequences of dots and dashes to convey messages, SNNs use **patterns or timings of spikes** to process and transmit information, similar to how **neurons in the brain communicate** through **electrical impulses called spikes**.
- **Lifelong Learning (L2):**
 - Lifelong Learning (L2) or **Lifelong Machine Learning (LML)** is a **machine learning** paradigm that **involves continuous learning**. It involves accumulating knowledge from previous tasks and using it to help with future learning and problem-solving.
 - L2 serves as a strategy to **mitigate the overall energy demands** of ANNs throughout their lifetime.
 - Training ANNs sequentially on new tasks **leads to forgetting previous knowledge**, necessitating retraining from scratch with changes in the operating environment, thus increasing AI-related emissions.

Water Footprint of AI

- The **water footprint of AI** is determined by the **water used for electricity generation and cooling** in data centres running AI models.
 - The water footprint consists of **direct water consumption** (from cooling processes) and **indirect water consumption** (for electricity production).
- **Factors affecting the water footprint** include AI model type and size, data centre location and efficiency, and electricity generation sources.
- Training a large AI model like GPT-3 can consume up to 700,000 litres of fresh water, equivalent to producing 370 BMW cars or 320 Tesla electric vehicles.
 - Interactions with AI chatbots like ChatGPT can consume up to 500 ml of water for 20-50 Q&A sessions.
 - GPT-4, with a larger model size, is expected to increase water consumption, but exact figures are hard to estimate due to data availability.

Genome India Project

Why in News?

The **Genome India Project**, a project funded and coordinated by the Department of Biotechnology (DBT), announced that it had finished sequencing 10,000 Indian genomes.

What is the Genome India Project?

- DBT initiated the ambitious Genome India Project (GIP) on 3rd January 2020. It is led by the **Centre for Brain Research at the Indian Institute of Science, Bengaluru**, and involves collaboration with 20 institutions.
- The project involves **whole-genome sequencing** and data analysis of **10,000 individuals** to understand disease nature in the Indian population and develop predictive diagnostic markers.
 - India's population of 1.3 billion comprises over 4,600 population groups, many of which are **endogamous (Matrimony in Close Ethnic Groups)**, contributing to **genetic diversity** and disease-causing mutations.
- This huge dataset of 8 petabytes will be stored at the **Indian Biological Data Centre (IBDC) in Faridabad**.

Note:

- Inaugurated in 2022, the IBDC is **India's first national repository for life science data**.

Note: The first whole human genome was sequenced with the collaboration of an international team. It took 13 years and \$3 billion, and was completed in 2003. India announced its first complete human genome in 2009.

- However, now, it takes only about 5 days to sequence an entire human genome and perform all the quality checks.

What is Genome Sequencing?

- **Gene and DNA:** DNA (Deoxyribonucleic acid) is the molecule that carries the genetic instructions for the development, functioning, growth, and reproduction of all known living organisms and many viruses.
 - Genes are specific segments of DNA that contain the instructions for producing proteins, which are essential for various biological functions.
- **Genome:** The genome represents the **entirety of an organism's hereditary information**, serving as a biological instruction manual inherited from parents.
 - Composed of four nucleotide bases: **adenine (A), cytosine (C), guanine (G), and thymine (T)**, the genome contains approximately 3 billion base pairs in humans.
 - This complex sequence encodes **essential information governing an individual's physical characteristics**, susceptibility to diseases, and other biological traits.
- **Genome Sequencing:** Genome sequencing is the process of determining the **precise order of nucleotides** within an organism's genome.
 - Whole genome sequencing is a laboratory procedure that determines the order of all four bases in the genome of an organism in one process.

Claude 3 AI Chatbot

Why in News?

Recently, the **Artificial Intelligence (AI)** start-up Anthropic announced its latest family of AI models called **Claude 3**, stating that it "sets new industry benchmarks across a wide range of cognitive tasks".

- The family includes **three state-of-the-art AI models** in the ascending order of capabilities— Claude 3 Haiku, Claude 3 Sonnet, and Claude 3 Opus.

Note:

- Anthropic is an OpenAI rival started by former leaders at the ChatGPT maker.
- While OpenAI has closely tied itself to its business partner Microsoft, Anthropic's primary **cloud computing partner is Amazon**.

What is Claude 3?

- **About Claude:**
 - Claude is a group of **Large Language Models (LLMs)** developed by Anthropic.
 - LLMs are a specific class of **generative AI** models that are trained to understand and generate human-like text.
 - The chatbot is capable of **handling text, voice messages, and documents**.
 - The chatbot is **capable of generating faster, contextual responses** compared to its peers.
- **Training:**
 - Claude sources include the **Internet and some licensed datasets** using two methods, **Supervised Learning (SL)** and **Reinforcement Learning (RL)**.
 - In the SL phase, the LLM produces responses to prompts, and then **self-assesses them** based on a set of guiding principles.
 - It later revises the responses — and according to its makers, this process is aimed at **reducing the harmful effects of the AI's outputs**.
 - RL phase involves **training the model based on AI-generated feedback**, in which the AI evaluates responses based on a set of constitutional principles.
 - These methods, and the general approach, has been chosen with the aim of making Claude helpful and harmless.
- **Claude 3:**
 - Among the new releases, **Claude 3 Opus** is the most powerful model, Claude 3 Sonnet is the **middle model that is capable and price competitive**, and **Claude 3 Haiku** is relevant for any use case that requires instant responses.
 - Claude Sonnet powers the Claude.ai chatbot for free at present and users only need an email sign-in.

Note:

- However, Opus is only available through Anthropic's web chat interface and if a user is subscribed to the Claude Pro service on the Anthropic website.

Obelisks

Why in News?

Scientists at Stanford University have identified a new, remarkably simple form of life, which they have named "obelisks."

- These obelisks bridge the **gap between viruses and viroids** in terms of complexity, adding a new category to the existing spectrum of life forms.
- Obelisks were identified through an extensive analysis of RNA sequences from bacteria in the human gut, using **next-generation sequencing (NGS) technology**.

Note:

- NGS is a **Deoxyribonucleic acid (DNA) sequencing technology** that uses parallel sequencing to determine the **sequence of multiple small fragments of DNA**. It is used to determine the **order of nucleotides** in entire genomes or targeted regions of DNA or RNA.
 - Nucleotides are organic molecules that are the basic building blocks of nucleic acids DNA and Ribonucleic acid (RNA).

What are Obelisks?

- Obelisks are a new class of virus-like entities. They are composed of diverse RNA molecules that reside within the human body and the global microbiome.
- Obelisks exhibit **highly symmetrical, rod-like structures** resembling the iconic **monuments (Obelisk)**.
- Their genetic sequences are approximately 1,000 nucleotides long, with no detectable similarities to known biological agents.
- The new study analyzed RNA data from gut and oral bacteria but couldn't determine which bacteria hosted a given obelisk.
 - While initial findings suggest a possible link to the bacterial species ***Streptococcus sanguinis***, commonly found in the human mouth.
- The discovery of obelisks raises questions about their genome replication, transmission, pathogenicity, evolution, and potential roles in human health and disease.
 - Further research is needed to unravel the mysteries surrounding Obelisks, shedding light on their ecological significance and impact on human health.

Feature	Viruses	Viroids
Discovery	Dmitry Ivanovsky was the first to discover viruses at the end of the 19 th century.	Discovered by Theodor Diener in 1971 while studying the pathogen causing potato spindle tuber disease.
Composition	Each virion contains a nucleic acid (DNA or RNA) core surrounded by a protein coat , sometimes with a lipid layer outside.	Consists of naked RNA without a lipid layer or protein coat, primarily composed of a single-stranded circular RNA molecule .
Size	Varied in size, generally smaller (30-50 nm).	Smaller compared to viruses.
Host Range	Can infect a wide range of organisms , including plants and animals.	Primarily infect plant cells , causing various diseases characterized by stunted growth, leaf distortion, and other symptoms.
Replication Method	Depends on host cells to replicate and propagate themselves.	Enter a cell as RNA, force the cell to produce more copies of itself, and then infect other cells, primarily through mechanical transmission, seed transmission, pollen, and insect vectors.

Note:

Genetic Material	Contains either DNA or RNA, which may code for proteins.	Contains RNA, but does not code for any protein.
Examples	<i>Influenza virus, rabies virus, Herpes virus, SARS-CoV-2.</i>	<i>Potato spindle tuber viroid (PSTVd), Citrus exocortis viroid (CEVd), Coconut cadang-cadang viroid (CCCVd).</i>

Gene Therapy for Hemophilia A

Why in News?

Recently, the Union Minister of Science & Technology addressing the **National Science Day 2024** programme stated that India conducted its first human clinical trial of gene therapy for **hemophilia A (FVIII deficiency)** at Christian Medical College (CMC) Vellore.

- India's progress in **science and technology (S&T)** was also highlighted at the event.

What is Hemophilia A?

- **About:** Hemophilia is a group of **rare bleeding disorders** caused by a congenital deficiency in specific clotting factors. The most prevalent form is **Hemophilia A**.
 - **Hemophilia A** results from a deficiency in a crucial blood clotting protein known as **factor VIII**.
 - Due to this deficiency, individuals experience prolonged bleeding after injuries, as their blood takes longer to clot than usual.
- **Causes:** It is primarily inherited (**genetic**) and follows an **X-linked recessive pattern**, meaning the gene responsible for **factor VIII production** is located on the X chromosome.
 - Males have **one X and one Y chromosome**, while females have two X chromosomes.
 - If a male inherits an X chromosome with the defective gene from his mother, he will have hemophilia A.
 - Females with one defective copy typically do not experience symptoms because the other X chromosome usually provides enough factor VIII.
 - However, females can have hemophilia A if they **inherit two defective copies**, one from each parent (much less common).
- **Symptoms:** The severity of hemophilia A varies depending on the level of factor VIII activity in the blood. Common symptoms can include:

- **Easy bruising** and excessive bleeding from minor injuries (cuts, scrapes)
- Bleeding in the joints (especially knees, elbows, and ankles), causing pain, swelling, and stiffness
- Bleeding after surgery or dental procedures.

What is National Science Day?

- The National Science Day is celebrated on **28th February** every year to commemorate the discovery of '**Raman Effect**' in 1928 by **Sir Chandrasekhara Venkata Raman**, which led to the **Nobel Prize being awarded to him in 1930**.
 - **Raman effect** is a method for identifying materials based on how they scatter light.
 - By shining light on a substance, scientists can analyze the unique way it interacts with molecules, revealing its chemical composition and structure.
- The purpose of celebrating this day is to **enhance scientific temper, popularization of science** and encouraging innovative activities by infusing scientific temperament in the masses and creating a positive scientific research culture.
 - Theme for National Science Day 2024: '**Indigenous Technologies for Viksit Bharat.**'

Laser Cooling of Positronium

Why in News?

The **AEgIS collaboration** has achieved a significant breakthrough by demonstrating the **laser cooling of Positronium**.

- The experiment was performed at the **European Organisation for Nuclear Research**, more popularly known as CERN, in Geneva.

What are the Key Highlights of the Study?

- **About AEgIS:**
 - Anti-hydrogen Experiment: Gravity, Interferometry, Spectroscopy (AEgIS) is a collaboration of physicists

Note:

from a number of countries in Europe and from India.

- In 2018, AEGIS became the **first in the world to demonstrate the pulsed production of antihydrogen atoms.**

➤ **Aim:**

- This is an important precursor experiment to the formation of antiHydrogen and the measurement of Earth's gravitational acceleration on antihydrogen in the AEGIS experiment.
- This scientific feat could open prospects to produce a **gamma-ray laser** that would eventually allow researchers to look inside the atomic nucleus and have applications beyond physics.

➤ **Positronium:**

- **Positronium**, comprising a bound **electron (e⁻) (matter)** and **positron (e⁺) (matter)**, is a fundamental atomic system.
 - Electrons and positrons are leptons. They interact through electromagnetic and weak forces.
- Since Positronium is only made up of electrons and positrons, and no usual nuclear matter, it has the unique **distinction of being a purely leptonic atom.**
 - Due to its very short life, it annihilates with a half life of **142 nano-seconds**. Its mass is **twice the electron mass.**

India's first Indigenous Hydrogen Fuel Cell Ferry

Why in News?

Recently, Prime Minister of India flagged off India's first indigenously built **hydrogen fuel cell ferry boat** in virtual.

- The hydrogen cell-powered inland waterway vessel launched under the **Harit Nauka initiative.**

What are the Other Key Highlights About the Ferry?

➤ **About:**

- The vessel's flagging off was a key component of a major program that involved the foundation stone laid for a **₹17,300-crore** project, including the outer harbor at the **V.O. Chidambaranar Port.**
- The vessel has been built at the **Cochin Shipyard.**

➤ **Importance:**

- It will make urban mobility smooth and easy through **inland waterways**. The vessel underscores the pioneering step for embracing **clean energy solutions** and aligning with the nation's **net-zero commitments.**

Note: The V.O. Chidambaranar Port is the **first Green Hydrogen Hub Port** of the country and the projects include a **desalination plant, hydrogen production and bunkering facility.**

What is the Harit Nauka initiative?

➤ **About:**

- The **Ministry of Ports, Shipping and Waterways** unveiled the **Harit Nauka guidelines** for inland vessels in January 2024.

➤ **Guidelines:**

- As per the guidelines, all states have to make efforts to use **green fuels** for **50% of inland waterways-based passenger fleets** in the **next one decade**, and **100% by 2045.**
- This is to reduce **greenhouse gas emissions** as per the **Maritime Amrit Kaal Vision 2047.**

- Globally, the shipping industry is increasingly transitioning to green fuels due to **environmental regulations, sustainability goals, and advancements** in green fuel technologies.
- Hydrogen and its derivatives are gaining attention for promising **zero-emission fuels** for the industry.

What is a Hydrogen Fuel Cell?

➤ **About:**

- Hydrogen fuel cells are a **clean, reliable, quiet, and efficient** source of **high-quality electric power.**
- They use hydrogen as a fuel to drive an **electrochemical process** that produces electricity, with **water** and **heat** as the only by-products.
 - Hydrogen is one of the most abundant elements on earth for a cleaner alternative fuel option.

➤ **Significance:**

- **Zero Emission Solutions:** It is one of the best **Zero Emission solutions**. It is completely environment friendly with no **tailpipe emissions** other than water.
 - **Tailpipe emissions:** Emission of something such as gas or radiation into the atmosphere.

Note:

- **Quiet Operation:** The fact that the fuel cells make little noise means that they can be used in challenging contexts, such as in hospital buildings.

Net-Zero Target

- It is referred to as **carbon neutrality**, which does not mean that a country would bring down its emissions to zero. Rather, it is a state in which a country's emissions are compensated by the absorption and removal of **greenhouse gasses** from the atmosphere.
 - Further, absorption of the emissions can be increased by creating more carbon sinks such as forests.
 - While the removal of gasses from the atmosphere requires futuristic technologies such as **carbon capture and storage**.
- More than 70 countries have promised to become **Net Zero** by the middle of the century i.e., by **2050**.
- India has promised to cut its emissions to **net zero** by **2070** at the **Conference of Parties (COP)-26 Summit of UNFCCC**.

Sustainable Funding for Research and Development

Why in News?

National Science Day, celebrated annually on **28th February**, honours the discovery of the Raman Effect and acknowledges scientists' contributions to India's development.

- It highlights the importance of Science in Fostering Sustainable Development.

What is National Science Day?

➤ About:

- **National Science Day** is observed on the day Indian Physicist Chandrasekhara Venkata Raman discovered the **Raman Effect**.
 - The Raman Effect is the phenomenon where **light gets scattered when passed through a transparent material**, leading to changes in wavelength and energy.
- In 1928, on 28th February CV Raman discovered the Raman Effect.

- He also received the **Nobel Prize in Physics** in 1930 due to his significant contribution to the field of Physics.

➤ **Theme:** Indigenous Technologies for Viksit Bharat

➤ Significance:

- The day is observed to **raise awareness about the importance of scientific applications** in our daily lives.
- The day also aims to celebrate and acknowledge the efforts and achievements of scientists in human welfare.
- The best **way to observe National Science Day** is by understanding the way science and technology have progressed and exploring the spaces where more efforts need to be made.

What are the Government Initiatives related to R&D?

- Development of **Centres of Excellence**.
- Creation of **National Research Foundation**
- **VAIBHAV Fellowship**
- **Global Innovation Index 2023:** India secured the **40th position** in the latest GII 2023.
- **Atal New India Challenge 2.0**
- **Announcement of New Science Awards** (Vigyan Yuva-Shanti Swarup Bhatnagar).
- **Post-Doctoral Fellowships (PDFs):** The government has **increased the number of Post-Doctoral Fellowships (PDFs) from 300 annually to 1000**.
 - In addition, the **SERB-Ramanujan Fellowship, SERB-Ramalingaswami re-entry Fellowship and SERB-Visiting Advanced Joint Research Faculty Scheme (VAJRA)** have been devised to promote brain gain by attracting bright researchers of Indian origin to work and contribute to STI (science, technology and innovation) ecosystem in India.

Bone Grafting Technology

Why in News?

Recently, the **Indian Institute of Technology (IIT) Kanpur** signed a **Memorandum of Understanding (MoU)** with **Canada based biotechnology company (Conlis Global)** for licensing of an innovative and indigenously developed technology that promotes **bone healing and regeneration**.

Note:

What are Nano Hydroxyapatite-based Porous Composite Scaffolds?

- **About:**
 - The **Nano Hydroxyapatite-based Porous Composite Scaffolds** are biodegradable and have **osteoinductive** and **osteopromotive** properties for bone regeneration.
 - It is highly biocompatible ensuring good cell material interaction with **osteoblast cells** exhibiting a high mechanical strength and interaction between the polymer network and the solvent.
- **Characteristics:**
 - It has **osteoinductive** and **osteopromotive** properties due to which it has **bone healing** and **bone growth** characteristics.
 - They are highly biocompatible, resulting in good cell material interaction with **osteoblast cells** exhibiting a high mechanical strength and interaction between the polymer network and the solvent.
 - Osteoblast cells are responsible for **mineralisation of bone** during **bone formation** and **bone remodelling**.

What is Bone Grafting?

- **About:**
 - **Bone grafting** involves a **surgical technique** where transplanted bone is utilised to **repair** and **reconstruct bones** affected by **disease** or **injury**.
 - This procedure is applicable for **repairing bones** throughout the body.
 - Surgeons may harvest bone from various sources such as the **hips, legs, or ribs** for grafting purposes.
- **Objective:**
 - The primary objective of the invention is to **overcome the drawbacks** of the existing remedies.
 - Other alternatives have been associated with **infection** and **immune** related complications.
 - This technology provides the delivery of **bone active molecules, antibiotics** or any other drug for combating bone pathologies, reconstruction of irregular bone defects and for dental applications as well.

Google DeepMind's SIMA and AlphaGeometry

Why in News?

Recently, Google DeepMind has revealed its various **AI (Artificial Intelligence)** products based on **Predictive AI Models**, such as **SIMA (Scalable Instructable Multiworld Agent)** and **AlphaGeometry**.

- **OpenAI's ChatGPT** and **Google's Gemini** have garnered significant attention from various sectors, with companies and researchers, including those in oil and gas as well as pharmaceutical industries, increasingly turning to **Generative AI** or **Predictive AI** for applications such as oil exploration and drug discovery.

What is Predictive AI?

- Predictive AI models are a **type of artificial intelligence system** designed to **forecast or predict future outcomes** based on historical data, patterns, and trends.
- These models utilise advanced algorithms, statistical techniques, and machine learning methods to analyse vast amounts of data and make informed predictions about future events or behaviours.

What is SIMA?

- **About:**
 - SIMA is an AI Agent, which is **different from AI models such as OpenAI's ChatGPT or Google Gemini**.
 - AI models are **trained on a vast data set and are limited when it comes to working on their own**.
 - On the other hand, an AI Agent can process **data and take action themselves**.
 - It is a game assisting AI, making it a valuable asset for enhancing the gaming experience.
 - SIMA can be called a **generalist AI Agent that is capable of doing different kinds of tasks**.
 - It is like a virtual buddy who can understand and follow instructions in **all sorts of virtual environments** – from exploring mysterious dungeons to building **lavish castles**. It can accomplish tasks or solve challenges assigned to it.

Note:



What is AlphaGeometry?

- **About:**
 - DeepMind's AlphaGeometry is a **specialised AI system** designed to tackle complex geometry problems.
 - Unlike general-purpose AI models like OpenAI's ChatGPT or Google's Gemini, AlphaGeometry is **tailored specifically for geometric reasoning tasks**.
 - It combines **advanced neural language modelling techniques** with a symbolic deduction engine specialised in algebraic and geometric reasoning.
 - **Neural language models** are built using neural network architectures, which are computational models inspired by the structure and function of the human brain.

Sickle Cell Disease

Why in News?

Amidst the unavailability of essential drugs to treat **Sickle Cell Disease (SCD)** at district healthcare institutions, there is growing concern about the challenges faced by people from marginalised Indigenous Tribal communities in managing the treatment of SCD.

What is Sickle-Cell Disorder?

- **About:**
 - **Sickle Cell Disease (SCD)** is an **inherited haemoglobin disorder** characterised by a **genetic mutation** that **causes red blood cells (RBCs) to assume a sickle or crescent shape** rather than their normal round shape.
 - This **abnormality** in RBCs **results in increased rigidity, impairing their ability to circulate effectively** throughout the body. Consequently, individuals with SCD often experience complications such as **anaemia, organ damage, recurrent and severe pain episodes, and a shortened lifespan**.
 - As per the Ministry of Health and Family Welfare, marginalised tribal populations are most vulnerable to SCD.
- **Symptoms:** Symptoms of sickle cell disease can vary, but some **common symptoms** are-
 - **Chronic anaemia** which leads to fatigue, weakness, and paleness.

- Painful episodes (also known as **sickle cell crisis**) cause sudden and intense pain in the bones, chest, back, arms, and legs.
- Delayed growth and puberty.

What are the Government Initiatives Regarding SCD?

- **National Sickle Cell Anaemia Elimination Mission:**
 - Aimed at enhancing the care for all **Sickle Cell Disease (SCD)** patients and reducing the disease's prevalence through an integrated approach **encompassing screening and awareness campaigns**.
 - Targeting **complete elimination of sickle cell disease as a public health concern by 2047**.
 - Under the Sickle Cell Anaemia Mission, the **Council of Scientific and Industrial Research (CSIR)** is developing gene-editing therapies for SCD.
- **National Health Mission (NHM) 2013:**
 - It is, a flagship programme of the Indian government, that encompasses provisions for disease prevention and management, with a **specific focus on hereditary anomalies such as sickle cell anaemia**.
 - Dedicated programs within NHM focus on **raising awareness, facilitating early detection, and ensuring timely treatment** of sickle cell anaemia.
 - NHM facilitates drugs like hydroxyurea to treat SCD in its "**essential medicines List**".
- **The National Guidelines for Stem Cell Research 2017:**
 - It **restricts the commercialisation of stem cell therapies** to clinical trials, except for Bone marrow transplantation (BMT) for SCD.
 - Gene editing on stem cells is permitted only for in-vitro studies.
- **National Guidelines for Gene Therapy Product Development and Clinical Trials 2019:** It provides guidelines for the development and clinical trials of gene therapies for inherited genetic disorders.
 - India has also approved a **five-year project** to develop CRISPR techniques for sickle cell anaemia treatment.
- **State Haemoglobinopathy Mission of Madhya Pradesh:**
 - It aims to address the challenges in **screening and management of the disease**.

Note:

- **Rights of Persons with Disabilities (RPwDs) Act, 2016:**
 - **SCD is included in the 21 disabilities** that provide for benefits such as **reservation in higher education (minimum 5%), government jobs (minimum 4%), and allocation of land (minimum 5%),** for persons with benchmark disabilities and those with high support needs.
 - **Free education** is guaranteed for every child with a benchmark disability between 6 and 18 years.

Purification Processes of Water

Why in News?

In recent years, **Reverse Osmosis (RO)** has gained popularity for its ability not only to eliminate impurities and pathogens from water but also to reduce **TDS (Total Dissolved Solids)** levels, however, concerns arise due to the loss of essential minerals **such as calcium and magnesium.**

What is the RO Water Purification Method?

- **About:**
 - RO is a water purification process that **removes contaminants from water by utilising a semi-permeable membrane.**
 - A typical RO system consists of a semi-permeable membrane, **with pores 0.0001 to 0.001 microns in size.**
 - In this method, **water is forced through the membrane under pressure,** while contaminants such as **dissolved solids, chemicals, microorganisms,** and other impurities are left behind.

What are the Recommended TDS Limits for Safe Drinking Water?

- The **Bureau of Indian Standards (BIS)** states that the maximum TDS limit for safe drinking water is **500 milligrams per litre (ppm).**
 - However, in the absence of any alternative water source, a TDS limit of 2,000 mg/l is permissible.
- In its drinking water standards issued in **2017, WHO (World Health Organization)** states that TDS in drinking water **should be between 600 and 1,000 mg/l.**
- Countries in **Europe, the US and Canada** have set **TDS standards at 500 to 600 mg/l.**

Refrigerants

Why in News?

A recent court case in San Diego, US, highlighted the **smuggling of banned refrigerants from Mexico into the US,** shedding light on the environmental repercussions of such illicit activities.

- The refrigerants in question are **hydrofluorocarbons** and a form of hydrochlorofluorocarbons, known as **HCFC 22.**

What are Refrigerants?

- **About:** A refrigerant is a chemical substance used in **refrigeration and air conditioning systems.**
 - They work by absorbing heat and transferring it in a cycle to achieve cooling of air or objects.
 - They typically have **low boiling points,** allowing them to evaporate and cool the surrounding environment at relatively low temperatures.
 - **Example:** chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs).
- **HFCs and HCFCs:** In the 1990s, **hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs)** gained popularity as substitutes for **chlorofluorocarbons (CFCs)** in refrigeration and air conditioning systems.
 - This shift came after research in 1985 confirmed that **CFCs were causing abnormally low ozone concentrations** above Antarctica, leading to the ozone hole phenomenon.

What Measures have been Taken Globally to Reduce the Usage of Refrigerants?

- The **Vienna Convention for the Protection of the Ozone Layer (Vienna Convention)** was agreed in 1985. It established global monitoring and reporting on ozone depletion.
 - In 1987, nearly **200 countries** signed the **Montreal Protocol** aiming to halt the production and use of **ozone-depleting substances** like CFCs.
 - India became a signatory to the Montreal Protocol in 1992.
 - The Protocol mandated the **phasing out of CFCs by 1996 and HCFCs by 2030,** with HCFCs acting as a temporary solution due to their lesser impact on the ozone layer.

Note:

- Consequently, HFCs emerged as the primary refrigerant as they do not deplete the ozone layer.
 - However, they were later recognised as **potent greenhouse gasses**.
- The **Climate and Clean Air Coalition (CCAC) report** highlighted that HFCs contribute significantly to global warming, despite having zero ozone-depleting potential.
- In 2016, over 150 countries agreed to the **Kigali Amendment under the Montreal Protocol** aiming to **reduce HFC consumption by 80-85% by the late 2040s**.
 - India is also signatory to the Kigali Amendment.
 - India will complete its phase down of production and consumption of HFCs for controlled uses in 4 steps from 2032 onwards with cumulative reduction of **10% in 2032, 20% in 2037, 30% in 2042 and 85% in 2047**.

Use of Snake Venom for Intoxication

Why in News?

Recently, a few people have been arrested by the police on charges of allegedly providing snake venom for a rave party under the **Wild Life (Protection) Act, 1972**, and the **Indian Penal Code (Bharatiya Nyay Sanhita, 2023)**.

What are Key Facts About Snake Venom and its Use?

- **About:**
 - Out of nearly 3400 snake species globally, **India hosts around 300 snake species** inhabiting varying habitats across the country.
- **Types of Snake:** The species falls under 4 families namely - **Colubridae, Elapidae, Hydrophiidae, and Viperidae**.
- **Venomous Snake:** Out of 300 species found in India, more than 60 are venomous, 40+ mildly venomous, and about 180 non-venomous.
 - **Snake venoms (highly toxic saliva)** are the **secretions of venomous snakes**, which are synthesised and stored in special glands.

Astronomical Grand Cycles

Why in News?

A recent study published in the journal **Nature Communications** has found evidence of erosion in the deep sea linking **astronomical grand cycles** with the **orbits of Earth and Mars**, and **global warming or cooling**.

What are the Key Findings of the Study?

- **Astronomical Grand Cycles:**
 - Geological sedimentary evidence in the deep sea has revealed a newly discovered **2.4-million-year cycle, known as "astronomical grand cycles,"** linked with the orbits of Earth and Mars.
 - The cycle influences **global warming or cooling trends** and has been detected through **erosion patterns in deep-sea sedimentary data**.
- **Connection Between Mars' Orbit and Earth's Climate:**
 - The **gravity fields of planets in the solar system** interfere with each other, leading to changes in their **orbital eccentricity (how circular their orbits are)**.
 - The interaction between Earth and Mars' orbits causes variations in the **amount of solar radiation received by Earth**, resulting in **cycles of warming and cooling over 2.4 million years**.

What are Astronomical Cycles?

- Astronomical cycles refer to **periodic variations in the Earth's orbit and orientation towards the Sun** that impact the amount of solar radiation received by our planet over long periods.
 - These cycles are caused by the **gravitational forces between the Earth, Sun, and other planets** in the solar system.
- These cycles were first theorised by **Serbian scientist Milutin Milankovitch** in the 1920s to explain the cyclical patterns of **ice ages** on Earth also called **Milankovitch cycles, or Milankovitch oscillations**.
 - Some key astronomical cycles include
 - **Eccentricity** (100,000 years) - Changes in the elliptical shape of Earth's orbit around the Sun.
 - **Obliquity** (41,000 years) - Variations in the tilt of Earth's axis relative to its orbital plane.
 - **Precession** (23,000 years) - The shifting orientation of **Earth's axis over time**.

Note:

Challenges of Handling Nuclear Waste

Why in News?

Recently, India loaded the core of its long-delayed **prototype fast breeder reactor (PFBR) vessel**, bringing it to the cusp of stage II — powered by **uranium and plutonium** — of its three-stage nuclear programme.

- By **stage III**, India hopes to be able to **use its vast reserves of thorium** to produce nuclear power.
- Managing nuclear waste poses a significant challenge due to the widespread use of nuclear power.

Prototype Fast Breeder Reactor (PFBR)

- A breeder reactor is a nuclear reactor that **generates more fissile material than it consumes** by irradiation of fertile material, such as Uranium-238 or Thorium-232 that is loaded into the reactor along with fissile fuel.

- These are designed to extend the nuclear fuel supply for electric power generation.
- PFBR is a 500-megawatt electric (MWe) fast-breeder nuclear reactor presently being constructed at the Madras Atomic Power Station in Kalpakkam (Tamil Nadu).
 - It is fuelled by Mixed Oxide (MOX) Fuel.

What is Nuclear Waste?

- In a **fission reactor**, **neutrons bombard the nuclei of atoms of certain elements**. When one such nucleus absorbs a neutron, it destabilises and breaks up, yielding some energy and the nuclei of different elements.
 - **For example**, when the **uranium-235 (U-235)** nucleus absorbs a neutron, it can fission to **barium-144, krypton-89, and three neutrons**. If the **'debris' (barium-144 and krypton-89)** constitute elements that can't undergo fission, they become nuclear waste.

Note:



