



Drishti IAS Presents...

PT

SPRINT 2022

SCIENCE & TECHNOLOGY

(January 2021 – March 2022)



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Epilepsy

Why in News

Recently, a major drugmaker has developed the **Active Pharmaceutical Ingredient (API)** and the finished dosage formulation of Brivanext, a drug for **epilepsy**.

Key Points

➤ Epilepsy:

- Epilepsy is a central nervous system (neurological) disorder in which brain activity becomes abnormal, causing seizures or periods of unusual behavior, sensations, and sometimes loss of awareness.
- Epilepsy is the fourth most common neurological disorder and affects people of all ages.
- Anyone can develop epilepsy, but it's more common in young children and older adults. It occurs slightly more in males than in females.

➤ Symptoms:

- Alterations to sense of taste, smell, sight, hearing, or touch, dizziness, tingling and twitching of limbs, Staring blankly, unresponsiveness, performing repetitive movements.
- It may or may not involve loss of awareness or consciousness.

➤ Cure:

- There's **no cure for epilepsy**, but the disorder can be managed with medications and other strategies.

➤ Initiative to Raise Awareness: In 2019, a report **Epilepsy, a public health imperative** was released by the **World Health Organization**.

- It is the first global report on epilepsy summarizing the available evidence on the burden of epilepsy and the public health response required at global, regional and national levels.

Active Pharmaceutical Ingredients (APIs)

- APIs, also called bulk drugs, are significant **ingredients in the manufacture** of drugs. The Hubei province of China is the hub of the API manufacturing industry.
- India is heavily import-dependent for APIs from China. India's API imports stand at around \$3.5 billion per year, and around 70%, or \$2.5 billion, come from China.

Genetically Modified Organisms as Imported Food Crops

Why in News

The **Food Safety and Standards Authority of India (FSSAI)** in a recent order has set 1% threshold for **Genetically Modified Organisms (GMO)** in food crops imported into India.

- Earlier in August 2020, FSSAI had issued the order that 24 food crops the country imports would need a '**non-GM-origin-cum-GM-free certificate**' issued by a competent authority.

Key Points

➤ Genetically Modified Organisms (GMOs):

What is a GM crop?
A crop which has a gene artificially inserted into it from another species, even unrelated, to give it some desired properties. GM crops are mostly either pest-resistant or herbicide-tolerant

When did India get its first GM crop?
The first GM crop variety approved for commercialisation was Bt cotton. Bollgard-I, which provided immunity against the pink bollworm and developed by Monsanto, was given the go ahead in 2002. Monsanto released Bollgard-II in 2006. India has become the world's largest producer of cotton partly due to Bt cotton, which accounts for over 90% of the total cotton acreage in the country

Are there other GM crops in India?
No, the government has not approved commercial cultivation of other GM crops, though efforts have been made for brinjal and mustard

- These are **living organisms whose genetic material has been artificially manipulated** in a laboratory through **genetic engineering**.
- This creates combinations of plant, animal, bacteria, and virus genes that do not occur in nature or through traditional crossbreeding methods.

➤ Genetically Modified Crops:

- Conventional plant breeding involves crossing of species of the same genus to provide the offspring with the desired traits of both parents.
 - Genus is a class of items such as a group of animals or plants with similar traits, qualities or features.
- **Bt cotton** is the only Genetically Modified (GM) crop that is allowed in India. It has alien genes from the soil bacterium *Bacillus thuringiensis* (*Bt*) that allows the crop to develop a protein toxic to the common pest **pink bollworm**.

Note:



- **Herbicide Tolerant Bt (Ht Bt) cotton**, on the other hand is derived with the insertion of an additional gene, from another soil bacterium, which allows the plant to resist the common herbicide glyphosate.
- In **Bt brinjal**, a gene allows the plant to resist attacks of fruit and shoot borers.
- In **DMH-11 mustard**, genetic modification allows cross-pollination in a crop that self-pollinates in nature.
- **Legal Position of GM crops in India:**
 - In India, the **Genetic Engineering Appraisal Committee (GEAC)** is the apex body that allows for commercial release of GM crops.
 - Use of the unapproved GM variant can attract a jail term of 5 years and fine of Rs. 1 lakh under the **Environment Protection Act, 1986**.
- **Regulation of Imported Crops:**
 - The task of regulating GMO levels in **imported consumables** was **initially with the Genetic Engineering Appraisal Committee (GEAC)**.
 - Its role was diluted with the enactment of the **Food Safety and Standards Act, 2006** and **FSSAI** was asked to take over approvals of imported goods.

Airline Mapping of Ocean Floor

Why in News

The **Indian National Centre for Ocean Information Services (INCOIS)** is planning to conduct **airline mapping of Andaman and Nicobar Islands and Lakshadweep** to get a better picture of the ocean floor.

- **Lakshadweep Islands** are located in the Arabian Sea. These are **coral islands** located off the coast of Kerala. The **Andaman and the Nicobar Islands** lie to the southeast of the Indian mainland in the Bay of Bengal.

Key Points

- **About INCOIS:**
 - INCOIS is an **autonomous organization** under the **Ministry of Earth Sciences (MoES)**.
 - It is located in **Hyderabad** & was established in 1999.
 - It is a unit of the **Earth System Science Organization (ESSO)**, New Delhi.
 - The ESSO operates as an **executive arm of the Ministry of Earth Sciences (MoES)** for its policies and programmes.

- **Mandate of INCOIS:** To provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvement through systematic and focused research.
- **Recent Initiative:**
 - The INCOIS is planning to take the help of the **National Remote Sensing Centre (NRSC)** to conduct '**bathymetric**' study of Andaman and Nicobar Islands and Lakshadweep.
 - **NRSC:** It is one of the primary centres of **Indian Space Research Organisation (ISRO)**, Department of Space (DOS).
 - **Bathymetry:**
 - It is the study of the "beds" or "floors" of water bodies, including the ocean, rivers, streams, and lakes.
 - The term "bathymetry" originally referred to the ocean's depth relative to sea level, although it has come to mean "submarine topography," or the depths and shapes of underwater terrain.
 - NRSC has already done a similar high resolution topographic **Airborne Laser Terrain Mapping (ALTM)** for entire coastal areas of the country.
 - ALTM is an active remote sensing technology that employs **Light Detection and Ranging (LIDAR)** to measure topography at high spatial resolution over large areas.
 - ALTM pulses a laser to measure the range between an airborne platform and the Earth's surface at many thousands of times per second.
 - Using a rotating mirror or other scanning mechanism inside the laser transmitter, the laser pulses can be made to sweep through an angle, tracing out a line or other patterns on the reflecting surface.
 - The scientists are in the **process of integrating the data for a 3D multi-hazard mapping of both the east and west coastline** for a more precise picture of the ocean floor.
- **Significance:**
 - Such a study has become imperative **in view of the recent tsunamis warning**.
 - Recently, at Indonesian coasts, where more than the quake related high waves, **damage was due**

Note:



to landslides that had under the sea beds causing sudden wave surge leading to much damage without giving sufficient time to alert people.

➤ **Similar Global Initiative:**

- **Seabed 2030** is a collaborative project between the Nippon Foundation of Japan and the General Bathymetric Chart of the Oceans (GEBCO).
- The project **aims to bring together all available bathymetric data to produce the definitive map of the world ocean floor by 2030** and make it available to all.

NASA's Mars 2020 Mission

Why in News

National Aeronautics and Space Administration (NASA's) Perseverance Rover has landed on Mars.

- This was one of the most crucial aspects of the **Mars 2020 Mission**.

Key Points

➤ **About:**

- The mission is designed to better understand the **geology of Mars** and seek **signs of ancient life**.

➤ **Objectives:**

- Assess **ancient habitability**.
- **Demonstrate technology** for future robotic and human exploration.

- **Duration:** At least one Mars year (about 687 Earth days).

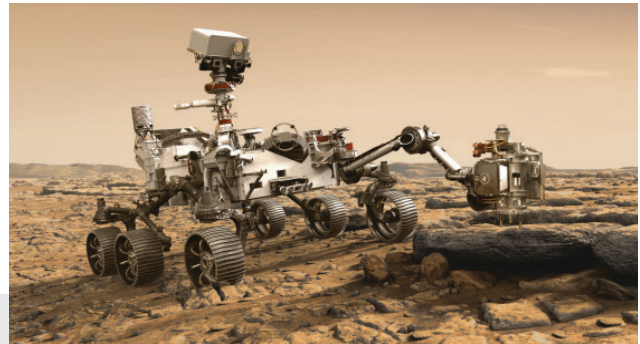
➤ **Mission Steps:**

- **Collect:** Perseverance will collect rock and soil samples in cigar-sized tubes. The samples will be collected, the canisters will be sealed, and left on the ground.
- **Fetch:** A **Mars Fetch Rover (provided by the European Space Agency)** will land, drive, and collect all samples from the different locations, and return to the lander.
- **Transfer:** These samples will be transferred to the **Mars Ascent Vehicle** which will meet with an Orbiter.
- **Return:** The **Orbiter** will carry the samples back to Earth.

Perseverance Rover

➤ **About:**

- Perseverance is the most advanced, most expensive and most sophisticated mobile laboratory sent to Mars.
- It is **different from previous missions** because it is capable of drilling and collecting core samples of the most promising rocks and soils, and setting them aside in a "cache" on the surface of Mars.



- **Launch:** 30th July, 2020

- **Landing:** 18th February, 2021

➤ **Landing Site:**

- **Jezero Crater** (an ancient river delta that has rocks and minerals that could only form in water).

➤ **Power Source:**

- A Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) which converts heat from the natural **radioactive decay of plutonium (Plutonium Dioxide)** into electricity.

NASA's Ingenuity Mars Helicopter

Why in News

Recently, NASA's miniature **robot helicopter Ingenuity** performed a successful takeoff and landing on **Mars**. It was the **first powered, controlled flight on another planet**.

- The **first powered flight on Earth** was achieved by the **Wright brothers in 1903** in Kitty Hawk, North Carolina.

Key Points

➤ **About Ingenuity:**

- Ingenuity is the **first helicopter to fly on Mars**.

Note:





- It was carried by **NASA's rover called Perseverance** that was launched in July 2020.
- Ingenuity is able to fly using counter-rotating blades that spin at about 2,400 rpm (Rotations Per Minute).
- It has a **wireless communication system**, and is equipped with computers, navigation sensors, and two cameras.
- It is **solar-powered**, able to charge on its own.
- **Mission of the Helicopter:**
 - It will help collect samples from the surface from locations where the rover cannot reach.
- **Importance of this Flight:**
 - Its performance during these experimental test flights will **help inform decisions about small helicopters for future Mars missions** — where they can perform a support role as **robotic scouts, surveying terrain from above**, or as full standalone science craft carrying instrument payloads.

UAE's Hope Mars Mission

Why in News

Recently, the **United Arab Emirates' (UAE's) first-ever interplanetary Hope Probe mission** has successfully entered orbit around **Mars**.

Key Points

- **Hope Probe Mission:**
 - **About:**
 - The UAE's Mars Mission called 'Hope' was announced in 2015 with the aim of creating

mankind's first integrated model of the Red planet's (Mars) atmosphere.

- 'Hope' was developed by UAE scientists in the USA and was launched in July 2020 from the Tanegashima Space Centre in Japan.
- **Specification:**
 - The Mars Hope Probe **weights just 1.5 tonnes**, about the same size as an SUV. It is **expected to complete one orbit around the planet every 55 hours**.
 - The **overall life of UAE's Mars mission is around one Martian year**, which is about 687 days on Earth.
- **Significance:**
 - With the successful Mars orbit insertion, the **UAE becomes the fifth entity to reach the Red Planet**, joining NASA, the Soviet Union, the European Space Agency and India.
 - Success of this mission will help UAE in building a knowledge-based economy, leading to **more investment in Science, Technology, Engineering and Mathematics (STEM)** for young Emiratis.
 - The probe reached Mars in the year the **UAE celebrates its 50th anniversary**.
 - 'Hope' mission is not only important for UAE, but also for the whole of Arab world, as it is the **Arab world's first interplanetary mission**.

India's Mars Orbiter Mission

- Also known as Mangalyaan, it was launched from the Satish Dhawan Space Centre in Andhra Pradesh by **Indian Space Research Organisation (ISRO)** in November 2013.
- It was launched on board a PSLV C25 rocket with aim of studying Martian surface and mineral composition as well as scan its atmosphere for methane (an indicator of life on Mars).

Mars

- **Size and Distance:**
 - It is the **fourth planet from the Sun** and the **second-smallest planet** in the Solar System.
 - Mars is about half the size of Earth.
- **Similarity to the Earth (Orbit and Rotation):**
 - As Mars orbits the Sun, it completes one rotation every 24.6 hours, which is very similar to one day on Earth (23.9 hours).

Note:



- Mars' axis of **rotation is tilted 25 degrees** with respect to the plane of its orbit around the Sun. This is similar with Earth, which has an axial tilt of 23.4 degrees.
- Like Earth, Mars has distinct seasons, but they last longer than seasons on Earth since Mars takes longer to orbit the Sun (because it's farther away).
- Martian days are called sols — short for '**solar day**'.
- **Surface:**
 - It has colors such as brown, gold and tan. The reason Mars looks reddish is due to oxidation or rusting of iron in the rocks, and dust of Mars. Hence it is also called **Red Planet**.
 - Mars has the **largest volcano in the solar system i.e. Olympus Mons**. It's three times taller than Earth's Mt. Everest with a base the size of the state of New Mexico.
- **Atmosphere:**
 - Mars has a thin atmosphere made up mostly of carbon dioxide, nitrogen and argon gases.
- **Magnetosphere:**
 - Mars has no magnetic field till date, but areas of the Martian crust in the southern hemisphere are highly magnetized, indicating traces of a magnetic field.
- **Moons:**
 - Mars has two small moons, **Phobos and Deimos**, that may be captured asteroids.
- **Previous Mars Missions:**
 - The **Soviet Union in 1971** became the first country to carry out a Mars landing, Mars 3.
 - The second country to reach Mars's surface is the **United State of America (USA)**. Since 1976, it has achieved 8 successful Mars landings, the latest being the '**InSight**' in 2019.
 - **European Space Agency** has been able to place their spacecraft in Mars's orbit through the **Mars Express Mission**.
- **India's Mars Orbiter Mission (MOM) or Mangalyaan:**
 - It was launched from the Satish Dhawan Space Centre in Andhra Pradesh by **Indian Space Research Organisation** in November 2013.

- It was launched on board a PSLV C-25 rocket with aim of studying Martian surface and mineral composition as well as scan its atmosphere for methane (an indicator of life on Mars).
- **Reasons for Frequent Missions to Mars:** There are **two primary** reasons:
 - **Similar to Earth:**
 - First, Mars is a planet where life may have evolved in the past. Conditions on early Mars roughly around 4 billion years ago were very similar to that of Earth.
 - It had a thick atmosphere, which enabled the stability of water on the surface of Mars.
 - If indeed conditions on Mars were similar to those on Earth, there is a real possibility that microscopic life evolved on Mars.
 - **Most Suitable among Other Planets:**
 - Mars is the only planet that humans can visit or inhabit in the long term. Venus and Mercury have extreme temperatures – the average temperature is greater than 400 degree C. All planets in the outer solar system starting with Jupiter are made of gas – not silicates or rocks – and are very cold.
 - Mars is comparatively hospitable in terms of temperature, with an approximate range between 20 degrees C at the Equator to minus 125 degrees C at the poles.

Bhuvan Portal

Why in News

Recently, **Indian Space Research Organisation (ISRO)** and **MapmyIndia** have partnered to come up with an **indigenous geospatial portal** known as '**Bhuvan**'.

- This is in line with the above discussed new **guidelines for the Geo-Spatial Sector** in India.

Key Points

- **Geospatial Portal (Bhuvan):**
 - It is a type of web portal **used to find and access geographic information** (geospatial information) **and associated geographic services** (display, editing, analysis, etc.) **via the Internet**.

Note:



➤ The Collaboration:

- MapmyIndia's database will be connected with ISRO's high-end satellite catalogue and earth observation data, which it generates through a constellation of its satellites.
- The collaboration will enable them to jointly identify and build a holistic **geospatial portal** utilising earth observation datasets, **Navigation in Indian Constellation (NavIC)**, Web Services and **APIs** (application programming interface) available in MapmyIndia.
 - API is a **software intermediary** that allows two applications to talk to each other.
 - It is a computing interface that defines **interactions between multiple software intermediaries**

➤ Significance of the Portal:

- **True Maps:**
 - Its services will **reflect the true borders of the country** as per the information available from Government of India.
- **Protects Privacy:**
 - By using MapmyIndia maps and applications instead of the foreign map apps, **users can better protect their privacy.**
 - As foreign search engines and companies claim to offer 'free' maps, but in reality, they make money by targeting the same users with advertising, by **invading the user's privacy and auctioning private location and movement data.** However there is no such provision of advertisement in MapmyIndia.
- **Atma Nirbhar Bharat:** Being an Indian platform, it is well aligned with the government's Mission of **Atma Nirbhar Bharat.**

Navigation in Indian Constellation (NavIC)

➤ About:

- It is an **Indian Regional Navigation Satellite System (IRNSS)**, developed by the Indian Space Research Organization (ISRO).
 - IRNSS consists of **eight satellites**, three satellites in geostationary orbit and five satellites in geosynchronous orbit.
- It works just like the established and popular **U.S. Global Positioning System (GPS)** but within a 1,500-km radius over the sub-continent.

- It has been **certified by the 3rd Generation Partnership Project (3GPP)**, a global body for coordinating mobile telephony standards.

➤ Objective:

- The main objective is to **provide reliable position, navigation and timing services** over India and its neighbourhood.

➤ Potential Uses:

- Terrestrial, aerial and marine navigation;
- Disaster management;
- Vehicle tracking and fleet management (especially for mining and transportation sector);
- Integration with mobile phones;
- Precise timing (as for ATMs and power grids);
- Mapping and geodetic data capture.

➤ Other Global Navigational Systems:

- **BeiDou / BDS** (China)
- **Galileo** (Europe)
- **GLONASS** (Russia)
- **Quasi-Zenith Satellite System (QZSS)** (Japan)

Sandes: Government Instant Messaging System

Why in News

The **National Informatics Centre (NIC)** has launched an instant messaging platform called **Sandes** on the lines of WhatsApp.

- NIC is under the aegis of the **Ministry of Electronics and Information Technology**. It provides network backbone and e-Governance support to the Central Government, State Governments and UT Administrations.

Key Points

➤ Sandes App:

○ About:

- It is a **Government Instant Messaging System (GIMS)** that can be used for official or casual use by any Government employee or public user having a valid Mobile No./Email ID.

○ Features:

- It offers features such as group making, broadcast message, message forwarding and emojis.

Note:



- Although there is **no option to transfer the chat history between two platforms**, the **chats on GIMS can be backed up** to a users' email.
- The **user will have to re-register as a new user** in case they wish to change their registered Email Id or phone number on the App.
- It **allows a user to mark a message as confidential**, which will allow the recipient to be made aware the message should not be shared with others.

➤ **Significance:**

○ **Ensures Secure Communication:**

- The **Computer Emergency Response Team (Cert-In)** and the **Ministry of Home Affairs** in April, 2020 had issued an advisory to all government employees to **avoid using platforms like Zoom** for official communication over safety and privacy concerns.

○ **Promoting Indigenous Products:**

- The launch of the App is also a **part of the government strategy to push for use of India-made software** so as to build an ecosystem of indigenously developed products.

Silver Antimony Telluride: A Material to Tap Waste Heat

Why in News

Scientists at the **Bengaluru-based Jawaharlal Nehru Centre for Advanced Scientific Research**, have found a new material, **Silver Antimony Telluride (AgSbTe_2)**, that can help in tapping waste heat produced by all kinds of domestic and industrial appliances, and use it to accomplish other useful work.

- Basically, the material will **exploit the benefits of thermo-electric effect**. The thermo-electric effect involves the process by which heat is transformed to electrical energy.

Key Points

➤ **About Silver Antimony Telluride:**

- It is a **nanomaterial** compound synthesised from **Silver, Copper and Tellurium**.
- A crystalline solid, it has free electrons that help in conduction of electricity but its lattices (arrangement

of atoms) are rather inflexible, and vibrate quite slowly thereby inhibiting the propagation of heat.

- Thus, it is a **good conductor of electricity but a bad conductor of heat**, a property important for **Thermo-electric effect**.

- There are **a variety of potential applications**. Industrial processes and power plants, along with all kinds of domestic appliances, produce ample amounts of waste heat that can be utilised to do significant amounts of work.

- The heat from the laptop, for example, can be used to charge a mobile phone. Or, that from the phone can be used to charge a small watch.

➤ **Challenge:**

- Energy conversion is not a very efficient process. Typically, **not more than 15 to 20% of the waste heat can be utilised**.

Clean Fuel Hydrogen

Why in News

Recently, researchers at the **Indian Institute of Technology, Delhi (IIT-D)** have come up with a way to **generate clean fuel hydrogen from water at a low-cost**.

- It is a significant step towards efforts across the globe that are being made to look for cleaner and greener energy sources.
- Hydrogen gas is a viable choice as a **renewable substitute for fossil fuels**, and can help **mitigate emissions to reduce pollution**.

Key Points

➤ **About:**

- The researchers at IIT-D have successfully split water by a process known as **Sulphur-Iodine (SI) thermochemical hydrogen cycle (SI Cycle)** to **generate low-cost**, clean hydrogen fuel for industrial consumption.
- Generally in **SI Cycle**, the **separation of Hydrogen from oxygen requires a high amount of heat** (generally from non-renewable sources such as coal, oil and natural gas). This makes the large-scale production of hydrogen gas economically non viable and non environment friendly.

- The main achievement has been **designing a suitable catalyst** for the energy intensive, corrosive step of sulphuric acid conversion to sulphur-dioxide and oxygen.

Sulfur-Iodine Cycle

➤ Process:

- The sulfur-iodine cycle (**SI cycle**) is a three-step **thermochemical cycle** used to produce hydrogen. In this cycle, all the chemicals are recycled. The SI process requires an efficient source of heat.
- Heat enters the cycle in high-temperature endothermic chemical reactions in the initial process and heat exits the cycle in the low-temperature exothermic reaction in the final stage of obtaining hydrogen gas.

➤ Three-Step Thermochemical Cycle:

- **Step 1:** Iodide (I_2) is reacted with Sulphur dioxide (SO_2) to produce Hydriodic acid (HI) and Sulphuric acid (H_2SO_4).
 - $I_2 + SO_2 + 2 H_2O \rightarrow 2 HI + H_2SO_4$
- **Step 2:** The water, SO_2 and residual H_2SO_4 is separated from the oxygen byproduct by condensation so as to obtain Hydriodic acid (HI).
 - $2 H_2SO_4 \rightarrow 2 SO_2 + 2 H_2O + O_2$
- **Step 3:** It is the Hydriodic acid (HI) from which Hydrogen gas (H_2) is obtained.
 - $2 HI \rightarrow I_2 + H_2$
- The difference between the heat entering and leaving the cycle exits the cycle in the form of the heat of combustion of the hydrogen produced.
- Major **challenges** of the sulfur-iodine cycle are to **reduce the surplus of water** and iodine and find separation **processes that consume less energy** than distillation.
- Traditionally development of the SI cycle has been pursued by several countries for hydrogen production with the **Generation IV nuclear reactors**.

➤ Significance of the Discovery:

- **Enhancing Hydrogen Fuel Cell Technology:**
 - Enabling availability of low cost hydrogen through this discovery will enhance and improve the application of **Hydrogen fuel cell technology** which offers the advantages of a clean and reliable alternative energy source to applications such as – electric vehicles, primary

and backup power for a variety of commercial, industrial, and residential buildings; and more futuristic-sounding applications like air taxis.

- **A hydrogen fuel cell is an electrochemical power generator** that combines hydrogen and oxygen to produce electricity, with water and heat as by-products.

○ Help Adhering Emission Targets:

- It could help India to adhere to its commitment in the **Paris Climate Agreement** and its **Intended Nationally Determined Contribution (INDC) Targets** and ensure that its mobility in the future is with zero emissions.

○ Complements FAME India Scheme:

- It will complement the implementation of the **FAME India Scheme** launched with the objective to support hybrid/electric vehicles market development and manufacturing ecosystem.

Square Kilometre Array Telescope

Why in News

Recently, the **Square Kilometre Array Observatory (SKAO)** Council held its inaugural meeting and approved the establishment of the **world's largest radio telescope**.

- The new venture is being deemed as important following the collapse of one of the most prolific radio telescopes in the world, the **Arecibo in Puerto Rico**, in December last year.
- **SKAO** is a new **intergovernmental organisation dedicated to radio astronomy** and is **headquartered in the UK**.
 - At the moment, organisations from ten countries are a part of the SKAO.
 - These include **Australia, Canada, China, India, Italy, New Zealand, South Africa, Sweden, the Netherlands and the UK**.

Key Points

➤ Radio Telescopes:

- Radio telescope, **astronomical instrument** consisting of a **radio receiver and an antenna system** that is used to detect radio-frequency radiation between wavelengths of about **10 metres (30 megahertz**

Note:



[MHz]) and 1 mm (300 gigahertz [GHz]) emitted by extraterrestrial sources, such as **stars, galaxies, and quasars**.

- Unlike optical telescopes, **radio telescopes can detect invisible gas** and, therefore, they can **reveal areas of space that may be obscured by cosmic dust**.
 - **Cosmic dust** consists of tiny particles of solid material floating around in the space between the stars.
- Since the first radio signals were detected in the 1930s, astronomers have used radio telescopes to detect **radio waves** emitted by different objects in the universe and explore it.
- According to the **National Aeronautics and Space Administration (NASA)**, the field of **radio astronomy evolved after World War II** and became one of the most important tools for making astronomical observations.

➤ **The Arecibo Telescope:**

- The Arecibo telescope in Puerto Rico, which was **the second-largest single-dish radio telescope** in the world, collapsed in December 2020.
 - China's **Sky Eye** is the world's largest single-dish radio telescope.
- The telescope **was built in 1963**.
- Because of its powerful radar, scientists employed it to **observe planets, asteroids and the ionosphere, making several discoveries** over the decades, including **finding prebiotic molecules in distant galaxies, the first exoplanets, and the first-millisecond pulsar**.

➤ **Square Kilometer Array (SKA) Telescope:**

- **Location:**
 - The telescope, proposed to be the largest radio telescope in the world, will be **located in Africa and Australia**.
- **Development:**
 - The development of SKA will use the results of various surveys undertaken using another powerful telescope called the **Australian Square Kilometre Array Pathfinder (ASKAP)**.
 - ASKAP is developed and operated by the Australia's science agency **Commonwealth Scientific and Industrial Research Organisation (CSIRO)**.

- This telescope, which has been fully operational since February 2019 **mapped over three million galaxies** in a record 300 hours during its first all-sky survey conducted late last year.
- ASKAP surveys are **designed to map the structure and evolution of the Universe**, which it does by observing galaxies and the hydrogen gas that they contain.

○ **Maintenance:**

- Its operation, maintenance and construction will be overseen by **SKAO**.

○ **Cost and Completion:**

- The completion is expected to take nearly a decade at a cost of over **1.8 billion pounds**.

○ **Significance:**

- Some of the questions that scientists hope to address using this telescope:
 - The **beginning of the universe**.
 - How and when the **first stars** were born.
 - The **life-cycle of a galaxy**.
 - Exploring the possibility of **detecting technologically-active civilisations elsewhere** in our galaxy.
 - Understanding where **gravitational waves** come from.

○ **Function:**

- As per NASA, the telescope will accomplish its scientific goals by **measuring neutral hydrogen over cosmic time, accurately timing the signals from pulsars in the Milky Way, and detecting millions of galaxies out to high redshifts**.

Lumpy Skin Disease

Why in News

Recently, a **Lumpy Skin Disease (LSD)** has been infecting India's bovines.

- The disease is being reported for the **first time in India**.

Key Points

➤ **Cause:**

- The LSD is caused by infection of cattle or water buffalo with the **poxvirus Lumpy skin disease virus (LSDV)**.

Note:



- The virus is one of three closely related species within the genus **capripoxvirus**, the other two species being **Sheeppox virus** and **Goatpox virus**.

➤ Symptoms:

- It appears as **nodules of two to five centimetre diameter** all over the body, particularly around the **head, neck, limbs, udder (mammary gland of female cattle) and genitals**.
 - The lumps gradually open up like large and deep wounds.
- Other clinical signs include **general malaise, ocular and nasal discharge, fever, and sudden decrease in milk production**.

➤ Effect:

- According to the **Food and Agriculture Organization (FAO)** the mortality rate is less than 10%.

➤ Vectors:

- It spreads through **mosquitoes, flies and ticks** and also through **saliva and contaminated water and food**.

➤ Prevention:

- Control and prevention of lumpy skin disease relies on four tactics - **movement control (quarantine), vaccination, slaughter campaigns and management strategies**.

➤ Treatment:

- There is **no treatment for the virus**, so **prevention by vaccination** is the most effective means of control.
 - **Secondary infections** in the skin may be **treated with Non-Steroidal Anti-Inflammatories (NSAIDs)** and also **antibiotics** when appropriate.

➤ Global Spread:

- LSD is endemic to **Africa and parts of West Asia**, where it was first **discovered in 1929**.
- In Southeast Asia the first case of LSD was reported in **Bangladesh in July 2019**.
- In India, which has the **world's highest 303 million heads of cattle**, the disease has spread to **15 states within just 16 months**.
 - In India it was first reported from **Mayurbhanj, Odisha in August 2019**.

➤ Implication:

- This will have a **devastating impact on the country**, where most dairy farmers are either landless or marginal landholders and **milk is among the cheapest protein sources**.

Trans Fatty Acids

Why in News

The **Food Safety and Standards Authority of India (FSSAI)** has capped the amount of **trans fatty acids (TFA)** in oils and fats to **3% for 2021** and **2% by 2022** from the current permissible limit of **5%** through an **amendment to the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations 2011**.

- The **Regulations deal with the prohibitions and restrictions on sales of various food products, ingredients and their admixtures**.

Key Points

- The revised regulation **applies to** edible refined oils, vanaspati (partially hydrogenated oils), margarine, bakery shortenings, and other mediums of cooking such as vegetable fat spreads and mixed fat spreads.
- As per the **World Health Organisation (WHO)**, approximately **5.4 lakh deaths** take place each year globally because of intake of **industrially produced trans fatty acids**.
- The FSSAI rule comes at the time of a **pandemic** where the burden of **non-communicable diseases (NCD)** has risen.
 - Trans-fat consumption is a significant risk factor for cardiovascular diseases.
 - Cardiovascular diseases account for most NCD deaths.
- Previously it was in 2011 that India first passed a regulation that set a TFA limit of **10%** in oils and fats, which was further reduced to **5%** in **2015**.

Trans Fat

- Trans fatty acids (TFAs) or Trans fats are the **most harmful type of fats** which can have much more adverse effects on a human body than any **other dietary constituent**.
- These fats are **largely produced artificially** but a **small amount also occurs naturally**. Thus in our diet, these may be present as Artificial TFAs and/or Natural TFAs.
 - Artificial TFAs are formed when **hydrogen is made to react with the oil to produce fats resembling pure ghee/butter**.

Note:



- In our diet the major sources of artificial TFAs are the **partially hydrogenated vegetable oils (PHVO)/ vanaspati/ margarine** while the **natural TFAs are present in meats and dairy products**, though in small amounts.
- **Usage:**
 - TFA containing oils can be preserved longer, they give the food the **desired shape and texture** and can easily substitute 'Pure ghee'. These are comparatively far lower in cost and thus add to profit/saving.
- **Harmful effects:**
 - TFAs pose a higher **risk of heart disease** than saturated fats. While saturated fats raise total cholesterol levels, TFAs not only **raise total cholesterol levels** but also **reduce the good cholesterol** (HDL), which helps to protect us against heart disease.
 - It is also associated with a higher risk of developing **obesity, type 2 diabetes, metabolic syndrome, insulin resistance, infertility, certain types of cancers** and can also lead to **compromised fetal development** causing harm to the yet to be born baby.
 - Metabolic syndrome includes **high blood pressure, high blood sugar, excess body fat around the waist and abnormal cholesterol levels**. The syndrome increases a **person's risk of heart attack and stroke**.
- **Efforts to reduce their intake:**
 - **National:**
 - FSSAI launched a **"Trans Fat Free"** logo for voluntary labelling to promote **TFA-free products**. The label can be used by bakeries, local food outlets and shops for preparations containing TFA not exceeding **0.2 per 100 g/ml**.
 - FSSAI launched a new mass media campaign **"Heart Attack Rewind"** to **eliminate industrially produced trans fat** in the food supply by the year 2022.
 - "Heart Attack Rewind" is a follow-up to an earlier campaign called **"Eat Right"**, which was launched in **July, 2018**.
 - Edible oil industries took a pledge to reduce the levels of salt, sugar, saturated fat and trans fat content by 2% by 2022.

- **Swasth Bharat Yatra**, an initiative started under the **"Eat Right" campaign** is a **Pan-India cyclothon** to engage citizens on issues of food safety, combating food adulteration and healthy diets.

○ **Global:**

- WHO launched a **REPLACE campaign in 2018** for global-level elimination of trans-fats in **industrially produced edible oils by 2023**.

MukundPura Meteorite

Why in News

A recent study has shed light on the mineralogy of the meteorite named Mukundpura CM2 which fell in Mukundpura village near Jaipur in **2017**.

- A meteorite is a **solid piece of debris** from an object, such as a **comet, asteroid, or meteoroid**, that **originates in outer space** and survives its passage through the atmosphere to reach the **surface of a planet or moon**.

Key Points

➤ **About:**

- The meteorite named **Mukundpura CM2** was classified to be a **carbonaceous chondrite**. The composition of carbonaceous chondrites are also similar to the Sun.
- Chondrites are silicate droplet bearing meteorites, and this Mukundpura chondrite is the **5th carbonaceous meteorite known to fall in India**.

➤ **Classification Of Meteorite:**

- Meteorites are classified into **three groups: Stony** (silicate rich), **Iron** (Fe-Ni alloy), and **Stony Iron** (mixed silicate iron alloy).
- **Mukundpura CM2** is a type of **stony meteorite**, considered the **most primitive meteorite** and a remnant of the first solid bodies to accrete in the solar system.

➤ **Components of Meteorite:**

- Detailed spectroscopic studies revealed that the **meteorite had very high (about 90%) phyllosilicate minerals** comprising both **magnesium and iron**.
- **Forsterite and FeO olivine, calcium aluminium rich inclusion (CAI) minerals**.

Note:



Difference between Meteor, Meteorite and Meteoroid

- When **meteoroids** enter Earth's atmosphere (or that of another planet, like Mars) at **high speed and burn up**, the fireballs or "shooting stars" are called **meteors**.
- When a meteoroid **survives a trip through the atmosphere and hits the ground**, it's called a **meteorite**.
 - Few **magnetites, sulphides, aluminium complexes and calcites** were also found.

Quantum Technology

Why in News

The detailed project report for a **National Mission on Quantum Technology and Applications (NMQTA)** has been drawn out and finalised.

- In 2018, the **Department of Science & Technology** unveiled a programme called **Quantum-Enabled Science & Technology (QuEST)** and committed to investing Rs. 80 crore over the next three years to accelerate research.
 - The mission **seeks to develop quantum computing linked technologies amidst the second quantum revolution** and make **India the world's third-biggest nation in the sector** after the US and China.

Key Points

- **About Quantum Technology/Computing:**
 - Quantum Technology is **based on the principles of Quantum mechanics that was developed in the early 20th century** to describe nature at the scale of **atoms and elementary particles**.
 - The first phase of this revolutionary technology has **provided the foundations of our understanding of the physical world, including the interaction of light and matter**, and led to ubiquitous inventions such as **lasers and semiconductor transistors**.
 - A second revolution is currently underway with the **goal of putting properties of quantum mechanics in the realms of computing**.
- **Difference Between Conventional and Quantum Computing:**
 - **Conventional computers** process information in '**bits**' or **1s and 0s**, following classical physics under which our computers can process a '1' or a '0' at a time.

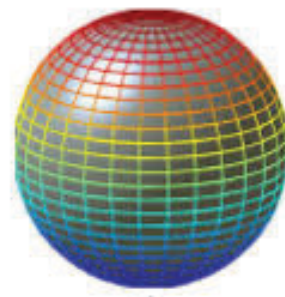
- **Quantum computers** compute in '**qubits**' (or **quantum bits**). They exploit the properties of quantum mechanics, the science that governs how matter behaves on the atomic scale.
 - In this scheme of things, processors can be a 1 and a 0 simultaneously, a state called quantum superposition.
 - Because of quantum superposition, a quantum computer — if it works to plan — can **mimic several classical computers working in parallel**.

Bit
0



1

Qubit
0



1

➤ Applications of Quantum Technology:

- **Secure Communication:**
 - **China recently demonstrated** secure quantum communication links between terrestrial stations and satellites.
 - This area is **significant to satellites, military and cyber security** among others as it promises unimaginably fast computing and safe, unhackable satellite communication to its users.
- **Research:**
 - It can **help in solving some of the fundamental questions in physics related to gravity, black hole etc.**
 - Similarly, the quantum initiative could give a big boost to the **Genome India project**, a collaborative effort of 20 institutions to enable new efficiencies in life sciences, agriculture and medicine.
- **Disaster Management:**
 - **Tsunamis, drought, earthquakes and floods** may become more predictable with quantum applications.

Note:



- The collection of data regarding **climate change** can be streamlined in a better way through quantum technology.
- **Pharmaceutical:**
 - Quantum computing **could reduce the time frame of the discovery of new molecules and related processes** to a few days from the present 10-year slog that scientists put in.
- **Augmenting Industrial revolution 4.0:**
 - Quantum computing is an integral part of **Industrial revolution 4.0**.
 - Success in it will help in **Strategic initiatives aimed at leveraging other Industrial revolution 4.0 technologies** like the **Internet-of-Things**, machine learning, **robotics**, and **artificial intelligence** across sectors will further help in laying the foundation of the Knowledge economy.

Two Dimensional Electron Gas

Why in News

Scientists at **Institute of Nano Science and Technology (INST)**, Mohali, Punjab have produced an **ultra-high mobility Two dimensional (2D)-electron gas (2DEG)**.

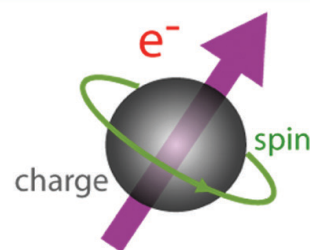
Key Points

- **Two Dimensional Electron Gas (2DEG):**
 - It is an electron gas that is free to move in **two dimensions**, but tightly **confined in the third**. This tight confinement leads to **quantized energy levels for motion in the third direction**. Thus the electrons appear to be a **2D sheet embedded in a 3D world**.
 - One of the most important recent developments in **semiconductors** has been the achievement of structures in which the electronic behavior is essentially **two-dimensional (2D)**.
 - Most 2DEGs are found in **transistor-like structures** made from **semiconductors**.
 - 2DEG is a valuable system for exploring the physics of **superconductivity magnetism and their coexistence**.
 - Superconductivity is a phenomenon whereby a **charge moves through a material without resistance**. In theory this **allows electrical energy to be transferred between two points** with perfect efficiency, losing **nothing to heat**.

➤ Cause for Development of 2DEG:

- The need for attaining new functionalities in modern electronic devices has led to the **manipulation of property of an electron called spin degree of freedom along with its charge**. This has given rise to an altogether new field of spin-electronics or '**spintronics**'.
- The manipulation of **electron spin** offers **new dimensions for basic and applied research**, and the potential for **new capabilities for electronics technology**. This motivates studies of spin polarized electrons in a **high mobility two dimensional electron gas (2DEG)**.
 - Spintronics is the study of the **intrinsic spin of the electron** and its associated **magnetic moment**, in addition to its fundamental electric charge, in solid-state devices.

Spintronics



- It has been realized that a phenomenon called the '**Rashba effect**', which consists of splitting of spin-bands in an electronic system, might play a key role in spintronic devices.
 - **Rashba Effect:** Also called **Bychkov–Rashba effect**, it is a **momentum-dependent splitting of spin bands** in bulk crystals and low-dimensional condensed matter systems.
- **Mechanism and Importance:**
 - Due to the **high mobility of the electron gas**, electrons **do not collide** inside the medium for a **long distance** and hence **do not lose the memory and information**.
 - Hence, it can speed up transfer of quantum information and signal from one part of a device to another and increase data storage and memory.
 - Since they collide **less during their flow**, their **resistance is very low**, and hence they **don't dissipate energy as heat**.
 - So, such devices **do not heat up easily** and need **less input energy** to operate.

Note:



UV-Bright Stars Spotted in Globular Structure NGC 2808

Why in News

Recently, astronomers have spotted rare hot **Ultra Violet (UV)-bright stars** in the **massive intriguing globular cluster** in the **Milky Way Galaxy** called **NGC 2808**.

- **India's first multi-wavelength space satellite AstroSat** helped astronomers in this.

Key Points

- **Data:**
 - Scientists combined data from the **Ultraviolet Imaging Telescope (on board AstroSat)** with observations made using other space missions such as the **Hubble Space Telescope** and the **Gaia telescope** along with **ground-based optical observations**.
 - **Hubble Space Telescope:** The HST or Hubble (NASA) is a space telescope that was launched into **Low Earth orbit** in 1990 and remains in operation. It is one of the **largest and most versatile space telescopes** till date.
 - **Gaia** is a space observatory of the **European Space Agency**, launched in **2013 and expected to operate until 2022**. The spacecraft is designed for astrometry: measuring the positions, distances and motions of stars with unprecedented precision.
- **Findings:**
 - About **34 UV-bright stars** were found to be members of the globular cluster (NGC 2808). One of the UV-bright stars was found to be about **3000 times brighter** than the Sun with a surface temperature of about **1,00,000 K**.
 - **Hot UV-bright stars** have been distinguished from the **relatively cooler red giant and main-sequence stars**.
 - Most of the stars were found to have evolved from a solar stage called the **horizontal branch stars** with hardly any outer envelope. Thus, they were bound to skip the last major phase of life called the **asymptotic giant phase (it is one of the last major phases in the life of stars)** and directly become dead remnants or **white dwarfs**.

- The **horizontal branch (HB)** is a stage of stellar evolution that immediately follows the **red giant branch** in stars.

➤ About NGC 2808:

- NGC 2808 is a **globular cluster in the constellation Carina**. The cluster belongs to the **Milky Way**, and is one of our home galaxy's **most massive clusters**, millions of stars. It is estimated to be 12.5-billion years old.
- It is said to have at least **five generations of stars**.

Stellar Evolution

➤ Nebula:

- A nebula is a cloud of gas (mostly hydrogen and helium) and dust in space.
- Nebulae are the birthplaces of stars.

➤ Main Sequence Stars:

- Main sequence stars are stars that are fusing hydrogen atoms to form helium atoms in their cores.
- Most of the stars in the universe i.e. about 90% of them are main sequence stars. The **sun** is a main sequence star.
- Towards the end of its life, a star like the Sun **swells up into a red giant**, before losing its **outer layers as a planetary nebula and finally shrinking to become a white dwarf**.

➤ Red Dwarf:

- The **faintest (less than 1/1000th the brightness of the Sun) main sequence stars** are called the red dwarfs.
- **Proxima Centauri**, the nearest star to the Sun, is a red dwarf.

➤ Red Giant:

- Red giants have diameters between 10 and 100 times that of the Sun.
- They are very bright, although their surface temperature is lower than that of the Sun.
- A red giant is formed during the **later stages of the evolution as it runs out of hydrogen fuel at its centre**.
- A very large red giant is often called **Red Supergiant**.

➤ Planetary Nebula:

- Planetary nebula is an outer layer of gas and dust that are lost **when the star changes from a red giant to a white dwarf**.

Note:



➤ White Dwarf:

- A white dwarf is a **very small, hot star, the last stage in the life cycle of a star.**
- White dwarfs are the remains of normal stars, whose nuclear energy supplies **have been used up.**
- White dwarf consists of degenerate matter with a **very high density** due to gravitational effects.

➤ Nova:

- Novae occur on the surface of a **white dwarf** in a binary system.
- If the two stars of the system are sufficiently near to one another, material (hydrogen) can be pulled from the companion star's surface onto the white dwarf.
- When enough material builds up on the surface of the white dwarf, it triggers a nuclear fusion on a white dwarf which causes a **sudden brightening of the star.**

➤ Supernova:

- A supernova is the **explosive death of a star** and often results in the star obtaining the brightness of **100 million suns for a short time.**
- The extremely luminous burst of radiation expels much or all of a **star's material at a great velocity**, driving a shock wave into the surrounding interstellar medium.
- These shock waves trigger condensation which is a nebula paving the way for the birth of a new star.

➤ A neutron star is the **collapsed core of a massive supergiant star.**

AstroSat

- It is a **multi-wavelength astronomy mission** on an IRS-class (Indian Remote Sensing-Class) satellite in a **650-km, near-equatorial orbit.**
- **Launch:** It was launched by the Indian launch vehicle **PSLV** from Satish Dhawan Space Centre, Sriharikota in 2015 by ISRO.
- It is the **first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands** simultaneously with its five unique X-ray and ultraviolet telescopes working in tandem.
- One of the unique features of AstroSat mission is that it enables the **simultaneous multi-wavelength observations** of various astronomical objects with a single satellite.

- The Ground Command and Control Centre for ASTROSAT is located at **ISRO Telemetry, Tracking and Command Network (ISTRAC), Bangalore, India.**
- This has put India in an exclusive club of countries which have multi wavelength space observatories.
- The minimum life of the AstroSat mission was expected to be **5 years.**

Open-RAN Architecture

Why in News

Recently, **Telecom Regulatory Authority of India (TRAI)** Chairman said that use of **Open-RAN (Radio Access Network)** and software defined telecom networks will open new opportunities for Indian entities to enter into the network equipment market.

Key Points

➤ About:

- **Open-RAN** is not a technology, but rather an **ongoing shift in mobile network architecture** that allows networks to be built using subcomponents from a variety of vendors.
 - O-RAN has an **open, multi-vendor architecture** for deploying mobile networks, as **opposed to the single-vendor proprietary architecture.**
 - O-RAN **uses software to make hardware manufactured by different companies work together.**
- The key concept of Open RAN is **"opening" the protocols and interfaces between the various subcomponents** (radios, hardware and software) **in the RAN.**
 - **Radio Access Network (RAN):**
 - It is the **part of a telecommunications system** that connects individual devices to other parts of a network through radio connections.
 - A RAN resides between user equipment, such as a mobile phone, a computer or any remotely controlled machine, and **provides the connection with its core network.**
 - As a technical matter this is what the industry refers to as a **disaggregated RAN.**
- **Elements of RAN:**
 - **The Radio Unit (RU)** is where the radio frequency signals are transmitted, received, amplified and

Note:



digitized. The RU is located near, or integrated into, the antenna.

- **The Distributed Unit (DU)** is where the real-time, baseband processing functions reside. The DU can be centralized or located near the cell site.
- **The Centralized Unit (CU)** is where the less time-sensitive packet processing functions typically reside.

PM2.5 and Anaemia

Why in News

A recent study by IIT Delhi has tried to establish the association between ambient PM 2.5 exposure and occurrence of anaemia among children under the age of 5 years of age in India.

- PM2.5 refers to particles that have a diameter less than 2.5 micrometres (more than 100 times thinner than a human hair) and remain suspended for longer.
- These particles are formed as a result of **burning fuel and chemical reactions** that take place in the atmosphere. Natural processes such as **forest fires** also contribute to PM2.5 in the air. These particles are also the primary reason for the occurrence of smog.

Key Points

- **Findings**
 - Extended periods of exposure to PM 2.5 can lead to anemia among children under the age of 5 years. About 63% of the included children were found to be anaemic.
- **Children at Risk:**
 - **Young Children:** Children with lower age had higher vulnerability of being anaemic.
 - **Poverty :** Children from lower wealth index levels had higher percentages of anemia.
 - **Maternal Anaemia:** Children born to anaemic women have higher chances of developing anaemia.
- **Intensity:**
 - Higher PM2.5 levels exposure decreases the average haemoglobin levels in children.
- **Significance:**
 - The study is important because so far anaemia has been looked at through the prism of **nutrition deficiency**, specifically that of iron.

- Exposure to air pollution, especially PM 2.5, has been shown to induce systemic inflammation.
 - Inflammation refers to the body's process of fighting against things that harm it, such as infections, injuries, and toxins, in an attempt to heal itself.
 - Over time, chronic inflammation may have a negative impact on tissues and organs.

- **Current Scenario:** According to the **India National Family and Health Survey 2015–2016 (NFHS-4)**, 53.1% of women in India with 15–49 years of age and 58.5 % of children under five were anaemic.
 - A '**Lancet Global Health report**' also revealed that **23% of Indian men suffer from anaemia**.

NISAR: Joint Earth Observing Mission of NASA and ISRO

Why in News

NASA and ISRO are collaborating on developing an SUV-sized satellite called NISAR, which will **detect movements of the planet's surface as small as 0.4 inches** over areas about half the size of a tennis court.

- The satellite **will be launched in 2022 from the Satish Dhawan Space Center** in Sriharikota (Andhra Pradesh) into a near-polar orbit.

Key Points

- **The Name 'NISAR':** The name **NISAR** is short for **NASA-ISRO-SAR**.
 - **SAR** here refers to the **Synthetic Aperture Radar** that NASA will use to measure changes in the surface of the Earth.
 - 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**.
- **Function:** It will scan the globe **every 12 days** over the course of its **three-year mission** of imaging the **Earth's land, ice sheets and sea ice** to give an unprecedented view of the planet.
- **Role of NASA:**
 - **National Aeronautics and Space Administration (NASA** - space agency of the USA) will provide one of the radars for the satellite, a high-rate

Note:



communication subsystem for science data, GPS receivers and a payload data subsystem.

- **NISAR** will be equipped with the **largest reflector antenna** ever launched by **NASA**.

➤ **Role of ISRO:**

- **Indian Space and Research Organisation (ISRO)** will provide the spacecraft bus, the second type of radar (called the **S-band radar**), the launch vehicle and associated launch services.

➤ **Primary Goals:**

- Tracking subtle changes in the Earth's surface,
- Spotting warning signs of imminent volcanic eruptions,
- Helping to monitor groundwater supplies, and
- Tracking the rate at which ice sheets are melting.

53rd PSLV Flight

Why in News

Recently, the **53rd flight of PSLV-C51** marked the first dedicated mission for **New Space India Ltd (NSIL)**, the commercial arm of **Indian Space Research Organisation (ISRO)**.

- In this flight, ISRO successfully launched **Brazil's optical earth observation satellite, Amazonia-1**, and **18 co-passenger satellites from India (5) and the USA (13)** from the **Satish Dhawan Space Centre (SHAR)** at Sriharikota.
- **SHAR, Sriharikota** is the **Spaceport of India**. It is responsible for providing Launch Base Infrastructure for the Indian Space Programme.

Key Points

➤ **Brazilian Satellite Amazonia 1:**

- **About:**
 - Weighing 637 kg, belonging to the Brazilian National Institute for Space Research (INPE), was injected into its precise orbit of 758 km in a **sun-synchronous polar orbit** successfully.
- **Objective:**
 - To strengthen the existing structure by providing **remote sensing data to users for monitoring deforestation in the Amazon region** and for analysis of **diversified agriculture across the Brazilian territory**.

Blazing a trail

ISRO's first launch of 2021 in numbers

19 satellites, including Brazil's earth observation satellite Amazonia-1, were carried by the Polar Satellite Launch Vehicle, PSLV-C51

13 satellites were from the U.S.

5 satellites, including the Satish Dhawan Satellite from the Chennai-based Space Kidz India, were built by students

78 th mission from Sriharikota

53 rd flight of India's workhorse launch vehicle PSLV

■ It was the first dedicated launch by the NewSpace India Limited (NSIL), a PSU set up under the Department of Space in 2019

■ ISRO has till date launched 342 foreign satellites from 34 countries

■ Amazonia-1, with a mission life of four years, will monitor deforestation in the Amazon region

■ The SDSAT has an engraving of Prime Minister Narendra Modi on the top panel to show solidarity and gratitude for the *aatmanirbhar* initiative and space privatisation

➤ **5 Indian Satellites:**

○ **UNITYsat (three satellites):**

- They have been deployed to provide **Radio relay services**.
- UNITYsat was designed and built as a joint development by Jeppiaar Institute of Technology, Sriperumpudur (JITSat), G. H. Rasoni College of Engineering, Nagpur (GHRCEsat) and Sri Shakthi Institute of Engineering and Technology, Coimbatore (Sri Shakthi Sat).

Note:



○ SDSAT:

- Satish Dhawan Satellite (SDSAT) is a **nano satellite** intended to study the radiation levels/ space weather and demonstrate long range communication technologies.
- It was built by Chennai-based **Space Kidz** (an organization dedicated to designing innovative concepts for students in the field of education).
- SDSAT also has an engraving of the Indian Prime Minister on the top panel of the satellite to show solidarity and gratitude for the **Atmanirbhar initiative** and space privatisation.
- A Bhagavad Gita was also sent on-board in an SD card to give the scripture, which teaches oneness as the highest form of humanity, the highest honour.

○ SindhuNetra:

- It was developed by students of Bengaluru-based PES University, which was awarded the Rs. 2.2 crore contract by the **Defence Research and Development Organisation (DRDO)**.
- This project will help in identifying suspicious ships through satellite imaging.

➤ USA Satellites:

- 13 satellites were from the USA, one was a technology demonstration satellite (**SAI-1 Nano Connect 2**) and the remaining for 2-way communications and data relay (**SpaceBEEs**).

Most Distant Quasar P172+18

Why in News

Recently, an international team of astronomers has discovered the most distant 'Radio-Loud' Quasar with the help of **European Southern Observatory's Very Large Telescope (ESO's VLT)**.

Key Points

➤ Quasars:

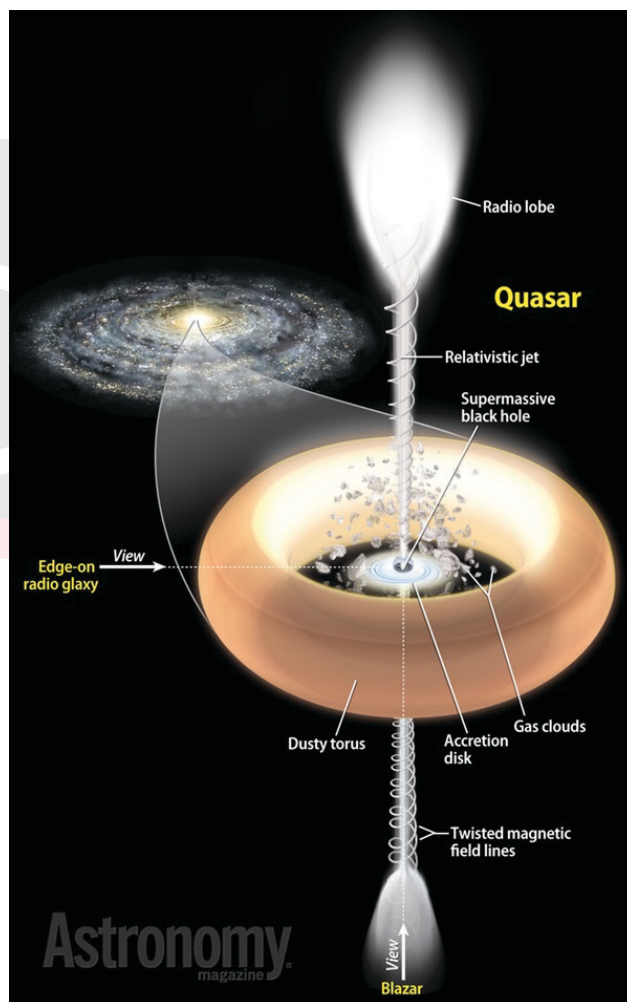
- Quasars are very **luminous objects** in faraway galaxies that **emit jets at radio frequencies**.
- The word quasar is short for "**quasi-stellar radio source**".
 - The name, which means star-like emitters of radio waves, was given in the 1960s when quasars were first detected.

- The name is retained today, even though astronomers now know most quasars are faint radio emitters. In addition to radio waves and visible light, quasars also emit ultraviolet rays, infrared waves, X-rays, and gamma-rays.

- Most quasars are larger than our solar system. A quasar is **approximately 1 kiloparsec in width**.

- They are **only found in galaxies that have supermassive blackholes** which power these bright discs.

- **Black hole** refers to a point in space where **matter is so compressed** as to create a **gravity field** from which **even light cannot escape**.



- Most **active galaxies** have a **supermassive black hole** at the centre which sucks in surrounding objects.
- Quasars are **formed by the energy emitted by materials swirling around a blackhole** right before being sucked into it.

Note:



- They are further categorised into the “radio-loud” and the “radio-quiet” classes.
 - **Radio-loud:**
 - They are with powerful jets that are **strong sources of radio-wavelength emission**.
 - These make up about **10%** of the overall quasar population.
 - **Radio-quiet:**
 - They are those quasars lacking powerful jets, with relatively **weaker radio emission** than the radio-loud population.
 - The majority of quasars (about **90%**) are radio-quiet.
- **Recently Discovered Quasar/P172+18:**
 - Named P172+18, the quasar emitted wavelengths which had a **redshift** of 6.8.
 - It took **13 billion years** for the quasar’s light to reach earth.
 - This particular quasar appears to the scientists as it was when the universe was just around **780 million years old**.
 - The glowing disc around a blackhole is **300 million times more massive than our Sun**.
 - It is also **one of the fastest accreting quasars**, which means it is accumulating objects from the galaxy at an enormous speed.
 - Only **three other ‘radio-loud’ sources with redshift greater than six have been discovered** so far and the **most distant one had a redshift of 6.18**.
 - The **higher the redshift** of the radio wavelength, the **farther away is the source**.
- **About the ESO’s VLT:**
 - The **Very Large Telescope** used to observe the **P172+18** is located at Paranal Observatory in the **Atacama Desert**.
 - The four Unit Telescopes boast 8.2-meter (27 feet) mirrors.
 - Just one of these instruments **can spot objects that are 4 billion times fainter than what can be seen with the unaided eye**.
 - According to the **European Southern Observatory**, the **Very Large Telescope** is the **world’s most advanced optical telescope**.

International Lunar Research Station: Russia and China

Why in News

China and Russia have agreed to build a **International Lunar Research Station (ILRS)**, possibly on the moon’s surface, marking the start of a new era in space cooperation between the two countries.

- Russia is a part of **International Space Station** which is a **habitable artificial satellite** - the single largest man-made structure in low earth orbit.

Key Points

- **International Lunar Research Station (ILRS):**
 - **About:**
 - The ILRS is a comprehensive scientific experiment base with the capability of **long-term autonomous operation**.
 - The station would be **built on the lunar surface and/or on the lunar orbit** that would **carry out scientific research activities** such as the lunar exploration and utilization, lunar-based observation, basic scientific experiment and technical verification.
 - **Principle:**
 - Russia and China will adhere to the principle of **co-consultation, joint construction, and shared benefits**.
 - They will facilitate **extensive cooperation** in the ILRS, **open to all interested countries** and international partners.
 - **Significance:**
 - ILRS will strengthen scientific research exchanges, and promote humanity’s exploration and use of outer space for peaceful purposes.

France’s First Space Military Exercise: AsterX

Why in News

Amid the growing competition among the world powers in the field of space, France has begun its **first space military exercises** to test its ability to defend its satellites.

Key Points

➤ About the Exercise:

- The exercise drills are codenamed “**AsterX**” to commemorate the first French satellite **Asterix** from 1965.
- The exercises are part of France’s strategy to become the world’s **third-largest space power**, after the USA and China.
- These space military exercises are the first ever attempt not only for the French army but also for Europe.
- Moreover, France has planned to develop **anti-satellite laser weapons** and to strengthen surveillance capabilities to close the gap with rivals; China and Russia.
- **Aim of the Exercise:**
 - To monitor a potentially dangerous space object as well as threats to its own satellite from another foreign power possessing a considerable space force.
- **Participants:**
 - Along with France, the new **US Space Force** and **German space agencies** are taking part in the exercises.

Equine Herpes Virus Outbreak in Europe

Why in News

Recently, there has been an outbreak of **Equine Herpes Virus (EHV-1)** among horses in Europe.

Key Points

➤ About Equine Herpes Virus (EHV):

- Equine Herpes Virus is a common **DNA virus** that occurs in horse populations worldwide.
- EHV is a family of viruses which are named by numbers such as **EHV 1, 2, 3, 4 and 5**.
 - There are more viruses in this family, but **EHV 1, 3, and 4 pose the most serious health risks for domestic horses**.
- **Health Risks:**
 - **EHV1** can cause manifestations of disease in

horses, including **respiratory disease, abortion and neonatal death**.

- This strain can also cause **neurological problems**, leading to **paralysis** and in some cases, **death**. Horses that contract this virus can develop a **lack of coordination, weakness, loss of appetite and are unable to stand**.

➤ Spread of EHV-1 Virus:

- It is **contagious** and spread by **direct horse-to-horse contact** via the respiratory tract through nasal secretions.
- This virus **can also be spread indirectly** through **contact with physical objects** that are contaminated with the virus.

➤ Equine Herpesvirus Myeloencephalopathy (EHM) is another name for the **neurologic disease** associated with Equine Herpes Virus (EHV) infections.

➤ Precautions and Treatment:

- As the infection has a high transmission rate, **keeping a diseased horse in isolation** is required.
- Treatments may include **anti-inflammatory drugs**

Narrow-Line Seyfert 1 (NLS1): Farthest Gamma-Ray Emitting Galaxy

Why in News

Recently, Astronomers have discovered a **new active galaxy** called **Narrow-Line Seyfert 1 (NLS1)** which has been identified as the **farthest gamma-ray emitting galaxy**.

Key Points

➤ The Study:

- Scientists from **Aryabhata Research Institute of Observational Sciences (ARIES)** in collaboration with researchers from other institutions, studied around 25,000 luminous **Active Galactic Nuclei (AGN)** from the **Sloan Digital Sky Survey (SDSS)**.
 - **AGN** are the most **powerful, long-lived objects and steady sources of luminosity in the Universe**. The emission is spread widely across the **electromagnetic spectrum**, often peaking in the Ultra-Violet, but with significant luminosity in the x-ray and infrared bands.

Note:



- **SDSS** is a major **multi-spectral imaging and spectroscopic redshift survey** using a dedicated 2.5-m wide-angle optical telescope at Apache Point Observatory in New Mexico, United States.
 - It has created the **most detailed three-dimensional maps of the Universe** ever made, with deep multi-color images of one third of the sky, and spectra for more than three million astronomical objects.

➤ Findings:

- They found a **unique object that emits high-energy gamma rays** located at a **high redshift (more than 1)**
 - It was identified as a **gamma-ray emitting NLS1 galaxy**, which is a rare entity in space.
 - The new gamma-ray emitting NLS1 was **formed when the Universe was only about 4.7 billion years old** as compared to its current age of about 13.8 billion years.

Redshift

➤ About:

- It is the **displacement of spectral lines towards longer wavelengths** (the red end of the spectrum) in radiation from distant galaxies and celestial objects.
- It **reveals how an object is moving in space and enables astronomers to discover otherwise-invisible planets and the movements of galaxies**, and to uncover the beginnings of our universe.

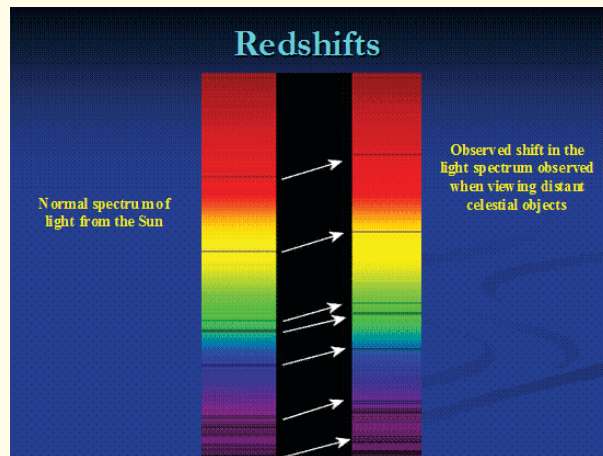
➤ Significance:

- Astronomers use redshifts **to measure how the universe is expanding**, and thus to **determine the distance to our universe's most distant (and therefore oldest) objects**.

➤ Measurement:

- The most accurate way to measure redshift is by using **spectroscopy**.
 - When a beam of white light strikes a triangular prism it is separated into its various components (**ROYGBIV**). This is known as a spectrum (plural: spectra).
- Astronomers can look at the **spectra created by different elements and compare these with the**

spectra of stars. If the absorption or emission lines they see in the star's spectra are shifted, they know the object is moving either towards us or away from us.



- Astronomers calculate redshift in terms of the **redshift parameter (z)** which helps in calculating the distance of the object (galaxy, planet etc).
 - With increasing value of **z** the distance of the object increases.

Monkeydactyl: Pterosaur Species

Why in News

The **new pterosaur fossil** was **discovered in the Tiaojishan Formation of Liaoning, China**, and is thought to be 160 million years old.

- It has been **named Kunpengopterus antipollicatus**, also **dubbed "Monkeydactyl"**.

Tiaojishan Formation

- Geographically, the Tiaojishan Formation is **widely distributed in western Liaoning Province and the neighboring northern Hebei Province (China)**.
- This formation is lithologically **composed of** intermediate lava and pyroclastic rocks, inter-layered with basic volcanic rocks and sedimentary deposits.
- It **contains abundant and well-preserved fossil plants**, including leaves, seeds and fruits, permineralized rhizomes and wood.

Note:



LOCATION OF MONKEYDACTYL FOSSIL



Evidence of a sharp toothed tree climbing dinosaur with opposable thumbs has been discovered and experts are calling it the "Monkeydactyl"



Key Points

- **About Pterosaurs:**
 - The pterosaur species were **reptiles**, close cousins of dinosaurs and the **first animals after insects to evolve powered flight**.
 - They evolved into **various species**, while some were as large as an F-16 fighter jet, others were as small as paper airplanes.
 - They **flourished** during all periods (**Triassic, Jurassic, and Cretaceous**) of the **Mesozoic Era** (252.2 million to 66 million years ago).
- **About the Monkeydactyl Fossil (*Kunpengopterus antipollicatus*):**
 - "**Antipollicatus**" in ancient Greek means "**opposite thumbs**", and it was attached to the name because the researchers' findings **could be the first discovery of a pterosaur with an opposed thumb**.
 - It could **likely be the earliest-known instance of the limb**.
 - It is **far older than the one identified in 2019**.
 - Paleontologists had identified that species as a **pterosaur that lived over 77 million years ago** in what is **Western Canada** today.
 - Named **Cryodrakon boreas**, it was believed to be one of the largest flying animals, which "flew over the heads of dinosaurs", with a wingspan of **over 10 metres**.

Baikal-GVD Telescope

Why in News

Russian scientists have launched **one of the world's biggest underwater neutrino telescopes** called the **Baikal-GVD (Gigaton Volume Detector)** in the waters of **Lake Baikal**, the world's deepest lake situated in **Siberia**.

- The construction of this telescope, which started in 2016, is motivated by the mission **to study in detail the elusive fundamental particles called neutrinos** and to possibly determine their sources.



Key Points

- **About Baikal-GVD Telescope:**
- It is **one of the three largest neutrino detectors in the world** along with the **IceCube at the South Pole** and **ANTARES in the Mediterranean Sea**.
- GVD is **designed to detect high-energy neutrinos** that may have come from the Earth's core, or could have been produced during nuclear reactions in the Sun.
- It will **aid scientists' understanding of the origins of the universe** since some neutrinos were formed during the **Big Bang**, others continue to be formed as a result of **supernova explosions** or because of **nuclear reactions in the Sun**.

Harlequin Ichthyosis: Rare Genetic Disorder

Why in News

Recently, **Odisha reported its first-ever case of a baby born with Harlequin Ichthyosis**, a rare genetic skin condition.

Note:



- **India's first recorded case** of a baby born with harlequin ichthyosis **was in 2016**, at a private hospital in Nagpur, Maharashtra.

Key Points

- **About:**
 - **Harlequin Ichthyosis** is a rare **genetic skin disorder** to a newborn infant.
 - It's a type of ichthyosis, which refers to a group of disorders that cause persistently dry, scaly skin all over the body.
 - It is inherited in an **autosomal recessive pattern**.

Autosomal Recessive Pattern

- Autosomal (that means inherited) Recessive Pattern is a way, where a **genetic trait or condition can be passed down from parent to child**.
- A genetic condition **can occur when the child inherits one copy of a mutated (changed) gene from each parent**.
- If an individual receives one normal gene and one abnormal gene for the disease, the person will be a **carrier for the disease**.
- The risk to have a child who is a carrier, like the parents, is 50% with each pregnancy. The chance for a child to receive normal genes from both parents is 25%. The risk is the same for males and females.
- **Causes:**
 - It can be **caused by changes (mutations) in the ABCA12 gene**.
 - ABCA12 Gene **gives instructions for making a protein that is necessary for skin cells to develop normally**.
 - It plays a key role in the transport of fats (lipids) to the most superficial layer of the skin (epidermis), creating an effective skin barrier.
 - When this gene is mutated, the skin barrier is disrupted.
- **Impact:**
 - Newborn infants **are covered with plates of thick skin** that crack and split apart and can **restrict breathing and eating**.
 - Premature birth is typical, leaving the infants at risk for complications from early delivery.
- **Affected Population:**
 - It affects males and females in equal numbers.

- It affects **approximately one in 5,00,000 persons**.
 - There are around 250 such cases across the world.
- **Treatment:**
 - A newborn with Harlequin ichthyosis **requires neonatal intensive care**, which may include spending time in a heated incubator with high humidity.
- **Related Disorder:**
 - **Lamellar ichthyosis** is an inherited skin disorder characterized by broad, dark, plate-like scales separated by deep cracks.
 - Its **symptoms are similar to Harlequin Ichthyosis**.

NASA's OSIRIS-REx Mission

Why in News

Recently, **NASA's OSIRIS-REx spacecraft departed from asteroid Benu**, and started its two-year long journey **back to Earth**.

- **OSIRIS-REx is NASA's first mission to visit a near-Earth asteroid**, survey its surface and collect a sample from it.

Key Points

- **About OSIRIS-REx Mission:**
 - It is the **United States' first asteroid sample return mission**, aiming to collect and carry a pristine, unaltered sample from an asteroid back to earth for scientific study.
 - The **OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer) spacecraft was launched in 2016** for the journey **to Benu**.
 - The mission is essentially a **seven-year-long voyage** and will **conclude when at least 60 grams of samples are delivered back to the Earth (in 2023)**.
 - As per the **National Aeronautics and Space Administration (NASA)**, the mission promises to bring the largest amount of extraterrestrial material back to the Earth since the **Apollo era**.
 - **Apollo** was the NASA program that resulted in American astronauts' making a total of 11 space flights and walking on the moon (1968-72).
 - The spacecraft **contains five instruments meant to explore Benu** including cameras, a spectrometer and a laser altimeter.

Note:



- Recently, the **spacecraft's robotic arm called the Touch-And-Go Sample Acquisition Mechanism (TAGSAM)**, made an attempt to "TAG" the asteroid at a sample site and **collected a sample**.

➤ **Significance:**

- Scientists will use the asteroid samples **to study the formation of the solar system and of habitable planets such as Earth**.
- NASA will also **distribute a part of the samples to laboratories worldwide** and will **reserve about 75% of the samples for future generations** who can study it with technologies not yet created.

Kyasanur Forest Disease

Why in News

A **new point-of-care test** has been found to be highly sensitive in the rapid diagnosis of **Kyasanur Forest Disease (KFD)**.

- This disease is also known as **monkey fever**.

Key Points

➤ **Point-of-care Test:**

○ **About:**

- It is developed by **Indian Council of Medical Research (ICMR)-National Institute of Virology**.
- It includes a **battery-operated Polymerase Chain Reaction (PCR) analyser**, which is a portable, lightweight and universal cartridge-based sample pre-treatment kit and nucleic acid extraction device that aid in sample processing at the point of care.

○ **Benefits:**

- It would be beneficial for the **diagnosis of KFD** as the outbreaks mainly happen in remote areas, where there is lack of well-equipped sample handling and laboratory testing facilities.
- It would be useful in **quick patient management and controlling further spread of the virus**.

➤ **Kyasanur Forest Disease:**

○ **About:**

- It is caused by **Kyasanur Forest disease Virus (KFDV)**, which primarily affects **humans and monkeys**.

- It was **first identified in 1957** in a sick monkey from the **Kyasanur Forest in Karnataka**. Since then, between 400-500 human cases per year have been reported.

- Eventually, KFD emerged as a grave public health problem spreading through the **entire Western Ghats**.

○ **Transmission:**

- In nature, the virus is maintained mainly in **hard ticks (Haemaphysalis spinigera)**, **monkeys, rodents and birds**.
- **To humans**, it may occur after a **tick bite or contact with an infected animal (a sick or recently dead monkey)**.

○ **Symptoms:**

- Characterised by **chills, frontal headache, body ache, and high fever** for five to 12 days with a case fatality rate of 3 to 5%.

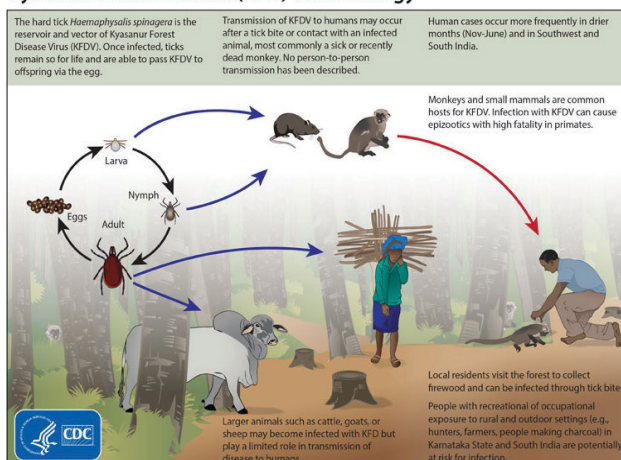
○ **Diagnosis:**

- Diagnosis can be made in the early stage of illness by molecular detection by PCR or virus isolation from blood.
- Later, serologic testing using **Enzyme-linked Immunosorbent Serologic Assay (ELISA)** can be performed.

○ **Treatment and Prevention:**

- There is **no specific treatment** for monkey fever.
- A **vaccine (Formalin inactivated KFDV vaccine)** does exist for KFD and is used in endemic areas of India.
 - However, it is found that vaccines are not effective once the person is infected with fever.

Kyasanur Forest Disease (KFD) Virus Ecology



Note:



Tianwen-1: China's Mars Mission

Why in News

Recently, China's spacecraft **Tianwen-1** landed on Mars carrying its **first Mars rover** named **Zhurong**.

- It became the **third country** to land on Mars **after the US and Soviet Union**.
- China's previous 'Yinghuo-1' Mars mission, which was supported by a Russian spacecraft, **had failed** after it did not leave the earth's orbit and disintegrated over the Pacific Ocean in **2012**.

Key Points

- **About the Tianwen-1 Mission:**
 - **Launch:**
 - The **Tianwen-1 Spacecraft** was **lifted off on a Long March 5 rocket**, from the Wenchang launch center in **July 2020**.
 - **Three Parts:**
 - The Spacecraft consists of three parts - the **orbiter, the lander and the rover** - which separated in Mars orbit.
 - The **orbiter will remain in the orbit for scientific operations** and to relay signals while the **lander-rover combination has made an autonomous descent and landing**.
 - The **lander from Tianwen-1 has touched down on Utopia Planitia**, a large plain in the northern hemisphere of Mars.
 - **Objectives:**
 - To conduct scientific investigations into the planet's soil, geological structure, environment, atmosphere and water.
 - The mission **will be the first to place a ground-penetrating radar** on the Martian surface, which will be able to study local geology, as well as rock, ice, and dirt distribution.

Disinfection System Vajra Kavach

Why in News

Vajra Kavach is a simple disinfection process that enables Corona Warriors to **reuse their masks and PPEs**.

- The technology has been developed under the **NIDHI-PRAYAS** program initiated by the **Department of Science and Technology (DST)**.

Key Points

- **About Vajra Kavach:**
 - Vajra Kavach's **UV (Ultra Violet)** disinfection system **removes any possible traces of the disease-causing SARS-Cov-2 (Covid-19) virus** from **Personal Protective Equipment (PPE), N95 masks, coats, gloves and gowns**.
 - It **enables reuse** of PPEs and other materials used by healthcare workers.
 - It thus protects not only them, but our environment too, by **helping reduce biomedical waste generation**. It is also making personal protective equipment more available, affordable, and accessible.
- **NIDHI-PRAYAS:**
 - NIDHI-PRAYAS is **National Initiative for Developing and Harnessing Innovation PRomoting and Accelerating Young and aspiring Innovators & startups**.
 - The **Department of Science & Technology** has launched a **NIDHI** program under which programmes for setting up of **incubators, seed fund, accelerators** and '**Proof of concept**' grants for innovators and entrepreneurs have been launched.
 - Under **NIDHI, PRAYAS** programme has been initiated in which established **Technology Business Incubators (TBI)** are supported with **PRAYAS grant** to support innovators and entrepreneurs with grants for '**Proof of Concept (PoC)**' and developing prototypes.
 - **PoC** is evidence that a business idea works.

AmbiTAG

Why in News

Recently, Indian Institute of Technology (IIT) Ropar, Punjab has developed a **first-of-its-kind IoT (Internet of Things) device** – **AmbiTag** that records **real-time ambient temperature** during the **transportation of perishable products, vaccines** and even **body organs and blood**.

- The device has been developed under **Technology Innovation Hub – AWaDH (Agriculture and Water Technology Development Hub)** and it's Startup **ScratchNest**.

Note:



Key Points➤ **About AmbiTAG:**

- This is **shaped as a USB (Universal Serial Bus) device**.
- It is **India's first indigenous** temperature data logger for **cold chain management**.
- It continuously records the temperature of its immediate surroundings **from -40 to +80 degrees in any time zone for a full 90 days on a single charge**.
 - Most of the similar devices available in the international market record data only for a duration of 30- 60 days.
- It **generates an alert** when the temperature goes **beyond a pre-set limit**.
- The recorded data can be retrieved by **connecting the USB** with any computer.

➤ **Significance:**

- Besides **perishable items** including **vegetables, meat and dairy products**, it can also monitor the temperature of **animal semen** during transit.
- The device will be made available to all companies involved in **Covid-19** vaccine transportation from production facilities to the last mile vaccination centers in the country.
- It is a push towards **Atmanirbhar Bharat** as such devices are being imported by India in a massive quantity from other countries such as **Singapore, Hong Kong, Ireland, and China**.

PASIPHAE: A Sky Surveying Project

Why in news

The **Wide Area Linear Optical Polarimeter (WALOP)**, a **vital instrument for the PASIPHAE Project**, is being developed at **Inter-University Centre for Astronomy and Astrophysics (IUCAA)**, India.

- **Polar-Areas Stellar-Imaging in Polarisation High-Accuracy Experiment (PASIPHAE)** is an international collaborative sky surveying project.

Key Points➤ **About the PASIPHAE Survey:**

- It is an **opto polarimetric survey** aiming to **measure the linear polarization from millions of stars**.

- The survey **will use two high-tech optical polarimeters to observe the northern and southern skies, simultaneously**.
- The survey **will be conducted** concurrently from the **South African Astronomical Observatory in Sutherland**, South Africa in the **southern hemisphere**, and the **Skinakas Observatory in Crete, Greece**, in the **north**.
- It will focus on **capturing starlight polarisation** of very faint stars that are so far away that polarisation signals from there have not been systematically studied.
- The distances to these stars will be obtained from measurements of the **GAIA satellite**.
 - GAIA is on a **mission to chart a three-dimensional map of our Galaxy**, the Milky Way, in the process revealing the composition, formation and evolution of the Galaxy. It is a **European Space Agency astronomical observatory mission**.
- Scientists from the University of Crete, Greece, Caltech, USA, **IUCAA, India**, the South African Astronomical Observatory and the University of Oslo, Norway, are involved in this project, steered by the Institute of Astrophysics, Greece.

➤ **Importance of the Project:**

- Since its birth about 14 billion years ago, the **universe has been constantly expanding**, as evidenced by the presence of **Cosmic Microwave Background (CMB) radiation** which fills the universe.
 - The **Milky Way Galaxy contains a lot of dust clouds** that are present in the form of clusters. When **starlight passes through these dust clouds**, they **get scattered and polarised**.
- The PASIPHAE polarimetric map **will be used to perform magnetic tomography of the Milky Way Galaxy**.
 - That is, it will **deduce the 3-dimensional structure of the magnetic field and the dust that resides in our own Galaxy**.
 - This map will **provide invaluable information for future CMB B-mode experiments** searching for inflationary **gravitational waves**.
 - The **B-mode experiment** was used to **test the theory of cosmic inflation** and distinguish between inflationary models of the very early universe by making precise measurements of the polarization of the Cosmic Microwave Background (CMB).

Note:



- According to the **theory of inflation**, the **early Universe expanded exponentially fast for a fraction of a second** after the **Big Bang**.
- Beyond studies of the early Universe, the survey will **lead to leaps forward in some of the most actively pursued areas in Astrophysics**, including high-energy astrophysics, stellar astrophysics, and interstellar medium dynamics.
- **Wide Area Linear Optical Polarimeter (WALOP):**
 - It was **planned in 2013** after the success of the **RoboPol experiment survey during 2012-2017**.
 - WALOP and its predecessor RoboPol **share the photometry (measurement of the brightness of celestial objects) principle**.
 - But the **WALOP will be capable of observing hundreds of stars concurrently** present both in the northern and the southern skies as opposed to RoboPol, which has a much smaller field of view in the sky.
 - **Working Principle:**
 - WALOP will operate on the principle that at any given time, the data from a portion of the sky under observation will be split into four different channels.
 - Depending on the manner in which light passes through the four channels, the polarisation value from the star is obtained.
 - That is, each star will have four corresponding images which when stitched together will help calculate the desired polarisation value of a star.
 - **Installation:**
 - A WALOP each will be mounted on the 1.3-metre Skinakas Observatory, Crete, and on the 1-metre telescope of the South African Astronomical Observatory located in Sutherland.

EnVision Mission to Venus: European Space Agency

Why in News

Recently, the **European Space Agency (ESA)** has announced a new mission- **EnVision mission to Venus**.

Key Points

- **About:**
 - It is an **European Space Agency (ESA)** led mission with contributions from the **National Aeronautics and Space Administration (NASA)**.
 - It is likely **to be launched sometime in the 2030s**. Once launched on an Ariane 6 rocket, the spacecraft will take about 15 months to reach Venus and will take 16 more months to achieve orbit circularisation.
- **Aim:**
 - The mission will carry a range of instruments to study the **planet's atmosphere and surface, monitor trace gases in the atmosphere and analyse its surface composition**.
- **Significance:**
 - EnVision will follow another ESA-led mission to Venus called '**Venus Express**' (2005-2014) that **focussed on atmospheric research and pointed to volcanic hotspots** on the planet's surface.

Recent Findings about Venus

Why in News

Recently, scientists have obtained **new data about Venus** by **bouncing radio waves** off the planet.

- The scientists **transmitted radio waves toward Venus 21 times from 2006 to 2020** from **NASA's Goldstone Antenna in the Mojave Desert of California** and studied the radio echo, which provided information on certain planetary traits.

Key Points

- **Latest Findings:**
 - A single Venusian **rotation takes 243.0226 Earth days**. This means **a day lasts longer than a year on Venus**, which **makes a complete orbit around the sun in 225 Earth days**.
 - The **Venusian planetary core has a diameter of about 7,000 km**, comparable to **Earth's core** which is 6,970 km.
 - The **Venusian tilt is at about 2.64 degrees**. **Earth's is about 23.5 degrees**.
- **Previous Findings:**
 - **Presence of phosphine** was detected in the atmosphere of Venus. This indicates the possibility of the presence of lifeforms on Venus.

Note:



- According to a study published in **Nature Geoscience**, Venus is still **geologically active**.
 - The study identified **37 active volcanoes**, in the form of ring-like structures known as coronae, on the surface of Venus.

➤ About Venus:

- Venus, the **second planet from the sun**, is similar in structure but slightly smaller than Earth (**Earth's Twin**).
- It has a **thick and toxic atmosphere** that consists primarily of carbon dioxide, with clouds of sulfuric acid droplets.
- With a **runaway greenhouse effect**, its surface temperatures reach 471 degrees Celsius, hot enough to melt lead.
 - The phenomenon, called the '**runaway greenhouse**' effect, occurs when a planet absorbs more energy from the sun than it can radiate back to space. Under these circumstances, the hotter the surface temperature gets, the faster it warms up.
- Venus is **one of just two planets that rotate from east to west**. Only **Venus and Uranus** have this "backwards" rotation.
- Venus has **no moons and no rings**.
- On Venus, **one day-night cycle takes 117 Earth days** because Venus rotates in the direction opposite of its orbital revolution around the Sun.

➤ Missions Related to Venus:

- **ISRO Shukrayaan**: The **Indian Space Research Organisation (ISRO)** is also planning a mission to Venus, tentatively called Shukrayaan
- **Akatsuki** (Japanese 2015)
- **Venus Express** (European Space Agency 2005)
- **NASA's Magellan** (1989)

China's Shenzhou-12 Manned Mission

Why in News

Recently, a Chinese spaceship "**Shenzhou-12**" carrying a **three-person crew** docked with China's new **space station module Tianhe-1**.

- This has come after the launch of the **Tianzhou-2 cargo spacecraft**, which carried vital supplies for the space station.

Key Points

➤ About Mission:

- The **Shenzhou-12 craft** connected with the **Tianhe space station module** about six hours after takeoff from the **Jiuquan launch center in Gobi Desert**.
- The **three-man crew** will spend **three months on the Tianhe module**, which is orbiting at some **340km to 380km** above the earth.
 - China is the **third country** after the former **Soviet Union** and the **United States** to carry out a **manned mission** on its own.
- This is the **first of two manned space missions** planned for this year, part of an intense schedule of launches aimed at completing the **Chinese space station in 2022**.
 - At least **five more missions** are planned for the year, with the **Shenzhou-13** manned mission, also carrying three astronauts, set for later this year.
- The three astronauts are the first to take up residency in the main living module and **will carry out** experiments, test equipment, conduct maintenance and prepare the station for receiving two laboratory modules next year.
- It was **China's seventh crewed mission to space** but marked a **number of firsts for the country** – the first manned one during the construction of China's space station, the first in nearly five years after the country's **last manned mission in 2016** and China's **longest crewed space mission** to date.

➤ Purpose of the Mission:

- It will help test technologies related to **long-term astronaut-stays** and health care, the recycling and life support system, the supply of space materials, extravehicular activities and operations, and in-orbit maintenance.

Deep Ocean Mission

Why in News

Recently, the **Cabinet Committee on Economic Affairs** has approved the proposal of the Ministry of Earth Sciences (MoES) on the **Deep Ocean Mission (DOM)**.

- The **blueprint of the DOM** to explore the deep recesses of the ocean was unveiled in 2018. Earlier, MoES had also rolled out the **draft Blue Economy Policy**.

Key Points

➤ About:

- The cost of the Mission has been estimated at Rs. 4,077 crore **over a five-year period** and will be **implemented in phases**. MoES will be the **nodal ministry** implementing this multi-institutional ambitious mission.
- It will be a **mission mode project to support the Blue Economy Initiatives** of the Government of India.
 - **Blue Economy** is the **sustainable use of ocean resources** for economic growth, improved livelihoods and jobs, and ocean ecosystem health.
- The **technology and expertise** needed in such missions is now available with only five countries - US, Russia, France, Japan and China.
 - India will now be the sixth country to have it.

➤ Major Components:

- **Development of Technologies for Deep Sea Mining, and Manned Submersible:**
 - A **manned submersible will be developed to carry three people** to a depth of 6,000 metres in the ocean with a **suite of scientific sensors and tools**.
 - An **Integrated Mining System** will be also developed for mining **polymetallic nodules** at those depths in the central Indian Ocean.
 - **Polymetallic nodules** are rocks scattered on the seabed containing iron, manganese, nickel and cobalt.
 - The exploration studies of minerals **will pave the way for commercial exploitation in the near future**, as and when commercial exploitation code is evolved by the **International Seabed Authority**, an **United Nations (UN)** organisation.
- **Development of Ocean Climate Change Advisory Services:**
 - It entails developing a suite of observations and models **to understand and provide future projections of important climate variables** on seasonal to decadal time scales.
- **Technological Innovations for Exploration and Conservation of Deep-sea Biodiversity:**
 - **Bio-prospecting of deep sea flora and fauna** including microbes and studies on sustainable

utilization of deep sea bio-resources will be the main focus.

○ Deep Ocean Survey and Exploration:

- It will explore and identify **potential sites of multi-metal Hydrothermal Sulphides mineralization** along the Indian Ocean mid-oceanic ridges.

○ Energy and Freshwater from the Ocean:

- Studies and detailed engineering design for off-shore **Ocean Thermal Energy Conversion (OTEC)** powered **desalination plants** are envisaged in this proof of concept proposal.
 - OTEC is a technology which **uses ocean temperature differences** from the surface to depths lower than 1,000 meters, **to extract energy**.

○ Advanced Marine Station for Ocean Biology:

- It is aimed at the development of human capacity and enterprise in ocean biology and engineering.
- It will translate research into **industrial application and product development** through on-site business incubator facilities.

➤ Significance:

- **Oceans**, which cover **70% of the globe**, remain a key part of our life. About **95% of the Deep Ocean remains unexplored**.
- **Three sides of India are surrounded by the oceans** and around **30% of the country's population living in coastal areas**, the ocean is a major economic factor supporting fisheries and aquaculture, tourism, livelihoods and blue trade.
- India has a unique maritime position. Its **7517 km long coastline is home to nine coastal states and 1382 islands**.
- The Government of India's **Vision of New India by 2030** announced in February 2019 highlighted the Blue Economy as one of the ten core dimensions of growth.
- Oceans are also a **storehouse of food, energy, minerals, medicines, modulator of weather and climate and underpin life on Earth**.
- Considering the importance of the oceans on sustainability, the UN has declared the decade, **2021-2030 as the Decade of Ocean Science for Sustainable Development**.

Note:



Peter Pan Syndrome

Why in News

Recently, a special court in Mumbai granted bail to an accused of sexually assaulting a minor as he was suffering from **Peter Pan Syndrome (PPS)**.

- A **syndrome** is a **combination of symptoms and signs** that together **represent a disease process**.

Key Points

- **About:**
 - PPS is a **psychological condition** that is used to **describe an adult** who is **socially immature**.
 - People **who develop similar behaviours** of living life carefree, finding responsibilities challenging in adulthood, and basically **never growing up** suffer from **PPS**.
 - The term was coined by **psychologist Dan Kiley** to explain the behaviour of such men who 'refuse to grow' and behave their age in **1983**.
 - Dan Kiley got the idea of PPS after noticing Peter Pan, a **fictional character created by Scottish novelist James Matthew Barrie**.
 - Peter Pan was a **care-free young boy, who never grew up**.
 - While the **WHO (World Health Organization)** does not recognise Peter Pan Syndrome as a health disorder, **many experts believe it is a mental health condition** that can affect one's quality of life.
- **Symptoms:**
 - PPS hasn't officially been diagnosed as a health disorder, **there are no clearly-defined symptoms or characteristics** or even reasons which cause it.
 - However, it could affect **one's daily routine**, relationships, work ethic, and result in **attitudinal changes**.
- **People Affected:**
 - It **can affect anyone**, irrespective of gender, race or culture. However, it appears to be **more common among men**.
 - It **affects people who do not want or feel unable to grow up**, people with the body of an adult but the mind of a child.
 - They **don't know how to or don't want to stop being children** and start being mothers or fathers.

- It is **not currently considered a psychopathology**. However, a large number of adults are presenting emotionally immature behaviors in Western society.
 - **Psychopathology** is a term which refers to either the **study of mental illness or mental distress** or the manifestation of behaviours and experiences which may be indicative of mental illness or psychological impairment.

Wendy Syndrome

- The Psychologist who defined PPS also used the term **Wendy Syndrome (WS)** to describe **women who act like mothers with their partners or people close to them**.
- People suffering from WS are often seen **making decisions, tidying up messes, and offering one-sided emotional support**.

Ebola Virus

Why in News

Recently, the **World Health Organisation (WHO)** has declared that the **Ebola** outbreak, that started in February 2021 in Guinea, is over now.

- In its **first deadly wave in 2013-2016**, the Ebola outbreak killed 11,300 people, mostly in Guinea, Sierra Leone and Liberia.
- The WHO in its list of **"Ten threats to global health in 2019"** also included Ebola.

Key Points

- **About Ebola Virus Disease (EVD):**
 - EVD, formerly known as **Ebola haemorrhagic fever**, is **transmitted to people from wild animals and spreads in the human population through human to human transmission**.
 - Ebola virus was **first discovered in 1976 near the Ebola River** in what is now the **Democratic Republic of Congo**.
- **Transmission: Fruit bats of the Pteropodidae family** are natural Ebola virus hosts.
 - **Animal to Human Transmission:** Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals such as fruit bats, chimpanzees, gorillas, monkeys, forest antelope or porcupines found ill or dead or in the rainforest.

Note:



- **Human-to-Human Transmission:** Ebola spreads via direct contact (through broken skin or mucous membranes) with:
 - Blood or body fluids of a person who is sick with or has died from Ebola.
 - Objects that have been contaminated with such body fluids (like blood, feces, vomit).
- **Symptoms:**
 - These can be sudden and include: Fever, Fatigue, Muscle pain, Headache, Sore throat, Vomiting, Diarrhoea, Symptoms of impaired kidney and liver function, in some cases, both internal and external bleeding.
- **Diagnosis:**
 - It can be **difficult to clinically distinguish** Ebola from other infectious diseases such as **malaria**, typhoid fever, and meningitis but confirmation that symptoms are caused by Ebola virus infection are made using the following diagnostic methods:
 - **ELISA** (antibody-capture enzyme-linked immunosorbent assay)
 - **Reverse transcriptase polymerase chain reaction** (RT-PCR) assay, etc.
- **Vaccines:**
 - The **Ervebo vaccine** has been shown to be effective in **protecting people from the species Zaire ebolavirus**.
 - In May 2020, the European Medicines Agency recommended granting marketing authorization for a **2-component vaccine** called **Zabdeno-and-Mvabea** for individuals 1 year and older.
- **Treatment:**
 - Two **monoclonal antibodies** (Inmazeb and Ebanga) have been approved for the treatment of Zaire ebolavirus infection in adults and children by the US.

Zika Virus Disease

Why in News

Recently, Zika Virus Disease (ZVD) was reported for the first time in Kerala.

Key Points

- **About:**
 - Zika virus is a **mosquito-borne flavivirus** that was **first identified in Uganda** in 1947 in monkeys. It

was later identified in **humans in 1952 in Uganda** and the **United Republic of Tanzania**.

➤ Transmission:

- ZVD is caused by a virus **transmitted primarily by Aedes mosquitoes (AM)**, mainly *Aedes aegypti*.
 - This is the same mosquito that **transmits dengue, chikungunya and yellow fever**.
- Zika virus is **also transmitted** from mother to fetus during pregnancy, through sexual contact, transfusion of blood and blood products, and organ transplantation.

➤ Symptoms:

- Symptoms are generally mild and include fever, rash, conjunctivitis, muscle and joint pain, malaise or headache. Most people with Zika virus infection do not develop symptoms.
- Zika virus infection during pregnancy **can cause infants to be born with microcephaly** (smaller than normal head size) and other congenital malformations, known as congenital Zika syndrome.

➤ Treatment:

- There is **no vaccine or medicine for Zika**. Instead, the focus is on relieving symptoms and includes rest, rehydration and acetaminophen for fever and pain.

dbGENVOC

Why in News

Recently, the **National Institute of Biomedical Genomics (NIBMG)**, funded by the **Department of Biotechnology**, has **created the world's first database of genomic variations in oral cancer** (dbGENVOC).

Key Points

➤ About dbGENVOC:

- dbGENVOC, a comprehensive, flexible database framework, developed with **an aim to allow potential users to access, query, browse and download** clinically relevant somatic and germline variation data from Indian oral cancer patients.
- **Somatic or acquired genomic variants** are the most common cause of cancer, occurring from **damage to genes in an individual cell** during a person's life.

Note:



- A germline variant occurs in gametes and is **passed directly from a parent to a child** at the time of conception. Cancers caused by **germline pathogenic** variants are called inherited or hereditary.
- It will be updated annually with variation data from new oral cancer patients from different regions of India and southeast Asia.

Suborbital Flight

Why in News

Recently, a six person crew on **Virgin Galactic's VSS Unity spaceship** undertook a brief trip to the "edge of space" which is known as **Suborbital Flight**.

- **Sirisha Bandla**, an astronaut born in India, was a part of the crew. She was the **third woman of Indian origin** to go to space after **Kalpna Chawla** and **Sunita Williams**.
- **Virgin Galactic** is a British-American **spaceflight company**, operating in the United States.

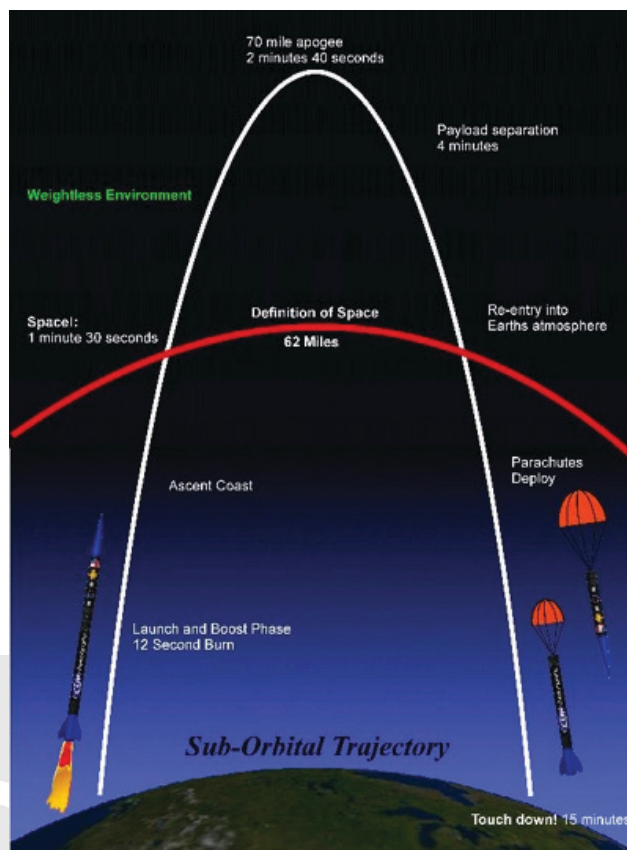
Key Points

➤ Suborbital Flight/Trajectory:

- When an **object travels at a horizontal speed of about 28,000 km/hr or more**, it **goes into orbit** once it is above the atmosphere.
 - The **satellites need to reach that threshold speed (orbital velocity)** in order to orbit Earth.
- Such a satellite would be **accelerating towards the Earth due to gravity**, but its **horizontal movement is fast enough to offset the downward motion** so that it moves along a circular path.
- Any object travelling **slower than 28,000 km/hr must eventually return to Earth**.
- Any object that launches to space but **does not reach sufficient horizontal velocity to stay in space falls back to Earth**. Hence they **fly in a suborbital trajectory**.
 - It means that while these **vehicles will cross the ill-defined boundary of space**, they will **not be going fast enough to stay in space** once they get there.

➤ Significance of Suborbital Flights:

- **Increased Access:**



- It would provide **increased flight access for design innovation** and experimental manipulation due to high projected flight rates.

○ Research:

- Suborbital flights will be helpful for **microgravity research**. Microgravity is the **condition in which people or objects appear to be weightless**.
- Suborbital flights **could also be an alternative to parabolic flights** in aeroplanes that space agencies currently use to simulate **zero gravity**.
 - **Zero Gravity** or Zero-G can simply be defined as the **state or condition of weightlessness**.

○ Cost Effective:

- They would be **far less expensive** than carrying experiments and people to the **International Space Station**.

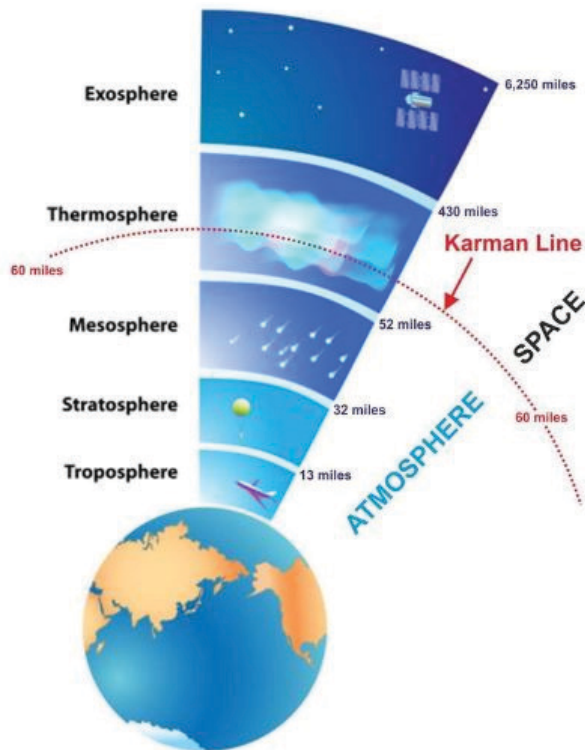
➤ Edge of Space/Karman Line:

- The most widely accepted boundary of space is known as the **Karman line**. The **Fédération Aéronautique Internationale (FAI)** defines Karman Line as the altitude of 100 kilometres above Earth's mean sea level.

Note:



- FAI is the world governing body for air sports, and also stewards definitions regarding human spaceflight.



- The Kármán line has been compared to international waters, as there are no national boundaries and human laws in force beyond the line.
- It is named after **Theodore von Karman (1881–1963)**, a Hungarian American engineer and physicist, who was active primarily in aeronautics and astronautics.
 - He was the **first person to calculate the altitude at which the atmosphere becomes too thin to support aeronautical flight** and arrived at 83.6 km himself.
- However, other organizations do not use this definition. **There is no international law defining the edge of space**, and therefore the limit of national airspace.

Discrete Auroras of Mars

Why in News

Recently, the UAE's **Hope spacecraft** has captured images of glowing atmospheric lights in the Mars night sky, known as discrete auroras.

- The Hope Probe, the Arab world's first mission to Mars, took off from Earth in July 2020, and has been orbiting the Red Planet (Mars) since February 2021. It is expected to create the **first complete portrait of the planet's atmosphere**.



Key Points

- Auroras:**
 - An Aurora is a **display of light in the sky predominantly seen in the high latitude regions** (Arctic and Antarctic). It is **also known as a Polar light**.
 - They commonly occur at high northern and southern latitudes, less frequent at mid-latitudes, and seldom seen near the equator.
 - While **usually a milky greenish color**, auroras can also show red, blue, violet, pink, and white. These colors appear in a variety of continuously changing shapes.
 - Auroras are **not just something that happens on Earth**. If a planet has an atmosphere and magnetic field, they probably have auroras.
- Cause of Auroras on Earth:**
 - Auroras are caused **when charged particles ejected from the Sun's surface - called the solar wind - enter the Earth's atmosphere**.
 - The typical aurora is **caused by collisions between charged particles from space with the oxygen and nitrogen in Earth's upper atmosphere**.
 - The electrons - which come from the **Earth's magnetosphere**, the region of space controlled by Earth's magnetic field - transfer their energy to the oxygen and nitrogen atoms and molecules, making them "excited".
 - When a large number of electrons come from the magnetosphere to bombard the atmosphere, the **oxygen and nitrogen can emit enough light for the eye to detect, giving us beautiful auroral displays**.

Note:



- In the **northern part of our globe**, the **polar lights are called aurora borealis or Northern Lights**, and are seen from the US (Alaska), Canada, Iceland, Greenland, Norway, Sweden and Finland.
- In the **south, they are called aurora australis or southern lights**, and are visible from high latitudes in Antarctica, Chile, Argentina, New Zealand and Australia.
- **Discrete Auroras of Mars:**
 - Unlike auroras on Earth, which are seen only near the north and south poles, **Discrete Auroras (DA) on Mars are seen all around** the planet at night time.
 - These DAs are traced out where **energetic particles excite the atmosphere** after being funneled down by a patchy network of crustal **magnetic fields that originate from minerals** on the surface of Mars.
- **Martian Auroras are Different:**
 - Unlike Earth, which has a strong magnetic field, the **Martian magnetic field has largely died out**. This is because the molten iron at the interior of the planet - which produces magnetism - has cooled.
 - However, the **Martian crust**, which hardened billions of years ago when the magnetic field still existed, **retains some magnetism**.
 - So, in contrast with Earth, which acts like one single bar magnet, **magnetism on Mars is unevenly distributed**, with fields strewn across the planet and differing in direction and strength.
 - These **disjointed fields channel the solar wind to different parts of the Martian atmosphere**, creating “discrete” auroras over the entire surface of the planet as charged particles interact with atoms and molecules in the sky— as they do on Earth.

Methane in the Moons of Saturn

Why in News

NASA's (National Aeronautics and Space Administration) Cassini spacecraft had detected an unusually high **concentration of methane, along with carbon dioxide and dihydrogen, in the moons (Titan and Enceladus) of Saturn** by flying through their plumes (in 2017).

- It found that **Titan** has methane in its atmosphere and **Enceladus** has a liquid ocean with erupting plumes of gas and water.

- An international research team has used new statistical methods to understand if methanogenesis or methane production by microbes could explain the molecular hydrogen and methane.

Key Points

- **Findings:**
 - Cassini found **ice particles, salts, hydrogen and organic molecules** in the plumes, tentative **hints of an ocean that is similar to Earth's oceans** in composition.
 - There is also evidence for **alkaline hydrothermal vents on Enceladus' seafloor**, similar to those that **support methanogens in Earth's oceans**.
- **About Methanogens:**
 - Most of the methane on Earth has a biological origin. **Microorganisms called methanogens are capable of generating methane** as a metabolic byproduct.
 - They **do not require oxygen to live** and are widely distributed in nature.
 - They are **found in swamps, dead organic matter, and even in the human gut**.
 - They are **known to survive in high temperatures** and simulation studies have shown that they **can live in Martian conditions**.
 - Methanogens have been widely studied to understand **if they can be a contributor to global warming**.
- **Possibility of Methanogens on Enceladus:**
 - Methane **could be formed by the chemical breakdown of organic matter** present in Enceladus' core.
 - **Hydrothermal processes** could help the formation of carbon dioxide and methane.
 - Enceladus' hydrothermal vents **could be habitable to Earth-like microorganisms (Methanogens)**.

Titan

- Titan is the **largest moon of Saturn** and the second largest moon in our solar system.
 - **Jupiter's moon Ganymede** is just a little bit larger.
- It has **liquid rivers, lakes, and seas on its surface** (though these contain hydrocarbons like methane and ethane, not water).
- Titan's atmosphere is **made mostly of nitrogen**, like Earth's, **but is four times denser**.

Note:



- Unlike Earth, it has **clouds and methane rain**.
- Because it is so far from the **Sun** its **surface temperature** is **(-179 degree Celsius)**.

Enceladus

- Enceladus is a **small, icy moon which has an abundance of hydrogen molecules** in water plumes. 98% of the gas in the plumes was found to be water and **1% is hydrogen** and the remaining is a mixture of molecules of carbon dioxide, methane, and ammonia.
- Underwater **vents present on Enceladus resemble the vents present on Earth's ocean floors**, where microbes and other sea life congregate.

Moon's Wobble Effect

Why in News

Recently, the **National Aeronautics and Space Administration (NASA)** has highlighted **Moon's Wobble** as a **potential problem in the near future**.

Key Points

- **Moon's Wobble:**
 - When the Moon makes its **elliptical orbit**, its **velocity varies and alters causing our perspective of the "light side"** to appear at **slightly different angles**. This is what it calls the **Moon's wobble** or that is how it appears to our eyes.
 - It is a **cyclical shift in the moon's orbit**, it is a **regular swaying (Oscillation) in the moon's orbit**.
 - It was first documented **way back in 1728**. This wobble takes **over an 18.6-year** period to complete. It acts as a background of **sea level rise**.
- **Impact of Wobble on Earth:**
 - The moon wobble impacts the gravitational pull of the moon, and therefore, indirectly influences **the ebb and flow of tides** on the Earth.
 - Each wobble cycle has the **power to amplify and suppress the tides on Earth**.
 - During **half of the Moon's orbit of 18.6 years**, the **Earth's regular tides are suppressed** i.e. high tides are lower than normal and low tides higher than normal (Current situation).
 - In the **other half**, the **effect is reversed, which is called the tide-amplifying phase** of the Moon.

Related Concerns:

- The **lunar cycle is expected to shift again by mid-2030**, and in the coming phase, the **tides will amplify once again**.
- The upcoming changes in the lunar cycle will pose a serious threat, as the amplified **high tides coupled with the rising sea levels** will make the risk of flooding far greater across **all coastal regions of the globe**.
 - It raises **the baseline**, and the more the baseline is raised, the smaller the weather event to cause flooding.
- The **high tide-associated floods**—also known as nuisance floods or sunny day floods—**may occur in clusters that could last for months** or even for longer periods.
 - This surge will be closely associated with the **position of the Moon, Earth and the Sun**.

Pegasus Spyware

Why in News

Recently, it has been reported that **Pegasus**, the **malicious software**, has allegedly been used to secretly monitor and spy on an extensive host of public figures in India.

Key Points

- **About Pegasus:**
 - It is a type of malicious software or **malware** classified as a **spyware**.
 - It is **designed to gain access to devices, without the knowledge of users**, and gather personal information and relay it back to whoever it is that is using the software to spy.
 - Pegasus has been **developed by the Israeli firm NSO Group** that was set up in 2010.
 - The earliest version of Pegasus discovered, which was captured by researchers in 2016, **infected phones through what is called spear-phishing** – text messages or emails that trick a target into clicking on a malicious link.
 - Since then, however, NSO's attack capabilities have become more advanced. Pegasus infections can be achieved through so-called **"zero-click" attacks**, which do not require any interaction from the phone's owner in order to succeed.

Note:



- These will often exploit “zero-day” vulnerabilities, which are flaws or bugs in an operating system that the mobile phone’s manufacturer does not yet know about and so has not been able to fix.

Nauka Module of Russia

Why in News

Recently, the **Russian Space Agency Roscosmos**, launched its **biggest space laboratory** named **Nauka** to the **International Space Station (ISS)**.

- Earlier, **four astronauts** were launched to the ISS from **Florida** as part of a **collaboration** between **NASA** and **SpaceX** under the **Commercial Crew Program**. The mission is called **Crew-2**.

International Space Station

- ISS is a habitable artificial satellite - the **single largest man-made structure in low earth orbit**.
- It is a collaborative effort between **five participating space agencies**: **NASA** (National Aeronautics and Space Administration), **Roscosmos (Russia)**, **JAXA (Japan)**, **ESA (Europe)** and **CSA (Canada)**.
- A space station is **essentially a large spacecraft that remains in low-earth orbit for extended periods of time**.
- It is like a large laboratory in space, and allows astronauts to come aboard and stay for weeks or months to carry out experiments in microgravity.

Other Space Stations

- **China** has launched an unmanned module **“Tianhe”** of its permanent space station that it plans to complete by the end of 2022.
- **India** is also planning to launch its **own space station by 2030**, joining the league of US, Russia, and China to an elite space club.

Key Points

- **About Nauka Module:**
 - Nauka **means Science** in Russian. This is **Russia’s most ambitious research facility in space** and is fitted with an oxygen generator, robotic cargo crane, a toilet and a bed for Russian astronauts.

- This was **sent into orbit using a Proton rocket** (family of rockets in Russia - the most powerful in Russia’s space inventory) and will **take eight days to reach the ISS**.
- During this period, engineers and flight controllers will test Nauka in space, and prepare for its arrival on the space station.
- It will **replace Pirs**, and **will be attached to the critical Zvezda module**, which provides all of the space station’s life support systems and serves as the structural and functional centre of the Russian Orbital Segment (ROS).
- **Pirs** has been part of the space station since September 2001, functioning as a docking port for Russian visiting spacecraft and an airlock for Russian spacewalks.

➤ Significance:

- It will **increase the habitable volume of the ISS to 70 cubic Metres**. Cosmonauts will use the extra space to conduct experiments and to store cargo.
- Nauka will serve as a **new science facility, docking port, and spacewalk airlock for future operations**.
- For more than 20 years, people **have been carrying out research under microgravity conditions** which is not possible on earth, this module will help augment the ongoing research.
- Research is being carried out in various disciplines such as, biology, human physiology, and physical, material and space science.

National Gene Bank

Why in News

Recently, the **Union Minister for Agriculture and Farmers Welfare** inaugurated the **world’s second-largest refurbished state-of-the-art National Gene Bank** at the **National Bureau of Plant Genetic Resources (NBPGR)**.

- **Gene Banks** are a type of biorepository which preserve genetic material. A **collection of seed plants, tissue cultures etc.**
- A gene is the **basic physical and functional unit of heredity**. Genes are made up of **Deoxyribonucleic Acid (DNA)**.

National Bureau of Plant Genetic Resources (NBPGR)

- It is a **nodal organisation for management of plant genetic resources** in India and functions under the control of **Indian Council of Agricultural Research (ICAR)**.
- It is **conserving seed germplasm** for long-term conservation (at -20°C) in its **National Genebank (NGB)**.
- It **plans, organizes, conducts and coordinates exploration and collection** of indigenous and exotic **plant genetic resources**. It is **headquartered in New Delhi** and has 10 regional stations.

Key Points

- **About:**
 - The **National Gene Bank** was established in the year 1996 to preserve the seeds of **Plant Genetic Resources (PGR)** for future generations, and has the capacity to preserve about one million germplasm in the form of seeds.
 - **Germplasm is living tissue** from which **new plants can be grown**.
 - **NBPGR** is meeting the **need of in-situ and ex-situ germplasm conservation** through Delhi Headquarters and 10 regional stations in the country.
 - **In situ and ex situ conservation focuses** on the **maintenance of species diversity** within or away from their natural habitats, respectively.
- **Significance:**
 - Presently, it is protecting **4.52 lakh accessions, of which 2.7 lakh are Indian germplasm** and the rest have been imported from other countries.
 - An **accession** is a **single, collected variety or varieties of a wild plant, a landrace or a plant variety** that has been produced by **selective breeding, more commonly known as a cultivar**.
- **Functioning:**
 - The **NGB has four kinds of facilities**, namely, **Seed Genebank (-18°C)**, **Cryogenebank (-170°C to -196°C)**, **In vitro Genebank (25°C)** and **Field Genebank**, to cater to long-term as well as medium-term conservation.
 - It stores different crop groups such as **cereals, millets, medicinal and aromatic plants and narcotics, etc.**
- **Other Facilities:**

- The **Svalbard Global Seed Vault** in Norway houses the **world's largest collection of seeds**.
- **India's seed vault** is at Chang La (Ladakh) in the Himalayas.
- **National Animal Gene Bank**, established at the National Bureau of Animal Genetic Resources (NBAGR - Karnal, Haryana), has the objective of conserving the indigenous livestock biodiversity.
 - NBAGR is one of the **Indian Council of Agricultural Research (ICAR)** institutes.

Coronal Mass Ejections**Why in News**

Indian Scientists, along with international collaborators, have **measured the magnetic field of an eruption from the Sun's atmosphere** (solar corona), offering a rare peek to the interior of the Sun.

- **Coronal Mass Ejection (CME)** is **one of the biggest eruptions from the Sun's surface** that can contain a billion tons of matter accelerated to several million miles per hour into space.

Key Points

- **About the Coronal Mass Ejections:**
 - The Sun is an extremely active object, **spewing out vast quantities of gas and plasma** in many violent events.
 - A class of such eruptions are **Coronal Mass Ejections (CMEs)**.
 - CMEs are the **most powerful explosions happening in the solar system**.
 - The underlying cause of CMEs is not well understood. Astronomers agree, however, that the **sun's magnetic field plays a major role**.
 - Though CMEs can occur anywhere on the Sun, it is primarily those which originate from regions near the centre of the visible solar surface (**called the photosphere**) that are important for study, since they may propagate directly towards the Earth.
 - This field of research helps to understand **Space Weather**.
 - When a really strong CME blows past the Earth, it can **damage the electronics in satellites** and **disrupt radio communication networks** on Earth.

Note:



- When the plasma cloud hits our planet, a **geo-magnetic storm** follows.
 - A geomagnetic storm is a **major disturbance of Earth's magnetosphere** (space controlled by earth's magnetic field) that occurs when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth.
- They can trigger intense light in the sky on Earth, called **auroras**.
 - Some of the energy and small particles travel down the magnetic field lines at the north and south poles into Earth's atmosphere.
 - There, the particles interact with gases in the atmosphere resulting in beautiful displays of light in the sky.
 - The aurora in Earth's northern atmosphere is called an **aurora borealis** or northern lights. Its southern counterpart is called an **aurora australis** or the southern lights.

Hycean Worlds: Exoplanets

Why in News

Recently, some astronomers have identified a new class of **exoplanets** – Hycean worlds.

Key Points

- **About:**
 - The word **Hycean** comes from the words **hydrogen and ocean**. Planet-wide **oceans** and **hydrogen-rich atmospheres** might cover these worlds.
 - They are also uniquely alien, **up to 2.6 times the diameter of Earth**, with **temperatures up to 200 degrees celsius** and **thick hydrogen atmospheres**. This places them somewhere **between Earth and giant planets** like Neptune or Uranus.
 - With no analogs in the Solar System, these planets are variedly classed as **super-Earths** or **mini-Neptunes** depending on inferences about their bulk compositions based on their densities.
 - These planets, unlike most mini-Neptunes, **may have solid surfaces**, like Earth. Many of the known Hycean candidates are **larger and hotter than Earth**, but still would be able to host large oceans.

- Some Hyceans orbit so close to their stars that they're **tidally locked**, with one hot dayside and one eternally dark nightside. And some orbit very far away, receiving very little stellar radiation. But **life could exist even on such extreme Hyceans**.
 - **Tidal locking** is the name given to the situation when an object's orbital period matches its rotational period.

➤ Significance:

- The **conditions** on such planets might be **similar to some of the more extreme aquatic environments on our planet**, but could theoretically still **support at least microbial life**.
- Hycean worlds could greatly accelerate the search for life elsewhere. In some ways **they are reminiscent of Earth**, largely or even completely covered by oceans.
 - Hycean worlds **could support life different from that on Earth**.

➤ Exoplanets:

- An exoplanet or extrasolar planet is a planet **outside the Solar System**. The **first** confirmation of detection of exoplanets occurred in **1992**.
 - More than 4,400 exoplanets have been discovered till now.
- They are very **hard to see directly with telescopes**. They are hidden by the **bright glare of the stars they orbit**. So, astronomers use other ways to detect and study exoplanets such as looking at the effects these planets have on the stars they orbit.

Blue Straggler Stars

Why in News

Recently, in the **first-ever comprehensive analysis of blue stragglers**, Indian researchers have proposed a **hypothesis for evolution of blue straggler stars**.

- Blue stragglers is a class of stars on open or globular clusters that **stand out as they are bigger and bluer than the rest of the stars**.

Key Points

➤ About Blue Straggler Stars:

- These are **unusually hot and bright stars found in the cores of ancient star clusters known as globulars**.

Note:



- A clue to their origin is that they are **only found in dense stellar systems**, where distances between stars are extremely small (a fraction of a light year).
- **Allan Sandage** (an astronomer with Carnegie Observatories in Pasadena, California) **discovered blue stragglers** in the **globular cluster M3** in 1952-53.
- Most are located at least several thousand light-years away from the sun, and most are around 12 billion years old or more.
- The **Milky Way's largest and brightest globular** is **Omega Centauri**.
- **Peculiarity about Blue Stragglers:**
 - Blue straggler stars **appear to violate standard theories of stellar evolution**.
 - A bunch of stars born at the same time from the same cloud form a star cluster. Star formation happens in interstellar molecular clouds: opaque clumps of very cold gas and dust.
 - Under standard stellar evolution, as time passes, **each star evolves differently depending on its mass**, in which **all stars born at the same time should lie on a clearly defined curve in the Hertzsprung-Russell diagram**.
 - Hertzsprung-Russell diagram **plots the temperature of stars against their luminosity** or the colour of stars against their absolute magnitude. It **shows a group of stars in various stages of their evolution**.
 - By far the **most prominent feature is the main sequence**, which runs from the upper left (hot, luminous stars) to the bottom right (cool, faint stars) of the diagram.
 - In **case of blue straggler**, they evolve and move off the main sequence creating a bend in their track, **known as the turnoff**.
 - Since blue stragglers often lie well off this curve, they **may undergo abnormal stellar evolution**.
 - They **appear to be lagging behind most of the other stars in the cluster in its evolution toward a cooler, reddish state**.
- **About the Hypothesis:**
 - Indian researchers have found that:
 - Half of the blue stragglers are formed through mass transfer from a close binary companion star.
 - One third are likely formed through collisions of two stars.

- Remains are formed through interactions of more than two stars.
- For this Hypothesis, the researchers utilised the **Gaia telescope of the European Space Agency**.
- For further study, Ultraviolet Imaging Telescope on **AstroSat**, India's first dedicated space observatory, as well as the **3.6 m Devasthal Optical Telescope in Nainital** will be used.
- The study **will help improve understanding of these stellar systems** to uncover exciting results in studies of large stellar populations, including galaxies.

Dark Energy

Why in News

Recently, an international team of researchers made the **first direct detection of dark energy**. The experiment named **XENON1T**, is the **world's most sensitive dark matter experiment** and was operated deep underground at the **INFN Laboratori Nazionali del Gran Sasso in Italy**.

- Dark energy is the mysterious form of energy that makes up about **68% of the universe**, and has intrigued physicists and astronomers for decades.

Key Points

➤ About the Experiment:

- The XENON1T is a dark matter research project, operated at the **Italian Gran Sasso National Laboratory**.
- It is a deep underground research facility featuring increasingly ambitious experiments aiming to detect dark matter particles.
- The experiments aim to detect particles in the form of **Weakly Interacting Massive Particles (WIMPs)** by looking for rare interactions via nuclear recoils in a **liquid xenon target chamber**.

➤ Other Dark Matter and Energy Experiments:

- **LUX-Zeplin** – a next generation dark matter experiment located at the Sanford Underground Research Facility, US.
- **PandaX-xT** – project at China Jinping Underground Laboratory.

➤ Dark Matter And Dark Energy:

- While **dark matter attracts and holds galaxies together**, **dark energy repels and causes the expansion of our universe**.

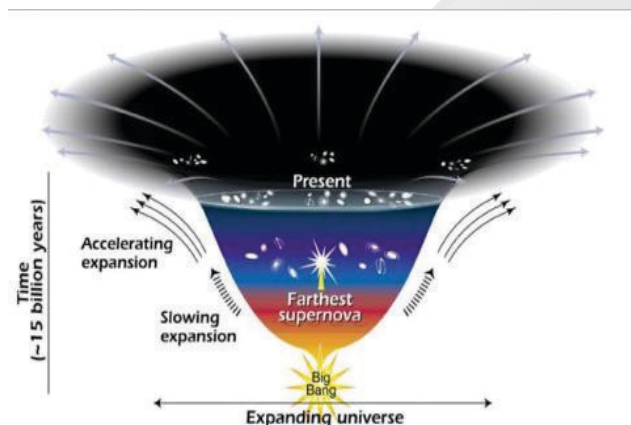
Note:



- Despite both components being invisible, a lot more is known about dark matter, since its existence was suggested as early as the 1920s, while dark energy wasn't discovered until 1998.

➤ About Dark Energy:

- The **Big Bang** occurred nearly **15 billion years ago** and expanded. Earlier, astronomers believed that eventually the expansion of the Universe will slow down because of gravity and it will recollapse.
- However, data from the **Hubble Telescope** suggested that the **Universe's expansion is accelerating**.
- The astronomers theorize that the **faster expansion rate is due to a mysterious, dark force or energy** that is pulling galaxies apart.
 - The term '**dark**' is used to denote the unknown.
- The following diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago.



➤ Possible Explanations of Dark Energy:

- **Property of Space:** Albert Einstein was the first person to realize that empty space is not nothing.
 - One version of **Einstein's gravity theory**, the version that contains a **cosmological constant**, implies that "empty space" can possess its own energy.
 - Because this energy is a property of space itself, it would not be diluted as space expands. As more space comes into existence, more of this energy-of-space would appear. As a result, this form of energy would cause the universe to expand faster and faster.
- **Quantum Theory of Matter:** Another explanation for how space acquires energy comes from the **quantum theory of matter**.

- In this theory, "empty space" is **actually full of temporary ("virtual") particles that continually form and then disappear**.

- **Fifth Fundamental Force:** There are four fundamental forces in the universe, and speculative theories have proposed a **fifth force** – something that can't be explained by the four forces.

- To hide or screen this fifth force, many models for dark energy use special mechanisms.
- Some theorists have named this "**quintessence**," after the **fifth element of the Greek philosophers**.

- However, **none of the theories have been proved**. Due to this, Dark energy has been noted as "the most profound mystery in all of science".

Herbicide-Tolerant Rice Varieties

Why in News

Recently, the **Indian Agricultural Research Institute (IARI)** has developed the **country's first-ever non-GM (genetically modified) herbicide-tolerant rice varieties (Pusa Basmati 1979 and Pusa Basmati 1985)**.

- These varieties **can be directly seeded** and significantly save water and labour **compared to conventional transplanting**.
- **ICAR-IARI** is a deemed university.

Key Points

➤ About the New Varieties of Rice:

- The new varieties contain a **mutated AcetoLactate Synthase (ALS) gene** making it possible for farmers to spray **Imazethapyr**, a broad-spectrum herbicide, to control weeds.
 - The **ALS gene** in rice codes for an enzyme (protein) that **synthesises amino acids for crop growth and development**.
 - The **herbicide sprayed on normal rice plants binds itself to the ALS enzymes, inhibiting their production of amino acids**.
- **Imazethapyr**, effective against a range of broadleaf, grassy and sedge weeds, **can't be used on normal paddy**, as the chemical **does not distinguish between the crop and the invasive plants**.

Note:



- However, the new basmati varieties contain a **mutated ALS gene** whose DNA sequence has been altered using **ethyl methanesulfonate, a chemical mutant**.
 - As a result, the ALS enzymes no longer have binding sites for Imazethapyr and amino acid synthesis isn't inhibited.
- The plants can now **"tolerate" application of the herbicide**, and hence it kills only the weeds.
- It is important to note that, as **there is no foreign gene involved in the process**, the herbicide-tolerance is through mutation breeding. **Thus, it is not a Genetically modified organism.**
- **Advantages of These Varieties:**
 - **Direct Seeding of Rice Activity:** The new varieties simply replace water with Imazethapyr and there's no need for nursery, puddling, transplanting and flooding of fields.
 - Water is a natural herbicide that takes care of weeds in the paddy crop's early-growth period.
 - The new varieties will help in **Direct Seeding of Rice (DSR) which has several advantages over paddy transplantation.**
 - **Cheaper Option:** DSR cultivation is currently based on two herbicides, Pendimethalin and Bispyribac-sodium.
 - However, Imazethapyr is cheaper than these two options.
 - **Safer Option:** Imazethapyr, moreover, has a wider weed-control range and is safer, as the ALS gene isn't present in humans and mammals.

Landsat 9

Why in News

Recently, NASA has launched an **earth monitoring satellite called Landsat 9** from Vandenberg Space Force Base in California. The satellite is a **joint mission of NASA and the US Geological Survey (USGS).**

- This satellite is referred to as **NASA's' new eye in the sky'** that will help study climate change.

Key Points

- **About Landsat 9:**

- The Landsat 9 **joins Landsat 8 that was launched in 2013** and the satellites together will collect images of Earth's surface.
 - It takes 8 days to capture the whole Earth.
- Landsat 9 carries instruments similar to the other Landsat satellites, but it is the **most technologically advanced satellite of its generation.**
- The instruments aboard Landsat 9 are the **Operational Land Imager 2 (OLI-2)** and the **Thermal Infrared Sensor 2 (TIRS-2).**
 - **OLI-2:** It captures sunlight reflected off Earth's surface and studies the visible, near-infrared, and short wave infrared portions of the spectrum.
 - **TIRS-2:** It has a four-element refractive telescope and photosensitive detectors that capture thermal radiation and help study the Earth's surface temperature.
- Along with the **European Union's Sentinel-2 satellites**, the Landsat Satellite will provide better estimation of the extent of climate change.

First Malaria Vaccine: Mosquirix

Recently, the **World Health Organisation (WHO)** **endorsed the world's first Malaria Vaccine** in the hope that it will spur stalled efforts to curb the spread of the parasitic disease.

- **Malaria** is a life-threatening disease **caused by parasites** that are transmitted to people **through the bites of infected female Anopheles mosquitoes**. It is **preventable and curable.**

Key Points

- **About:**
 - **RTS,S/AS01, trade name Mosquirix, is an injectable vaccine targeting P. falciparum**, the most prevalent malaria strain in Africa. It is the **first and only vaccine to show partial protection in young children.**
 - It was developed by British drugmaker Glaxo-SmithKline in 1987.
 - The active substance in Mosquirix is **made up of proteins found on the surface of the Plasmodium falciparum parasites (PFP).**
 - **RTS,S aims to trigger the immune system to defend against the first stages of malaria when**

the PFP enters the human host's bloodstream through a mosquito bite and infects liver cells.

- It also helps **protect against infection of the liver with the Hepatitis B virus.**

New Biodegradable Polymer

Why in News

Recently, scientists have developed a **New bio-degradable polymer**, using **Guar Gum, and Chitosan**, which has high potential for packaging material.

Key Points:

➤ About:

- It is a **guar gum-chitosan composite film** which is a **cross-linked polysaccharide** developed with the help of **solution casting method** (a simple technique to make polymer films). It overcomes the challenges of polysaccharides.
- **Polysaccharides** is one of the **biopolymers with high potential for use in synthesis of packaging material.**
- However, due to some drawbacks of polysaccharides, such as low mechanical properties, high water-solubility, and low barrier properties, they are not preferred.
- **Guar Gum, and Chitosan** are polysaccharides extracted from guar beans and shells of crab and shrimps.

➤ Properties of the Film:

- **High water stability, high mechanical strength** as well as **excellent resistance** towards harsh environmental conditions.
- The fabricated cross-linked film is **not easily soluble in water.** As per scientists, it did not dissolve even after 240 hours.
- It is **highly water repellent or hydrophobic** because of its high contact angle of 92.8°.
- **Water vapor permeability is low** as compared to the film made only from chitosan.
- **Vapour permeability** is a material's ability to allow a vapour (such as water vapour or, indeed any gas) to pass through it.

➤ Significance:

- It is likely to **help effectively deal with the menace**

of piling non-biodegradable packaging materials, including water and soda bottles.

- Normally, Polymers have a **wide variety of industrial and commercial uses** but it is not biodegradable and hence poses a **major challenge to the environment and earth's ecosystem.**

Quantum Key Distribution

Why in News

Recently, the government has inaugurated **C-DOT's (Centre for Development of Telematics)** Quantum Communication Lab and unveiled the indigenously developed **Quantum Key Distribution (QKD) solution.**

- The government has also allocated **USD 1 billion for the National Mission on Quantum Technologies and Applications** spanning over a period of 8 years.

Key Points

➤ About:

- QKD, also called **Quantum Cryptography**, is a mechanism to develop secure communication.
- It provides a way of **distributing and sharing secret keys** that are necessary for cryptographic protocols.
- **Cryptography** is the **study of secure communications techniques** that allow only the sender and intended recipient of a message to view its contents.
- **Cryptographic algorithms and protocols** are necessary to keep a system secure, particularly when communicating through an untrusted network such as the Internet.
- The **conventional cryptosystems** used for data-encryption **rely on** the complexity of **mathematical algorithms**, whereas the security offered by **quantum communication is based on the laws of Physics.**

➤ Mechanism:

- In the QKD, **encryption keys are sent as 'qubits' (or quantum bits) in an optical fibre.**
- **Optical fibers** are capable of transmitting more data over longer distances and faster than other mediums. It works on the principle of **total internal Reflections.**

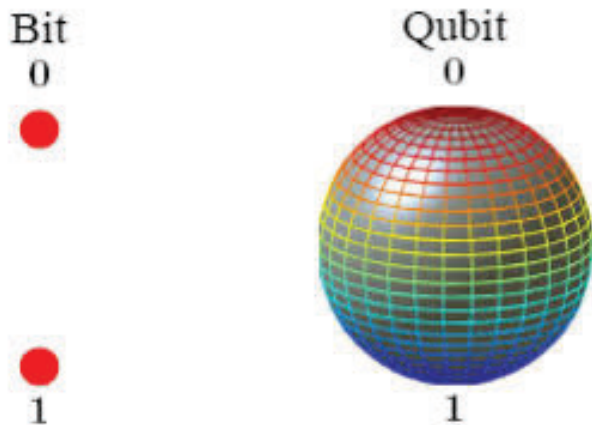
Note:



- QKD implementation requires **interactions between the legitimate users**. These interactions **need to be authenticated**. This can be achieved through various cryptographic means.
 - QKD allows two distant users, who do not share a long secret key initially, to produce a common, random string of secret bits, called a **secret key**.
- The end-result is that QKD can **utilize an authenticated communication channel and transform it into a secure communication channel**.
- It is designed in a way that **if an illegitimate entity tries to read the transmission, it will disturb the qubits** – which are encoded on photons.
- This will generate transmission errors, leading to legitimate **end-users being immediately informed**.

➤ **Qubits:**

- **Conventional computers process information in 'bits' or 1s and 0s**, following classical physics under which our computers can process a '1' or a '0' at a time.
- Quantum computers compute in **qubits**. They exploit the properties of quantum mechanics, the science that governs how matter behaves on the atomic scale.
 - In this scheme of things, **processors can be a 1 and a 0 simultaneously**, a state called **quantum superposition**.
 - Because of quantum superposition, a quantum computer — if it works to plan — **can mimic several classical computers working in parallel**.



➤ **Need:**

- QKD is **essential to address the threat that rapid advancement in Quantum Computing poses to the**

security of the data being transported by various critical sectors through the current communication networks.

➤ **Benefits:**

- The technology would be useful in **enabling various start-ups and small and medium enterprises** in the domain of quantum information.
- It is expected **to create a definition of standards and formulate crypto technology-related policies**.

➤ **Significance:**

- **Detection of Leak:**
 - It **allows the detection of data leak or hacking** because it can detect any such attempt.
- **Predetermined Error Levels:**
 - It also **allows the process of setting the error level** between the intercepted data.
- **Unbreakable Encryption:**
 - The **encryption is unbreakable** and that's mainly because of the way data is carried via the photon.
 - A photon cannot be perfectly copied and any attempt to measure it will disturb it. This means that a person trying to intercept the data will leave a trace.

Katol Meteorite

Why in News

Recently, some researchers studied a **meteorite from Katol**, Maharashtra which was from the meteor shower of 2012.

- A **meteorite** is a solid piece of debris from an object, such as a **comet, asteroid, or meteoroid**, that originates in outer space and survives its passage through the atmosphere to reach the surface of a planet or moon.

Key Points

➤ **Findings:**

- **Depth of Olivine:**
 - Initial studies revealed that the **host rock was mainly composed of olivine**, an olive-green mineral.
 - **Olivine is the most abundant phase in our Earth's upper mantle**.

Note:



- Earth is composed of different layers including the outer **crust**, followed by the **mantle** and then the inner **core**.
- It was believed that we can reach the **upper mantle if we drill for about 410 kilometers**.
- However, by studying the composition of these meteorite fragments, researchers have unravelled the composition expected to be present in the **Earth's lower mantle which is at about 660 km deep**.
- **Formation of Bridgmanite:**
 - Various computational and experimental studies have shown that about **80% of the Earth's lower mantle is made up of bridgmanite**. By studying this meteorite sample, **scientists can decode how bridgmanite crystallized** during the final stages of our Earth's formation.
 - **Bridgmanite** is a magnesium-silicate mineral, MgSiO_3 , the most abundant mineral on earth.
 - The mineral was **named in 2014 after Prof. Percy W. Bridgman**, recipient of the 1946 **Nobel Prize in Physics**.
 - As the **bridgmanite of the Katol meteorite sample closely matches with the bridgmanite on Earth**.
- **Bridgmanite on Earth vs Meteorite:**
 - The bridgmanite in the meteorite was found to be formed at **pressures of about 23 to 25 gigapascals generated by the shock event**.
 - The high temperature and pressure in our Earth's interior have **changed over billions of years** causing crystallisation, melting, remelting of the different minerals before they reached their current state.
- **Significance:**
 - Studying the meteorite could also **tell us more about how our Earth evolved** from being a magma ocean to a rocky planet and researchers can unearth more details about the formation of Earth.
 - It is important to study these individual minerals to get a thorough idea of **how and when the Earth's layers formed**.
 - Scientists can also **decode how bridgmanite crystallized** during the final stages of our **Earth's formation**.

Mission Lucy: NASA

Why in News

National Aeronautics and Space Administration (NASA) is set to launch '**Lucy**', its **first mission to explore the Jupiter Trojan Asteroids**.

Key Notes

- **Mission Lucy:**
 - **Duration:**
 - The **solar-powered mission is estimated to be over 12 years long**, during which the spacecraft will visit **eight asteroids covering a distance of about 6.3 billion km** to deepen the understanding of the "young solar system".
 - **Name and Launch:**
 - The mission is **named after 'Lucy', a 3.2 million-year-old ancestor** who belonged to a species of **hominins** (which include humans and their ancestors). The spacecraft will be **launched on an Atlas V 401 rocket**.
 - **Asteroid Donald Johnson:**
 - The spacecraft's first encounter will be with an asteroid that lies in the main belt that can be found between **Mars and Jupiter**. This asteroid is named '**Donald Johnson**' after the paleoanthropologist who discovered the fossilised remains of 'Lucy'.

Nobel Prize for Physiology/Medicine, 2021

Why in News

Recently, two United States-based scientists, **David Julius** and **Ardem Patapoutian**, have been awarded the **2021 Nobel Prize for Physiology/Medicine** for their **discoveries of receptors for temperature and touch**.

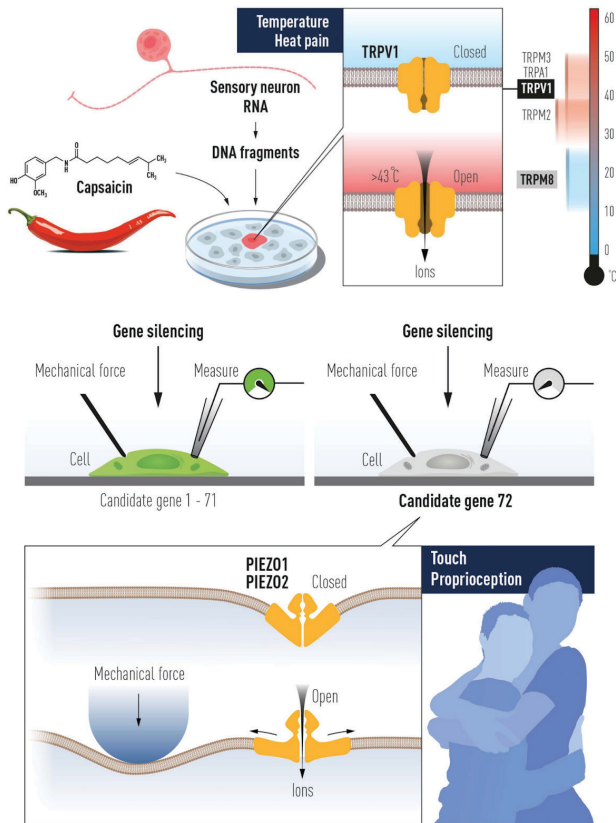
- They have focused their work on the **field of somatosensation**, that is the ability of specialised organs such as eyes, ears and skin to see, hear and feel.

Key Points

- **About the Discoveries:**

Note:





○ **David Julius:**

- He discovered **TRPV1**, a **heat-sensing receptor**.
- His findings on the **skin's sense of temperature** was based on how certain cells react to **capsaicin**, the molecule that makes chili peppers spicy, by simulating a false sensation of heat.

○ **Ardem Patapoutian:**

- He discovered two **mechanosensitive ion channels** known as the **Piezo channels**.
 - The **Piezo1** is named after the Greek word for **pressure**, 'piesi'.
- He is credited for finding the **cellular mechanism** and the **underlying gene** that **translates a mechanical force on our skin into an electric nerve signal**.

➤ **Significance of Discoveries:**

- The findings have allowed us to **understand how heat, cold and mechanical force can initiate the nerve impulses** that allow us to perceive and adapt to the world around us.
- This knowledge is being **used to develop treatments for a wide range of disease conditions**, including chronic pain.

Note:

- **Somatosensation** is a collective term for the sensations of touch, temperature, body position, and pain recognized through neural receptors in the skin and certain internal organs.
 - It includes processes such as "mechanoreception, thermoreception, proprioception."
- **Mechanosensitive channels** are fascinating proteins, being able to serve both as sensors and effectors.
 - Embedded in membranes, they convert mechanical stimuli such as in-plane membrane tension and curvature into electrical or biochemical signals, leading to regulation of a wide repertoire of cellular processes allowing adaptive response.

Nobel Prize in Physics, 2021

Why in News

The 2021 Nobel Prize in Physics is awarded with **one half jointly to Syukuro Manabe, Klaus Hasselmann** and the **other half to Giorgio Parisi** "for groundbreaking contributions to our understanding of complex physical systems".

- This is the **first time climate scientists** (Manabe and Hasselmann) have been awarded the Physics Nobel. Last year, the award was given for the **research into black holes**.
- The **Nobel Prize in Physiology or Medicine 2021** has already been announced.

Key Points

➤ **About:**

○ **Manabe and Hasselmann:**

- Awarded for work in **physical modelling of Earth's climate**, quantifying variability and reliably predicting **global warming**.
 - Demonstrated how **increases in the amount of carbon dioxide** in the atmosphere would **increase global temperatures**, laying the foundations for current climate models.

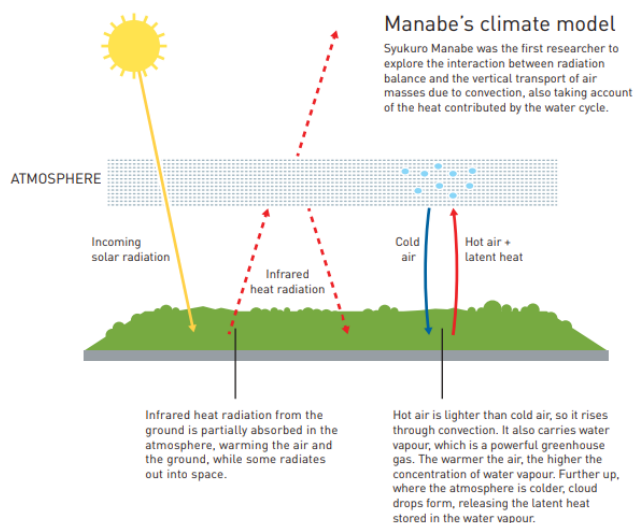
○ **Parisi:**

- Awarded for **"the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales."**

Note:



- He “built a deep physical and mathematical model” that made it possible to understand complex systems in fields such as mathematics, biology, neuroscience and machine learning.



➤ Climate Science and Nobel Prize Recognition:

- The **Intergovernmental Panel on Climate Change (IPCC)** had won the Peace Nobel in 2007, an acknowledgement of its efforts in creating awareness for the fight against climate change.
- A **Chemistry Nobel to Paul Crutzen in 1995**, for his work on the **ozone layer**, is considered the only other time someone from atmospheric sciences has won this honour.

Semi-Cryogenic Propellant Tank

Why in News

Recently, **Hindustan Aeronautics Ltd (HAL)** delivered the **heaviest semi-cryogenic propellant tank (SC120- LOX)** to the **Indian Space Research Organization (ISRO)**.

- In 2020, HAL delivered the **biggest ever cryogenic Liquid Hydrogen tank (C32-LH2)** to ISRO.

Key Points

➤ About:

- The **semi cryo-liquid oxygen (LOX) tank** - the first developmental welded hardware - is a part of the **SC120 stage intended for payload enhancement** by replacing the L110 (liquid) stage in the existing **Mk-III launch vehicle**.

- **GSLV Mk III** is a three-stage heavy-lift launch vehicle developed by ISRO. The vehicle has two solid strap-ons, a core liquid booster and a cryogenic upper stage.

➤ Cryogenic Engine:

- A cryogenic engine/ cryogenic stage is the **last stage of space launch vehicles which makes use of Cryogenics**.
- Cryogenics is the study of the production and behaviour of materials at extremely low temperatures (below -150 degree Centigrade) to lift and place heavier objects in space.
- A cryogenic engine provides **more force with each kilogram of cryogenic propellant it uses** compared to other propellants, such as **solid and liquid propellant rocket engines** and is more efficient.
- It uses **Liquid Oxygen (LOX)** and **Liquid Hydrogen (LH2)** as propellants which liquefy at -183 deg C and -253 deg C respectively.

➤ Semi Cryogenic Engine:

- Unlike a Cryogenic engine, a Semi Cryogenic engine **uses Refined kerosene instead of liquid hydrogen**.
- The liquid oxygen is used as a Oxidiser.
 - That's the advantage of using a Semi Cryogenic engine as it requires Refined Kerosene which is lighter than liquid fuel and can be stored in a normal temperature.
- Kerosene combined with liquid oxygen **provide a higher thrust to the rocket**.
- Refined Kerosene occupies less space, **making it possible to carry more propellant** in a Semi Cryogenic engines fuel compartment.
- A semi cryogenic engine is **more powerful, environment friendly and cost effective** as compared to a cryogenic engine.

New Gene Editing Technique

Why in News

The proposal for Indian regulators to consider a **new gene editing technique** has been pending with the **Genetic Engineering Appraisal Committee** for almost two years.

Key Points

➤ About:

Note:



Gene Editing

- Genome editing (also called **gene editing**) is a **group of technologies that give scientists the ability to change an organism's Deoxy-Ribonucleic Acid (DNA)**.
- These technologies **allow genetic material to be added, removed, or altered** at particular locations in the genome.
 - The **Indian Agricultural Research Institute (IARI)** has now moved to newer technologies such as **Site Directed Nuclease (SDN) 1 and 2**.
 - New technique aims to bring **precision and efficiency into the breeding process** using gene editing tools such as **CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)**, whose developers won the **Nobel Prize for Chemistry in 2020**.
 - **SDN genome editing** involves the **use of different DNA-cutting enzymes** (nucleases) that are directed to cut the DNA at a **predetermined location** by a range of different DNA binding systems.
 - After the cut is made, the **cell's own DNA repair mechanism recognizes the break and repairs the damage**, using one of two pathways that are naturally present in cells.
 - It **involves the use of gene editing tools to directly tweak (improve\change)** the plant's own genes instead.
 - It would allow plants to be genetically modified **without the need for conventional transgenic technology**.
- **Current Application:**
 - A research coalition under the **Indian Council of Agricultural Research (ICAR)**, which includes the **IARI**, is using these techniques to **develop rice varieties which are drought-tolerant, salinity-tolerant and high-yielding**. They could potentially be ready for commercial cultivation within three years.
 - The IARI has previously worked on golden rice, a traditional GM variety which inserted genes from other organisms into the rice plant, but ended trials over five years ago due to agronomic issues.
- **Significance of New Techniques:**
 - **Safe:**
 - In this case, you are **just tweaking a gene that is already there in the plant**, without bringing in any gene from outside.

- When a protein comes from an outside organism, then you need to test for safety. But in this case, this protein is right there in the plant, and is being changed a little bit, just as nature does through **mutation**.

○ Fast:

- It is **much faster and far more precise than natural mutation** or conventional breeding methods which involve trial and error and multiple breeding cycles. It is potentially a new **Green Revolution**.

Hypersonic Technology

Why in News

Recently, it has been reported that **China tested a nuclear-capable hypersonic glide vehicle** that circled the globe before speeding towards its target.

- Several countries, including the **US, Russia and China**, are developing **hypersonic missiles** which travel at a speed five times that of sound.
- Though **slower than ballistic missiles**, they are harder to intercept and can be manoeuvred.

Key Points

➤ Hypersonic Speed and Technology:

○ About:

- Hypersonic speeds are **5 or more times the Mach or speed of sound**.
- **Mach Number:** It describes an aircraft's speed compared with the speed of sound in air, with Mach 1 equating to the speed of sound i.e. **343 metre per second**.

○ Types (2):

- **Hypersonic cruise missiles:** These are the ones that **use rocket or jet propellant** through their flight and are regarded as being just faster versions of existing cruise missiles.
- **Hypersonic Glide Vehicle (HGV):** These missiles first go up into the atmosphere on a conventional rocket before being launched towards their target.

- **Technology Used:** Most hypersonic vehicles primarily use the **scramjet technology**, which is a type of **Air Breathing propulsion System**.

Note:



- This is extremely complex technology, which also needs to be able to handle high temperatures, making the hypersonic systems extremely costly.

➤ Development of Hypersonic Technology in India:

- India, too, is working on hypersonic technologies.
 - As far as space assets are concerned, India has already proved its capabilities through the test of **ASAT under Mission Shakti**.
- Hypersonic technology has been developed and tested by both DRDO and ISRO.
- Recently, DRDO has successfully flight-tested the **Hypersonic Technology Demonstrator Vehicle (HSTDV)**, with a capability to travel at 6 times the speed of sound.
- Also, a **Hypersonic Wind Tunnel (HWT)** test facility of the DRDO was inaugurated in Hyderabad. It is a pressure vacuum-driven, enclosed free jet facility that simulates Mach 5 to 12.

White Dwarf

Why in News

Recently, an international team saw a **white dwarf losing its brightness in 30 minutes**, which usually takes a period of several days to months.

- This peculiarity in brightness of white dwarfs can be referred to as **switch on and off phenomena**.
- Using the **Hubble Space telescope** and **Transiting Exoplanet Survey Satellite (TESS)**, astronomers have identified several white dwarfs over the years.

Key Points

➤ About White Dwarfs:

- **Formation:**
 - White dwarfs are **stars that have burned up all of the hydrogen** they once used as nuclear fuel.
 - Such stars have very high density.
 - A typical white dwarf is half the size of our Sun and has a surface gravity 1,00,000 times that of Earth.
 - Stars like our **sun fuse hydrogen in their cores into helium** through **nuclear fusion reactions**.
 - **Fusion in a star's core produces heat and outward pressure** (they bloat up as enormous red giants), but this pressure is **kept in balance**

by the inward push of gravity generated by a star's mass.

- When the **hydrogen, used as fuel, vanishes and fusion slows**, gravity causes the **star to collapse in on itself into white dwarfs**.

○ Black Dwarfs:

- Eventually - **over tens or even hundreds of billions of years - a white dwarf cools** until it **becomes a black dwarf, which emits no energy**. Because the universe's oldest stars are only 10 billion to 20 billion years old there are **no known black dwarfs**.

- It must be noted that **not all white dwarfs cool** and transform into black dwarfs.

○ Chandrasekhar Limit:

- Those **white dwarfs which have enough mass reach a level** called the **Chandrasekhar Limit**.
- At this point the pressure at its center becomes so great that the star will detonate in a **thermonuclear supernova** (explosion).

➤ Switch on and off Phenomena:

- The **white dwarf**, which is discussed, is **part of a binary system called TW Pictoris**, where a star and a white dwarf orbit each other.
 - The two objects are so close to each other that the **star transfers material to the white dwarf**.
- **As this material approaches the white dwarf it forms an accretion disk** or a disk of gas, plasma, and other particles around it.
- As the **accretion disk** material slowly sinks closer towards the white dwarf it **generally becomes brighter**.
- Also there are **cases when the donor stars stop feeding the white dwarf disk**. However, reasons for this are still not clear.
- When this happens the **disk is still bright** as it **"drains" material that was previously still there**.
 - It then **takes the disk about 1-2 months** to drain most of the material.
- However, **TW Pictoris' drop in brightness in 30 mins** was totally unexpected and it may be **due to the process called magnetic gating**.
 - Magnetic gating happens when the **magnetic field is spinning so rapidly around the white Dwarf** it creates a barrier disrupting the amount of matter the white dwarf can receive.

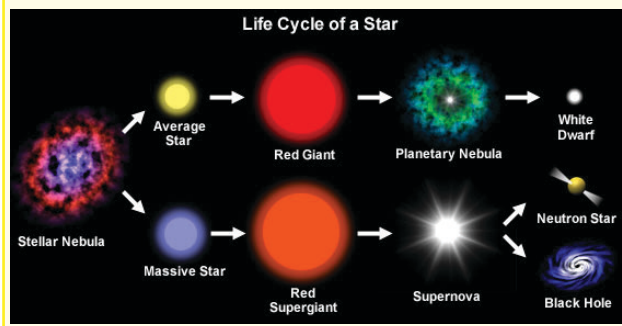
Note:



- **Significance:** This discovery will help **understand the physics behind accretion** – how **black holes** and **neutron stars** feed material from their nearby stars.

Chandrasekhar Limit

- Chandrasekhar Limit is the **maximum mass theoretically possible** for a stable white dwarf star.
- A limit which mandates that **no white dwarf** (a collapsed, degenerate star) can be more massive than about **1.4 times the mass of the Sun**.
- Any degenerate object **more massive must inevitably collapse into a neutron star or black hole**.
- The limit is **named after the Nobel laureate Subrahmanyan Chandrasekhar**, who first proposed the idea in 1931.
 - He was awarded the **Nobel Prize in Physics** in 1983 for his work on the physical processes involved in the structure and evolution of stars.



Converting CO₂ to Methane

Why in News

Recently, Indian Scientists have designed a **photochemical method (Photocatalyst)** to convert Carbon Dioxide (CO₂) to Methane (CH₄).

- A photochemical method is a **chemical reaction** initiated by the absorption of **energy in the form of light**.

Key Points

- **About:**
 - A polymer has been designed to **absorb visible light and catalyse the reaction** which reduces CO₂.
 - Most catalysts contain toxic and expensive metal counterparts. Therefore scientists designed a **metal-free porous organic polymer to overcome this drawback**.

- The photochemical method of reducing CO₂ uses **solar light as a renewable source of energy**.
 - There are several ways in which CO₂ can be reduced, including photochemical, **electrochemical**, photoelectrochemical, photothermal, and so on.

➤ Mechanism:

- The catalyst has a chemical called the **Conjugated Microporous Polymer (CMP)**.
- It can uptake CO₂ onto its surface due to its high CO₂ intake capability at room temperature, **converting it into methane as a value-added product**.
- There are some **key requirements** of a photo-catalyst to convert CO₂ into value-added products, which rely upon:
 - Light-harvesting property.
 - Charge carrier (electron-hole pair) separation proficiency.
 - Presence of proper electronically aligned conduction band.

➤ Significance:

- Methane can be one of the value-added products with significant uses as the cleanest burning **fossil fuel** and can directly be used in **fuel cells** as a hydrogen carrier.
- It is also the main component of **natural gas** and has the potential to replace coal for electricity generation and furnishing flexible supply to reinforce intermittent renewable generators.

Double Asteroid Redirection Test (DART) Mission: NASA

Why in News

NASA will launch its **first planetary defense test mission** named the **Double Asteroid Redirection Test (DART)**.

- The DART spacecraft **will be launched on a SpaceX Falcon 9 rocket**.

Key Points

➤ Aim of the Mission:

- The mission is to test the new technology **to be prepared in case an asteroid heads towards Earth in the future**.

Note:



- The aim is to test the newly developed technology that **would allow a spacecraft to crash into an asteroid and change its course.**
- The target of the spacecraft is a **small moonlet called Dimorphos** (Greek for “two forms”).
 - **Dimorphos** orbits a **larger asteroid named Didymos** (Greek for “twin”).
- It is a **suicide mission** and the spacecraft will be completely destroyed.
- The collision is expected to take place **between 26th September and 1st October, 2022.**
- **About the Mission:**
 - DART is a **low-cost spacecraft.**
 - It has **two solar arrays and uses hydrazine propellant** for maneuvering the spacecraft.
 - It also carries about 10 kg of xenon which will be used to demonstrate the **agency’s new thrusters called NASA Evolutionary Xenon Thruster–Commercial (NEXT-C)** in space.
 - **NEXT-C** gridded ion thruster system provides a combination of performance and spacecraft integration capabilities that **make it uniquely suited for deep space robotic missions.**
 - The spacecraft carries a **high-resolution imager called Didymos Reconnaissance and Asteroid Camera for Optical Navigation (DRACO).**
 - Images from DRACO will be sent to Earth in real-time and will help study the impact site and surface of Dimorphos (the target asteroid).
 - DART will also carry a **small satellite or CubeSat named LICIACube (Light Italian CubeSat for Imaging of Asteroids).**
 - LICIACube is expected to **capture images of the impact and the impact crater** formed as a result of the collision.

Preserving Landraces

Why in News

Recently, **Padma Shri award** was given to **Rahibai Popere**, popularly known as **Seedmother**, from Akole taluka of Ahmednagar, Maharashtra.

- She was awarded for recognition of her work that **has helped save hundreds of landraces (wild varieties of commonly grown crops) at the village level.**

Key Points

➤ Landraces:

- **About:** Landraces refer to **naturally occurring variants of commonly cultivated crops.**
 - These are as **opposed to commercially grown crops**, which are developed by selective breeding (hybrids) or through **genetic engineering** to express a certain trait over others.
- **Utility of Landraces:** Amid the threat of climate change, a challenge before scientists and policymakers is to develop varieties that can withstand both abiotic and biotic stresses.
 - **Rich Genetic Pool:** Naturally occurring landraces have a large pool of still untapped genetic material, which can provide solutions.
 - The wider the gene pool, the more the chance of developing a trait that can help in surviving extreme climate events.
 - **Higher Yields With Proper Input:** There is a common misconception that landraces have lower yields than hybrids. However, with proper agricultural practices, landraces can give better yield with lower input costs.
 - **High Nutrition Profile:** Many landraces are richer in nutrients than commercially grown variants.
- **Examples of Landraces:** Kalbhat is a unique **landrace of scented rice.**
 - Over the years, this variant had almost vanished from cultivators’ fields as hybrid variants became popular.
 - It has better climate resilience than popularly grown rice and can withstand floods or drought better

Kamo’oalewa

Why in News

Recently, scientists have observed a **quasi-satellite named Kamo’oalewa**, tracking the Earth’s orbit around the Sun, could be a fragment from the moon.

- A **mission to collect Kamo’oalewa’s samples** has been scheduled for a launch **in 2025.**

Key Points

- **Kamo’oalewa:**

Note:



- **Discovered in 2016** (through the **PanSTARRS telescope in Hawaii**), Kamo'oalewa is a word that is part of a Hawaiian chant, and alludes to an offspring that travels on its own.
- It is **one of Earth's quasi-satellites, a space rock that orbits the Sun, but remains relatively close to the planet** – in this case about **9 million miles away**.
- The asteroid is **roughly the size of a Ferris wheel – between 150 and 190 feet in diameter**.
- Because of its small size (about 50 metres wide), this quasi-satellite has been difficult for scientists to study, **and little was known about it so far**.

Omicron: New Corona Variant

Why in News

The **World Health Organization** has declared the recently-discovered B.1.1.529 strain of **Covid-19**, to be a **variant of concern**.

- The virus was first detected in **Southern Africa** and it is **renamed Omicron**.

Key Points

- **About:**
 - Omicron is placed in the **most-troubling category of Covid-19 variants**, along with the **globally-dominant Delta plus** its weaker rivals Alpha, Beta and Gamma.
 - This variant has a **large number of mutations**. Some of them are cause for serious concern because they may allow the new variant to evade immunity obtained from a past infection or via a vaccine.
- **Nomenclature:**
 - The WHO has decided to name the variants **after the letters of the Greek alphabet**, to avoid the **countries that first detected them being stigmatised**.
 - WHO selected the name Omicron, **instead of Nu or Xi**, the two letters between Mu and Omicron. This is because:
 - Xi happens to be a popular **surname in China** (avoiding 'causing offence to any cultural, social, national, regional, professional or ethnic groups).
 - Nu could have been confused with the **word 'new'**.

Variants of Concern

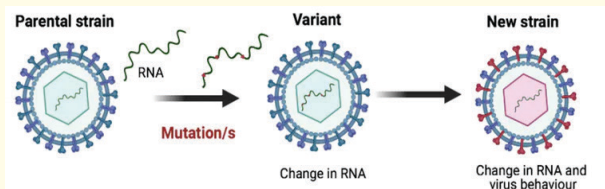
- A variant for which there is evidence of an **increase in transmissibility, more severe disease** (e.g., increased hospitalizations or deaths), **significant reduction in neutralization by antibodies** generated during previous infection or vaccination, **reduced effectiveness of treatments or vaccines**, or diagnostic detection failures.
- The new Variants could kick off **new wave(s) of epidemic transmission**.
- The WHO currently lists **5 variants of concern**:
 - **Omicron (B.1.1.529)**, identified in southern Africa in November 2021
 - **Delta (B.1.617.2)**, which emerged in India in late 2020 and spread around the world
 - **Gamma (P.1)**, which emerged in Brazil in late 2020
 - **Beta (B.1.351)**, which emerged in South Africa in early 2020
 - **Alpha (B.1.1.7)**, which merged in Britain in late 2020.

Variants of Interest

- A variant **with specific genetic markers** that have been associated with changes to receptor binding, reduced neutralization by antibodies generated against previous infection or vaccination, reduced efficacy of treatments, potential diagnostic impact, or predicted increase in transmissibility or disease severity.
- There are currently two:
 - **Mu (B.1.621)**, which emerged in Colombia in early 2021
 - **Lambda (C.37)**, which emerged in Peru in late 2020

Mutation, Variant and Strain

- When a virus replicates it doesn't always manage to produce an exact copy of itself.
- This means that, over time, the virus may start to differ slightly in terms of its genetic sequence.



- Any changes to the viral genetic sequence during this process is known as a **Mutation**.
- Viruses with new mutations are sometimes called **Variants**. Variants can differ by one or multiple mutations.

Note:



- When a new variant has different functional properties to the original virus and becomes established in a population, it is sometimes referred to as a **New Strain of the virus**.
 - All strains are variants, but not all variants are strains.

Tundra Satellite System: Russia

Why in News

Recently, Russia has successfully placed into **orbit a military satellite**. The satellite is believed to be a **Tundra Satellite**, part of **Russia's early warning anti-missile system named Kupol or dome**.

Key Points

- **About:**
 - Tundra satellite system is a **constellation of Missile Early Warning Satellites** established by Russia between 2015 and 2020.
 - It carries a secure emergency communications payload to be used in case of a **nuclear war**.
 - It is a series of satellites that are the next generation of Russian early warning satellites to replace the early warning satellites of the **Oko-1 system**.
 - This final **Oko (Eye) satellite (missile defence early warning program)** reportedly stopped operating in mid 2014, leaving Russia relying on ground-based missile detection systems.
 - They are part of the **EKS or Unified Space System (USS-Also sometimes referred as Kupol or dome)**, which will also include several satellites in geostationary orbit.
 - Unveiled in 2019, Kupol is designed to detect launches of **ballistic missiles** and track them to their landing site, **though its exact configuration is unknown**.

Havana Syndrome

Why in News

Recently, the **US Federal Bureau of Investigation (FBI)** has said that dealing with the issue of **Havana**

Syndrome is a top priority and that it will keep investigating the cause and how to protect staff.

Key Points

- **About:**
 - The **symptoms of the syndrome include** Nausea, Severe headaches, Fatigue, Dizziness, Sleep problems, Hearing loss.
 - A few of those who had been affected more faced chronic issues like vestibular processing and cognitive problems.
 - In 2020, a **report** by the National Academies of Sciences (NAS), **US found directed microwave radiation to be the plausible cause** of the Havana syndrome.
- **Microwave Weapons:**
 - **Direct Energy Weapon (DEW):**
 - They are a **type of direct energy weapons**, which aim highly focused energy in the form of sonic, laser, or microwaves, at a target.
 - They release **electromagnetic radiation** which causes sensations in the human body.
 - **Electromagnetic radiation** heating the water in the human body makes a person feel dizziness and nausea.
 - **Countries with Microwave Weapons:**
 - **A number of countries** are thought to have developed these weapons to target both humans and electronic systems.
 - China had first put on display its microwave weapon, **called Poly WB-1**, at an air show in 2014.
 - The US has also developed a **prototype microwave-style weapon**, which it calls the **"Active Denial System"**, which is the first non-lethal, directed-energy, counter-personnel system with an extended range greater than currently fielded non-lethal weapons.

Multisystem Inflammatory Syndrome in Children

Why in News

Recently, the **World Health Organization (WHO)** has released fresh guidelines for treating children who developed **Multisystem Inflammatory Syndrome (MIS-C)** after being exposed to **Covid-19 infection**.

Key Points

➤ About:

- MIS-C is a condition where **various organs of the body are affected by inflammation**. The patient develops heart problems, the severity of which may determine the line of treatment.
- It is a **rare but severe hyperinflammatory condition** in children and adolescents that **typically occurs 2-6 weeks after a Covid-19 infection**.
- It is a potentially deadly condition where different body parts can become inflamed, including the **heart, lungs, kidneys, brain, skin, eyes, or gastrointestinal organs**.
- Children with MIS-C may have a fever and **various symptoms**, including abdominal (gut) pain, vomiting, diarrhea, neck pain, rash, bloodshot eyes, or feeling extra tired.

➤ MIS-C with Neurological Complications:

- In a recent study, **young people with the MIS-C syndrome have shown neurological issues** which were life-threatening such as strokes or severe encephalopathy (any brain disease that alters brain function or structure).
- **Neurological symptoms** include hallucinations, confusion, speech impairments, and problems with balance and coordination.
- The new findings strengthen the theory that the **syndrome is related to a surge of inflammation triggered by an immune response to the virus**.

➤ Causes of MIS-C:

- As the Syndrome is less researched, there are **varied theories** as to what causes MIS-C.
- While some researchers believe that **MIS-C is a delayed response to the coronavirus** which in turn causes massive inflammation in the body and as a result damages organs.
- Others believe that it can also **be a result of the children's immune response making antibodies against the virus**.
- There may be a **genetic component as not every child develops MIS-C** and the presenting symptoms are so varied.

➤ WHO Guidelines for Treatment:

- It is suggested to use **corticosteroids in addition to the standard of care for Kawasaki disease** (conditional recommendation, very low certainty) in hospitalised **children (0-18 years of age)**.

- Commonly referred to as steroids, **corticosteroids are a type of anti-inflammatory drug**.
- Corticosteroids along with supportive care resulted in a more effective treatment than either **intravenous immunoglobulin plus supportive care** or supportive care alone.
- The treatment was also found to be effective in treating children with **Kawasaki disease** in association to **Covid-19**.
- Not to use corticosteroids in the treatment of patients **with non-severe Covid-19 as the treatment brought no benefits**, and could even prove harmful.

Kawasaki Disease

- It is an **acute inflammatory disease of the blood vessels** and usually occurs in children below the age of five.
- The inflammation in the coronary arteries that are responsible for supplying blood to the heart **results in enlargement or in the formation of aneurysms** (swelling of the wall of an artery), leading to heart attacks.
- **Symptoms:** Fever, rashes, redness of the cornea, red and cracked lips, a red tongue and lymph node enlargement of the neck.

NASA's New Communications System: LCRD

Why in News

Recently, **NASA (National Aeronautics and Space Administration)** has launched its new **Laser Communications Relay Demonstration (LCRD)**.

Key Points

➤ About:

- It is the **first-ever laser communications system** that will **pave the way for future optical communications missions**.
 - Currently, most NASA spacecraft use radio frequency communications to send data.
- The **LCRD payload is hosted onboard the US Department of Defense's Space Test Program Satellite 6 (STPSat-6)**. It will be in a **geosynchronous orbit**, over 35,000 km above Earth.

Note:



- It will be controlled by engineers at the **LCDR mission's ground stations in California and Hawaii**.
- The team will send test data through radio frequency signals and the LCDR will reply using optical signals.

➤ **Features:**

- It has **two optical terminals**. One to receive data from a user spacecraft, and the other to transmit data to ground stations.
- The modems will **translate the digital data into laser signals**. This will then be transmitted via encoded beams of light.
- These capabilities make **LCDR NASA's first two-way, end-to-end optical relay**.

➤ **Significance:**

- Laser uses infrared light and has a shorter wavelength than radio waves. This will **help the transmission of more data in a short time**.
 - Using infrared lasers, LCDR will send data to Earth at 1.2 gigabits-per-second (Gbps). At this speed, it will take less than a minute to download a movie.
 - It takes roughly nine weeks to transmit a completed map of Mars back to Earth with current radio frequency systems. **With lasers, we can accelerate that to about nine days.**
- Optical communications **will help increase the bandwidth 10 to 100 times more** than radio frequency systems.
- Optical communications systems are smaller in size, weight, and require less power compared with radio instruments.
- A smaller size means **more room for science instruments**.
- **Less weight means a less expensive launch**.
- Less power means **less drain on the spacecraft's batteries**.
- With optical communications supplementing radio, missions will have **unparalleled communications capabilities**.

James Webb Space Telescope

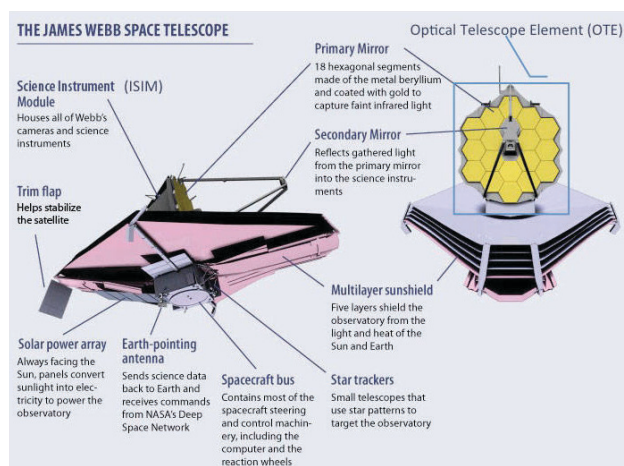
Why in News

The **James Webb Space Telescope (JWST)** is scheduled to be rocketed into orbit later this year (2021).

Key Points

➤ **About:**

- It is the **most powerful infrared telescope of National Aeronautics and Space Administration (NASA)**.
- It is also considered a successor of the **Hubble Telescope** and will extend and complement its discoveries.
 - Launched into **low Earth orbit in 1990**, the Hubble Space Telescope has made more than 1.4 million observations, including tracking interstellar objects, capturing a comet colliding with Jupiter, and discovering moons around Pluto.
 - Hubble has **captured galaxies merging, probed supermassive black holes** and has helped us understand the history of our universe.
- The telescope is the **result of an international collaboration** between NASA, the European Space Agency (ESA) and the Canadian Space Agency.
- Webb will **reveal new and unexpected discoveries**, and help humanity understand the origins of the universe and our place in it.
- The telescope will study the atmospheres of a **wide diversity of exoplanets**.
- It will **also search for atmospheres similar to Earth's**, and for the signatures of key substances such as methane, water, oxygen, carbon dioxide, and complex organic molecules, in hopes of finding the building blocks of life.



➤ **Launch:**

- It will be launched on an **Ariane 5 ECA rocket** from French Guiana in South America.

Note:



- The **Ariane 5** is believed to be **one of the most reliable launch vehicles**.
- **Webb Vs Hubble Telescope:**
 - **Wavelength:**
 - The JWST will **observe primarily in the infrared range** and provide coverage from 0.6 to 28 microns.
 - The instruments on **Hubble see mainly in the ultraviolet and visible part of the spectrum**. It could observe only a small range in the infrared from 0.8 to 2.5 microns.
 - The **infrared region of the electromagnetic spectrum** covers the wavelength range from approximately 0.7 to a few 100 microns.
 - **Size:**
 - Webb's primary mirror has a **diameter of 6.5 metres while Hubble's mirror was much smaller – 2.4 metres in diameter**.
 - So, Webb will have a **larger field of view compared to the camera on Hubble**.
 - Webb also **carries a large sun shield**.
 - **Distance:**
 - Webb's near- and mid-infrared instruments will **help study the first formed galaxies, exoplanets and birth of stars**.
 - Hubble can see the equivalent of **"toddler galaxies"** while Webb Telescope will be able to see **"baby galaxies"**.

Log4Shell Vulnerability

Why in News

A critical vulnerability called **Log4Shell**, detected last week in widely used **open-source logging software Apache Log4J**, is now being exploited by attackers to target organizations all over the world, including India.

- The vulnerability is **based on an open-source logging library** used in most applications by enterprises and even government agencies.

Vulnerability

- In computer security, a **vulnerability is a weakness which can be exploited** by a threat actor, such as an attacker, to cross privilege boundaries (i.e. perform unauthorized actions) within a computer system.

- To exploit a vulnerability, an attacker must have at least one applicable tool or technique that can connect to a system weakness. The vulnerabilities are **also known as the attack surface**.

Application Logging

- Application Logging is the process of **saving application events**. It varies from other event logs within IT systems in that the information collected by an application event log is dictated by each individual application, instead of the operating system.
- They help **provide visibility into how our applications are running** on each of the various infrastructure components.
- **Log data** contains information such as out of memory exceptions or hard disk errors.

Key Points

- **Name:**
 - The vulnerability is dubbed **Log4Shell** and is officially called **CVE-2021-44228**.
 - CVE number is the unique number given to each vulnerability discovered across the world.
 - The vulnerability was first detected on websites that were hosting servers of a Microsoft-owned game called **Minecraft**.
- **Log4j library:**
 - Log4j is open-source software maintained by a group of **volunteer programmers** as part of the nonprofit **Apache Software Foundation** and is a key **Java-logging framework**.
 - The **Log4j library** is embedded in every **Java-based web service or application** and is used by a wide number of companies to enable **logging in on applications**.
 - **Java** is one of the most commonly used programming languages in the world.
 - The **problem impacts Log4j 2 versions** which is a very **common logging library** used by applications across the world.
 - Logging lets developers see all the activity of an application.
 - Tech companies such as Apple, Microsoft, Google all rely on this open-source library, as do enterprise applications from CISCO, Netapp, CloudFare, Amazon and others.

Note:



➤ **Severe Rating:**

- Log4Shell has been assigned a **severity rating of 10** by security experts, the highest level possible.
- The vulnerability could allow a hacker to take control of a system.
 - Data supplied by an untrusted outsider – data that you are merely printing out for later reference, or logging into a file – **can take over the server on which you are doing the logging.**
 - This **could turn** what should be a basic “print” instruction into a **leak-some-secret-data-out-onto-the-internet situation**, or even into a download-and-run-my-malware-at-once command.
 - Simply put, a log entry that you intended to make for completeness, perhaps even for legal or security reasons, **could turn into a malware implantation event.**

➤ **Remote Code Execution:**

- The vulnerability can be **exploited by using a single line of code** and **allows attackers to execute remote commands** on a victim’s system.
- It can be exploited by attackers to take control of any Java-based web server and carry out **Remote Code Execution (RCE) attacks.**
- In an RCE attack, attackers take control over the targeted system and can perform any function they want.
- The exploits for this vulnerability are already being tested by hackers, according to several reports, and it grants them access to an application, and could potentially let them run malicious software on a device or servers.

➤ **Impact of Log4Shell Vulnerability:**

- **Cryptocurrency Mining:** Most of the attacks they have observed appear to **focus on the use of cryptocurrency mining** at the expense of the victims. However, new variations of the original exploit are being introduced rapidly.
 - Successful exploitation of this vulnerability could **lead to disclosure of sensitive information**, addition or modification of data, or **Denial of Service (DoS).**
- **Global:** The **Australia-New Zealand (ANZ) area** was the most impacted region with **46% of corporate networks facing an attempted exploit.**

- While North America was the least impacted with 36.4% of organizations facing such an attempt.
- **India:** About 41% of corporate networks in India have already faced an attempted exploit.
 - Indian companies are not more vulnerable than their western counterparts because **they use Java-based applications.**
 - **Indian companies are at high risk** because of their weak security posture, especially the smaller companies that may not have the know-how or resources to detect and fix the issue quickly.

Solid-State Batteries

Why in News

Car manufacturer Volkswagen plans to have production running for **solid-state batteries** by 2025 via the partnership with QuantumScape.

- QuantumScape’s solid-state battery — lithium metal with a solid electrolyte separating the two electrodes — is seen as an exceptionally bright prospect in an increasingly crowded space.

Liquid lithium-ion batteries	Solid-state lithium-ion batteries
Low processing cost	Excellent thermal stability
Flexible separators can withstand high mechanical stress	Comparatively less self-discharge
High ionic conductivity only at room temperature	High ionic conductivity over a broad range of temperatures
Self-discharge may reduce the shelf life	Electrolyte used is non-volatile
Electrolytes used are flammable; it can cause combustion	Electrolytes are non-flammable, and thus, safe
SEI layer formation affects life cycle	High energy density
Limited choice of cathode materials due to electrolyte reaction	High tolerance
Poor thermal stability	Ceramic separator used is rigid and it may break with additional stress
Sensitive to overcharge	No SEI layer formation, and thus, a longer life cycle
<input type="checkbox"/> Challenges <input checked="" type="checkbox"/> Advantages	

Key Points

➤ **About:**

- A solid-state battery has **higher energy density than a Lithium-ion battery** that uses liquid electrolyte solution.
 - It doesn’t have a risk of explosion or fire, so there is no need to have components for safety, thus saving more space. It will have more space to put more active materials which increase battery capacity in the battery.

Note:



- A solid-state battery can **increase energy density per unit area since only a small number of batteries are needed**. For that reason, a solid-state battery is perfect to make an **Electric Vehicle (EV)** battery system of module and pack, which needs high capacity.
- The energy density of lithium-ion cells used in today's mobile phones and electric vehicles is nearly four times higher than that of older-generation nickel-cadmium batteries.
- Despite improvements in technology over the last decade, issues such as **long charging times and weak energy density persist**. While lithium-ion batteries are seen as sufficiently efficient for phones and laptops, they still lack the range that would make EVs a viable alternative to internal combustion engines.

Lithium-ion Batteries

➤ About:

- It uses an intercalated (Intercalation is the reversible inclusion or insertion of a molecule into materials with layered structures) **lithium compound as one electrode material**, compared to the metallic lithium used in a non-rechargeable lithium battery.
- The battery consists of electrolyte, which allows for **ionic movement**, and the two electrodes are the constituent components of a lithium-ion battery cell.
- Lithium ions **move from the negative electrode to the positive electrode** during discharge and back when charging.

➤ Lithium-ion Battery Applications:

- Electronic gadgets, Tele-communication, Aerospace, Industrial applications.
- Lithium-ion battery technology has made it the favourite power source for electric and hybrid electric vehicles.

➤ Disadvantages of Li-ion Batteries:

- Long charging times.
- One major problem is that lithium metal is extremely reactive. Safety issues as instances of batteries catching fires have been there.
- Expensive to manufacture.

- While the Li-ion batteries are seen as sufficiently efficient for applications such as phones and laptops, in case of EVs, these cells still lack the range that would make them a viable alternative to internal combustion engines.

➤ Advantages Over Li-ion:

○ Higher Cell Energy Density:

- The advantages of the solid-state battery technology include **higher cell energy density** (by eliminating the carbon anode), lower charge time (by eliminating the need to have lithium diffuse into the carbon particles in conventional lithium-ion cells), ability to undertake more charging cycles and thereby a longer life, and improved safety.

○ Cost Effective:

- Lower cost could be a game-changer, given that at 30% of the total cost, battery expenses are a key driver of the vehicle costs.
- QuantumScape claims it is targeting to lower battery cost by 15-20% relative to the cost of lithium-ion batteries in several years.

➤ Other Potential Alternatives to Solid-state Batteries:

- **Graphene Batteries:** Graphene batteries may be an important alternative to lithium-ion batteries, with the latter having limitations due to the frequency with which lithium requires charging. Graphene is a newly stabilised and isolated material.
- **Fluoride Batteries:** Fluoride Batteries have the potential to last eight times longer than lithium batteries.
- **Sand Battery:** This alternative type of lithium-ion battery uses silicon to achieve three times better performance than current graphite Li-ion batteries. The battery is still lithium-ion like the one found in a smartphone, but it uses silicon instead of graphite in the anodes.
- **Ammonia-powered Batteries:** Ammonia-powered batteries may not be coming any time soon, but the chemical commonly known as a household cleaner is still an alternative to lithium in the way it can power fuel cells in vehicles and other equipment.
 - If scientists can figure out a way to produce ammonia without creating the greenhouse gas emissions that result right now, they can ship it anywhere in the world to be converted into hydrogen to power those fuel cells.

- **Lithium-Sulphur Batteries:** Researchers in Australia say they have developed the world's most powerful rechargeable battery using lithium-sulphur, said to perform four times better than the strongest batteries currently available.
- **Vertically Aligned Carbon Nanotube Electrode:** These are good candidates for lithium-ion battery electrodes which require high rate capability and capacity.

Lithium-ion Technology

Why in News

India, through a newly-floated state-owned company **Khanij Bidesh India Ltd**, has inked a pact with an **Argentine firm** to jointly **prospect lithium in Argentina**, a country that has the **one of the largest reserves** of Lithium in the world.

Key Points

- **Khanij Bidesh India Ltd** was incorporated in August 2019 by three state-owned companies, **NALCO**, **Hindustan Copper and Mineral Exploration Ltd**, with a specific mandate to **acquire strategic mineral assets such as lithium and cobalt abroad**.
- It is also learnt to be exploring options in **Chile and Bolivia**, two other top lithium-producing countries.
- Lithium is a crucial building block of the **lithium-ion rechargeable batteries** that power **electric vehicles (EVs)**, **laptops** and **mobile phones**.
- Currently, India is **heavily dependent on import of these cells** and the move to ink sourcing pacts for lithium is also seen as a move to **reduce its dependency on China** which is a **key source of both the raw material and cells**.

Abundance of Lithium in Stars

Why in News

Recently, Scientists have found a clue to the **mystery behind the high abundance of Lithium** in some evolved stars.

- The mystery is the reason behind the high abundance of Lithium in stars, which according to predicted models **must get destroyed in the hot plasma of the star**.



- Lithium is a **trace element on Earth**, and a key **component of rechargeable batteries**.

Key Points

- **Sample for Research:** The research involved the investigation of lithium among red giants showed that just about **1% of sun-like red giants** had a lithium-enriched surface.
- **Research Methodology:** The research surveyed (called **GALAH - named after a common Australian bird**) a collection of about **500,000 stars with well-determined physical and chemical properties**, including lithium abundances.
- **Findings of Research:** Regarding the reason for Lithium production, scientists have for the first time confirmed that all the **lithium-rich stars are burning helium in their core**.
 - They speculated that lithium production is linked to the **violent helium-core flash**.
 - It is proposed to be a simple and short sequence of **nuclear reactions involving a collision between the two stable helium isotopes which led to a stable lithium isotope**.
 - The survey revealed the rare presence of lithium-rich giants in all the **Sun-like low-mass stars**.

About Lithium

- **Properties of Lithium:**
 - It is a **chemical element** with the symbol **Li**.
 - It is a **soft, silvery-white metal**.
 - Under standard conditions, it is the **lightest metal and the lightest solid element**.
 - It is **highly reactive and flammable**, and must be stored in mineral oil.
 - Lithium has become the **new 'white gold'** as the demand for high performing **rechargeable batteries** is rising.

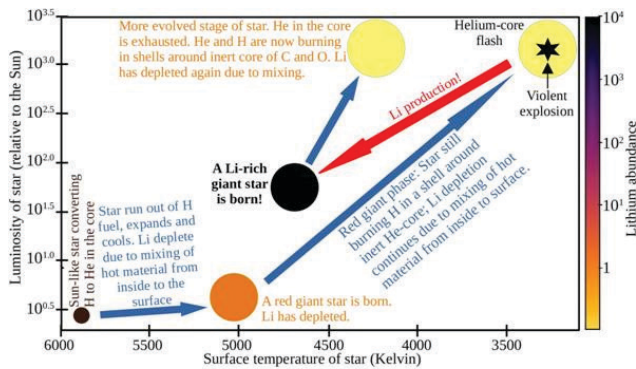


Figure 1: A cartoon illustration of the evolution of lithium (Li) in a Sun-like star. Color of the star symbol (filled circle) is proportional to star's Li abundance as shown in the color bar. Here, H is hydrogen, He is helium, C is carbon and O is oxygen.

- Rising global lithium demand and surging prices have drawn increased interest in the so-called 'lithium triangle' that spans parts of Argentina, Bolivia and Chile.



- **Uses:**
 - Lithium metal is used to make **useful alloys**.
 - **For example**, with lead to make 'white metal' bearings for motor engines, with aluminium to make aircraft parts, and with magnesium to make armour plates.
 - In Thermonuclear reactions.

- To make electrochemical cells. Lithium is an important component in **Electric Vehicles**, Laptops etc.
- **Countries with Largest Reserves:**
 - Chile > Australia > Argentina
- **Lithium in India:**
 - Researchers at the Atomic Minerals Directorate (under India's Atomic Energy Commission) have estimated lithium reserves of 14,100 tonnes in a small patch of land surveyed in **Southern Karnataka's Mandya district** recently.
 - Also to be India's first ever Lithium deposit site found.
- **Other Potential Sites in India:**
 - The major mica belts in Rajasthan, Bihar, and Andhra Pradesh.
 - Pegmatite (igneous rocks) belts in Odisha and Chhattisgarh.
 - Brines of Sambhar and Pachpadra in Rajasthan, and Rann of Kachchh in Gujarat.

Open Source Software Platform

Why in News

Recently, the Github, an **open-source software** repository service was used to create and share an offensively named app that **sexually harassed a women in India**.

- The app used pictures of the women stolen from their social media handles and invited "users" to bid for them.
- GitHub has blocked the user, and the Indian **Computer Emergency Response System (Cert-In)**, has been asked to form "a high-level committee."

GitHub

- GitHub is the **world's largest open-source developer community platform** where users upload their projects and code for others to view, edit, and tweak.
- The platform uses the **software Git**, which was created in 2005 by **Linus Torvalds**, the developer of the **open-source operating system Linux**, to track changes in a set of files and for coordination in software.

Key Points

- **Meaning of Open-Source:** The term open source refers to something people can modify and share because its design is publicly accessible.

Note:



- **Open Source Software:** Open source software (OSS) is **software that is distributed with its source code**, making it available for use, modification, and distribution with its original rights.
 - **Source code** is the part of software that most computer users don't ever see.
 - It's the code computer programmers **manipulate to control** how a program or application behaves.
- **Closed Source or Proprietary Software:** Closed source software is software that holds the source code safe and encrypted.
 - Meaning, the user can't copy, modify, or delete parts of the code without some type of consequence.

Note:

- While the operating system of **Apple's iPhones (iOS)** is **closed source**, meaning it cannot be legally modified or reverse engineered, **Google's Android operating system** is **open-source**, and therefore it is possible by smartphone manufacturers such as Samsung, Xiaomi, OnePlus, etc to modify it for their hardware.

Advantages and Disadvantages of Each Model**Open Source Advantages**

- Source code available, modifiable
- Redistribute solutions
- Use software in any way
- Eliminates single point of failure
- Democratic forum for action
- No vendor lock-in

Proprietary Software Advantages

- Predictable releases
- Entity to hold responsible for bugs, errors, and updates
- Consistent feature development
- More stable framework
- More consistent training options
- Easier access to support

Open Source Disadvantages

- No guarantee development will continue
- Intellectual property (algorithms)
- Support consistency

Proprietary Software Disadvantages

- Higher start-up costs
- Single company releasing patches
- Vendor owns software

Small Satellite Launch Vehicle

Why in News

Recently, the **Indian Space Research Organisation (ISRO) chairman** has mentioned the launch of an **"SSLV-D1 Micro SAT"** in April 2022".

- The **SSLV (Small Satellite Launch Vehicle)** aims to cater to the market for the launch of small satellites into **Earth's low orbits** that has emerged in recent years to cater to the needs of developing countries, universities for small satellites, and private corporations.

Key Points➤ **About:**

- It is the **smallest vehicle weighing only 110-tonne**. It will take only 72 hours to integrate, unlike the 70 days taken now for a launch vehicle.
- It can **carry satellites weighing up to 500 kg** to a low earth orbit while the tried and tested **Polar Satellite Launch Vehicle (PSLV)** can launch satellites weighing in the range of 1000 kg.
 - **SSLV is a three-stage all solid vehicle** and has a capability to launch up to 500 kg satellite mass into 500 km Low Earth Orbit (LEO) and 300 kg to Sun Synchronous Orbit (SSO).
- It is **perfectly suited for launching multiple microsatellites** at a time and supports multiple orbital drop-offs.
- The key features of SSLV are **low cost, with low turn-around time, flexibility in accommodating multiple satellites, launch on demand feasibility**, minimal launch infrastructure requirements, etc.
- The Government has sanctioned a total cost of **Rs. 169 Crores for the development project** including the development & qualification of the vehicle systems and the flight demonstration through three development flights (SSLV-D1, SSLV-D2 & SSLV-D3).
- **ISRO's new chairman Dr Somanath is credited with designing and developing the SSLV** during his tenure as director of the Vikram Sarabhai Space Centre in Thiruvananthapuram since 2018.
 - The maiden flight of the SSLV was scheduled to launch in July 2019 but that has since been delayed due to setbacks from Covid-19 and other issues.

➤ **Significance of SSLV:**

- The development and manufacture of the SSLV are **expected to create greater synergy between the space sector and private Indian industries** – a key aim of the space ministry.
 - Indian industry has a consortium for the production of PSLV and should come together to produce the SSLV as well once it is tested.
- One of the mandates of the newly-created ISRO commercial arm, **New Space India Limited (NSIL)** is to **mass-produce and manufacture the SSLV and the more powerful PSLV** in partnership with the private sector in India through technology transfers.

Note:



- Its aim is to **use research and development carried out by ISRO** over the years for commercial purposes through Indian industry partners.
- Small satellite launches have **so far depended on 'piggy-back' rides with big satellite launches on the Polar Satellite Launch Vehicle (PSLV)** — ISRO's work-horse with more than 50 successful launches. As a result, small satellite launches have relied on ISRO finalising launch contracts for larger satellites.
- **Indian Space Research Organisation (ISRO):**
 - It is the pioneer space exploration agency of India, headquartered at Bengaluru.
 - ISRO was formed in 1969 with a vision to develop and harness space technology in national development, while pursuing planetary exploration and space science research.
 - ISRO replaced its predecessor, **INCOSPAR (Indian National Committee for Space Research)**, established in 1962 by India's first Prime Minister Pt. Jawaharlal Nehru and scientist Vikram Sarabhai, considered amongst the founding fathers of the Indian space program.
- **Achievements of ISRO:**
 - The **first Indian satellite, Aryabhata**, was built by the ISRO and launched with the help of the Soviet Union on 19th April **1975**.
 - The **year 1980** marked the **launch of Rohini**, which was the first satellite to be successfully placed in orbit **by SLV-3, an Indian made launch vehicle**.
 - Subsequently with more efforts, two other rockets were developed by ISRO: the **PSLV (Polar Satellite Launch Vehicle)** for placing satellites into polar orbits and the **GSLV (Geosynchronous Satellite Launch Vehicle)** for placing satellites into geostationary orbits.
 - Both the rockets have successfully launched several earth observation and communication satellites for India as well as other countries.
 - Indigenous satellite navigation systems like **IRNSS** and **GAGAN** have also been deployed.
 - **Indian Regional Navigation Satellite System** is designed to provide accurate position information service to assist in the navigation of ships in the Indian Ocean waters.
 - **GAGAN** is India's **first satellite-based global positioning system** that relies on ISRO's GSAT satellites.
- In January 2014, ISRO used an **indigenously built cryogenic engine** for a GSLV-D5 launch of the GSAT-14 satellite making it one of the only six countries in the world to develop a cryogenic technology.
- Some remarkable space probes of ISRO include **Chandrayaan-1** lunar orbiter, **Mars Orbiter Mission (Mangalyaan-1)** and **ASTROSAT space observatory**.
 - The success of the **Mars Orbiter Mission** made India **only the fourth country in the world** to reach Martian orbit.
- India launched **Chandrayaan-2**, its second lunar exploration mission after Chandrayaan-1 on 22nd July 2019.
- **Major ISRO achievements of 2021:**
 - **Amazonia-1:**
 - The 53rd flight of PSLV-C51 marked the first dedicated mission for **New Space India Ltd (NSIL)**, the commercial arm of ISRO.
 - Amazonia-1, the optical **earth observation satellite** of National Institute for Space Research (INPE), would provide remote sensing data to users for monitoring deforestation in the Amazon region and analysis of diversified agriculture across the Brazilian territory.
 - **UNITYsat (three satellites):**
 - They have been deployed to provide **Radio relay services**.
 - **SDSAT:**
 - Satish Dhawan Satellite (SDSAT) is a **nano satellite** intended to study the radiation levels/ space weather and demonstrate long range communication technologies.
- **Upcoming Missions:**
 - **Gaganyaan Mission:** India's maiden space mission, Gaganyaan, will be launched in 2023.
 - **Chandrayaan-3 Mission:** Chandrayaan-3 is likely to be launched during the third quarter of 2022.
 - **Three Earth Observation Satellites (EOSs):**
 - **EOS-4 (Risat-1A) and EOS-6 (Oceansat-3)** — will be launched using Isro's workhorse PSLV, the third one, **EOS-2 (Microsat)**, will be launched in the first developmental flight of the **Small Satellite Launch Vehicle (SSLV)**.
 - These satellites will be launched in the **first quarter of 2022**.
 - **Other:**

Note:



- **Shukrayaan Mission:** The ISRO is also planning a mission to Venus, tentatively called Shukrayaan.
- **Own Space Station:** India is planning to **launch its own space station by 2030**, joining the league of US, Russia, and China to an elite space club.

New ISRO Chairman S. Somanath

Recently, S. Somanath, an eminent rocket scientist has been appointed as the **Chairman of the Indian Space Research Organisation (ISRO)** and the Space Secretary.

Major Contribution of Dr. Somanath

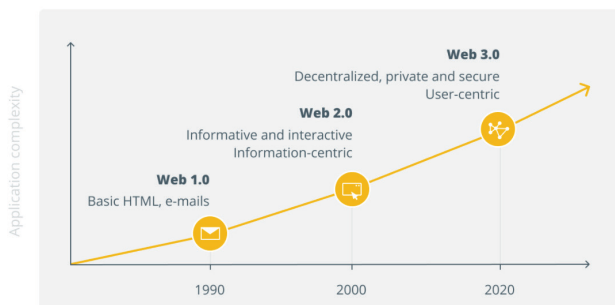
- He has played a major role in the development of the **Polar Satellite Launch Vehicle (PSLV)** and the **Geosynchronous Satellite Launch Vehicle Mk-III (GSLV Mk-III)**.
- He joined the **GSLV Mk-III** project in 2003, and served as Project Director from 2010 to 2014.
 - He is an expert in the area of system engineering of launch vehicles.
- Later on, he contributed to the development of the indigenous **cryogenic stages for the GSLV**.

Web 3.0

Why in News

The concept of **Web3**, also called **Web 3.0**, used to describe a potential **next phase of the internet**, created quite a buzz in 2021.

The history of the internet



Key Points

➤ About:

- **World Wide Web**, which is also known as a Web, is a **collection of websites or web pages stored in web servers** and connected to local computers through the internet.

- These websites contain text pages, digital images, audios, videos, etc. Users can access the content of these sites from any part of the world over the internet using their devices such as computers, laptops, cell phones, etc.
- Web 3.0 is a **decentralized internet** to be run on **blockchain technology**, which would be **different from the versions in use, Web 1.0 and Web 2.0**.
- In Web3, **users will have ownership stakes in platforms and applications** unlike now where tech giants control the platforms.
 - Gavin Wood, founder of **Ethereum**, a block chain technology company, used the term Web3 first in 2014 and in the past few years many others have added to the idea of Web3.

➤ Previous Versions:

○ Web 1.0:

- Web 1.0 is the **world wide web or the internet that was invented in 1989**. It became popular from 1993. It **lasted until 1999**.
- The internet in the Web 1.0 days **was mostly static web pages** where users would go to a website and then read and interact with the static information.
- Even though there were **e-commerce** websites in the initial days it was still a **closed environment** and the users themselves could not create any content or post reviews on the internet.

○ Web 2.0:

- Web 2.0 **started in some form in the late 1990s itself though 2004 was when most of its features were fully available**. It is still the age of Web 2.0 now.
- The differentiating characteristic of Web 2.0 compared to Web 1.0 is that **users can create content**.
- They can **interact and contribute** in the form of comments, registering likes, sharing and uploading their photos or videos and perform other such activities.
- Primarily, a **social media** kind of interaction is the differentiating trait of Web 2.0.

➤ Need of Web 3.0:

- In Web 2.0, **most of the data** in the internet and the internet traffic are **owned or handled by very few companies** ex. Google.

Note:



- This has **created issues related to data privacy, data security** and abuse of such data.
- There is a sense of disappointment that the **original purpose of the internet has been distorted**.
- **Significance of Web 3.0:**
 - **Decentralized and Fair Internet:** Web3 will deliver a **decentralized and fair internet** where users control their own data.
 - **Eliminates Intermediaries:** With block chain, the time and place of the transaction are recorded permanently.
 - Thus, Web3 enables peer to peer (seller to buyer) transactions by eliminating the role of the intermediary. This concept can be extended to
 - **Decentralization and Transparency:** The spirit of Web3 is Decentralized Autonomous Organization (DAO).
 - DAO is all about the business rules and **governing rules in any transaction are transparently available for anyone** to see and software will be written conforming to these rules.
 - With DAO, there is **no need for a central authority to authenticate or validate**.

5G Technology

Why in News

Recently, the **Department of Telecommunications (DoT)** has sought inputs from telecom companies and other industry experts on the sale and use of **radio frequency spectrum** over the next 10 years, including the 5G (Fifth Generation) bands.

Key Points

- **Features of 5G Technology:**
 - **Millimeter wave spectrum:** The 5G networks will operate in the **millimeter wave spectrum** (30-300 GHz) which have the advantage of sending large amounts of data at very high speeds because the frequency is so high, it experiences little interference from surrounding signals.
 - **Upgraded LTE:** 5G is the latest upgrade in the **long-term evolution** (LTE) mobile broadband networks.
 - **Internet speed:** In the high-band spectrum of 5G, internet speeds have been tested to be as high as **20 Gbps** (gigabits per second) as compared to the maximum internet data speed in 4G recorded at 1 Gbps.

- 5G network speeds should have a **peak data rate** of **20 Gb/s** for the downlink and **10 Gb/s** for the uplink.
- **Bands in 5G:** 5G mainly work in 3 bands, **namely low, mid and high frequency** spectrum — all of which have their own uses as well as limitations.
 - **Low band spectrum:** It has shown great promise in terms of coverage and speed of internet and data exchange however the maximum speed is **limited to 100 Mbps** (Megabits per second).
 - **Mid-band spectrum:** It offers higher speeds compared to the low band, but has limitations in terms of coverage area and penetration of signals.
 - **High-band spectrum:** It has the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength.

➤ Utility of 5G Applications:

- Combined with **IoT**, cloud, **big data**, **AI**, and **edge computing**, 5G could be a critical enabler of the **fourth industrial revolution**.
- **For India:** 5G networks could improve the accessibility of services such as **mobile banking and healthcare**, and enable exponential growth in opportunities for unemployed or underemployed people to engage in fulfilling and productive work. For this Government has rolled out enabling policies.

➤ 5G Enabling Policy:

- **India's National Digital Communications Policy 2018** highlights the importance of 5G when it states that the convergence of a cluster of revolutionary technologies including 5G, the cloud, Internet of Things (IoT) and data analytics, along with a growing **start-up** community, promise **to accelerate and deepen its digital engagement**, opening up a new horizon of opportunities.
 - It aims to reach 100% teledensity, high-speed internet highways and delivery of citizen-centric services electronically.

Millimetre Wave band in 5G

Why in News

Recently, **Satcom Industry Association-India (SIA)** has voiced concerns over the Government's plan to include the **Millimetre Wave (mm Wave) bands** in the **5G spectrum auction**.

Note:



- SIA is an industry body that represents the interests of the communication satellite ecosystem in India.
- **Telecom Regulatory Authority of India (TRAI)** had sought industries' views on topics related to **quantum of spectrum to be auctioned off**.
- **Millimetre Wave-Band:**
 - **About:**
 - It is a particular segment of the radio frequency spectrum that ranges between **24 GHz and 100 GHz**.
 - This spectrum, as the name suggests, **has a short wavelength**, and is appropriate to deliver **greater speeds and lower latencies**. This in turn makes **data transfer efficient and seamless** as the current available networks work optimally only on lower frequency bandwidths.
 - **Significance:**
 - 5G services can be deployed using lower frequency bands. They **can cover greater distances and are proven to work efficiently** even in urban environments, which are prone to interference.
 - But, when it comes to data speeds, these bands fail to hit peak potential needed for a true 5G experience. So, **mmWave is that quintessential piece in the 5G jigsaw puzzle for mobile service providers**.
 - **Effect on Satellite Industry:**
 - The Internet has largely been provided to users via fibre-optic based broadband connectivity or mobile network. Of late, another class of Internet vendors is showing up. These are **satellite-based communication service providers**.
 - This segment uses **Low-Earth Orbit (LEO)** satellites to provide broadband to both urban and rural users. Their service could also be used for weather predictions.
 - The mm-band had been the subject of controversy due to **out-of-band emissions into the passive satellite band used for weather satellites at 23.6-24 GHz**.
 - **Out-of-band emission** is emission on a frequency or frequencies immediately **outside the necessary bandwidth** which results from the modulation process.
 - The level of out-of-band emission can not be reduced without affecting the corresponding transmission of information.

➤ Concerns Raised by the Industry:

○ Against ITU Norms:

- SIA urged the regulator **to limit the inclusion of mmWave spectrum in the 5G auction as 27.5-31 GHz and 17.7-21.2 GHz bands have been preserved for satellite-based broadband services** as per the decision taken by the **International Telecommunication Union (ITU)**.
- The industry body **pointed to Europe's "5G Roadmap"**, which is built on the ITU's decision to hold these bands for satellite-based broadband services.

○ Denial of Benefits:

- It also noted that offering excessive spectrum resources in the upcoming 5G auction will result in **Indian citizens being denied the benefits of high-demand, advanced satellite broadband services**.

○ Loss to Economy:

- It will result in a **massive loss to the Indian economy** of up to USD 184.6 billion by 2030, along with the loss of **Foreign Direct Investment (FDI)** and employment generation benefits.

➤ SIA's Suggestions:

- SIA-India has noted that the **330 MHz of spectrum in the 3.3-3.67 GHz band is enough to satisfy India's mid-band 5G needs** while ensuring a competitive auction.
- The industry body also noted that **providing excess spectrum could pose a downside risk of the bands going unsold, or even worse**, underutilised by terrestrial players at the expense of satellite-based service providers. The **allocation of mmWave band is critical to the satellite communication industry, which needs a stronger regulatory support** to ensure that 5G operations don't interfere with their existing operations.

Dark Matter Shapes Galaxies

Why in News

Recently, scientists investigating how the **shape of dark matter** affects the motion of stars in the centre of some galaxies (stellar bars) have found that **out-of-plane bending** can be explained through **dark matter halos in barred galaxies**.

Note:



- Out of plane bending of the bar in **barred galaxies** is a rare violent bar thickening mechanism known as **buckling**.
- A **dark halo** is the inferred halo of invisible material (dark matter) that permeates and surrounds individual galaxies, as well as groups and clusters of galaxies.

Note:

- A barred spiral galaxy is a spiral galaxy with a central bar-shaped structure composed of stars.
- For example, the Milky Way is a disk galaxy made up of stars moving in circular orbits around the center in a flattened disk, with a dense collection of the stars at the center called the bulge.
 - These bulges can have shapes ranging from nearly spherical to as flat as the galaxy disk. The Milky Way has a flat boxy or peanut-shaped bulge in its center.
 - Such bulges are formed due to thickening of the stellar bars in galaxies.
- One of the violent thickening mechanisms is buckling, where the bar bends out of the plane of the galaxy disk.
- **Stellar bar:** A bar-shaped accumulation of stars in galaxies.

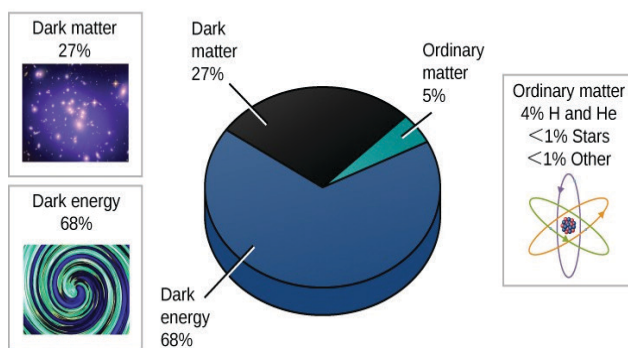
Key Points

- **About Dark Matter:**
 - Dark matter, though never detected, is believed to be present in the entire universe.
 - It is presumed that primordial black holes, those that were formed in the early age of the universe, are a source of dark matter. It was **proposed by Professor Stephen Hawking**.
 - It is believed that combined with dark energy, it makes up more than **95% of the universe**.
 - 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 Matter Presence in the Universe:**
 - **Laws of gravity** expect us to see stars closer to the center of galaxies rotating faster than the stars on the edge.

- However, in most galaxies, **the stars closer to the center and the stars at the edge of the galaxies take almost the same time to make one revolution.**

- This implied that something **invisible and enveloping the galaxies** was giving an extra push to the outer stars, speeding them up.
- This entity has remained as one of the unresolved puzzles in cosmology since the 1930s. **It was named 'Dark Matter'.**
- 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).
- **Dark Matter and Dark Energy:**
 - While dark matter attracts and holds galaxies together, dark energy repels and causes the expansion of our universe.
 - Despite both components being invisible, a lot more is known about dark matter, since its existence was suggested as early as the 1920s, while **dark energy** wasn't discovered until 1998.
- **About Dark Energy:**
 - The **Big Bang** occurred nearly 15 billion years ago and expanded.
 - Earlier, astronomers believed that eventually the expansion of the Universe will slow down because of gravity and it will recollapse.
 - However, data from the **Hubble Telescope** suggested that the Universe's expansion is accelerating.

Composition of the Universe



- The astronomers theorize that the faster expansion rate is due to a mysterious, dark force or energy that is pulling galaxies apart.
- The term 'dark' is used to denote the unknown.

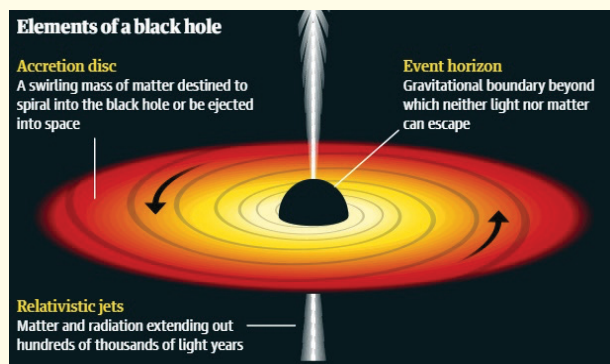
Note:



- The following diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago.

Black Holes

- It refers to a point in space where the matter is so compressed as to create a gravity field from which even light cannot escape.
- The concept was theorized by Albert Einstein in 1915 and the term 'black hole' was coined in the mid-1960s by American physicist John Archibald Wheeler.
- Usually, the black holes belong to two categories:
 - One category ranges between a few solar masses and tens of solar masses. These are thought to form when massive stars die.
 - The other category is of supermassive black holes. These range from hundreds of thousands to billions of times that of the sun from the Solar system to which Earth belongs.
- In April 2019, the scientists at the Event Horizon Telescope Project released the **first-ever image of a Black Hole** (more precisely, of its shadow).
 - The Event Horizon Telescope is a group of 8 radio telescopes (used to detect radio waves from space) located in different parts of the world.
- **Gravitational waves** are created when two black holes orbit each other and merge.



Negative Ion Technology

Why in News

Recently, the **Authority for Nuclear Safety and Radiation Protection (ANVS)**, Netherlands issued a statement **identifying various negative ion wearable products containing more Radioactivity than legally permitted.**

Key Points

➤ About:

- Negative ion technology **embeds negative ions in personal products** and is currently being advertised as a means to maintain health, balance energy, and improve well-being.
- This technology is used in certain silicone wristbands, quantum or scalar-energy pendants, and kinesthesiology tape.
 - Negative ions are also made **when sunlight, radiation, air, or water break down oxygen.**
- The minerals that produce these negative ions often include **naturally occurring radioactive substances such as uranium and thorium.**
- It is believed that negative ions create positive vibes and uplift the mood. They show the various mental and physical health benefits, such as stress reduction, better sleeping, respiration etc. whereas these ions **may also act on pollutants, make them negatively charged** and get them collected on surfaces.

➤ Related Concerns:

- The **radiation detected in some of these products has been higher than the background level and in some cases high enough** to require licensing.
- The minerals used in products contain varying levels of radioactivity, it **can be difficult for the consumer to know exactly how radioactive these items are.**
 - Radioactivity is the act of emitting radiation spontaneously.
- The products were found to contain radioactive materials and therefore continuously **emit ionizing radiation, thereby exposing the wearer.**
- Exposure to **ionizing radiation can cause adverse health effects** and wearing the products for extended periods could pose health risks that **include tissue and DNA damage.**
- Exposure can also cause **severe harmful effects such as:** Skin burns, Acute radiation sickness that causes cancer and hairfall, Temporary reduction in white blood cells, Possible chromosomal damage, Reduction in resistance to infection.
- **IAEA (International Atomic Energy Agency)** researchers found that the undergarment industry in Malaysia and elsewhere advertised that their

Note:



“negative ion undergarments” contain tourmaline, monazite and zircon, all known to contain uranium and thorium.

Earth Observation Satellite EOS-04

Why in News?

Recently, **Indian Space Research Organisation's earth observation satellite EOS-04** and two small satellites (INSPIRESat-1 and INS-2TD) were successfully placed into the intended orbit by the **PSLV-C52 rocket**.

- This launch was the **54th flight of the Polar Satellite Launch Vehicle (PSLV) rocket**, and the **23rd** of its most powerful **XL-version** that has six strap-on boosters.

What are Earth Observation Satellites?

- Earth observation satellites are the **satellites equipped with remote sensing technology**. Earth observation is the gathering of information about Earth's physical, chemical and biological systems.
- Many earth observation satellites have been employed on **sun-synchronous orbit**.
- Other earth observation satellites launched by ISRO include **RESOURCESAT- 2**, 2A, CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1, INSAT-3DR, 3D, etc.

What are the Three Satellites Launched?

- **EOS-04:**
 - EOS-04 weighing 1,710 kg and with a **mission life of ten years designed to provide high quality images** under all weather conditions for applications such as Agriculture, Forestry and Plantations, Soil Moisture and Hydrology and Flood mapping.
 - It will complement the data from **Resourcesat, Cartosat and RISAT-2B** series of satellites that are already in orbit.
 - The first of these newly named satellites, **EOS-01**, launched in November 2020, is in orbit right now. **EOS-02**, a micro-satellite to be flown on a new launch vehicle called **SSLV (Small Satellite Launch Vehicle)** is yet to be launched, while launch of **EOS-03** had ended in a failure in August, 2021.

- It will be placed in a **sun synchronous polar orbit** of 529 km, is a **radar-imaging satellite** which would have made it a part of the **RISAT series earlier**.
- In fact, it would **replace the RISAT-1** which was launched in 2012 but has been non-functional for the last few years.
 - RISATs use **synthetic aperture radars** to produce high-resolution images of the land.
 - **One big advantage that radar imaging has over optical instruments** is that it is **unaffected by weather, cloud or fog**, or the lack of sunlight.
 - It can **produce high-quality images** in all conditions and at all times, making it suitable for surveillance.

➤ INSPIRESat-1:

- INSPIRESat-1 is **part of a constellation of satellites planned under the International Space Program in Research and Education (INSPIRE)** involving the Small-spacecraft Systems and Payload Centre (SSPACE) at IIST, University of Colorado (US), Nanyang Technological University (NTU), Singapore, and National Central University (NCU), Taiwan.
- Two scientific payloads on INSPIRESat-1, with a mass of 8.1 kg and mission life of one year, are **aimed at improving the understanding of ionosphere** (part of Earth's upper atmosphere) **dynamics** and the **sun's coronal heating processes**.

➤ INS-2TD:

- INS-2TD is a **technology demonstrator for the first India-Bhutan joint satellite** that is scheduled to be launched in March, 2022.
 - The two countries had **signed a space agreement last year**, and its first outcome would be the launch of **BhutanSat, or INS-2B, on a PSLV rocket** in March, 2022.
- The **thermal imaging cameras of the INS-2TD** are meant for **earth observation purposes**, like assessment of land and water surface temperature, and identification of forest and tree cover.

How many satellites does India have in space?

- India currently has **53 operational satellites**, of which 21 are earth observation ones and another 21 are communication-based.
- Eight are navigation satellites, while the remaining three are science satellites.

Note:



Geomagnetic Storm

Why in News?

Recently, Elon Musk's **Starlink** has **lost dozens of satellites** that were caught in a geomagnetic storm a day after they were launched.

- The satellites were **designed to burn up on reentry into the Earth's atmosphere**, and did not create **debris in space**.
- However, the loss of 40 satellites — most of a launch batch — in a single solar event has been **described as "unheard of" and "huge"**.

What is Starlink?

- Starlink is a **SpaceX project** to build a broadband network with a cluster of orbiting spacecraft that could eventually number thousands.
- The **Starlink satellites carry Hall thrusters**, which use electricity and krypton gas to generate an impulse, to manoeuvre in orbit, maintain altitude and guide the spacecraft back into the atmosphere at the end of their mission.
- The Starlink network is **one of several ongoing efforts** to start beaming data signals from space.

What is a Geomagnetic Storm?

- Solar Storms occur during the **release of magnetic energy** associated with **sunspots** ('dark' regions on the Sun that are cooler than the surrounding photosphere - the lowest layer of the solar atmosphere), and can last for a few minutes or hours.
- A geomagnetic storm is a **major disturbance of Earth's magnetosphere** that occurs when there is a very **efficient exchange of energy from the solar wind into the space environment** surrounding Earth.
 - The magnetosphere **shields our home planet from harmful solar and cosmic particle radiation**, as well as erosion of the atmosphere by the solar wind – the constant flow of charged particles streaming off the Sun.
- These storms **result from variations in the solar wind** that produce major changes in the currents, plasmas, and fields in Earth's magnetosphere.
 - The solar wind conditions that are effective for creating geomagnetic storms are sustained (for several to many hours) periods of high-speed solar

wind, and most importantly, a southward directed solar wind magnetic field (opposite the direction of Earth's field) at the dayside of the magnetosphere.

- This **condition is effective for transferring energy** from the solar wind into Earth's magnetosphere.
- The largest storms that result from these conditions are associated with solar **Coronal Mass Ejections (CMEs)** where a billion tons or so of plasma from the sun, with its embedded magnetic field, arrives at Earth.
 - CMEs are large ejections of plasma and magnetic fields that **originate from the Sun's corona** (outermost layer).

How does it Affect Earth?

- **Can Impact Space Weather:**
 - Not all solar flares reach Earth, but solar flares/storms, **Solar Energetic Particles (SEPs)**, high-speed solar winds, and **Coronal Mass Ejections (CMEs)** that come close can impact space weather in **near-Earth space and the upper atmosphere**.
- **Can Hit Operations of Space-Dependent Services:**
 - Solar storms can hit operations of space-dependent services like **Global Positioning Systems (GPS)**, radio, and satellite communications. Aircraft flights, power grids, and space exploration programmes are vulnerable.
- **Can Potentially Create Disturbances in the Magnetosphere:**
 - **Coronal Mass Ejections (CMEs)** with ejectiles loaded with matter travelling at millions of miles an hour, **can potentially create disturbances in the magnetosphere**, the protective shield surrounding the Earth.
 - Astronauts on spacewalks face health risks from possible exposure to solar radiation outside the Earth's protective atmosphere.

How are Solar Storms Predicted?

- Solar physicists and other scientists use **computer models to predict solar storms** and solar activities in general.
 - Current models are **capable of predicting a storm's time of arrival** and its speed.
 - But the storm's structure or orientation still cannot be predicted.

Note:



- Certain orientations of the magnetic field **can produce a more intense response** from the magnetosphere, and trigger more intense magnetic storms.
 - With the **increasing global dependence on satellites** for almost every activity, **there is a need for better space weather forecasts** and more effective ways to protect satellites.

Nuclear Fusion Energy

Why in News?

Recently, the **Scientists in the United Kingdom** said they have achieved a new milestone in producing **nuclear fusion energy**, or imitating the way energy is produced in the Sun.

- Energy by **nuclear fusion** is one of mankind's long standing quests as it promises to be **low carbon**, safer than how nuclear energy is now produced and, with an efficiency that can technically exceed a 100%.
- One **kilogram(kg)** of fusion fuel contains about 10 million times as much energy as a kg of coal, oil or gas.

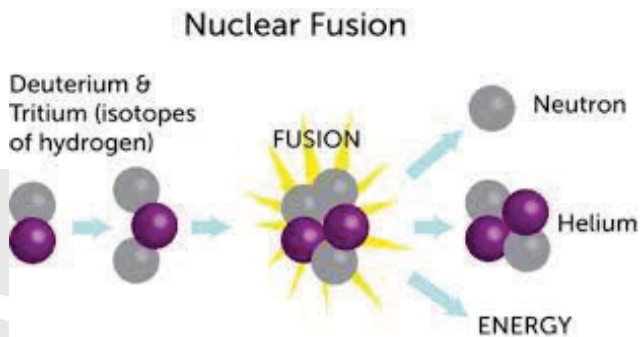
What was the Location of Experiment?

- The **JET (Joint European Torus facility)** site is the largest operational one of its kind in the world.
- The energy was produced in a machine called a **tokamak**, a doughnut-shaped apparatus.
 - A tokamak is a machine that confines a **plasma** using magnetic fields in a donut shape that scientists call a torus.
- **Deuterium and tritium**, which are isotopes of hydrogen, were heated to temperatures 10 times hotter than the centre of the sun to create plasma.
 - This was held in place **using superconductor electromagnets** as it spins around, fuses and releases tremendous energy as heat.
- The record and scientific data from these crucial experiments **are a major boost for ITER**, the larger and more advanced version of the JET.

What is Nuclear Fusion?

- Nuclear fusion is defined as the **combining of several small nuclei into one large nucleus** with the subsequent release of huge amounts of energy.
 - It is the **opposite reaction of fission**, where heavy isotopes are split apart.

- Harnessing fusion, **the process that powers the Sun**, could provide a limitless, clean energy source.
 - In the sun, the extreme pressure produced by its immense gravity creates the conditions for fusion to happen.
- Fusion reactions **take place in a state of matter called plasma**. Plasma is a hot, charged gas made of positive ions and free-moving electrons that has unique properties distinct from solids, liquids and gases.
 - At high temperatures, electrons are ripped from atom's nuclei and become a plasma or an ionised state of matter. Plasma is also known as the **fourth state of matter**.



What are Advantages of Nuclear Fusion?

- **Abundant energy:** Fusing atoms together in a controlled way releases nearly four million times more energy than a chemical reaction such as the burning of coal, oil or gas and four times as much as nuclear fission reactions (at equal mass).
 - Fusion has the potential to provide the kind of baseload energy needed to provide electricity to the cities and the industries.
- **Sustainability:** Fusion fuels are widely available and nearly inexhaustible. Deuterium can be distilled from all forms of water, while tritium will be produced during the fusion reaction as fusion neutrons interact with lithium.
- **No CO₂:** Fusion doesn't emit harmful toxins like carbon dioxide or other greenhouse gases into the atmosphere. Its major by-product is helium: an inert, non-toxic gas.
- **No long-lived radioactive waste:** Nuclear fusion reactors produce no high activity, long-lived nuclear waste.
- **Limited risk of proliferation:** Fusion doesn't employ fissile materials like uranium and plutonium (Radioactive tritium is neither a fissile nor a fissionable material).

Note:



- **No risk of meltdown:** It is difficult enough to reach and maintain the precise conditions necessary for fusion—if any disturbance occurs, the plasma cools within seconds and the reaction stops.

What are Other International Initiatives on Nuclear Fusion Energy?

- **International Thermonuclear Experimental Reactor (ITER) Assembly:** It aims to build the world's largest tokamak to prove the feasibility of fusion as a large-scale and carbon-free source of energy. The ITER members include China, the European Union, India, Japan, South Korea, Russia and the United States.
- **China's Artificial Sun:** The Experimental Advanced Superconducting Tokamak (EAST) device designed by China replicates the nuclear fusion process carried out by the sun.

What is the difference between Nuclear Fusion & Nuclear Fission?

	Fission	Fusion
Definition	Fission is the splitting of a large atom into two or more smaller ones.	Fusion is the fusing of two or more lighter atoms into a larger one.
Occurrence	Fission reaction does not normally occur in nature.	Fusion occurs in stars, such as the sun.
Energy Requirement	Takes little energy to split two atoms in a fission reaction.	Extremely high energy is required to bring two or more protons.
Energy Released	The energy released by fission is a million times greater than that released in chemical reactions, but lower than the energy released by nuclear fusion.	The Energy released by fusion is three to four times greater than the energy released by fission.
Energy production	Fission is used in nuclear power plants.	Fusion is an experimental technology for producing power.

Origami Metamaterials

Why in News?

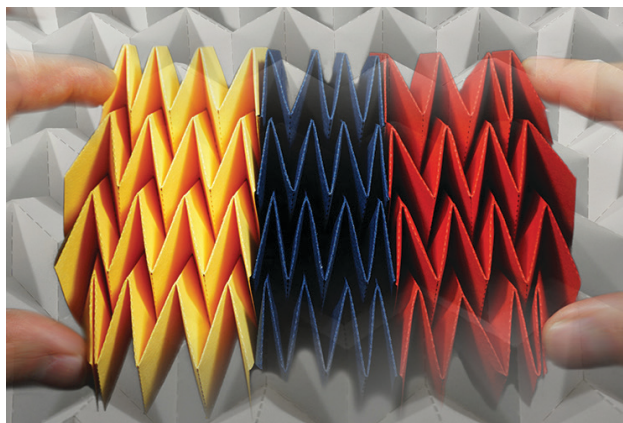
Researchers from **Indian Institute of Technology Madras** have developed such a material, called **Origami metamaterials** which could have many uses.

- These combine the **Japanese art of paper folding (origami)** and the existing material of choice and fold it to obtain desired properties.

What are the Origami Metamaterials?

- Researchers have developed a **special class of origami**

metamaterials which show a constant value of **Poisson Ratio** when subjected to stress.



- When a **material is crushed or stretched along a particular direction**, it undergoes a modification in the perpendicular, or lateral, direction.
- The **ratio between the deformation along the force and the deformation in a direction lateral to the force** is called the Poisson ratio. The Poisson ratio **can be positive or negative**.
- In order to be useful, **materials need to maintain a constant Poisson ratio** when they crumle under pressure. However, they are prone not to do so, and the Poisson ratio varies as they deform.
- The benefit is that the **observed property does not depend** on whether it is made from a **sheet of paper, polymer or metal** but under impact the sheet folds up along the creases.

What are Metamaterials?

- Metamaterials are **smart materials that have a wide range of properties** and can be so different from each other that there isn't a definition for them, although what they all have in common is that they are from an artificial origin.
- This means that **they aren't found in nature** and have been created by people.

What are the Properties of the Metamaterials?

- Apart from their artificial origin, metamaterials are characterized because they have **unusual electromagnetic properties**, coming from their structure and arrangement and not from their composition.
- This is similar to what happens with **graphite, diamond and graphene**, since they are all made of carbon,

Note:



but due to their structure, they have very different properties.

- One of the properties that can vary the metamaterials can be, for example, that the **material has a negative refractive index**.
 - This makes **these materials of great importance in optics** and electromagnetism applications.

What are the Potential Applications of Metamaterials?

- Potential Applications of Metamaterials include **optical filtering, medical devices, remote aerospace operations**, sensor detectors, solar power management, crowd control, radomes, antenna lenses, and even **earthquake** protection.
- **Lenses made of metamaterials** may even enable imaging below the diffraction limit that prevents conventional optical lenses from magnifying any further.

Variability in Ct Values

Why in News ?

Recently, a survey of 700 laboratories in the US using standardised proficiency testing material from the same batch found a **variability in Ct (Cycle Threshold) values by 14 cycles**.

- Even within the same test at the same lab the **Ct values could vary by 3 cycles for different target genes**, and up to **12 cycles for the same target gene** across labs.

What is the Cause of Variability in Ct Values?

- **Dynamic Measure and Evolves Rapidly:**
 - A low Ct value at the time of diagnosis **does not mean that it will stay low the next day**.
 - Similarly, a swab done very early in the infection may reveal a **high Ct value, which if repeated a day or two later, may reveal a lower Ct value**.
 - It is possible for this reason that **Ct values have not been convincingly correlated with disease severity, and serve no role in predicting the trajectory** for a patient (yet, this is commonly used as an argument to prescribe tests and medicines).
- **Influence of Technical and Logistical factors:**
 - The way specimens are collected, the type of specimen, the medium in which the swab is

transported, the time lag between collection of the specimen and processing.

- All of **this can influence the quantum of viral genetic material present, and subsequently, the Ct value**.

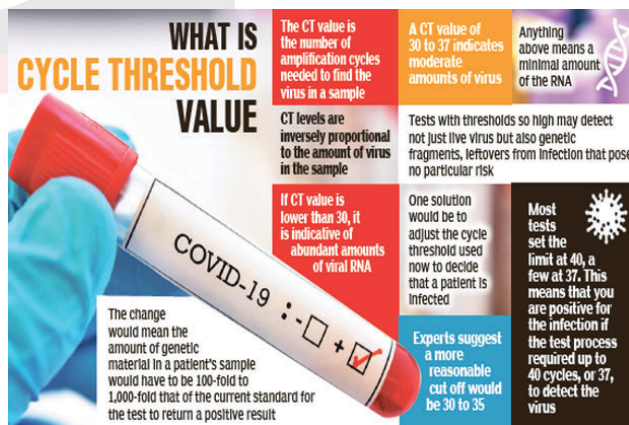
What is RT-PCR Test and Ct Value?

➤ RT-PCR Tests:

- In an **RT-PCR (Reverse Transcription Polymerase Chain Reaction) test**, **RNA (Ribonucleic acid)** is extracted from the swab collected from the patient. It is then converted into **DNA (Deoxyribonucleic acid)**, which is then amplified.
- Amplification refers to the process of creating multiple copies of the genetic material - in this case, DNA.
 - This **improves the ability of the test to detect the presence of the virus**.
- Amplification takes place through a series of cycles—one copy becomes two, two becomes four, and so on—and it is after multiple cycles that a detectable amount of virus is produced.

➤ Ct Value:

- Ct is short for '**Cycle Threshold**'.
- The Ct value refers to the **number of cycles after which the virus can be detected**.



- If a higher number of cycles is required, it **implies that the virus went undetected when the number of cycles was lower**.
- The lower the **Ct value, the higher the viral load—because** the virus has been spotted after fewer cycles.
- It has been found that the **time since the onset of symptoms has a stronger relationship with Ct values** as compared to the severity of the disease.

Note:



What is Viral Load?

- It refers to the **amount of genetic material, commonly RNA**, of a virus present in an infected person's blood.
 - This is expressed as the **total number of viral particles present in each millilitre of blood**.
- A higher viral load in the blood means that **the virus is replicating and the infection is progressing**.
 - An infected person with a high viral load is **more likely to shed more virus particles**, in the process known as "viral shedding".

■■■



Note:



Key Points

Details

[illegible]

Summary

Key Points

Details

Summary

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