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2021

SCIENCE & TECHNOLOGY

Complete **Current Affairs** Compilation
from **July 2020 to March 2021**

Vol-I

SCIENCE & TECHNOLOGY

Content

BIOTECHNOLOGY

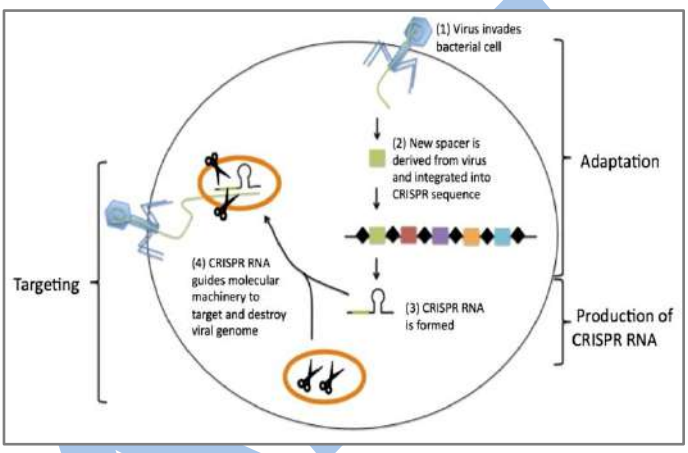
Nobel Prize in Chemistry

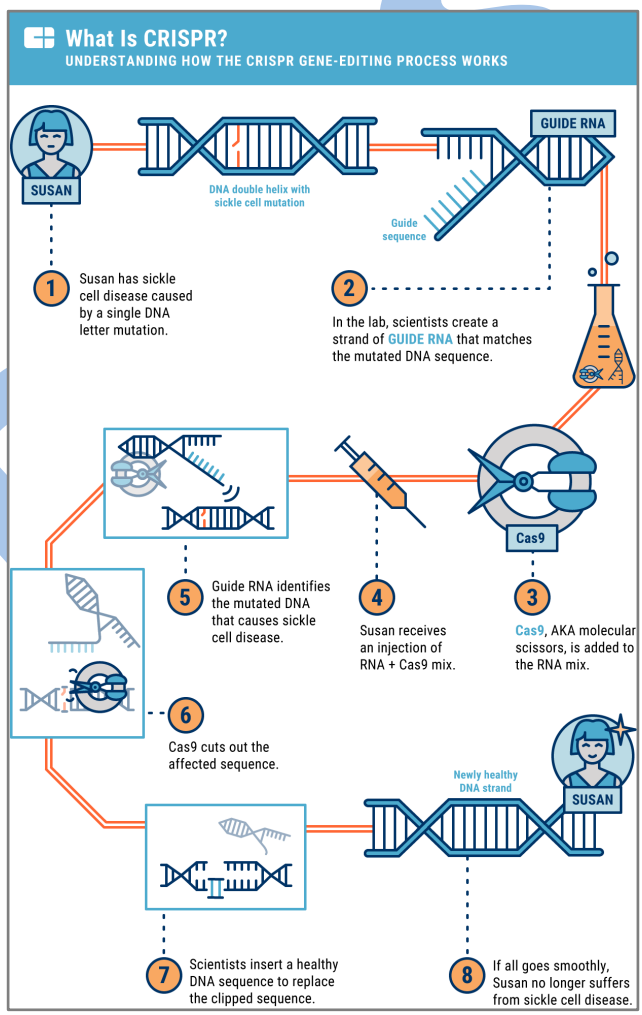
What is in news?

- This year's Nobel Prize in Chemistry has been awarded to two scientists who transformed **a bacterial immune mechanism**, called CRISPR, into a tool that can edit the DNA/genomes of everything from wheat to mosquitoes to humans.

CRISPR

- CRISPR **(clustered regularly interspaced short palindromic repeats)** is a family of DNA sequences found in the genomes of prokaryotic organisms such as bacteria and archaea.
- The CRISPR-Cas system is a prokaryotic immune system.
- It defends against phage and conjugative plasmid infection.
    - A bacteriophage, also known informally as a phage, is a virus that infects and replicates within bacteria and archaea.
    - A **plasmid** is a small, extra-chromosomal DNA molecule within a cell that is physically separated from chromosomal DNA and can replicate independently. It can cause infection.





Cas9

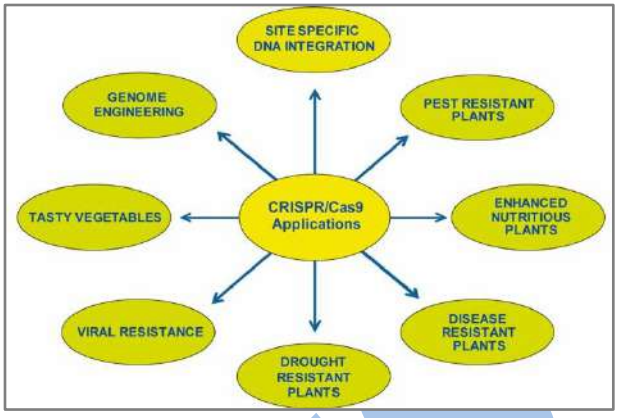
- Cas9 – is one of the enzymes produced by the CRISPR system – which binds to the DNA and cuts it, shutting the targeted gene off.

Significance

- The **ability to cut DNA wherever we want** has revolutionized the life sciences.
- This editing process has a wide variety of applications including **basic biological research, development of biotechnology products, and treatment of diseases.**
- CRISPR-based therapies hold promise for the treatment of cancer and inherited disorders such as **sickle cell disease** and for the prevention and treatment of infectious diseases.
- CRISPR could enable scientists to **repair genetic defects** or use genetically modified human cells as therapies. Traditional gene therapy uses viruses to insert new genes into cells to try to treat diseases.
- The crispr-Cas9 genetic scissors were discovered 8 years ago, but have already benefited humankind greatly.

Concerns

- Various ethical concerns can emerge with genome editing including safety.
- Studies have shown that it could lead to mutations that lead to others down the line. If genetic edits are made to embryos, or to egg or sperm cells, these changes will be inherited by all future generations.
- CRISPR has also been used in one of the most controversial biomedical experiments, when a Chinese scientist edited the genomes of human embryos, creating a Designer Baby.



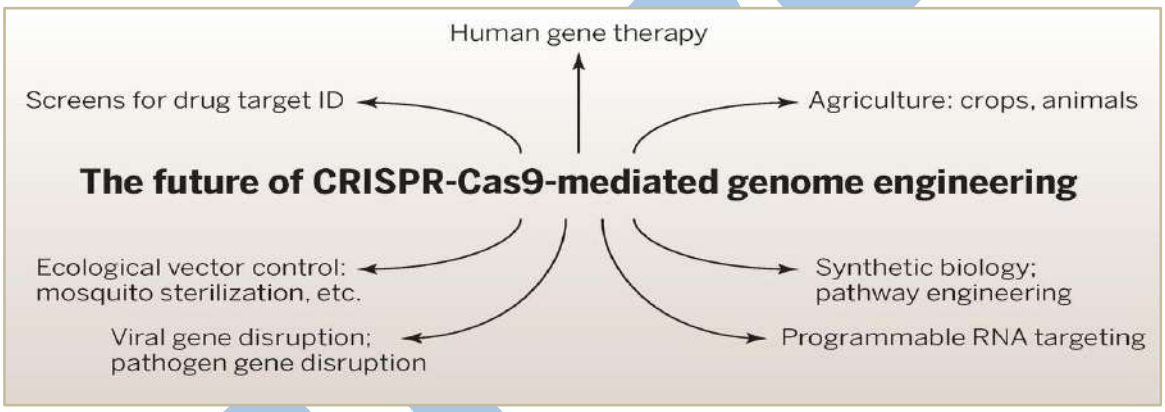
Way Ahead

- Genome editing should be regulated within the framework for gene-transfer research for allaying ethical concerns and reaping the benefits of this novel technology in medicine, genetics and agriculture to its fullest **potential.**

Indigen Project

Context

- Results from the computation analysis of 1,029 sequenced genomes from India under the Indigen Project were recently released.



What is IndiGen Project??

- IndiGen project is concerned with whole genome sequencing og human representative population of India. This project was undertaken by Center for Scientific and Industrial Research (CSIR) in April 2019. Under this project 1400 blood samples were collected from all over India. This collection sample included 55 various variant populations in India. Out of these complete genome sequencing of 1008 individuals was successfully done. The project was completed is six months.

What is whole genome sequencing?

- A genome is the DNA, or sequence of genes, in a cell.
- Most of the DNA is in the nucleus andintricately coiled into a structure called the chromosome.
- The rest is in the mitochondria, the cell's powerhouse.
- Every human cell contains a pair of chromosomes, each of which has three billion base pairs or one of four molecules that pair in precise ways.
- The order of base pairs and varying lengths of these sequences constitute the "genes", which are responsible for making amino acids, proteins and, thereby, everything that is necessary for the body to function.
- It is when these genes are altered or mutated that proteins sometimes do not function as intended, leading to disease.
- Sequencing a genome means deciphering the exact order of base pairs in an individual.
- peutics for targeting the disease

- Genome Sequencing is the **gold standard of precision medicine.**

APPLICATIONS:

- With its study we can understand the function of a specific sequence and the sequence responsible for any disease.
- With the help of comparative DNA sequence study we can detect any mutation.
- DNA fingerprinting.
- By knowing the whole genome sequence, Human genome project get completed.
- **Forensics:-**

DNA sequencing has been applied in forensics science to identify particular individual because every individual has unique sequence of his/her DNA. It is particularly ed to identify the criminals by finding some proof from the crime scene in the form of hair, nail, skin or blood samples.

- **Medicine:-**

In medical research, DNA sequencing can be used to detect the genes which are associated with some heredity or acquired diseases. Scientists use different techniques of genetic engineering like gene therapy to identify the defected genes and replace them with the healthy ones.

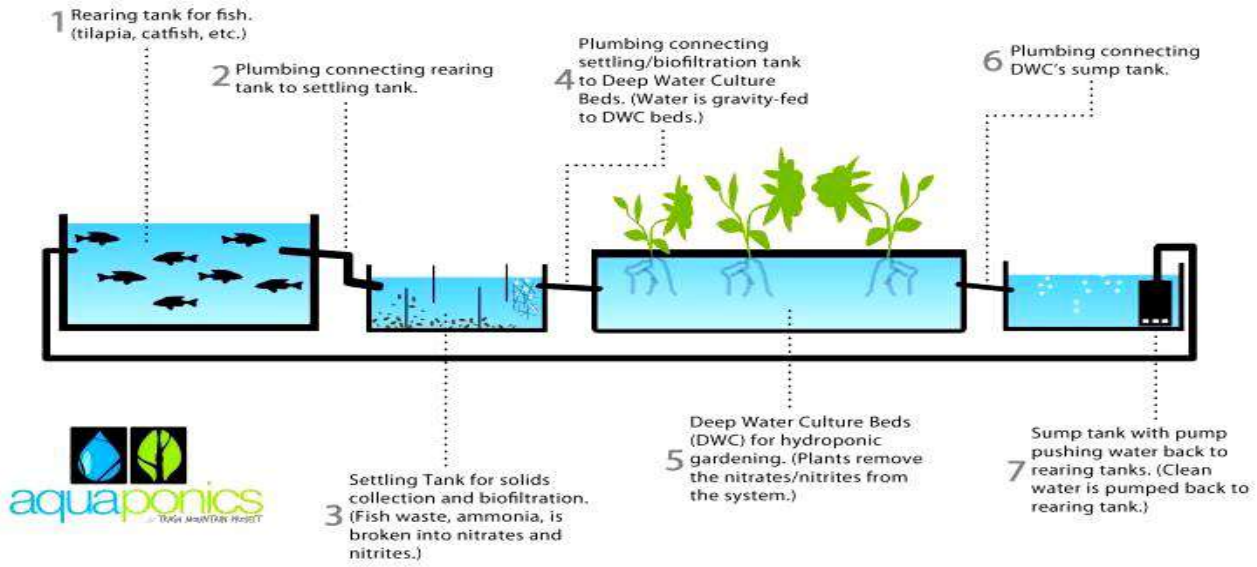
1.The whole human genome sequencing of Indian population will help to understand the genetic diversity in India.

2.Genome sequencing will revolutionize the healthcare System. It will help in predicting the risk of future diseases in persons. It will help in prescribing the precision medicine to the patients. Precision medicine or the personal medicines is a future concept of medical science in which a person will be given medicine on the basis of his /her genome. It will help in diagnosis of rare genetic diseases. Genome analysis of parents can help to predict the possibilities of disease in their future children.

Aquaponics

Context

- Recently, a pilot 'Aquaponics facility' has been developed by the Centre for Development of Advanced Computing Mohali.



Aquaponics

- Aquaponics is a form of agriculture that combines raising fish in tanks (recirculating aquaculture) with soilless plant culture (hydroponics).
- In aquaponics, the nutrient-rich water from raising fish provides a natural fertilizer for the plants and the plants help to purify the water for the fish.
    - Hydroponics is the cultivation of plants without using soil. Hydroponic flowers, herbs, and vegetables are planted in inert growing media and supplied with nutrient-rich solutions, oxygen, and water.

About

- The state-of-the-art facility in Mohali is equipped with advanced sensors for monitoring and automated controls.
- It has been developed with the funding support from **Ministry of Electronics and Information Technology**.
- The facility is **nearly 100% organic**, need much less land for a give yield of crop, consumes 90% less water.
- The fish and plants grown are more nutritious.

Benefits of Aquaponics

- Because aquaponics recycles the water in the system, we can grow in droughts and areas with little water.
- Less pests to deal with since we are growing indoors.
- There's no weeding.
- Plants Grows Twice As Fast. Due to the naturally fortified water from the fish.
- **Water Conservation:** Aquaponics uses 90% less water than traditional farming. Water and nutrients are recycled in a closed-loop fashion which conserves water.
- **Aquaponics Protects Our Rivers & Lakes:** No harmful fertilizer run off into the water shed. In efforts to maintain nutrient rich soil, farms have to use a lot of fertilizers, those excess fertilizers eventually make it the rivers, where there are countless harmful side effects.
- **Land Conservation:** The system grows six times more per square foot than traditional farming.
- Fish have no growth hormones, no mercury, no antibiotics.

Cancer Genome Atlas

Context

- The Minister of Science and Technology virtually inaugurated the 2nd Cancer Genome Atlas (TCGA) 2020 conference.

About TCGA

- The Cancer Genome Atlas (TCGA) is a project to catalogue genetic mutations responsible for cancer, using genome sequencing and bioinformatics.
- TCGA applies high-throughput genome analysis techniques to improve the ability to diagnose, treat, and prevent cancer through a better understanding of the genetic basis of this disease.

Lab-Grown Meat

Context

- The Singapore Food Agency (SFA) has approved the sale of a lab-grown meat product. This is the first time cultured meat has been cleared for sale anywhere in the world.

Lab-grown or cultured meat VS plant-based meat

- Plant based meat is made from plant sources such as soy or pea protein, while cultured meat is grown directly from cells in a laboratory.
- Both have the same objective: to offer alternatives to traditional meat products that could feed a lot more people, reduce the threat of zoonotic diseases, and mitigate the environmental impact of meat consumption.
- In terms of cellular structure, cultured or cultivated meat is the same as conventional meat — except that cultured meat does not come directly from animals.
- According to the Good Food Institute (GFI)'s 2019 State of the Industry Report on cultivated meats, compared to conventional meat could reduce land use by more than 95%, climate change emissions by 74-87% and nutrient pollution by 94%.
- The report adds that since cultivated meat is created in clean facilities, the risk of contamination by pathogens such as salmonella and E coli, which may be present in traditional slaughterhouses and meat-packing factories, is significantly reduced.
- It does not require antibiotics either, unlike animals raised for meat, thereby reducing the threat posed to public health by growing antibiotic resistance.

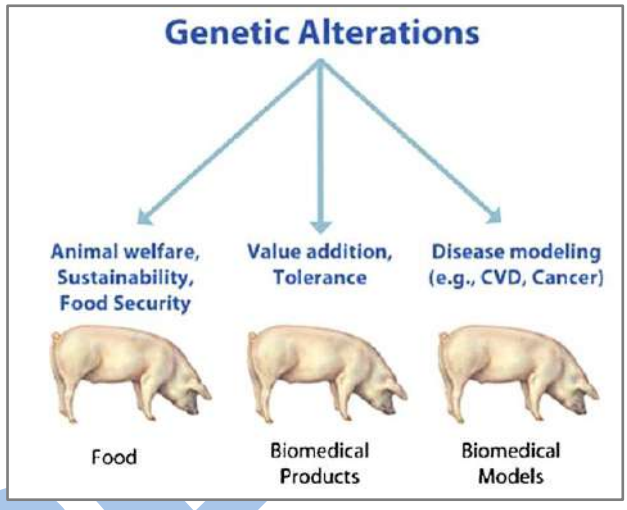
Intentional Genomic Alteration

Context

- Recently, the US Food and Drug Administration (FDA) approved a first-of-its-kind intentional genomic alteration (IGA) in a line of domestic pigs referred to as GalSafe pigs.

What is intentional genomic alteration?

- Intentional genomic alteration in animals means making specific changes to the genome of the organism using modern molecular technologies that are popularly referred to as **"genome editing"** or **"genetic engineering"**.
- Such changes in the DNA sequence of an animal may be carried out
- for research purposes
- to produce healthier meat for human consumption and
- to study disease resistance in animals among other reasons.
- One example is of using IGAs to make an animal more susceptible to certain diseases such as cancer, which helps researchers get a better understanding of the disease and develop new therapies to treat it.



Normal animal vs IGA animal

- The FDA maintains that the only difference between an animal with an IGA and one that does not have an IGA is that the IGA gives them a new trait or characteristic, such as faster growth or resistance to certain diseases.
- Essentially, an IGA is inserted into an animal to change or alter its structure and function.

Significance of FDA's recent approval

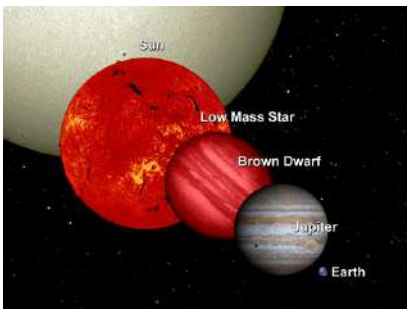
- The FDA allowed IGA in GalSafe pigs to eliminate a type of sugar found in mammals called alpha-gal.
- This sugar is present on the surface of these pigs' cells and when they are used for products such as medicines or food (the sugar is found in red meats such as beef, pork and lamb), the sugar makes some people with Alpha-gal Syndrome (AGS) more susceptible to developing mild to severe allergic reactions.
- Since GalSafe pigs may potentially be used to produce human medical products, IGA will help eventually free these products from detectable alpha-gal sugar, thereby protecting their human consumers from potential allergies.
- According to the FDA, GalSafe pigs may be used to make the blood-thinning drug heparin.

SPACE TECHNOLOGY

Luhman 16: Binary Brown Dwarf System

Context

- Astrophysicists have identified the **structure of cloud bands on the surface of Luhman 16A**, one of a pair of **binary brown dwarfs** in the Vela constellation.



Binary stars

- Binary stars are two stars orbiting a common center of mass.
- The brighter star is officially classified as the primary star, while the dimmer of the two is the secondary (classified as A and B respectively).

Luhman 16

- Luhman 16 is a **binary star system**, the third closest system to the Sun **after Alpha Centauri and Barnard's star.**
- At a distance of about **6.5 light years from the Sun,** this **pair of brown dwarfs referred to as Luhman 16A and Luhman 16Borbit each other**, casting a dim light.

Brown Dwarfs

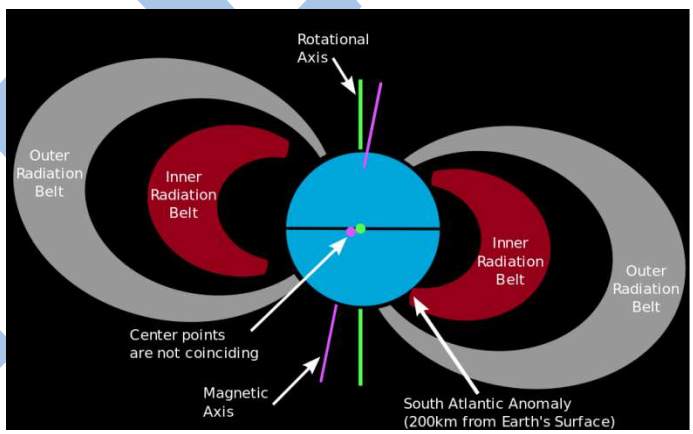
- Brown dwarfs are also called **failed stars**, because their masses are intermediate to the largest planets and the smallest stars.
- As their masses are too small, they are unable to sustain fusion of their hydrogen to produce energy.
- Some of the more massive brown dwarfs fuse deuterium or lithium and glow faintly.

South Atlantic Anomaly

Context

- The **magnetic field of the Earth between Africa and South America is gradually weakening**, causing problems for satellites and spacecraft.
- The phenomenon has been dubbed as the **South Atlantic Anomaly.**
- The date has been gathered by **European Space Agency's swarm of satellites.**

The formation of South Atlantic Anomaly (SAA)

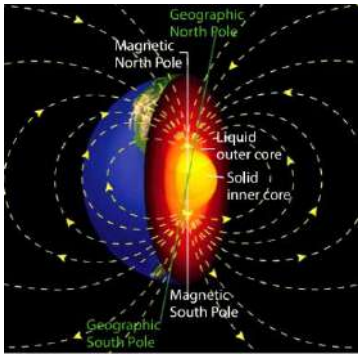


- The Earth is surrounded by a pair of concentric donut-shaped clouds called the **Van Allen radiation belts**.
- ✓ A Van Allen radiation belt is a zone of **energetic charged particles**, most of which **originate from the solar wind**, that are **captured by and held around a planet** by that planet's magnetic field.
- They are aligned with the magnetic axis of the Earth, which is **tilted by 11 degrees from the rotation axis of the Earth**.
- Above South America, about 200 - 300 kilometers off the coast of Brazil, the nearby portion of the Van Allen Belt **forms the South Atlantic Anomaly (SAA).**
- SAA is a region of **reduced magnetic intensitywhere the inner radiation belt makes its closest approach to the Earth's surface.**

Effects of SAA

- Satellites and other spacecraft passing through this region of space actually enter the Van Allen radiation belt and are **bombarded by protons exceeding energies of 10 million electron volts**.
- This can produce **'glitches' in astronomical data, problems with the operation of on-board electronic systems, and premature aging of computer, detector and other spacecraft components**.

What the scientists have discovered?



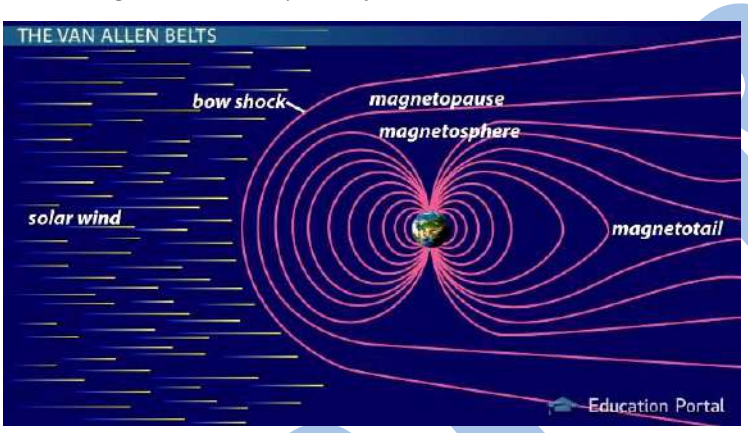
- South Atlantic Anomaly is developing vigorously.
- The magnetic field has lost nearly 9% of its strength on a global average in the last 200 years.
- This year, the **"minimum field strength"** in the South Atlantic Anomaly has seen a dropped tremendously.
- Moreover, another centre of "minimum field strength" has emerged in the past five years, which can possibly lead to the **spilt up of the South Atlantic Anomaly.**

What could be the implications?

- The weakening of magnetic field gives rise to speculations that **Earth is heading for a pole reversal - a phenomenon in which north and south poles gets reversed.**
- This reversal last happened **7.8 lakh years ago.** These reversals usually happen **at an interval of 250,000 years.**

Repercussions of Pole reversal

- It will **cause no harm on the surface level**, which means that people will not feel the change even if the pole shift happens.
- However, it could cause major issues for **telecommunications and satellite systems**.
- Certain **mobile phones and satellites may stop working**.
- The Earth's magnetic field plays an important role in protecting the planet from solar winds and cosmic radiation that are harmful and a pole flip means **Earth might be less protected from harmful space rays.**
- **Animals** that use Earth's magnetic field for navigation—including birds, salmon and sea turtles—**could get lost** during their routine journeys.



Earth's Magnetic Field

Earth's magnetic field, is the magnetic field that **extends from the Earth's interior out into space,where it interacts with the solar wind**, a stream of charged particles emanating from the Sun.

Origin of Magnetic Field

- The magnetic field is generated by electric currents due to the motion of convection currents of a mixture of molten iron and nickel in the Earth's outer core.
- These convection currents are caused by heat escaping from the core, a natural process called a geodynamo.
- It is represented by a field of a magnetic dipole currently tilted at an angle of about 11 degrees with respect to Earth's rotational axis.
- It is a magnetic dipole, with the magnetic field S pole near the Earth's geographic north pole (see Magnetic North Pole) and the other magnetic field N pole near the Earth's geographic south pole (see Magnetic South Pole).

Swarm

- Swarm is a European Space Agency (ESA) mission to study the Earth's magnetic field.

Use of Pole Reversal Information

- Magnetic reversals of the geomagnetic poles leave a record in rocks that are of value to **paleomagnetists** in calculating geomagnetic fields in the past.
- Such information is helpful in studying the **motions of continents and ocean floors** in the process of plate tectonics.

Earth's Magnetosphere

Context

- Scientists at the Indian Institute of Geomagnetism (IIG) an autonomous institution of the **Department of Science and Technology** have developed a generalized **one-dimensional fluid simulation code.**
- This code is capable of studying the coherent electric field structures in earth's magnetosphere.

Earth's Magnetosphere

- A magnetosphere is that area of space, around a planet, that is controlled by the Earth's **magnetic field.**
- It extends several tens of thousands of kilometers into space, protecting the Earth from the charged particles of the solar wind and cosmic rays.
- Solar wind would have otherwise stripped away the upper atmosphere, including the ozone layer that protects the Earth from harmful ultraviolet radiation.

- The solar wind is responsible for the overall shape of Earth's magnetosphere and fluctuations in its speed, density, direction etc.

Significance of the study

- It can be useful in planning of future space missions.
- Almost 99% of matter in the universe is in the form of plasma. Earth's magnetosphere, too, contains plasma can hamper the working of satellites placed in the magnetospheric region.
- To comprehend the cosmos in its entirety.
- To better understand the nature of space throughout the universe.
- Space weather within the magnetosphere can have adverse effects on communications systems. Better understanding of the science of the magnetosphere helps improve our space weather models.

Antarctic Impulsive Transient Antenna

What is ANITA?

- The Antarctic Impulsive Transient Antenna or ANITA instrument is a radio telescope to detect ultra-high energy cosmic-ray neutrinos from a scientific balloon flying over the continent of Antarctica.
- ANITA is the first NASA observatory for neutrinos of any kind.

What are Neutrinos?

- A neutrino is a subatomic particle that is very similar to an electron, but **has no electrical charge** and **a very small mass,** which might even be zero.
- Neutrinos are **one of the most abunda nt particles in the universe**.
- About 100 trillion neutrinos pass through our bodies every second without interacting with any of the particles in the body.
- Because they **have very little interaction with matter**, they are very difficult to detect.

How are they produced?

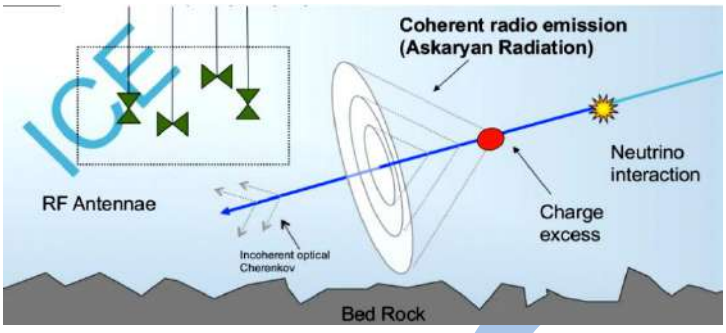
- The **Big Bang produced neutrinos**— that are still zooming through space yet today.
- During **nuclear fusion processes that power the sun and stars.**
- **During radioactive decays** that provide a source of heat inside our planet
- **In nuclear reactors**
- During a **supernova**

Why Study Neutrinos?

- Neutrinos are the only particle that can reach earth unattenuated at all energies.
- It is an important building block that can give us the blueprint of nature.
- Neutrinos also provide a tool to learn how matter evolved from simple particles into more complex composites of particles, creating everything around us.
- Neutrinos can also be used for tomography of the interior of the earth.

Askaryan Effect

- The Askaryan radiation also known as Askaryan effect is the phenomenon whereby a particle traveling faster than the phase velocity of light in a dense dielectric(such as salt, sand & ice) produces a shower of secondary charged particles.
- These particles emit a cone of coherent radiation in the radio or microwave part of the electromagnetic spectrum called Askaryan Pulses.
- Thus, when the neutrinos hit into an atom of such medium (salt, sand & ice), they produce a shower of secondary particles which can be detected.



Tianwen-1

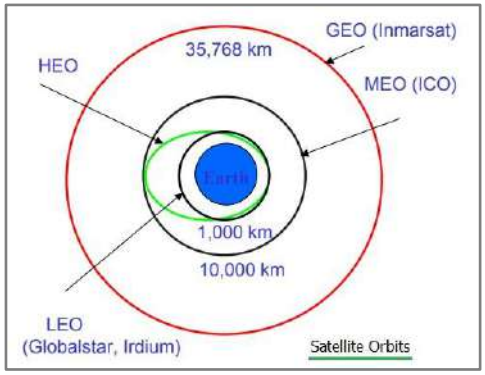
- Tianwen-1 is a planned mission **by China** to send a spacecraft, which consists of an orbiter, a lander and a rover, to **Mars.**
- The mission is planned to be launched in July 2020. Its objectives are to search for evidence of both current and past life, and to assess the planet's environment.

Arktika M- Satellite

- **Russia** will launch its first Arktika-M satellite for monitoring the Arctic climate and environment at the end of the year.
- The Arktika-M is **a remote-sensing and emergency communications satellite.**
- It will help collect **meteorological data from the polar regions of the Earth.**
- The data will help improve weather forecasts and enable scientists to better study climate change.

Long March5

- China recently launched a new rocket named **Long March 5.**
- It is a **Chinese heavy lift launch system**.
- The maximum payload capacities of the base variant are 25,000 kilograms to Low Earth Orbit and 14,000 kilograms to Geosynchronous Transfer Orbit.
- It is the first Chinese launch vehicle designed from the ground up to focus on **non-hypergolic liquid rocket propellants.**



Demo-2 Mission

- **NASA & SpaceX** Crew launched Dragon Demo-2 spacecraft recently.
- Under the Mission, **astronauts sent in the spacecraft will dock with International Space Station (ISS) and then remain there for between one to four months.**
- It marked the first time a private company had flown astronauts to orbit.
- The main objective of this program is to make access to space easier in terms of its cost, so that cargo and crew can be easily transported to and from the ISS, enabling greater scientific research.

Sonic Boom

- A sonic boom is the sound associated with the shock waves created whenever an object travels through the air faster than the speed of sound.
- Sonic booms generate enormous amounts of sound energy, sounding similar to an explosion or a thunderclap to the human ear.
- The loud noise produced when a bullet is fired from a gun is also a sonic boom, as the bullet travels at supersonic speed. Not all guns fire bullets at supersonic speeds.
- A sonic boom is most commonly heard when an aircraft is travelling at a low altitude, which leads to a very loud boom and tremors in the ground.

IN-Space

Context

- Recently, the Government approved the creation of the Indian National Space Promotion and Authorization Centre (IN-SPACe)

Aim

- To provide a level playing field for private companies to use Indian space infrastructure.

Mandates

- The IN-SPACe is supposed to be a **facilitator and also a regulator.**
- It will **promote and guide the private industries** in space activities through encouraging policies and a friendly regulatory environment.
- It will act as an **interface between ISRO and private parties** and assess how to utilise India's space resources and increase space-based activities.

Gateway Lunar Orbit Outpost

- NASA's Gateway Lunar Orbit Outpost is a **small spaceship that will orbit the Moon** - meant for astronaut missions to the Moon and later, for expeditions to Mars.
- It will act as a temporary office for astronauts, distanced at about 250,000 miles from Earth.
- The spaceship will also have living quarters, laboratories for science and research and docking ports for visiting spacecraft.
- The Gateway will act as an airport, where spacecraft bound for the lunar surface of Mars can refuel or replace parts and resupply things like food and oxygen, allowing astronauts to take multiple trips to the Lunar surface and exploration of new locations across the Moon.

Micius

- China's Satellite Micius sent light particles to Earth to establish the world's most secure communication link.
- Micius is the world's first quantum communications satellite and has, for several years, been at the forefront of quantum encryption.
- Secure long-distance links such as this one will be the foundation of the quantum internet, the future global network with added security powered by laws of quantum mechanics, unmatched by classical cryptographic methods.

- ✓ A quantum internet supports many applications, which derive their power from the fact that by creating quantum entangled qubits, information can be transmitted between quantum processors at distance. To know about Quantum Entanglement read June 2020 edition.

163348 (2002 Nn4)

- Recently, an asteroid made a close approach to Earth. A Near-Earth Object (NEO), the asteroid is called 163348 (2002 NN4) and is classified as a Potentially Hazardous Asteroid (PHA).
- **Near-Earth Objects (NEOs)** are **comets and asteroids** that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighborhood.

Moon More Metallic

- NASA recently said that its Lunar Reconnaissance Orbiter (LRO) spacecraft has found evidence that the Moon's subsurface might have greater quantities of metals such as iron and titanium than thought before.
  - The Lunar Reconnaissance Orbiter is a NASA robotic spacecraft currently orbiting the Moon in an eccentric polar mapping orbit. Data collected by LRO have been described as essential for planning NASA's future human and robotic missions to the Moon.
- The metallic distribution was observed by the **Miniature Radio Frequency (Mini-RF) instrument** aboard the LRO.
- According to the NASA, the findings raise the possibility that the dielectric constant increased in larger craters over time because the meteors that created them dug up dust containing iron and titanium oxides from beneath the Moon's surface.
- Dielectric properties are directly linked to the concentration of these metal minerals.

Lithium in Stars

Context

- A forty-year-old puzzle regarding the production of lithium in stars has been solved by Indian researchers.

Lithium

- Lithium is a light element commonly used today in communication device technology.
- It was first produced in the **Big Bang, around 13.7 billion years** ago when the universe came into being, along with other elements.
- While the abundance of other elements grew millions of times, the **present abundance of lithium in the universe is only four times the original [Big Bang] value**.
- It is **actually destroyed in the stars.**
- The Sun, for instance, has about a **factor of 100 lower amount of lithium than the Earth.**

What was the Puzzle?

- Planets were known to have more lithium than their stars — as is the case with the Earth-Sun pair.
- **Stars**, as per known mechanisms of evolution, actually **destroy lithium as they evolve into red giants.**
- However, about 40 years ago, a few large stars were spotted that were lithium-rich.
- This was followed by further discoveries of lithium-rich stars, and that posed a puzzle — if stars do not produce lithium, how do some stars develop to become lithium rich?

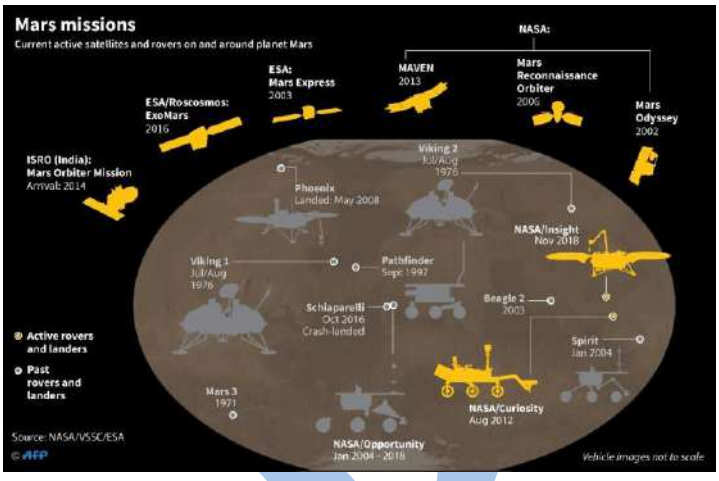
Neowise Comet

- The recently discovered comet **called C/2020 F3**, also known as **NEOWISE** made its closest approach to the Earth on July 22.
- Comets are mostly **made of dust, rocks and ice, the remnants from time the solar system was formed over 4.6 billion years ago**.
- As they orbit closer to the sun, they heat up and release debris of dust and gases that forms into a "glowing head" that can often be larger than a planet.
- Comets are occasionally pushed into orbits closer to the sun and the Earth's neighborhood **due to forces of gravity of other planets**.

- Comets hold important clues about the **formation of the solar system** and it is possible that comets brought water and other organic compounds, which are the building blocks of life to Earth.

Hope

- The first Arab space mission to Mars recently blasted off from Japan. This mission is called **HOPE**.
- "Hope" is expected to reach Mars's orbit by February 2021, marking the 50th anniversary of the unification of the UAE.
- The Emirates Mars Mission "Hope Probe" will be the first probe to **provide a complete picture of the Martian atmosphere and its layers**.



Phobos

- The Mars Colour Camera (MCC) onboard ISRO's Mars Orbiter Mission has captured the image of Phobos.
- **Phobos is the closest and biggest moon of Mars.**
- Phobos is the innermost and larger of the two natural satellites of Mars, the **other being Deimos.**
- Phobos is one of the **least reflective bodies in the Solar System**.
- Infrared spectra show that it has carbon-rich material found **in carbonaceous chondrites. (**Carbonaceous chondrites or C chondrites are a class of chondritic meteorites).

Tianwen-1

- Tianwen-1 is an interplanetary mission to Mars by the China National Space Administration (CNSA) to send a robotic spacecraft, which consists of an orbiter, a lander and a rover.
- The mission was successfully launched on 23 July 2020 with a Long March 5 heavy-lift rocket.
- It is currently en route to Mars and will reach the red planet in 2021.
- Tianwen-1 is China's first Mars probe.

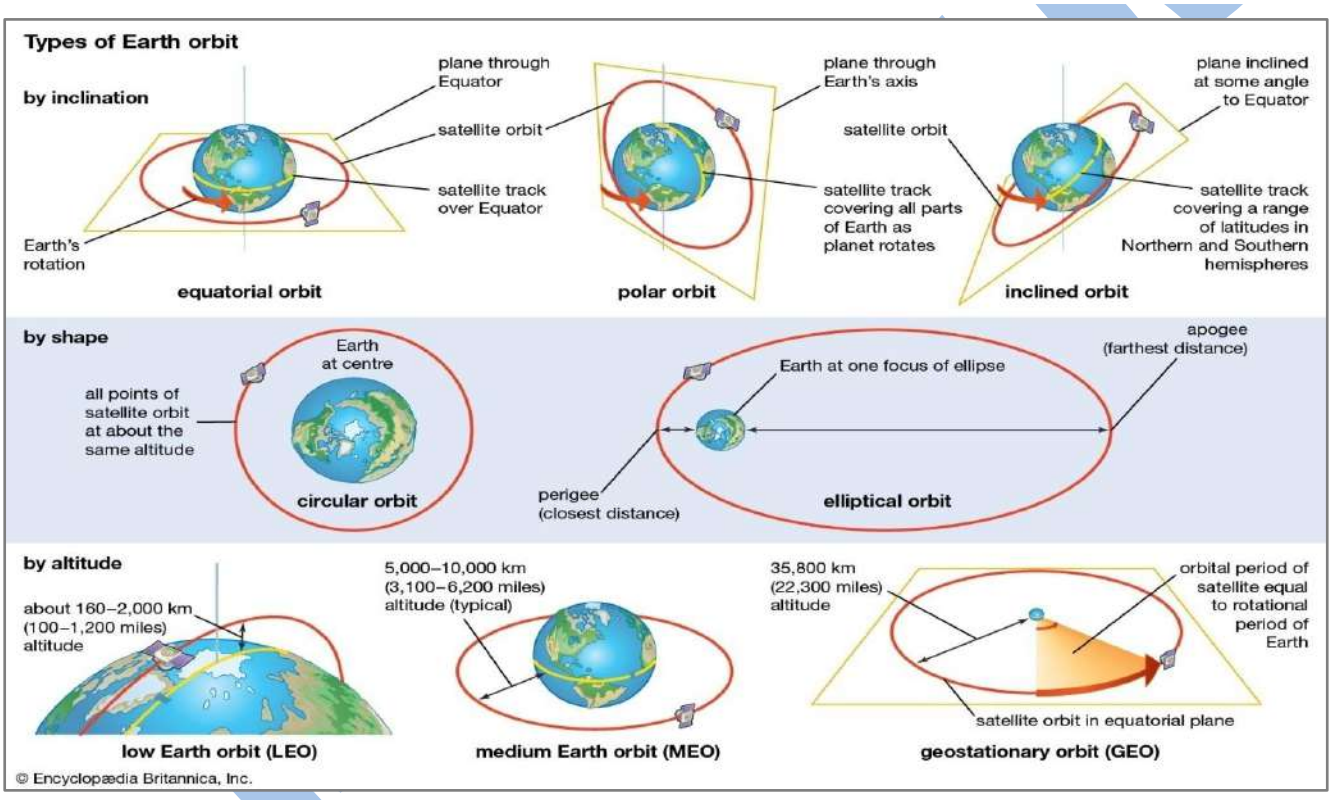
Nasa's Mars 2020 Mission

Perseverance - Mars rover carries seven scientific instruments to study the Martian surface at **Jezero crater.** It carries several cameras and two microphones. The rover is accompanied by the helicopter **Ingenuity,** which will help Perseverance to scout for locations to study.

Kuaizhou-11 Rocket

- Recently, **China's Kuaizhou-11 rocket**, failed in its mission.
- Also known as KZ-11, it had a lift-off mass of 70.8 tonnes, and was designed to launch **low-Earth and Sun-synchronous orbit satellites.**
- It was carrying two satellites –

1. **Remote sensing satellite** that would provide data to clients on a commercial basis for forecasting and managing geological disasters. It would also provide information required for natural resource exploration.
2. Series of satellites **for low-Earth orbit navigation.**
   - ✓ Remote sensing is the **science of obtaining information** about objects or areas from a distance, typically from aircraft or satellites.



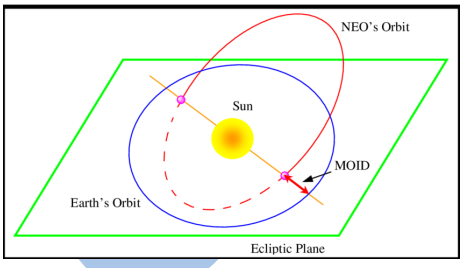
Asthros

- NASA has gearing up to send a 8.4-foot telescope into the stratosphere aboard a balloon of the size of a football stadium in 2023.
- It is called **The Astrophysics Stratospheric Telescope for High Spectral Resolution Observations at Submillimeter wavelengths (ASTHROS)**.
- It will be placed in the outer atmosphere to observe light wavelengths that are "blocked" by Earth's atmosphere.
- The mission will measure the motion and speed of gas around newly formed stars.
- ASTHROS will observe two regions in the Milky Way where stars are born.
- The telescope will also map the presence of two kinds of nitrogen ions that reveal
  - ✓ The places where "winds" from supernova explosions have reshaped the clouds of gas and
  - ✓ Dust in these active, energetic star-forming regions of the galaxy.

Coronae in Venus

- Scientists have identified **37 volcanic structures on Venus** that appear to be recently active - and probably still are today.
- The research focused on **ring-like structures called coronae**, caused by an upwelling of hot rock from deep within the planets interior.
- It provided compelling evidence of widespread **recent tectonic and magma activity on Venus's surface.**
- **Coronae a**re fields of lava flows and major faults spanning a large circular area.

Asteroid 2020 ND



- NASA had issued a warning that a huge "Asteroid 2020 ND" will move past Earth on July 24.
- Its distance from Earth has placed in the **"potentially dangerous" category.**
- Potentially Hazardous Asteroids (PHAs) are defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth.
- Specifically, all asteroids with a **Minimum Orbit Intersection Distance (MOID)of 0.05 au or less are considered PHAs**.
  - ✓ **MOID:** It is defined as the distance between the closest points of the osculating orbits of two bodies. Of greatest interest is the risk of a collision with Earth.
- **Near Earth Orbit Objects** are comets and asteroids nudged by the gravitational attraction of nearby planets into orbits, which allows them to enter the Earth's neighborhood.

Astrosat

Context

- India's AstroSat telescope has detected light from a galaxy, called **AUDFs01,** in the extreme-ultraviolet (UV) light.

About

- The galaxy is 9.3 billion light years away from Earth.
- Astrosat is India's first dedicated multi-wavelength space telescope. It was launched on a PSLV-XL on 28 September 2015.
- ASTROSAT observes universe in the optical, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum, whereas most other scientific satellites are capable of observing a narrow range of wavelength band.

SN5 Starship

Context

- SpaceX (a private company) successfully flew a prototype of its next-generation, deep-space rocket called SN5 Starship.

About

- Starship is a spacecraft and super-heavy booster rocket.
- It can act as a reusable transportation system for crew and cargo to the Earth's orbit, Moon and Mars.
- A majority of the launch cost is attributed to the expense of building a rocket which is ultimately designed to burn up during re-entry.
- A rapidly reusable space launch vehicle could reduce the cost of traveling to space by a hundredfold.
- Starship can deliver satellites further and at lower marginal costs than SpaceX's Falcon vehicles and it can ferry both cargo and crew to the International Space Station (ISS).
- Once developed, Starship is also expected to help carry large amounts of cargo to the Moon, for human spaceflight development and research.

Gaofen-9 Earth

- China launched its latest Gaofen-9 **Earth observation satellite.**
- Gaofen (GF) is a series of Chinese civilian remote sensing satellites for the state-sponsored program China High-definition Earth Observation System (CHEOS).
- Gaofen-9 the new optical remote-sensing satellite will help China inin land surveying, road networking, and disaster prevention.

Raman

- Skyroot Aerospace, a Hyderabad- based startup has successfully test-fired its upper stage rocket engine named 'Raman', which can place multiple satellites into orbit.
- The engine Raman, named after Nobel laureate CV Raman has fewer parts and weighs lesser than a conventional rocket engine.
- It is **India's first 100 per cent 3D-printed Bi-Propellant Liquid Rocket Engine injector.**
- Compared to traditional manufacturing this reduced the overall mass by 50 per cent.
- The engine is capable of multiple restarts enabling them to insert various satellites into multiple orbits in a single mission.

Ceres

- NASA researchers have discovered that the Ceres has an ocean world. Also, Ceres has a brine reservoir that is located 40 km deep and is 100s of miles wide. This makes the dwarf planet water rich.
- Ceres is a dwarf planet found between Mars and Jupiter.
- A Dwarf planet is a celestial body resembling a small planet but lacking certain technical criteria that are required for it to be classed as such.
- These four criteria are – that the body orbits around the Sun, it is not a moon, has not cleared the neighborhood around its orbit (which means it is not the dominant body in its orbit around the Sun and this is what differentiates a planet from a dwarf planet) and has enough mass for its gravity to pull it into a roughly spherical shape.
- As of 2014, the IAU recognizes five named dwarf planets: Ceres, Pluto, Eris, Haumea, and Makemake.

Space Bricks

- Indian Researchers have developed a process to make bricks on the moon for habitation.
- The process involves extracting lunar soil and using bacteria and guar beans to harden it (soil) into brick-like structures for habitation on the moon in the future.
- The making of space bricks brings biology and mechanical engineering together and using them to assemble structure for habitation on the moon's surface.
- As guar gum is used instead of cement for structures, space bricks will also lower carbon footprint in the lunar atmosphere.
- With the earth's resources dwindling, scientists have intensified efforts to inhabit the moon and other planets.

Mars 2020 Mission

What is in news?

- Recently, NASA launched the Mars 2020 mission that carries its Perseverance robotic rover.
- This rover is equipped with sensors specifically designed to find evidence of ancient, microbiotic life on Mars.

MARS 2020 MISSION

MARS 2020 MISSION	DETAILS
Aim	assess possibility of past life on Mars, search for biosignatures, Gather rock & soil samples
Part of	NASA'S Mar's Exploration Program

Rover	Perseverance
Helicopter	Ingenuity Drone
Landing Site	Jezero Crater, Mars
Mission Duration	1 Mars years or 687 Earth days
Key Hardware	7 Instruments on Rover

Beidou Satellite Constellation

In News

- China successfully completed the launched of all its members in its **Beidou** Navigation Satellite System constellation.
  - ✓ A satellite constellation is a group of artificial satellites working together as a system.
  - ✓ Unlike a single satellite, a constellation can provide permanent global or near-global coverage, such that at any time everywhere on Earth at least one satellite is visible.
  - ✓ Satellites are typically placed in sets of complementary orbital planes and connect to globally distributed ground stations. They may also use inter-satellite communication.

About Beidou

- BeiDou offers services including accurate positioning, navigation and timing as well as short message communication.
- It can provide positional accuracies of under ten metres (GPS provides positioning accuracies of under 2.2 metres).
- It consists of 27 satellites in medium Earth orbit, five in geostationary orbit and three more in inclined geosynchronous orbits.

Other Navigational Systems

System	GPS	GLONASS	BeiDou	Galileo	NAVIC
Owner	United States	Russian Federation	China	European Union	India

Vikram Sarabhai

Context

- Recently, ISRO paid tribute to Dr Vikram Sarabhai by announcing that Chandrayaan 2 Orbiter has captured the Moon images of "Sarabhai" Crater.

Sarabhai Crater

- Sarabhai is a small, circular, bowl-shaped crater on the **Mare Serenitatis**, in the northeast quadrant of the Moon.
- This crater is named after Indian astrophysicist Vikram Sarabhai- Father of the Indian Space Programme.

India Joins Hypersonic Missile Club

Context

- Recently, India became the **fourth country after the United States, Russia and China** to develop and successfully test hypersonic technology.

About

- India successfully flight tested the **Hypersonic Technology Demonstrator Vehicle (HSTDV)** for the first time from the Dr Abdul Kalam Island off the coast of Odisha.
- The HSTDV, has been developed by the Defence Research and Development Organisation (DRDO).

Hypersonic Weapon System

- In aerodynamics, a hypersonic speed is one that greatly exceeds the speed of sound, often stated as starting at speeds of Mach 5 and above.
- Thus, Hypersonic weapons **can travel at five times the speed of sound – Mach 5 and faster –** covering vast distances in minutes.

Mach Number

- It is the **ratio of the speed of a body to the speed of sound in the surrounding medium**. It is often used with a numeral (as Mach 1, Mach 2, etc.) to indicate the speed of sound, twice the speed of sound, etc.

'A Mach number is a measure of airspeed, and not of ground speed.

Key Concepts

- When an airplane is flying at **subsonic speed**, all of the air flowing around the airplane is at a velocity of less than the speed of sound (known as Mach 1).
- When an airplane is flying at **transonic speed,** part of the airplane is experiencing subsonic airflow and part is experiencing supersonic airflow. Transonic speed is typically between Mach 0.80 and 1.20.
- When an airplane is flying at **supersonic speed** (more than speed of sound: Mach1), the entire airplane is experiencing supersonic airflow. Supersonic speed is from Mach 1.20 to 5.0.
- If an airplane flies faster than Mach 5, it is said to be in hypersonic flight.

HSTDV

- The HSTDV is an **unmanned scramjet demonstration aircraft** for hypersonic speed flight.
- It is a carrier vehicle for hypersonic and long-range cruise missiles.
- It will have multiple civilian applications including the launching of small satellites at low cost.

Working

- The HSTDV cruise vehicle is **mounted on a solid rocket motor**, which will take it to a required altitude.
- Once it attains a certain speed, the **cruise missile will be ejected out of the launch vehicle**. Subsequently, the scramjet engine of the cruise missile will be ignited automatically.

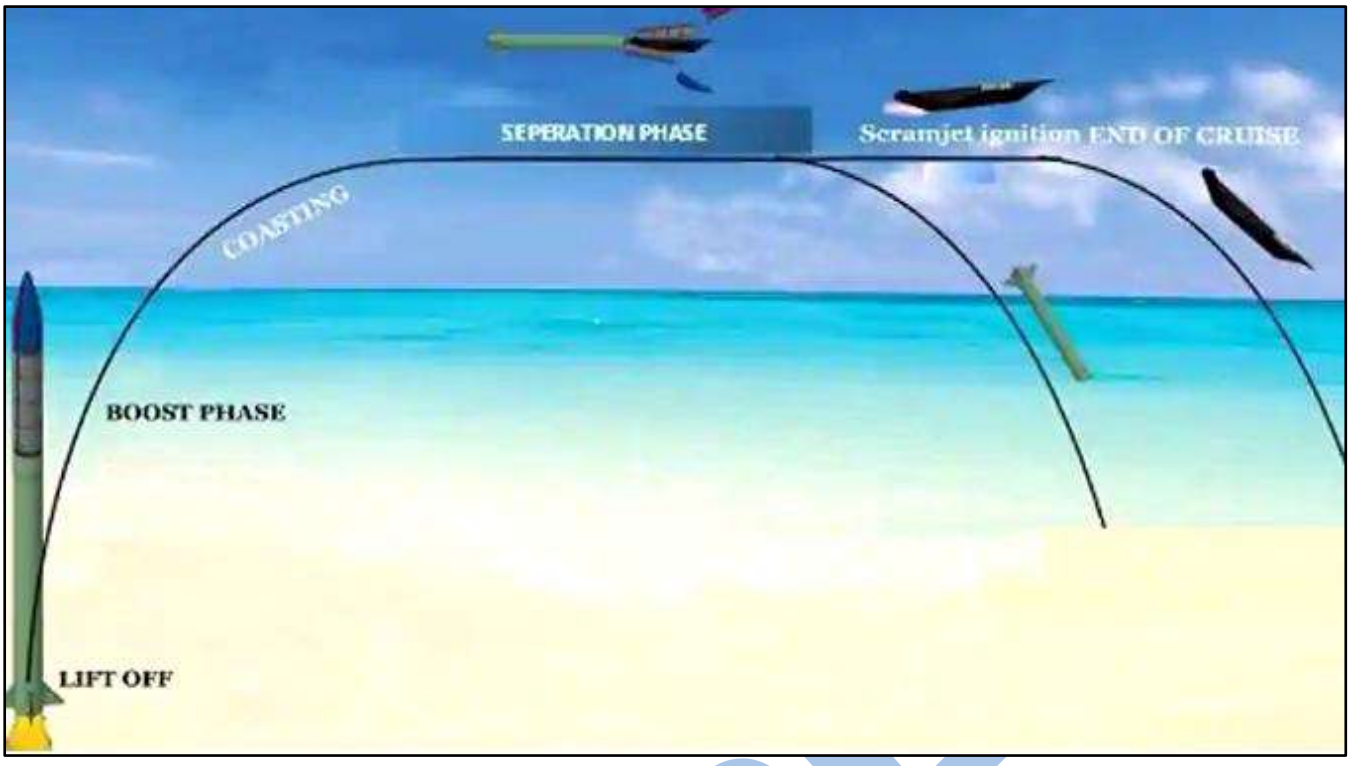


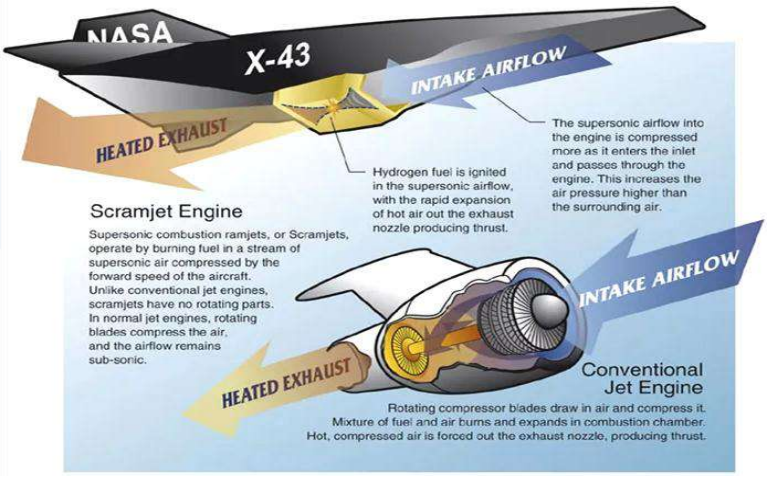
Fig: A graphic explaining the entire HSTDV flight maneuver. (Pic: DRDO)

SCRAMJET PROPULSION

A scramjet (supersonic combustion ramjet) is a **variant of a ramjet airbreathing, jet engine** in which combustion takes place in supersonic airflow.

As in ramjets, a scramjet relies on high vehicle speed to compress the incoming air forcefully before combustion.

But whereas a ramjet decelerates the air to subsonic velocities before combustion, the airflow in a scramjet is supersonic throughout the entire engine. That allows the scramjet to operate efficiently at extremely high speeds.



Why are hypersonic vehicles powered by scramjet engines?

- An improvement over the ramjet technology, the scramjet engine operates efficiently at hypersonic speeds and allows supersonic combustion.
- Ramjet engines are efficient at supersonic speeds of around Mach 3 but **their performance drops when the vehicle hits hypersonic speeds.**

Significance

- HSTDV paves the way for India to develop hypersonic weapons that can travel six times faster than the speed of sound (Mach 6).
- The dual-use hypersonic technology has non-military applications too --- it **can be used for launching satellites and developing commercial planes.**

Merger of Black Holes

Context

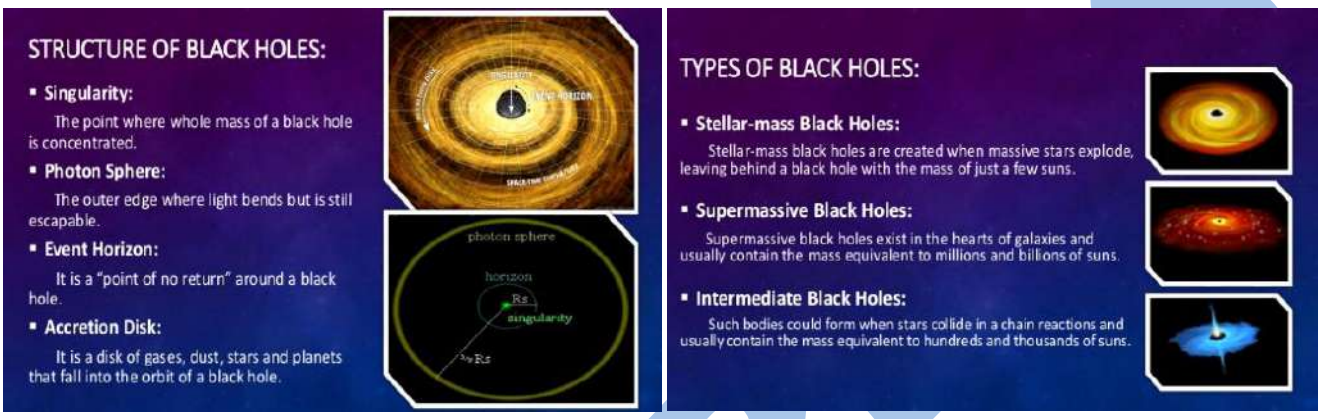
- LIGO and Virgo Observatories have for the first time detected a collision between two black holes.

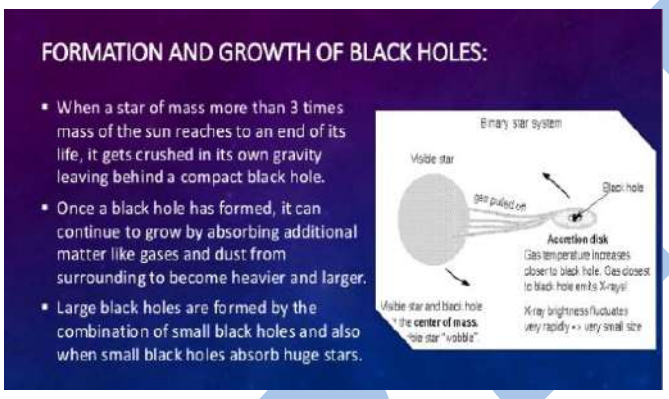
About

- A binary black hole merger produced **gravitational waves equal to the energy of eight suns**. These waves were detected by the observatories.
- The merger took place around 17 billion light years away. The universe was just about half its age at that time.

Black holes

- A black hole is an astronomical object with a gravitational pull so strong that nothing, not even light, can escape it.
- **Event horizon, defines the boundary of a black hole**. Here, the velocity of an object passing nearby needs to exceed the speed of light to escape the black hole.
- Otherwise Matter and radiation fall in, but they can't get out. Speed of light is the speed limit of the cosmos.





Gravitational Waves

Context

- A gravitational wave is an invisible (yet incredibly fast) ripple in space.
- Gravitational waves travel at the speed of light (186,000 miles per second).
- These waves **squeeze and stretch anything in their path as they pass by.**

What causes gravitational waves?

- The most powerful gravitational waves are created when objects move at very high speeds. Some examples of events that could cause a gravitational wave are:

✓ when a star explodes asymmetrically (called a supernova)
✓ when two big stars orbit each other
✓ **when two black holes orbit each other and merge.**

How do we know that gravitational waves exist?

- In 2015, scientists detected gravitational waves for the very first time. They used a very sensitive instrument called LIGO **(Laser Interferometer Gravitational-Wave Observatory).**
- These first gravitational waves happened when two black holes crashed into one another.
- The collision happened 1.3 billion years ago. But, the ripples didn't reach Earth until 2015!

How are gravitational waves detected?

- When a gravitational wave passes by Earth, it squeezes and stretches space.
- LIGO can detect this squeezing and stretching. Each LIGO observatory has two "arms" that are each more than 4 kilometers long.
- A passing gravitational wave causes the **length of the arms to change slightly**. The observatory uses lasers, mirrors, and extremely sensitive instruments to detect these tiny changes.
- Thus, VIRGO & LIGO are large interferometers designed to detect gravitational waves.

Solar Cycle 25

Context

- Scientists from NASA and the National Oceanic and Atmospheric Administration (NOAA) announced their predictions about the new solar cycle, called Solar Cycle 25, which has begun.

What is a solar cycle?

- Our Sun is a huge ball of electrically-charged hot gas. This charged gas moves, generating a powerful magnetic field.
- Since the gases on the Sun's surface are constantly moving, these magnetic fields can get stretched, twisted and tangled creating motion on the surface, which is referred to as solar activity.
- Thus, Sun's magnetic field goes through a cycle, called the solar cycle.
- **Every 11 years, the Sun's magnetic field completely flips.** This means that the Sun's north and south poles switch places. Then it takes about another 11 years for the Sun's north and south poles to flip back again.
- The **beginning of a solar cycle is a solar minimum**, or when the Sun has the least sunspots.
- Over time, solar activity—and the number of sunspots—increases.
- The middle of the solar cycle is the solar maximum, or when the Sun has the most sunspots.
- As the cycle ends, it fades back to the solar minimum and then a new cycle begins.
- ***Sunspots form a blanket that protects the solar system from harmful cosmic radiation.***

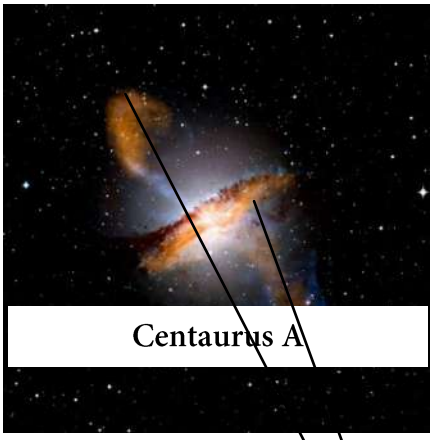
Significance

- Solar activity can affect satellite electronics and limit their lifetime.
- Radiation can be dangerous for astronauts who do work on the outside of the International Space Station.
- If scientists predict an active time in the solar cycle, satellites can be put into safe mode and astronauts can delay their spacewalks.
- Forecasting of the solar cycle can also help scientists protect our radio communications on Earth.

Giant Radio Galaxies

Context

- Researchers have found the largest sample of giant radio galaxies (GRG) in the Universe.
- This is the first time such a large catalogue of GRGs has been made.

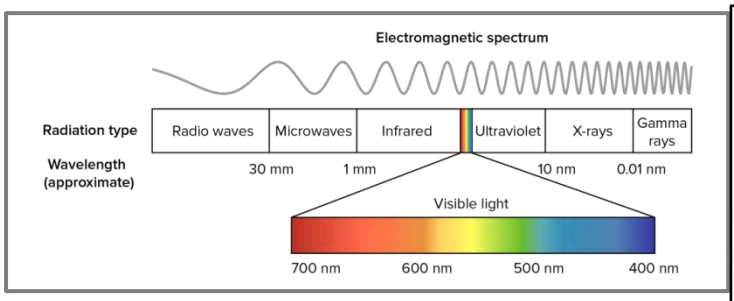


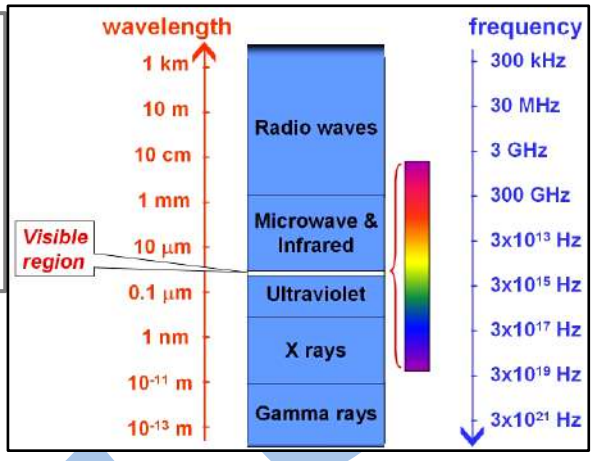
Radio Galaxies

- A particular type of active galaxy **that emits more light at radio wavelengths than at visible wavelengths**, also known as a radio-luminous galaxy or radio-loud galaxy.
- Radio galaxies are **driven by non-thermal emission**.
- Some radio galaxies, called extended radio galaxies, have lobes of radio emission extending millions of light-years from their nuclei.
- **Centaurus A** is a nearby example of an extended radio galaxy that features **two outer lobes 650,000 and 1,350,000 light-years** in diameter.
- In contrast, compact radio galaxies emit radio lobes not much larger than the galactic nucleus.

Origin

- The universe has billions of galaxies and almost all have super-massive black holes at the centre.
- Some of these black holes are active and produce jets travelling almost at the speed of light.
- These jets **are visible in radio light or at radio wavelength** of the electromagnetic spectrum.
- i.e. wavelengths between **10 MHz and 100 GHz.**
- Such galaxies, which have active black holes **shooting high-speed jets**, are called radio galaxies.





Data Sonification Project

Context

- Recently, NASA's Chandra X-Ray Center (CXC) has unveiled a new 'sonification' project that transforms data from astronomical images into audio.

What is data sonification?

- Data sonification refers to the **use of sound values to represent real data**. Simply put, it is the auditory version of data visualisation.
- In NASA's recent Chandra project, **data is represented using a number of musical notes.**
- With this project, users can now experience different phenomena captured in astronomical images as an auditory experience.
- The birth of a star, a cloud of dust or even a black hole can now be 'heard' as a high or low pitched sound.
- Users can now 'listen' to images of the Galactic Centre, the remains of a supernova called Cassiopeia A, as well as the Pillars of Creation Nebula. These are all located in a region around 26,000 light years away from Earth.

How is the data collected?

- The data has been collected by NASA's Chandra X-Ray Observatory, Hubble Space Telescope and Spitzer Space Telescope — each of which is represented by a different musical 'instrument'.

How did NASA translate astronomical images into sound?

- NASA's distant telescopes in space collect inherently digital data, in the form of ones and zero (binary).
- The Chandra project has translated the data into sound. Usually they are only converted into images.
- Pitch and volume are used to denote the brightness and position of a celestial object or phenomenon.

Galactic Center

- The Galactic Center is the rotational center of the Milky Way galaxy.
- It comprises a collection of celestial objects — neutron and white dwarf stars, clouds of dust and gas, and a supermassive black hole called Sagittarius A*.
- Sagittarius A* weighs four million times the mass of the sun.

Cassiopeia A

- Cassiopeia A (Cas A) is the remnant of a massive star that exploded about 300 years ago. (Supernova Explosion)
- Cassiopeia A, is the **strongest source of radio emission in the sky** beyond the solar system.
- It is located in the direction of the constellation Cassiopeia about **11,000 light-years from Earth**.
- The light from the event is estimated to have reached Earth between 1662 and 1700.
- At the centre of the remnant is a neutron star, which was the first detected to have a carbon atmosphere.

Significance of Data Sonification Project

- The sonification project aims to incorporate NASA science content into the learning environment effectively and efficiently for learners of all ages.
- Over the years, NASA has been working towards making data about space accessible for a larger audience.
- Sonification projects like this allow audiences, including visually-impaired communities to experience space through data.

Moon May Be Rusting

What is in news?

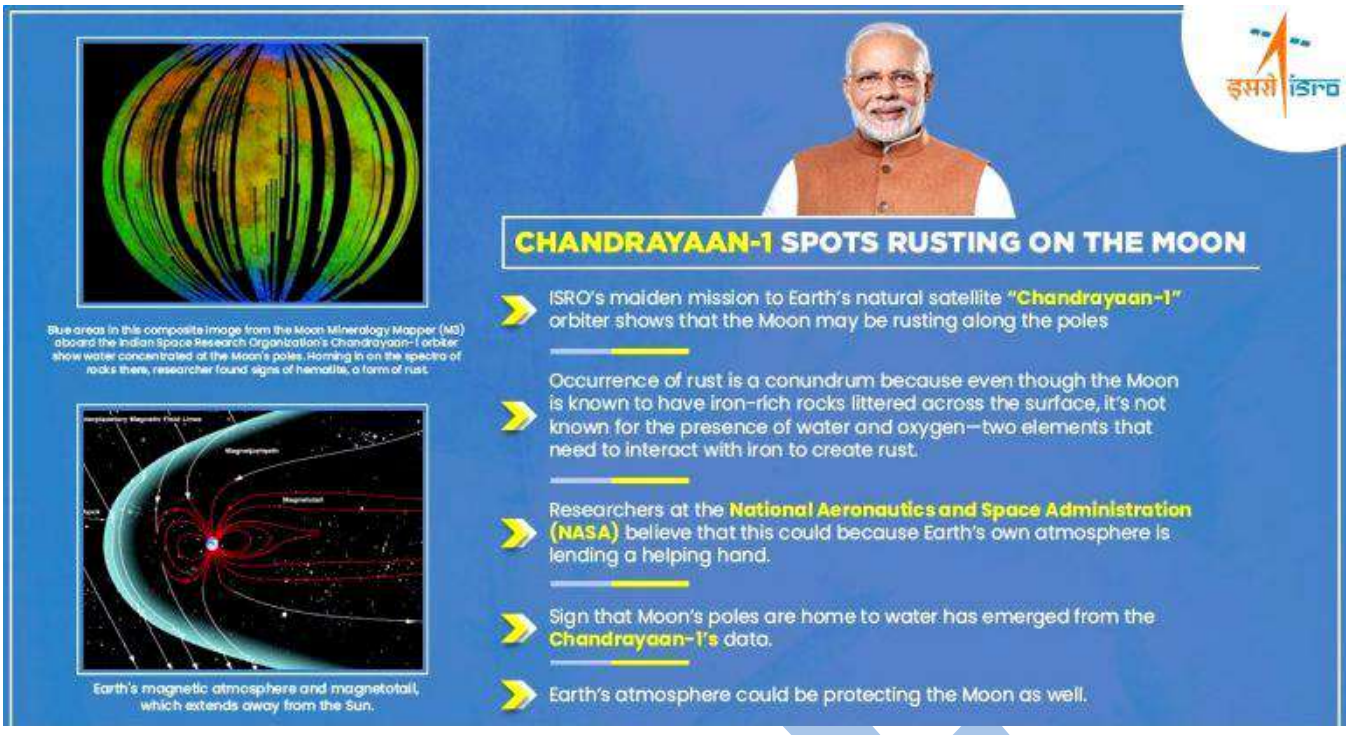
- Mars has long been known for its rust. Iron on its surface, combined with water and oxygen from the ancient past, give the Red Planet its hue.
- But scientists were recently surprised to find evidence that our airless Moon has rust on it as well.

Why is it puzzling?

- Moon's surface does not contain water and oxygen. And rust occurs when iron is exposed to a combination of water and oxygen.

Plausible explanation

- The Indian Space research Organization's Chandrayaan-1 orbiter while it surveyed the moon in 2008, revealed that the poles of the moon had very different compositions than the rest of it.
- This composite image of the moon, from the Moon Mineralogy Mapper shows water ice on the poles. The researchers found **hints of hematite when focusing in on the spectra in those regions.**
- The moon's polar surfaces has iron-rich rocks with spectral signatures that matches hematite.
- The mineral hematite, commonly found in Earth's surface, is a specific type of iron oxide, or rust, with the formula Fe_2O_3.
- Also, the moon doesn't have an atmosphere of its own to provide sufficient amounts of oxygen, but it has trace amounts **donated by Earth's atmosphere.**
- This terrestrial oxygen travels to the moon along an elongated extension of Earth's magnetic field called a "magnetotail."
- The moon is mostly devoid of water, apart from frozen water found in lunar craters on the moon's far side — far from where most of the hematite was found.
- But the researchers propose that fast-moving dust particles that bombard the moon might free water molecules locked into the moon's surface layer, allowing the water to mix with the iron.
- These dust particles might even be carrying water molecules themselves, and their impact might create heat that could increase the oxidation rate thereby creating rust.


इसरो ISRO
CHANDRAYAAN-1 SPOTS RUSTING ON THE MOON
Blue areas in this composite image from the Moon Mineralogy Mapper (M3) aboard the Indian Space Research Organization's Chandrayaan-1 orbiter show water concentrated at the Moon's poles. Homing in on the spectra of rocks there, researcher found signs of hematite, a form of rust.
Earth's magnetic atmosphere and magnetotail, which extends away from the Sun.
ISRO's maiden mission to Earth's natural satellite "Chandrayaan-1" orbiter shows that the Moon may be rusting along the poles
Occurrence of rust is a conundrum because even though the Moon is known to have iron-rich rocks littered across the surface, it's not known for the presence of water and oxygen—two elements that need to interact with iron to create rust.
Researchers at the National Aeronautics and Space Administration (NASA) believe that this could because Earth's own atmosphere is lending a helping hand.
Sign that Moon's poles are home to water has emerged from the Chandrayaan-1's data.
Earth's atmosphere could be protecting the Moon as well.


CHANDRAYAAN 1 VS 2
A look at the major differences between the two missions
CHANDRAYAAN-1
CHANDRAYAAN-2
Mission
India's first lunar mission
India's first deep-space mission
Follow-up mission to Chandrayaan-1
ISRO's first inter-planetary mission to land rover on any celestial body
Goals
Involved orbiting around moon
Involves orbiter, lander, and rover
Approx cost (Rs cr)
380
960
Launch vehicle
PSLV-C11
GSLV Mk-III
Operational for
312 days
Approx 365 days
Payloads (or study devices)
11 (built in India, USA, UK, Germany, Sweden & Bulgaria)
14 (13 Indian, 1 from NASA)
Major Objectives
To conduct scientific experiments using instruments on the spacecraft
To increase scientific knowledge
To soft-land on the lunar surface
Test new technologies and conduct experiments on the moon
Only US, Russia and China have been able to soft-land spacecraft on lunar surface
creative

Haiyang-2C

Context

- China on Monday sent its third **ocean dynamic environment monitoring satellite** into orbit from the Jiuquan Satellite Launch Center.

About

- The Haiyang-2C (HY-2C) satellite can provide all-weather and round-the-clock observation of wave height, sea surface height, wind, and temperature.
- Onboard equipment enables it to provide information on the identification of vessels.
- It also enables to receive, store and transmit buoy measurement data in China's offshore and other marine areas.
- HY-2C will also form a network with the previous HY-2B and subsequent HY-2D, scheduled for launch next year.
- Together they will carry out **high-precision maritime environment monitoring.**

Phosphine Gas In Venus

Context

- Recently, International astronomers have announced the discovery of traces of a molecule known as phosphine on Venus.
- This implies the possibility of existence of life forms in Venus that release this substance through bio-chemical pathways.

Phosphine

- It is a colourless, odourlesss, flammable, very toxic gas compound. It consists of inorganic nonmetals.
- Phosphine is **used in the semiconductor industry** to introduce phosphorus into silicon crystals .
- It is also used as **a fumigant, a polymerization initiator** and as an intermediate for the preparation of several flame retardants.

Venus

- It is called **Earth's "sister planet"** because of their similar size, mass, proximity to the Sun, and bulk composition.
- It has the **densest atmosphere of the four terrestrial planets**, consisting of more than **96% carbon dioxide** and remaining 3.5% being nitrogen
- Venus is shrouded by an opaque layer of **highly reflective clouds of sulfuric acid**, preventing its surface from being seen from space in visible light.
- Orbital period: 225 days
- One day on Venus lasts 243 Earth days because **Venus spins backwards**, with its sun rising in the west and setting in the east.
- The planet's surface temperature is about **900 degrees Fahrenheit** (465 degrees Celsius)—hot enough to melt lead.
- The '90s Magellan mission mapped the planet's surface and Akatsuki is currently orbiting Venus.

Himalayan Chandra Telescope

- The Himalayan Chandra Telescope (HCT) is located at the Indian Astronomical Observatory (IAO), **Mt. Saraswati, Digpa-ratsa Ri, Hanle, Ladakh,** at an altitude of 4500 m.
- The telescope is used in **monitoring stellar explosions, comets, and exo-planets, and has contributed significantly to these studies.**
- It is remotely operated using a dedicated satellite communication link from the Centre for Research & Education in Science & Technology (CREST), Indian Institute of Astrophysics, Hosakote, about 35 km northeast of Bangalore.
- The Himalayan Faint Object Spectrograph Camera (HFOSC) and the Near-infrared camera are available here for regular observations.

IAO

- The Indian Astronomical Observatory (IAO), located in Hanle near Leh in Ladakh, has one of the world's highest located sites for optical, infrared and gamma-ray telescopes.
- It is operated by the Indian Institute of Astrophysics, Bangalore. It is currently the ninth highest optical telescope in the world, situated at an elevation of 4,500 meters.

IIA

- The Indian Institute of Astrophysics (IIA), with its headquarters in Bengaluru (Karnataka), is an **autonomous Research Institute wholly financed by the department of Science and Technology**, Government of India.
- IIA conducts research primarily in the areas of astronomy, astrophysics and related fields.

Asteroid 465824 2010 FR

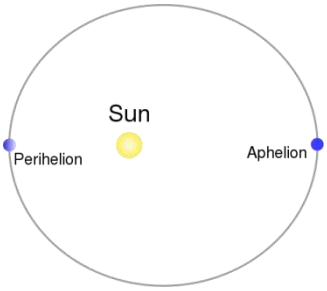
Context

- NASA was tracking Asteroid 465824 2010 FR, which is twice as big as the Pyramid of Giza. It crossed the Earth's orbit recently. It is classified **as a Near-Earth Object (NEO) and a potentially hazardous asteroid (PHA).**

Asteroids

- They are rocky objects that orbit the Sun, much smaller than planets. Asteroids are minor planets.
- There are over 20,000 known near-Earth asteroids.

NEOs and PHA



- A near-Earth object (NEO) is any small Solar System body whose orbit brings it to proximity with Earth.
- A Solar System body is a NEO if its closest approach to the Sun (perihelion) is less than 1.3 astronomical units (AU). NEOs have low surface gravity,
- If a NEO's orbit crosses the Earth's, and the object is larger than 140 meters across, it is considered a potentially hazardous object (PHO).
- Most known PHOs and NEOs are asteroids, but a small fraction are comets.
- Two scales, the **Torino scale and the Palermo scale, ratea risk** based on how probable the orbit calculations of an identified NEO make an Earth impact and on how bad the consequences of such an impact would be.

AU

- One astronomical unit (AU) represents the mean distance between the Earth and our sun.
- An AU is approximately 93 million miles (150 million km). It's approximately 8 light-minutes.

New Shepherd

Context

- Recently, a rocket system meant to take tourists to space successfully completed its seventh test launch. It is called New Shepherd.

About

- New Shephard has been named after astronaut Alan Shephard, the first American to go to space.
- It offers flights to space over **100 km above the Earth** and accommodation for payloads.
- It is a rocket system that has been designed to take astronauts and research payloads past the **Karman line – the internationally recognised boundary of space.**
- Aim: To provide easier and more cost-effective access to space meant for purposes such as academic research, corporate technology development and entrepreneurial ventures among others.
- New Shepherd has been built by Amazon founder Jeff Bezos's space company called Blue Origin.
- It will eventually allow space tourists to experience microgravity by taking them over 100 km above the Earth.

Sofia

Context

- NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) has confirmed, for the first time, water on the sunlit surface of the Moon.

About

- SOFIA has detected water molecules (H2O) in **Clavius Crater**, one of the largest craters **visible from Earth**, located in the Moon's southern hemisphere.
- Previous observations of the Moon's surface detected some form of hydrogen, but were unable to distinguish between water and its close chemical relative, hydroxyl (OH).
- Data from this location reveal water roughly equivalent to a 12-ounce bottle of water – trapped in a cubic meter of soil spread across the lunar surface.

The observatory

- SOFIA, the Stratospheric Observatory for Infrared Astronomy, is a Boeing 747SP aircraft modified to carry a 2.7-meter Reflecting Telescope.
- Flying into the stratosphere at 38,000-45,000 feet puts SOFIA above 99 percent of Earth's infrared-blocking atmosphere.
- This allows astronomers to study the solar system and beyond in ways that are not possible with ground-based telescopes.
- SOFIA is made possible through a partnership between NASA and the German Aerospace Center (DLR).

Nobel Prize in Physics

Context

- 2020 Nobel Prize in physics went to Roger Penrose and the other half jointly to Reinhard Genzel and Andrea Ghez for furthering the understanding of black holes.

Observation by Nobel Laureates

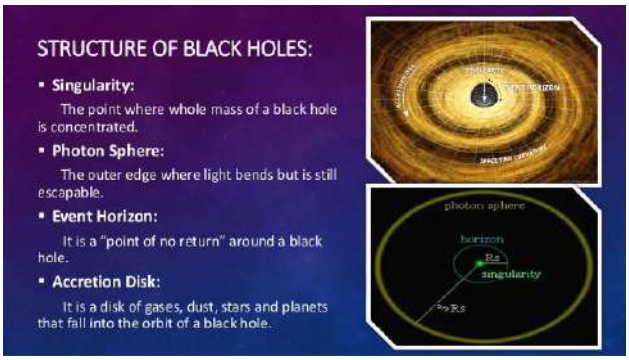
- Penrose proved with mathematics that the formation of black holes was possible, based on Albert Einstein's general theory of relativity.
- Reinhard Genzel and Andrea Ghez discovered a supermassive compact object at the centre of our galaxy.

What are Black Holes?

- A black hole is a region of space-time where gravity is so strong that nothing—no particles or even electromagnetic radiation such as light—can escape from it.
- i.e it has a high escape velocity. Escape velocity is the speed at which an object must travel to override a planet or an object's gravitational force. For instance, for a spacecraft to leave the surface of the Earth, it needs to be travelling at a speed of about 40,000 km per hour.
- The boundary of the region of the black hole from which no escape is possible is **called the event horizon.**
- Here, the velocity of an object passing nearby needs to exceed the speed of light to escape the black hole.
- Otherwise Matter and radiation fall in, but they can't get out. Speed of light is the speed limit of the cosmos.

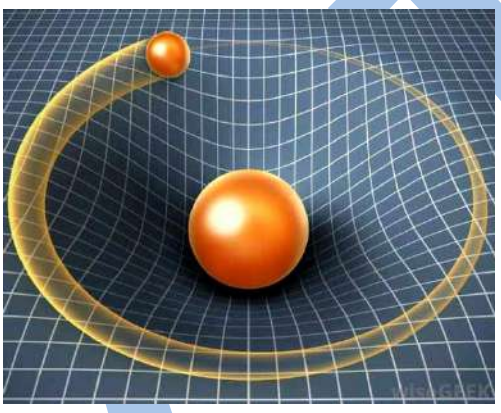
How Do Black Holes Form?

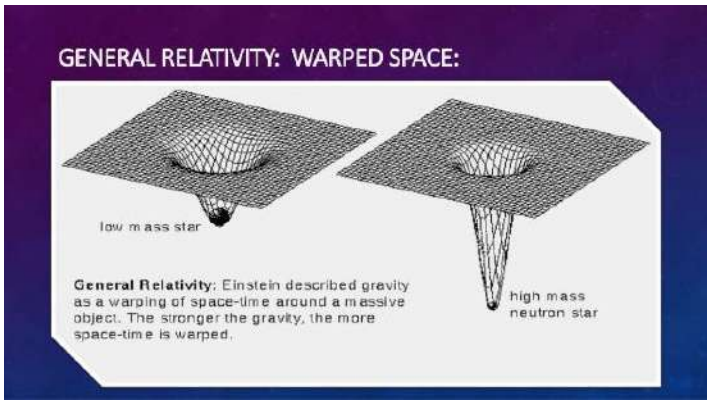
- Primordial black holes are thought to have formed in the early universe, soon after the big bang.
- Stellar black holes form when the center of a very massive star collapses in upon itself. This collapse also causes a supernova, or an exploding star, that blasts part of the star into space.
- Supermassive black holes formed at the same time as the galaxy they are in. The size of the supermassive black hole is related to the size and mass of the galaxy it is in.



Theory of General Relativity & Black Hole Formation

- Einstein's 1915 general theory of relativity holds that gravity is due to the warping/bending of space and time.
- As a heavy ball curves a good mattress and deforms it, same way energy and matter (objects like planets, sun) curves space and time and deforms it which in turn results in gravity.
- Deformation of space and time in the plane; here represented as grids, gives rise to the gravity:
- When the deformation of space and time is infinite, the deformation is not a curve anymore. It is now a black hole.
- Thus, the theory of general relativity predicts that a sufficiently compact mass can deform spacetime to form a black hole.





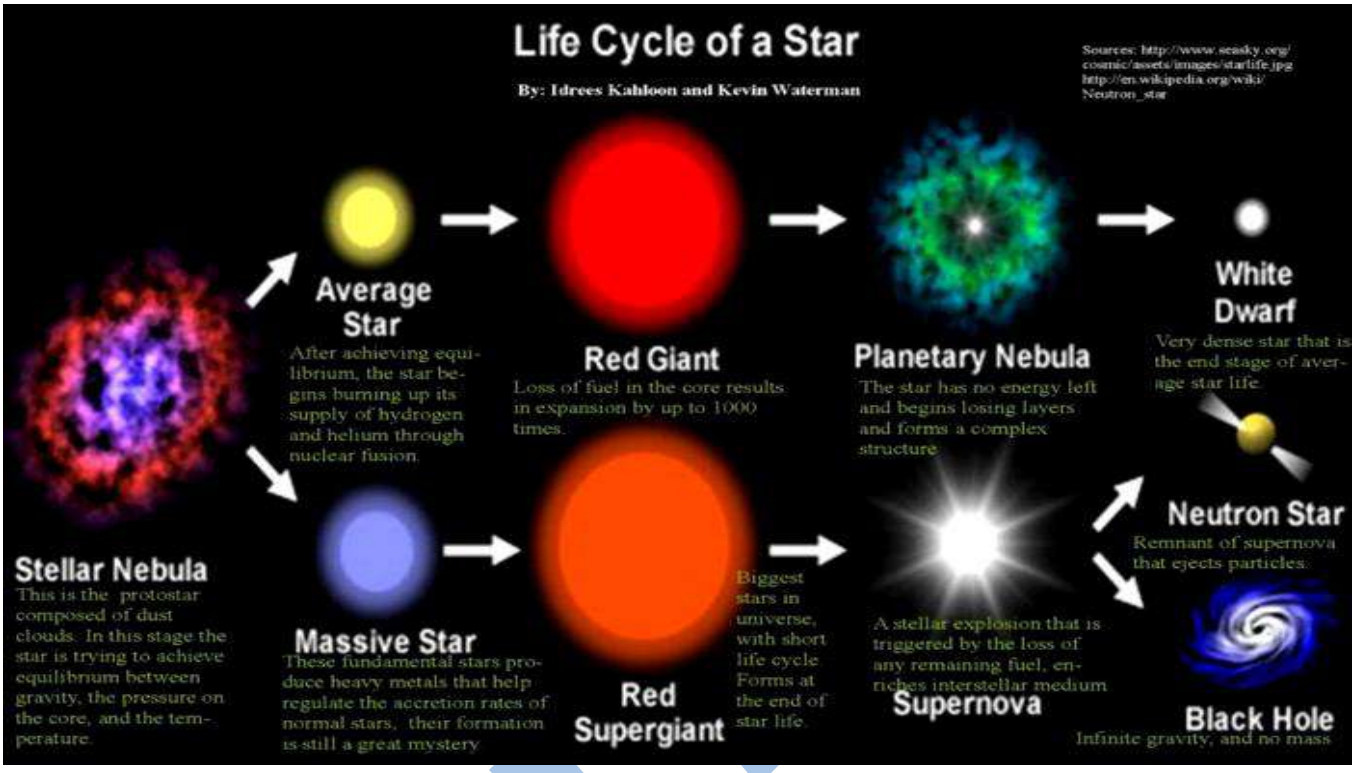
Could a Black Hole Destroy Earth?

- Black holes do not wander around the universe, randomly swallowing worlds.
- They follow the laws of gravity just like other objects in space.
- The orbit of a black hole would have to be very close to the solar system to affect Earth, which is not likely.
- If a black hole with the same mass as the sun were to replace the sun, Earth would not fall in.
- The black hole with the same mass as the sun would keep the same gravity as the sun.
- The planets would still orbit the black hole as they orbit the sun now.

Will the Sun Ever Turn Into a Black Hole?

- The sun does not have enough mass to collapse into a black hole.

- In billions of years, when the sun is at the end of its life, it will become a red giant star.
- Then, when it has used the last of its fuel, it will throw off its outer layers and turn into a glowing ring of gas called a planetary nebula.
- Finally, all that will be left of the sun is a cooling white dwarf star.



Mars Opposition

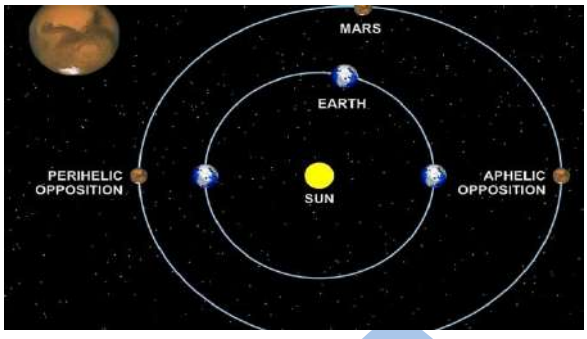
Context

- Mars reached opposition on Oct. 13.

What is Mars Opposition?

- Mars and Earth both orbit the sun, but at different distances, and thus, different speeds.

- Every two years or so, Mars, Earth and the sun form a straight line during the course of their orbits, **with Earth in the middle — an event known as opposition.**
- It is the point when the outer planet is typically also at its closest distance to the Earth.
- As a result, the Red Planet appears bigger, brighter and redder than usual.
- Mars actually outshine Jupiter, becoming the third brightest object (moon and Venus are first and second, respectively) in the night sky.



But why is it called opposition?

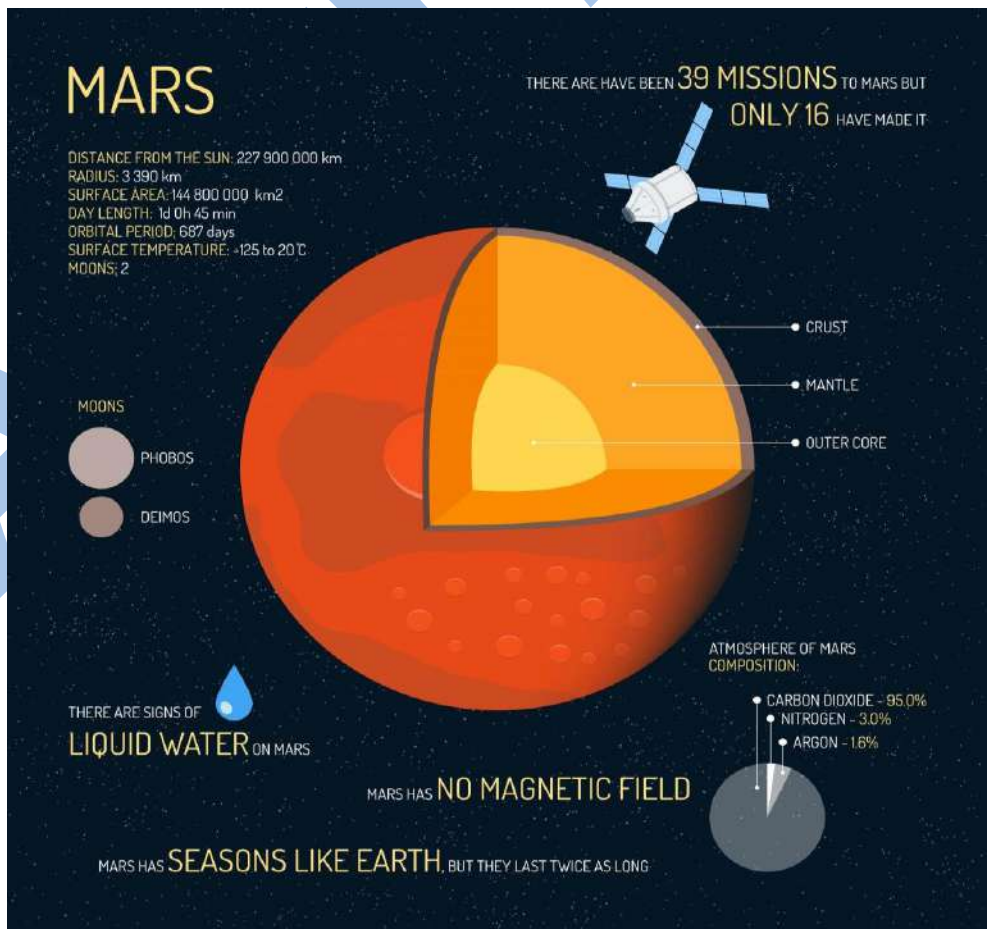
- As per NASA, from an individual's perspective on the Earth, Mars rises in the east and after staying up all night, it sets in the west just as the sun rises in the east and sets in the west.
- Because from the perspective on Earth, the sun and Mars appear to be on the opposite sides of the sky, Mars is said to be in "opposition".
- Essentially, opposition is a reference to "opposing the sun" in the sky.

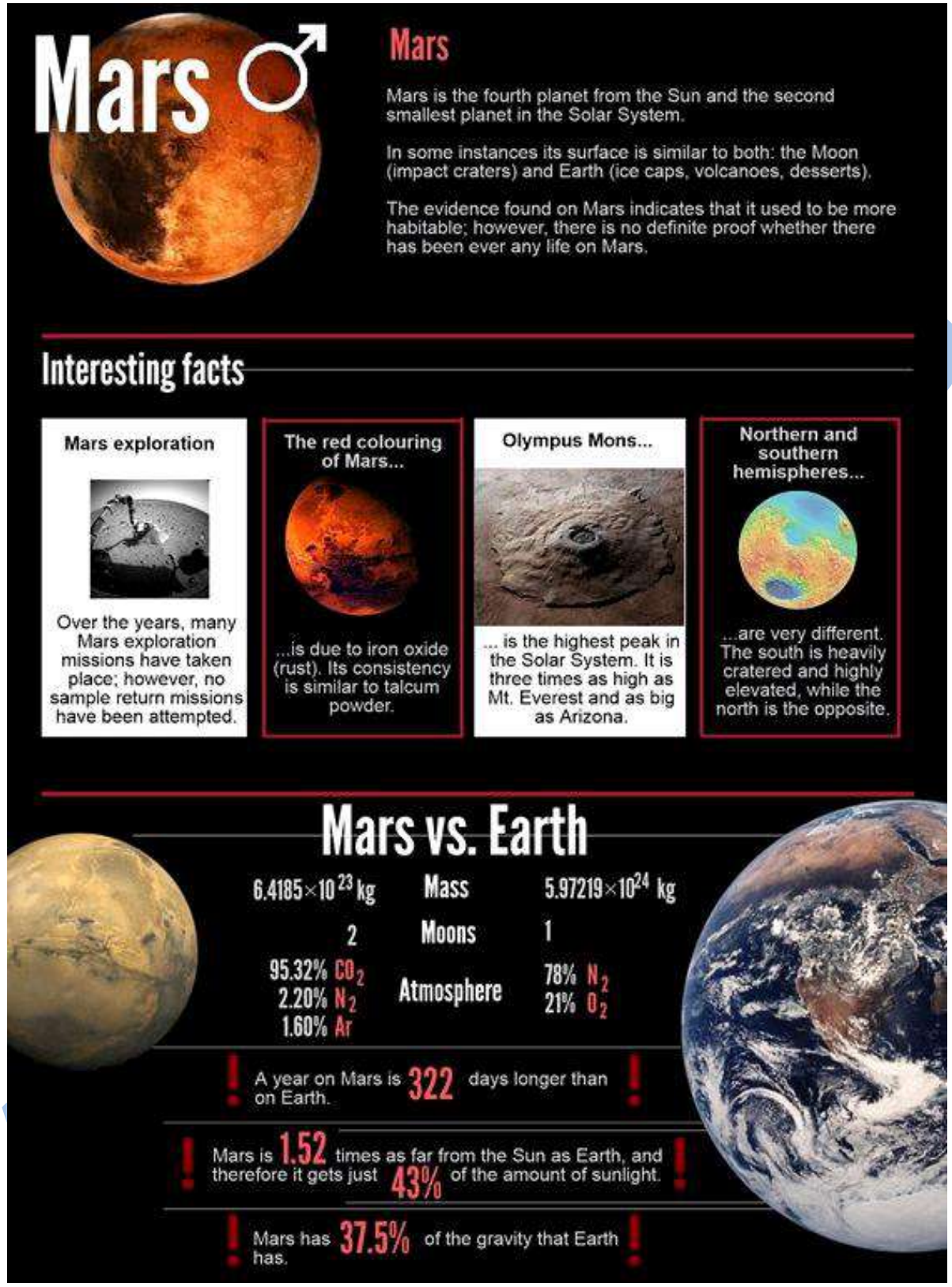
Why every two years?

- Mars orbits the sun at a greater distance than Earth and takes about 26 months to complete one orbit around the sun.
- Due to these different orbital speeds, Mars oppositions occur every two years or so.
- Mars's next close approach will happen on December 8, 2022, when the planet will be 62.07 km away from the Earth.

Note:

- ✓ Even so, the closest approach **does not mean** that Mars will appear to be the same size as that of the moon.
- ✓ Inner planets, Mercury and Venus cannot be in opposition to the Sun.





OSIRIS-Rex

Context

- After a four-year journey, NASA's robotic spacecraft OSIRIS-REx briefly touched down on asteroid Bennu's boulder-strewn surface to collect rock and dust samples.

OSIRIS-REx

- OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer) is a NASA asteroid-study and sample-return mission.
- The mission's primary goal is to obtain a sample of at least 60 g from 101955 Bennu, a carbonaceous near-Earth asteroid.

O – Origins

Return and analyze a sample of a pristine carbon-rich asteroid to study the nature, history, and distribution of its minerals and organic material.

SI – Spectral Interpretation

Define the global properties of a primitive carbon-rich asteroid to allow for direct comparison with existing ground-based telescopic data for all asteroids.

RI – Resource Identification

Map the global properties, chemistry, and mineralogy of a primitive carbon-rich asteroid to define its geologic and dynamic history and provide context for the returned sample.

S – Security

Measure the Yarkovsky effect* on a potentially hazardous asteroid and learn which asteroid properties contribute to this effect.

*a force caused by the emission of heat from a rotating asteroid that can change its orbit over time

REx – Regolith Explorer

Document the texture, morphology, geochemistry, and spectral properties of the regolith (surface material) at the sampling site.

Purpose

- The material returned is expected to enable scientists to learn more about
  - ✓ the formation and evolution of the Solar System,
  - ✓ its initial stages of planet formation, and
  - ✓ the source of organic compounds that led to the formation of life on Earth

Bennu

- 101955 Bennu is a **carbonaceous asteroid** in the Apollo group discovered by the **LINEAR Project** in1999.
- It is a **potentially hazardous object**.
- It has a cumulative 1-in-2,700 chance of impacting Earth between 2175 and 2199.
- Within 10 million years of our solar system's formation, Bennu's present-day composition was already established.
- Bennu likely broke off from a much larger carbon-rich asteroid about 700 million to 2 billion years ago.
- It formed in the Main Asteroid Belt between Mars and Jupiter, and has drifted much closer to Earth since then.
- Because its materials are so old, Bennu may contain organic molecules similar to those that could have been involved with the start of life on Earth.

The Lincoln Near-Earth Asteroid Research (LINEAR) project is a collaboration of the United States Air Force, NASA, and the MIT's Lincoln Laboratory for the systematic detection and tracking of near-Earth objects. LINEAR was responsible for the majority of asteroid discoveries from 1998 until it was overtaken by the Catalina Sky Survey in 2005.

Satellite EOS-01

Context

- Recently, India's Polar Satellite Launch Vehicle (PSLV C-49) successfully launched its latest earth observation satellite EOS-01 and nine customer satellites from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota.

Details

- EOS-01 is an earth observation satellite, intended for applications in **agriculture, forestry and disaster management support.**
- The nine other customer satellites from Lithuania (1), Luxembourg (4) and USA (4) were launched under a commercial arrangement with NewSpace India Limited (NSIL).
- EOS-01 is nothing but another **Radar Imaging Satellite (RISAT)** that will work together with RISAT-2B and RISAT-2BR1 launched last year

ISRO's new naming system

- EOS-01 was initially named RISAT-2BR2, and was supposed to be the third of the three-spacecraft constellation. It aimed at providing all-weather round-the-clock service for high-resolution images.
- With EOS-01, ISRO is moving to a new naming system for its earth observation satellites.
- Earlier satellites were named thematically, according to the purpose they are meant for.
- For example, the Cartosat series of satellites were meant to provide data for land topography and mapping,
- Oceansat satellites were meant for observations over sea.
- Some INSAT-series, Resourcesat series, GISAT, Scatsat etc are all earth observation satellites.
- Henceforth, all the earth observation satellites would be called EOS-series.

RISAT (Radar Imaging Satellite)

- RISAT is a series of Indian radar imaging satellites built by ISRO.
- They provide all-weather surveillance using synthetic aperture radars (SAR).
- The RISAT series are the first all-weather Earth observation satellites from ISRO.
- Previous Indian observation satellites relied primarily on optical and spectral sensors which were hampered by cloud cover.
- Post 2008 Mumbai attacks RISAT-2 were launched before RISAT-1 and it used SAR sensor of Israel Aerospace.
- The satellite is used for border surveillance, to deter insurgent infiltration and for anti-terrorist operations.

Note: Synthetic aperture radar is a way of creating an image using radio waves. The radio waves used in SAR typically range from approximately 3 cm up to a few meters in wavelength, which is much longer than the wavelength of visible light, used in making optical images. It creates two-dimensional images or three-dimensional reconstructions of objects, such as landscapes.

Types of satellites launched by ISRO

1. Communications Satellite
2. Remote Sensing Satellite
3. Navigation Satellite
4. Geocentric Orbit type satellites(LEO, MEO, HEO)
5. Global Positioning System (GPS)
6. Geostationary Satellites (GEOs)
7. Drone Satellite, Ground Satellite
8. Polar Satellite, Nano Satellites
9. CubeSats and SmallSats.

New Space India Limited (NSIL) is a Central Public Sector Enterprise of Government of India and commercial arm of ISRO. It was established on 6 March 2019 under the administrative control of Department of Space (DOS) and the Company Act 2013. The main objective of NSIL is to scale up industry participation in Indian space programmes.

Earth Observation Satellite/ remote Sensing

- Earth observation satellites are the satellites equipped with remote sensing technology.
  - ✓ Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft).
  - ✓ Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth.
- Functions: Land and forest mapping and monitoring, mapping of resources like water or minerals or fishes, weather and climate observations, soil assessment, geospatial contour mapping are all done through earth-observation satellites.

Radio Burst

Context

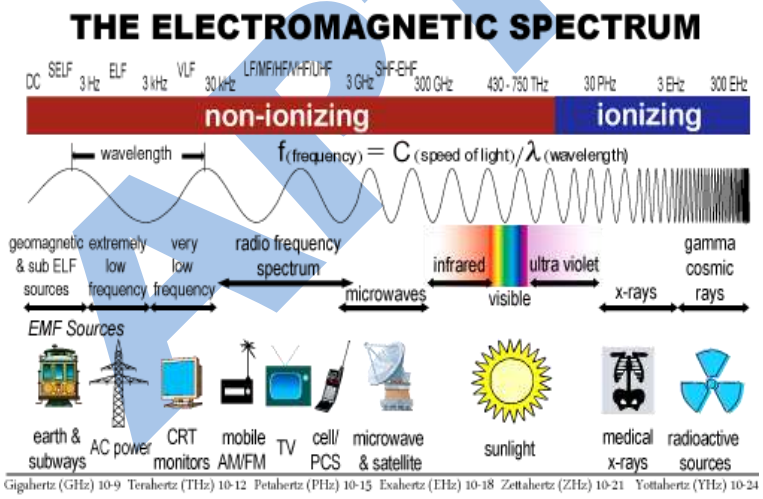
- NASA has recently observed a mix of X-ray and radio signals never observed before in the Milky Way.
- Significantly, the flare-up it observed included the first fast radio burst (FRB) seen within the galaxy.

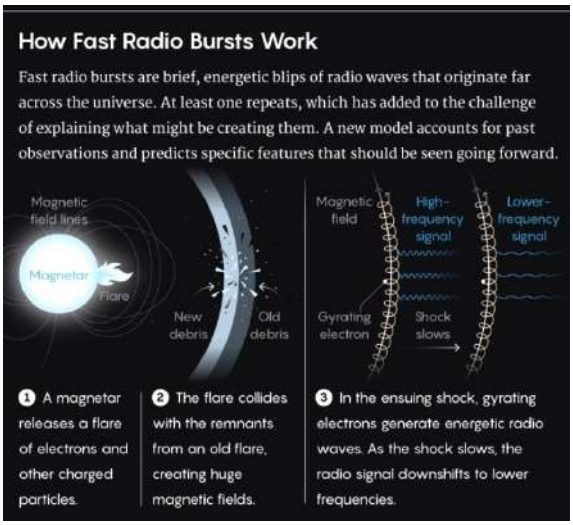
What are FRBs?

- Fast radio bursts, or FRBs, are incredibly powerful **flashes of radio waves** that mostly come from distant galaxies.
- Duration of these bright bursts of **radio waves lie in the millisecond-scale**.
- Due to this it is **difficult to detect them** and determine their position in the sky.
- Radio waves are produced by astronomical objects with changing magnetic fields.
- Astronomers estimate the average FRB releases as much energy in a millisecond as the sun puts out in 3 days.
- The first FRB was discovered by Duncan Lorimer in 2007, and it is therefore commonly referred to as the **Lorimer Burst.**
- The exact origin and cause of the FRBs is still the subject of investigation; proposals for **their origin range from a rapidly rotating neutron star and a black hole, to extraterrestrial intelligence**.

What is the origin of the FRB detected in Milky Way Galaxy?

- The source of the FRB detected in the Milky Way is a very powerful magnetic neutron star, referred to as a magnetar, called SGR 1935+2154 or SGR 1935.
- It is **located in the constellation Vulpecula** and is estimated to be between 14,000-41,000 light-years away.
- The FRBs as X-ray bursts are lasting less than a second.

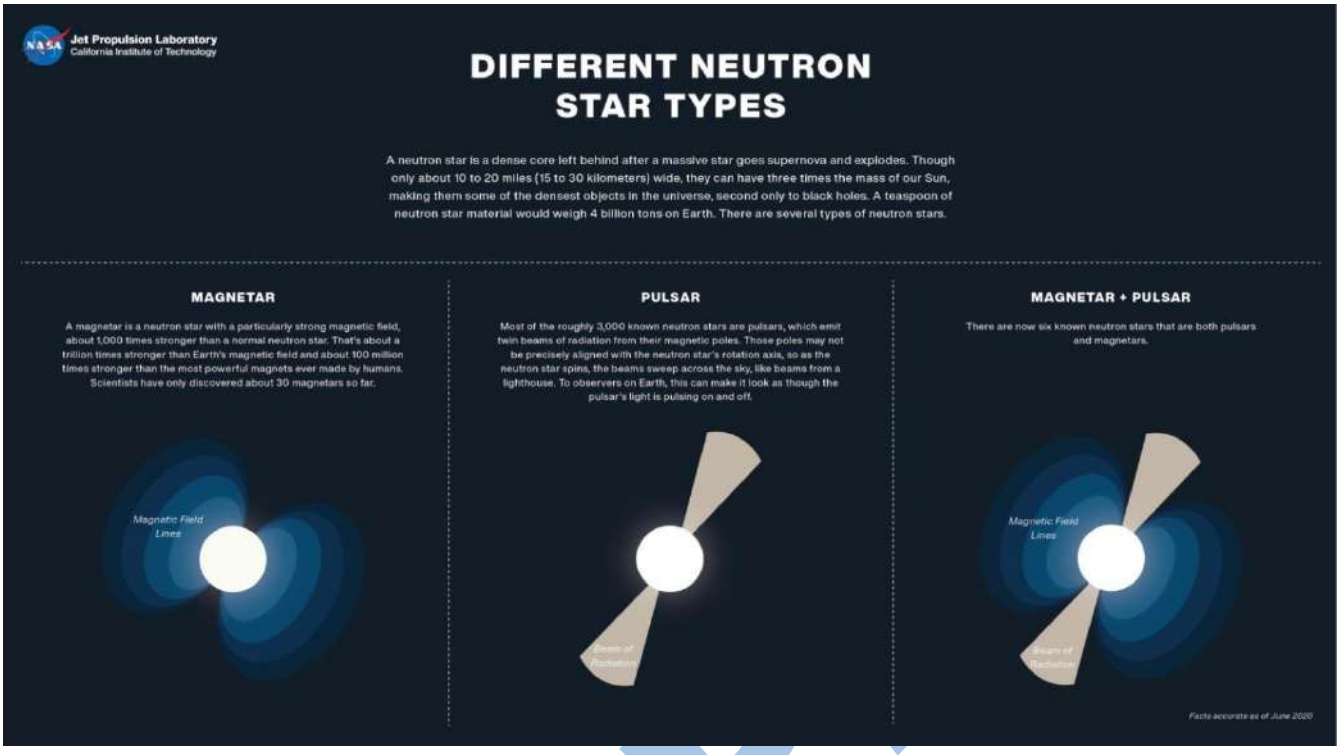




Magnetar

- A magnetar is a neutron star.
- Neutron stars are formed when the core of a massive star undergoes gravitational collapse when it reaches the end of its life.
- This results in the matter being so tightly packed that even a sugar-cube sized amount of material taken from such a star weighs more than 1 billion tons.

- Magnetars are a subclass of these neutrons that occasionally release flares with more energy in a fraction of a second than the Sun is capable of emitting in tens of thousands of years.



Ariel

Context

- The European Space Agency (ESA) has formally adopted Ariel.

About

- ARIEL stands for Atmospheric Remote-sensing Infrared Exoplanet Large-survey.
- Ariel, the explorer that will study the nature, formation and evolution of exoplanets.

Exoplanets

- Planets that lie outside of the Solar System and orbit around stars other than the Sun are called exoplanets or extrasolar planets.
- Exoplanets are not easy to detect since they are much less brighter than the stars they orbit and hence it is difficult to see them directly using telescopes.
- Only a handful of exoplanets have been found using telescopes and the rest have been detected using indirect methods.
- As of now the existence of more than 4,000 exoplanets is considered confirmed.
- There are thousands of other candidate exoplanets that need further observation.
- **Proxima Centauri b is the closest exoplanet** to Earth and is four light-years away.
- It inhabits the Goldilock Zone/"habitable zone" of its star, which means that it could possibly have liquid water on its surface.

Significance of ARIEL

- Ariel, which will be launched in 2029, will perform a large-scale survey of over a thousand exoplanets over a period of four years.
- Ariel is the **first mission of its kind dedicated to measuring the chemical composition and thermal structures of hundreds of exoplanets.**
- Further, Ariel will help to answer one of the key questions of ESA's Cosmic Vision Plan, which is, **"What are the conditions for planet formation and the emergence of life?**

Thirty Meter Telescope

Context

- 2020 Physics Nobel Laureate Prof. Andrea Ghez have worked closely with Indian astronomers on the design of Thirty Meter Telescope (TMT) project.

About

- The Thirty Meter Telescope (TMT) is a proposed extremely large in Mauna Kea on the island of Hawaii.
- "Thirty Metre" refers to the the 30-metre diameter of the mirror, with 492 segments of glass pieced together.
- This makes it **three times as wide as the world's largest existing visible-light telescope.**
- The larger the mirror, the more light a telescope can collect, which means, in turn, that it can "see" farther, fainter objects.
- It would be more than **200 times more sensitive than current telescopes,** and would be able to resolve objects 12 times better than the Hubble Space Telescope.

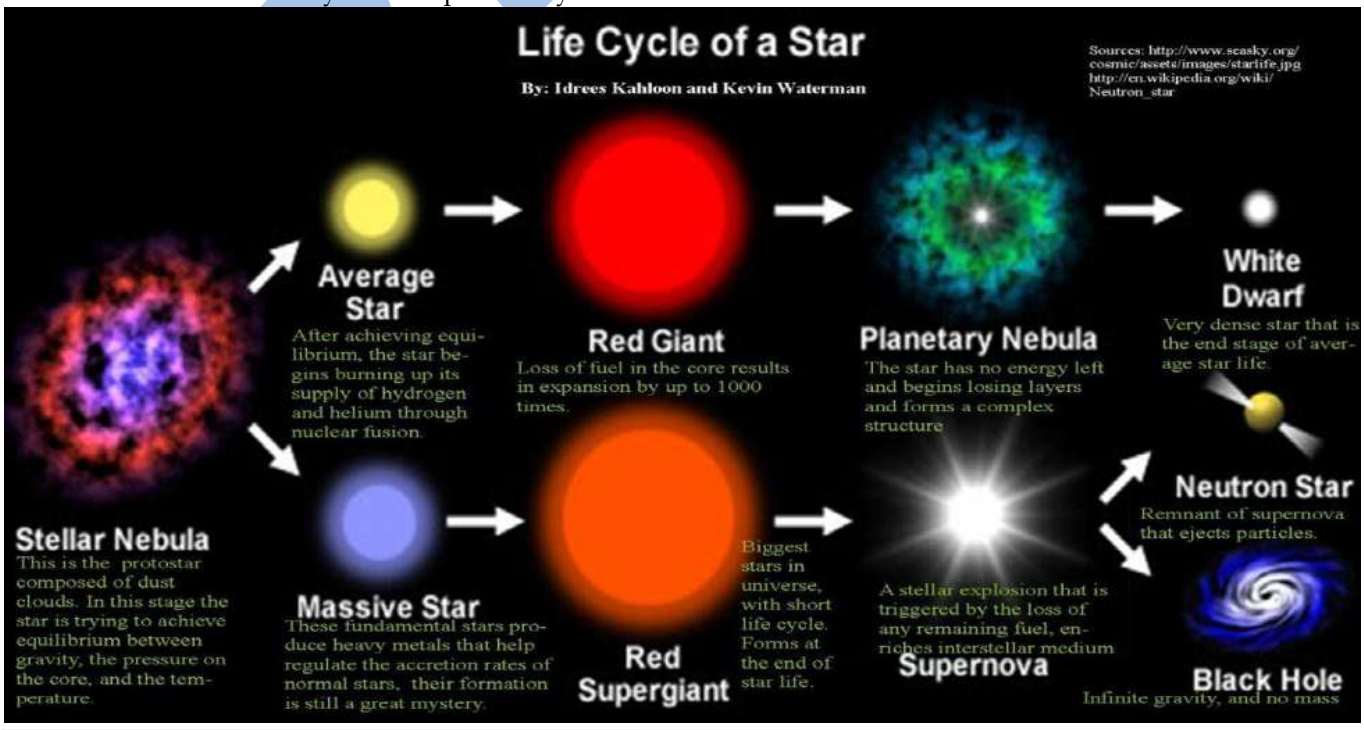
Uses

- Study of exoplanets,
- Whether their atmospheres contain water vapour or methane — the signatures of possible life.
- The study of black holes is another objective.
- The galaxy next to Milky Way is 100 times farther away. The Thirty Metre Telescope will help bring them galaxies closer.

M Dwarf Star

Context

- Scientists have established some empirical relationships for finding the fundamental parameters of M dwarf stars that could identify them as potentially habitable.



What are M Dwarfs?

- M dwarfs or Red Dwarfs are the tiniest of the stars that have masses ranging from about 8 percent to about 50 percent of the Sun's mass.
- A red dwarf is the smallest and coolest kind of star.
- More than 70% of all stars in our Galaxy are M dwarfs dominating the stellar populations by number.
- Proxima Centauri, the nearest star to the Sun, is a red dwarf.
- While stars like the Sun have a lifetime of about 10 billion years, even the oldest red dwarf stars have not yet exhausted their internal supplies of hydrogen.
- In a nutshell, the characteristics of a red dwarf star are**: low luminosity (say, not more than one tenth that of the sun), small mass (say, not more than three quarters that of the sun) and high density (perhaps 30–100 times the density of the sun).**

Do you know?

- Red dwarfs will not pass through a red giant phase in their evolution. Because convection occurs through the entire star, hydrogen is constantly recirculated from the outer regions to the core.
- Stars like the Sun are not completely convective and thus burn only the 10 percent of their hydrogen that is located in their cores. When that hydrogen is exhausted, such stars will expand enormously as they start to burn hydrogen on a shell surrounding their helium cores.
- Red dwarfs, however, because of convection, are completely efficient and will burn their entire supply of hydrogen. They will then become hotter and smaller, turning into blue dwarfs and finally ending their lives as white dwarfs.

Red Dwarfs and Habitable planets

- For long, scientists have considered them unlikely host of habitable planets.
- As per new evidences M dwarfs are becoming attractive hosts of potentially habitable planets due to their proximity, small size, and low mass.
- Because of its low luminosity, a red dwarf's Goldilock Zone/ habitable zone --- that is the region near a star where liquid water could be found on a planet's surface is very close to the Red Dwarf star.

Sentinel-6 Satellite

What is in news?

- Recently, The Copernicus Sentinel-6 Michael Freilich satellite, designed to monitor oceans, was launched from California aboard a SpaceX Falcon 9 rocket.
- It has been developed jointly by the European Space Agency (ESA), NASA, European Organisation for the Exploitation of Meteorological Satellites (Eumetsat), the USA's National Oceanic and Atmospheric Administration (NOAA) and the EU.

Aim

- The mission, called the **Jason Continuity of Service (Jason-CS) mission,** is designed to measure the height of the ocean, which is a key component in understanding how the Earth's climate is changing.

Significance

- The satellite will ensure the continuity of sea-level observations into the fourth decade and will provide measurements of global sea-level rise.
- It will also measure water vapour along this path and find its position using GPS and ground-based lasers.
- Further, the data it collects will support operational oceanography, by providing improved forecasts of ocean currents, wind and wave conditions.
- This data will allow improvements in both short-term forecasting for weather predictions in the
  - ✓ two-to-four-week range (hurricane intensity predictions), and
  - ✓ long-term forecasting, for instance for seasonal conditions like El Niño and La Niña

Note: Other satellites that have been launched since 1992 to track changes in the oceans on a global scale include the TOPEX/Poseidon, Jason-1 and OSTN/Jason-2, among others.

Chang'e-5 Lunar Probe

Context

- China has successfully launched the Chang'e-5 lunar probe.

About

- The spacecraft was launched by a Long March-5 rocket.
- This is China's first sample return mission.
- The rocket, weighing over eight tons, is comprised of four parts: an orbiter, a returner, an ascender and a lander.
- The lander will collect moon samples and place them in a vessel aboard the ascender, which will dock with the orbiter and returner in orbiting the moon.

IRNSS

Context

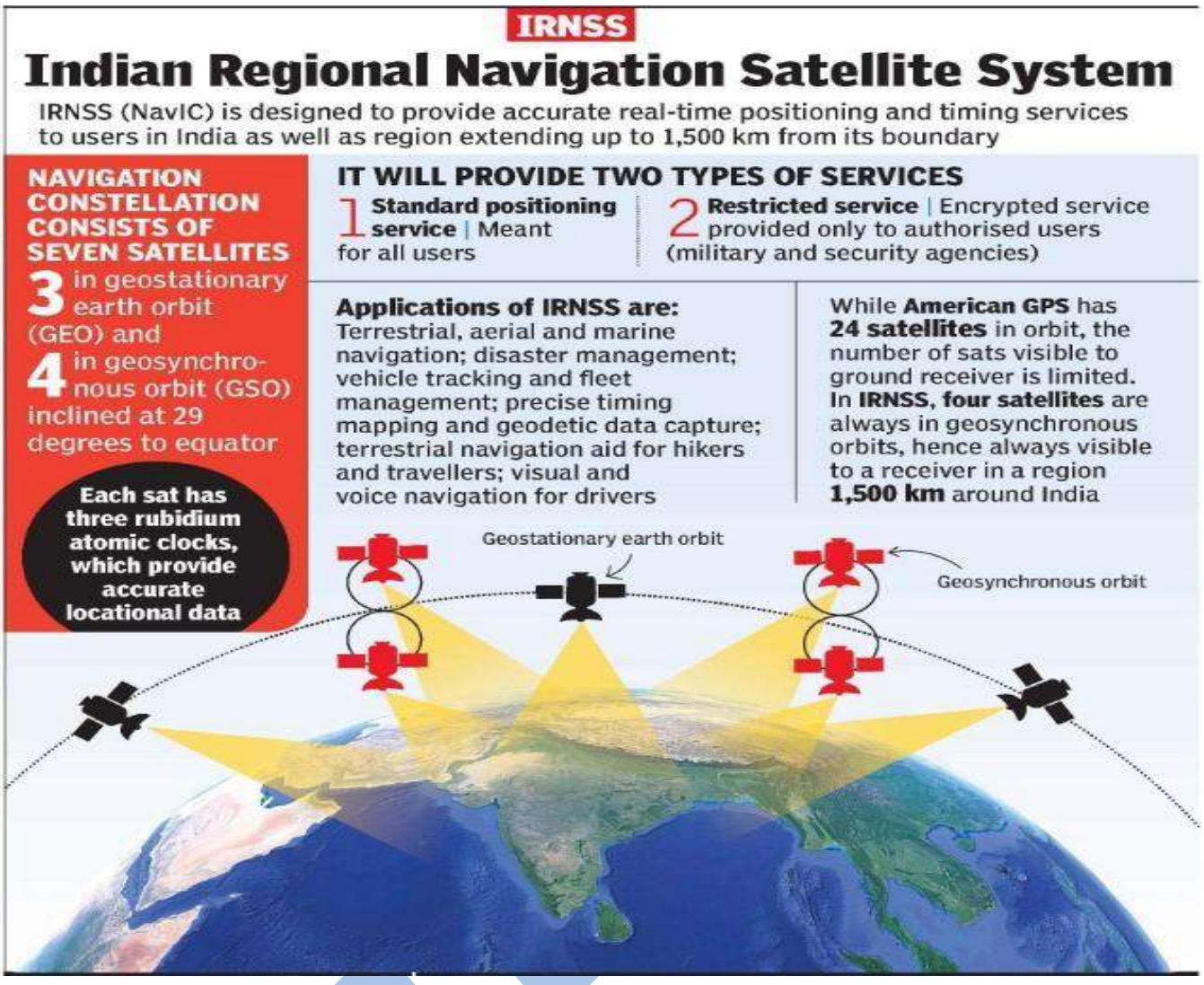
- The Indian Regional Navigation Satellite System (IRNSS) has been accepted as a component of the World Wide Radio Navigation System (WWRNS) for operation in the Indian Ocean Region by the International Maritime Organization (IMO).

Benefits of being WWRNS's component

- This will enable merchant vessels to use IRNSS for obtaining position information similar to GPS and GLONASS to assist in the navigation of ships in ocean waters within the area covered by 50°N latitude, 55°E longitude, 5°S latitude and 110°E longitude (approximately up to 1500 km from Indian boundary).

Navigation Systems Around The World

Navigation Systems	Country	Operator	Type	Coverage
Global Positioning System (GPS)	United States	Air Force Space Command (AFSPC)	Military, civilian	Global
GLONASS	Russia	Russian Aerospace Defense Forces, VKO	Military	Global
BeiDou Navigation Satellite System (BDS)	China	China National Space Administration (CNSA)	Military, commercial	Global Operational (regionally)
Indian Regional Navigation Satellite System, IRNSS (Operational by 2016)	India	Indian Space Research Organisation (ISRO)	Military, civilian	Regional
Galileo (In development)	European Union	GSA, ESA	Civilian, commercial	Global
Quasi-Zenith Satellite System (QZSS) (In development)	Japan	Japan Aerospace eXploration Agency (JAXA)	Civilian	Regional



Hayabusa2

Context

- Hayabusa2 returned the samples to Earth on 5 December 2020.

About

- Hayabusa2 is an asteroid sample-return mission operated by the Japanese state space agency JAXA.
- It is a successor to the Hayabusa mission, which returned asteroid samples for the first time in June 2010.
- Hayabusa2 was launched on 3 December 2014 to reach near-Earth asteroid 162173 Ryugu.
- It surveyed the asteroid for a year and a half and took samples.
- Its mission has now been extended through at least 2031, when it will rendezvous with the 1998 KY26 asteroid.

Arecibo Telescope

Context

- Puerto Rico's massive Arecibo telescope, famous for its stellar contributions to astronomy, recently collapsed.

About Arecibo telescope

- Completed in 1963, it was the world's largest single-aperture telescope for 53 years, surpassed in July 2016 by the Five-hundred-meter Aperture Spherical Telescope (FAST) in China.

Contribution

- In 1992, it was the first observatory to spot planets outside Earth's solar system.

ASKAP

Context

- A powerful new radio telescope- Australian Square Kilometre Array Pathfinder (ASKAP) has mapped vast areas of the universe in in just 300 hours, revealing about three million new galaxies.
- Comparable surveys of the sky have taken as long as 10 years.

About

- ASKAP is located in the Mid West region of Western Australia.
- The ASKAP telescope makes images of radio signals from the sky, allowing astronomers to view the Universe at wavelengths that our eyes cannot see.
- It is a type of radio telescope known as an 'interferometer'.
- This means it uses many antennas acting together as one large telescope.

Areas of study

ASKAP is intended to study the following topics:

- Galaxy formation and gas evolution in the nearby Universe through extragalactic HI surveys
- Evolution, formation and population of galaxies across cosmic time via high resolution, continuum surveys
- Characterisation of the radio transient sky through detection and monitoring (including VLBI) of transient and variable sources, and
- Evolution of magnetic fields in galaxies over cosmic time through polarisation surveys.
- In the past decades, it also played a large role in the search for extraterrestrial intelligence, including broadcasting the first terrestrial message to outer space.
- It has also observed the spinning stars known as pulsars that led to the 1993 Nobel Prize in Physics.
- The telescope has been used for radar assessments of near-Earth asteroids, to measure their threat to the planet.

Tau Bootes

Context

- An international team of scientists has collected the first possible radio signal from a planet beyond our solar system, emanating from an exoplanet system about 51 light-years away.

About

- Using the Low Frequency Array (LOFAR), a radio telescope in the Netherlands, the researchers uncovered emission bursts from the Tau Bootes star-system hosting a so-called hot Jupiter, a gaseous giant planet that is very close to its own sun.

Tau Boötis

- Tau Boötis is an F-type main-sequence star approximately 51 light-years awayin the constellation of Boötes.
- It is a binary star system, with the secondary star being a red dwarf.

The "Great Conjunction"

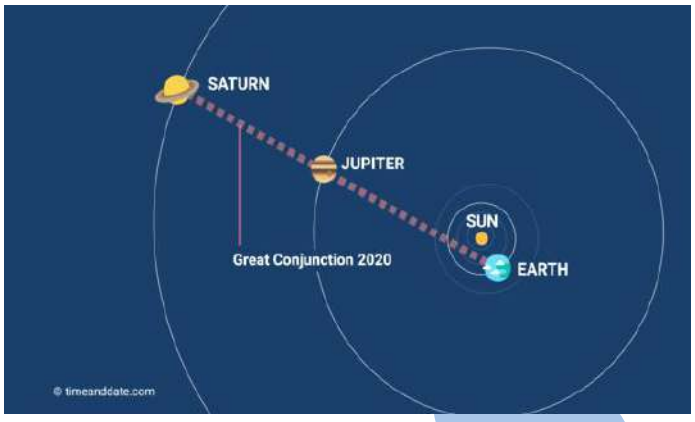
Context

- On December 21, almost all the viewers across the world could see the "great conjunction" is popularly referred to as the "Christmas Star."

What is a Great Conjunction?

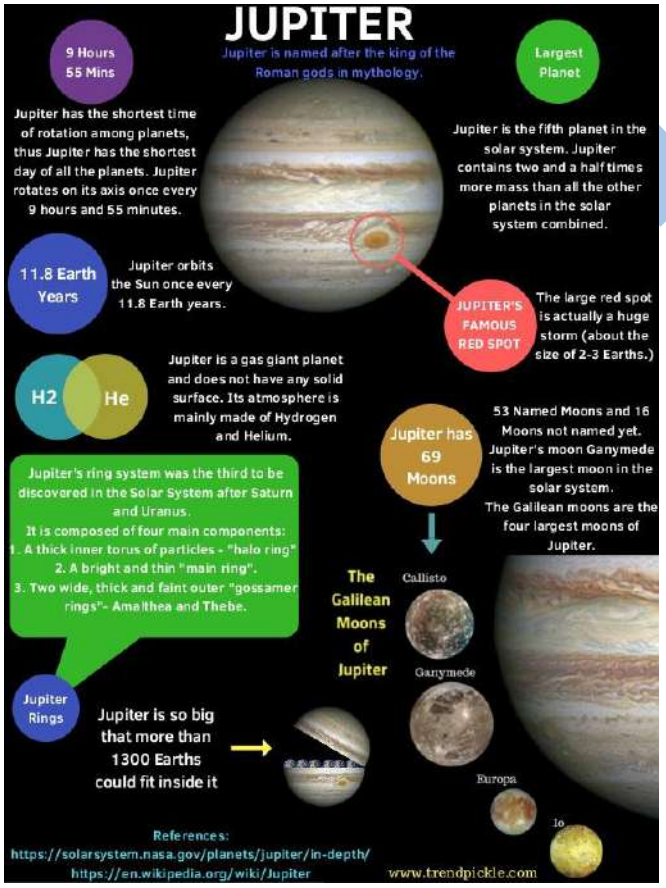
- A pairing between any pair of planets is a conjunction.
- Jupiter and Saturn are the two largest planets visible to the naked eye, hence the expression 'Great Conjunction'.

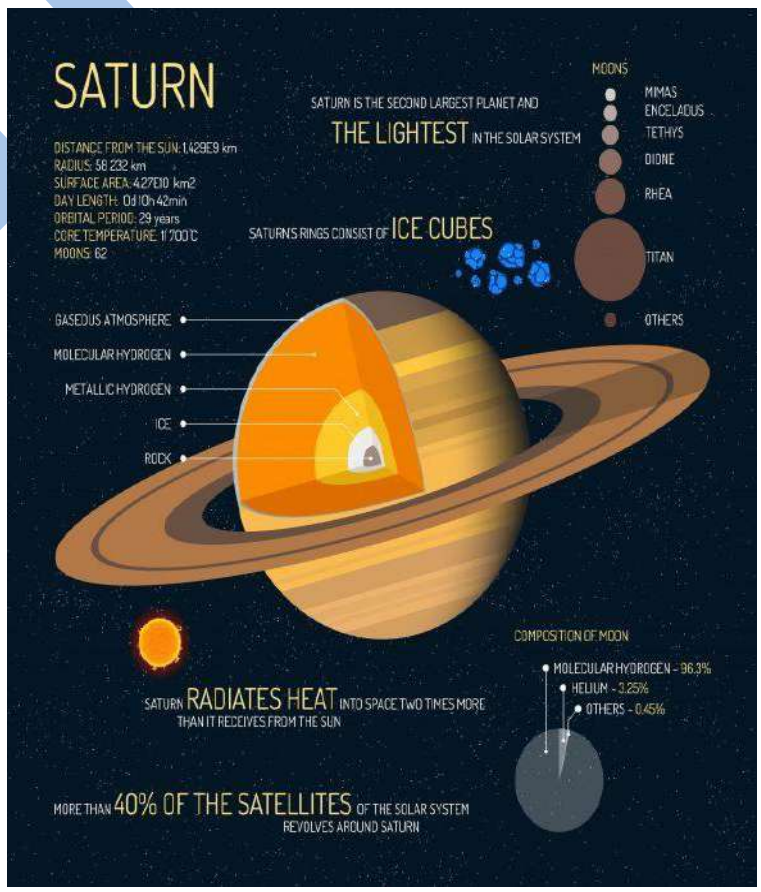
- Great conjunctions occur approximately every 20 years when Jupiter "overtakes" Saturn in its orbit.
- Jupiter orbits the Sun once in 12 years, and Saturn once in 30.
- In 60 more years i.e. in 2080, the two planets will align at roughly the same place where stargazers watched them on December 21, 2020.
- In these 60 years, Jupiter will have orbited the Sun five times, while Saturn will have done so twice.
- The spacing between the planets varies from conjunction to conjunction with most events being 0.5 to 1.3 degrees (30 to 78 arcminutes, or 1 to 2.5 times the width of a full moon).



Last Conjunction

- The last Great Conjunction happened in 1623.
- Galileo had discovered four of Jupiter's moons with his telescope a few years previously.
- From an Indian context, Jahangir was ruling the Mughal Empire at the time.
- The last time the two planets were close enough to be viewed in the night sky was in 1226. This was just a year before the death of the Mongol ruler Genghis Khan.





Giant Metrewave Radio Telescope

Context

- The Giant Metrewave Radio Telescope (GMRT) has been selected as a 'Milestone' facility by the U.S.-based Institute of Electrical and Electronics Engineers (IEEE).

About GMRT

- The **Giant Metrewave Radio Telescope (GMRT) Observatory**, located near Pune is an array of thirty fully steerable parabolic radio telescopes of 45 metre diameter, observing at metre wavelengths.
- It is operated by the National Centre for Radio Astrophysics (NCRA), a part of the Tata Institute of Fundamental Research, Mumbai.

Aim of GMRT

- To search for radiation from primordial neutral hydrogen clouds in order to determine the date of galaxy formation in the universe.
- Astronomers from all over the world regularly use this telescope to observe many different astronomical objects such as HII regions, galaxies, pulsars, supernovae, and Sun and solar winds.
- In August 2018, the most distant galaxy ever known, located at a distance of 12 billion light years, was discovered by GMRT.
- In February 2020, it helped in the observation of the biggest explosion in the history of the universe, the **Ophiuchus Supercluster explosion.**

A radio telescope is a specialized antenna and radio receiver used to detect radio waves from astronomical radio sources in the sky. Radio telescopes are the main observing instrument which studies the radio frequency portion of the electromagnetic spectrum emitted by astronomical objects. **Note:** Optical telescopes are the main observing instrument used in traditional optical astronomy which studies the light wave portion of the spectrum coming from astronomical objects. Unlike optical telescopes, **radio telescopes can be used in the daytime as well as at night**.

Mukundpura Meteorite

Context

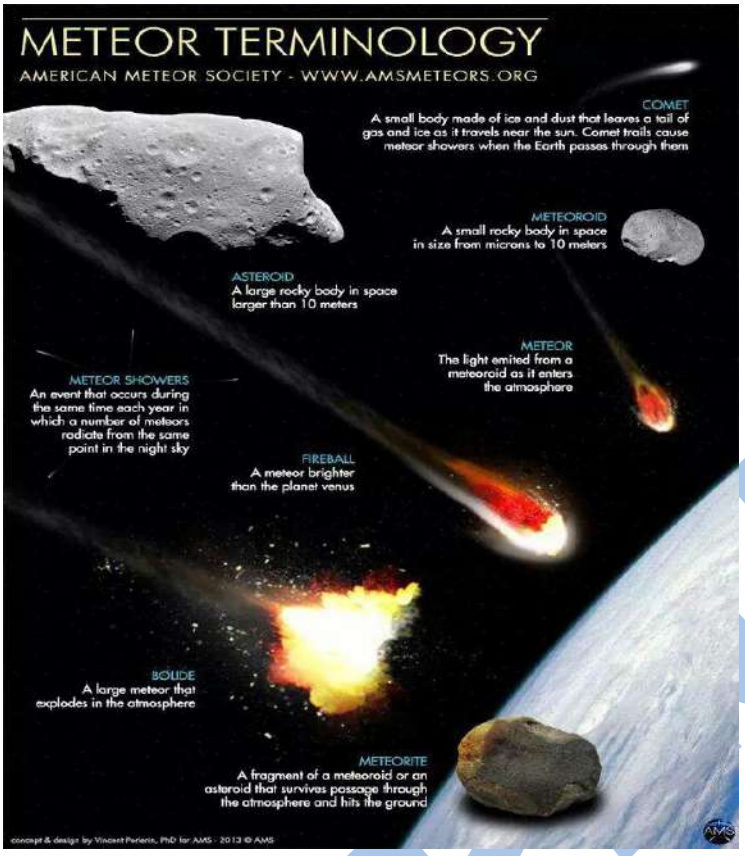
- An asteroid which has hit Mukundpura village near Jaipur in 2017 has been named after the same village and is under the study of Geological Survey of India, Kolkata.

Details

- The meteorite belongs to a very rare and primitive group of meteorites called CM group of carbonaceous chondrites.
- Note: An estimated 44 tonnes of meteoritic material hit the earth every day, but less than 5% of these belong to this group.
- Carbonaceous chondrite meteorites, unlike other meteorites, contain very primitive traces of carbon. And carbon forms the backbone of all life on earth.

Significance

- This meteorite could be carrying some of the most pristine primordial matter recovered from space as it is made up of materials which were formed during the early stages of the formation of the solar system.
- Its composition could be very close to that of Solar Nebula, from which the solar system is believed to have condensed.
- Hence it can shed light on formation and evolution of stars and provide information about the age, composition and evolution of the solar system
- A detailed analysis could provide clues about the origin of life as well.



Heliophysics Mission

Context

- NASA has approved two Heliophysics missions to explore the Sun and the system that drives space weather near Earth.

Details

- Together, NASA's contribution to the Extreme Ultraviolet High-Throughput Spectroscopic Telescope Epsilon Mission, or EUVST, and the Electrojet Zeeman Imaging Explorer, or EZIE, will help us understand the Sun and Earth as an interconnected system.

NASA's EZIE Mission

- The EZIE mission will study the atmosphere of the Earth and the electric currents in it, which link the aurora to the magnetosphere.
- The magnetosphere is a complex space weather system that responds to several factors, including solar activity.
- The levels of geomagnetic activity are commonly measured by the Auroral Electrojet (AE) index, even as scientists do not currently understand the details regarding the currents' structure.
- NASA has slated the mission for launch in June 2024.

JAXA's Solar-C EUVST Mission

- A solar telescope, the EUVST would be studying the solar wind released by the solar atmosphere.
- It will also study how this atmosphere drives solar material eruption.
- Studying them is important because they impact the space radiation environment throughout the solar system.
- The mission is aimed to be launched in 2026.

AstroSat

Context

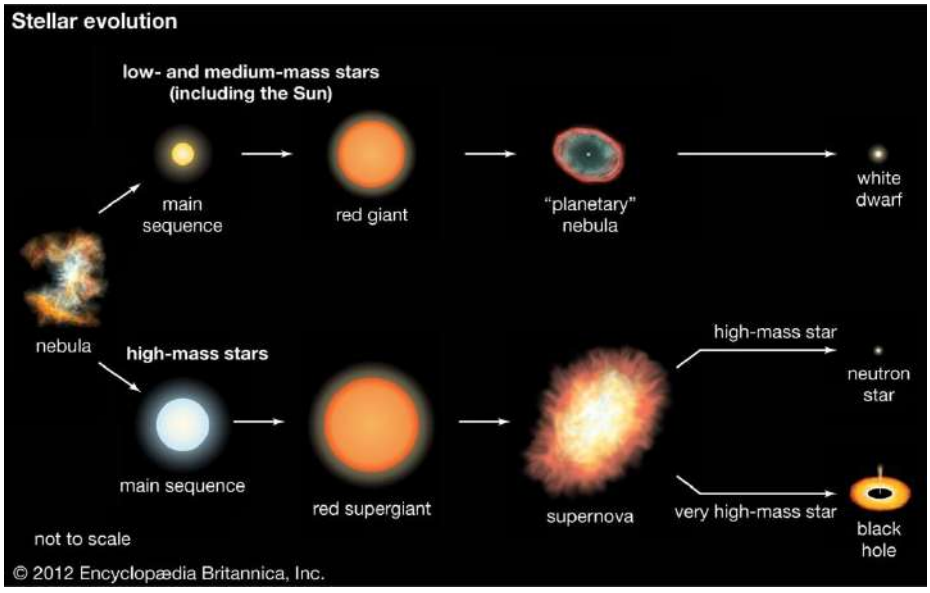
- Astronomers exploring the massive intriguing globular cluster in our Galaxy called NGC 2808 have spotted rare hot UV-bright stars in it using AstroSats Ultraviolet Imaging Telescope.

AstroSat

- AstroSat is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously.
- The payloads cover the energy bands of Ultraviolet (Near and Far), limited optical and X-ray regime (0.3 keV to 100keV).
- 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 scientific objectives of AstroSat mission are

- To understand high energy processes in binary star systems containing neutron stars and black holes;
- Estimate magnetic fields of neutron stars;
- Study star birth regions and high energy processes in star systems lying beyond our galaxy;
- Detect new briefly bright X-ray sources in the sky;
- Perform a limited deep field survey of the Universe in the Ultraviolet region.



Significance of the recent discovery

- Such UV-bright stars are speculated to be the reason for the ultraviolet radiation coming from old stellar

systems such as elliptical galaxies which are devoid of young blue stars.
- Hence, it is all the more important to observe more such stars to understand their properties.

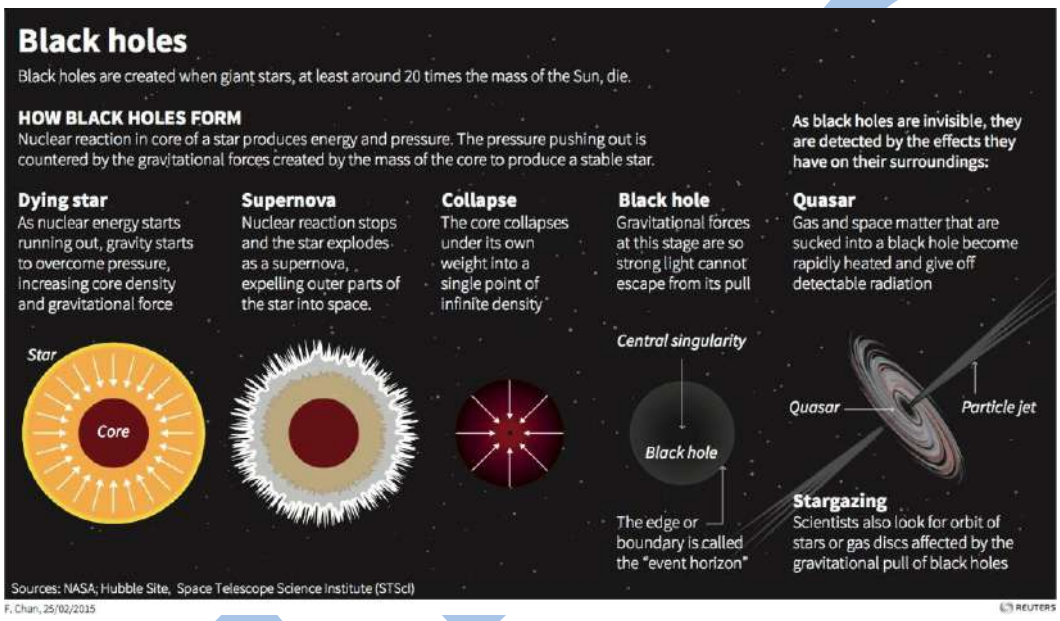
'Recoiling' Black Holes

Context

- Supermassive Black hole Abell 2261 has gone missing. Experts say the black hole have been ejected from centre of galaxy due to recoiling.

About

- When two black holes merge, they release what are known as gravitational waves– invisible ripples travelling at the speed of light, which squeeze and stretch anything in their path.
- As per the theory of gravitational waves, during such a merger, when the amount of waves generated in one direction is stronger than another, the new big black hole can be sent away from the centre of the galaxy into the opposite direction. This is known as a "recoiling" black hole.



Shukrayaan-1

Context

- The Indian Space Research Organisation (ISRO) has short-listed 20 space-based experiment proposals, including from France, for its proposed Venus orbiter mission 'Shukrayaan' to study the planet for more than four years.

Shukrayaan

- Shukrayaan-1 is a proposed orbiter to Venus by the Indian Space Research Organisation (ISRO) to study the surface and atmosphere of Venus. It will be launched by **GSLV Mk-II Rocket.**

Objectives

- Mapping the Venusian Surface at high spatial resolution of 30 to 40 m
- Understanding Cloud Dynamics
- Investigating Venusian Ionosphere
- Determining the structure and composition of the atmoshphere
- Determining the structure and stratigraphy of surface and sub surface features and volcanic hotspots.

IT & COMPUTER

5G Club

Context

- Recently, Britain said that it was pushing the U.S. to form a club of 10 nations that could develop its own 5G technology and reduce dependence on Huawei.

What is 5G?

- 5G is the 5th generation mobile network that is designed to connect virtually everyone and everything together including machines, objects, and devices.
- 5G is a backbone for IoT (Internet of Things)
  - ✓ IoT is the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Features

- Higher multi-GBPS peak data speeds,
- **Ultra low latency –** the time it takes for a cell phone (or other connected device) to make a request from a server and get a response.
- More reliability,
- Massive network capacity,
- Increased availability and a uniform user experience.
- It will be faster and able to handle more connected devices than the existing 4G LTE network.
- Will enable even more connected devices like smart toothbrushes and self-driving cars.

From 1G to 5G: a brief overview

Features	1G	2G	3G	4G	5G
Start/Devlopment	1970/1984	1980/1999	1990/2002	2000/2010	2010/2015
Technology	AMPS, NMT, TACS	GSM	WCDMA	LTE, WiMax	MIMO, mm Waves
Frequency	30 KHz	1.8 Ghz	1.6 - 2 GHz	2 - 8 GHz	3 - 30 Ghz
Bandwidth	2 kbps	14.4 - 64 kbps	2 Mbps	2000 Mbps to 1 Gbps	1 Gbps and higher
AccessSystem	FDMA	TDMA/CDMA	CDMA	CDMA	OFDM/BDMA
Core Network	PSTN	PSTN	Packet Network	Internet	Internet

Digital Currency Electronic Payment (DCEP) Project

- China is set to launch the world's first digital currency.
- It is not a new currency but a digitised version of the existing Chinese currency Yuan, which will be disbursed via a digital wallet.
- The central bank digital currency or digital Yuan, is officially referred to as the Digital Currency/Electronic Payment (DC/EP) Project.

Lisa

- Premature babies have the problem of less mature lungs, resulting in difficulty in breathing at the time of birth.
- **Less invasive surfactant administration (LISA)** is a new medical technique for respiratory management and ventilation. It is an alternative to mechanical ventilation that causes damage to the preterm lungs of newborns.

Satyabhama Portal

- Minister for Coal, Mines and Parliamentary Affairs has recently announced the launch of **"SATYABHAMA"** portal with an **aim to promote research and development in the mining and minerals sector.**
- It will allow **online submission of project proposals along with monitoring of the same and utilization of funds.**
- The portal has been designed, developed and implemented by National Informatics Centre (NIC), Mines Informatics Division.
- The portal is integrated with **NGO Darpan Portal of NITI Aayog.**

Captain Arjun

- Indian Railways has launched an **Artificial Intelligence enabled robot** called **'Captain ARJUN (Always be Responsible and Just Use to be Nice)** ' to intensify the screening and surveillance of railway passengers and railway staff.
- The robot is launched to screen passengers while they board trains and keep a watch on anti-social elements.

CogX 2020

- CogX is one of the **world's largest events on AI, held annually in London** with participants in attendance from the highest levels of business, government, industry, and research.
- The Cogx Awards are given out to the best-of-the-best in AI and emerging technologies across the world.
- AI enabled MyGov Corona Helpdesk bagged two awards IN cOGx 2020 under categories (1) "Best Innovation for Covid-19 – Society" and (2) "People's Choice Covid-19 Overall Winner".
- MyGov is the world's largest citizen engagement platform, which facilitates two-ways communication between the Government and Citizen and facilitates participatory governance in India, the world's largest democracy.

Frontier Technologies Cloud Innovation Center

Context

- The National Institution for Transforming India (NITI Aayog) has established a Frontier Technologies Cloud Innovation Center (CIC) with Amazon Web Services (AWS).
- It has such centres across countries like Australia, Bahrain, Canada, France, Germany, South Korea, and the US, including one in partnership with the University of British Columbia.

Aim

- To help address societal challenges through digital innovation.

Details

- The CIC addresses a core mission to identify and deploy leading edge technologies to drive continuous innovation in delivering citizen services.
- The centre will work to identify and prioritize projects as well as collaborate with local leaders, including subject matter experts at the state and district level, to solve critical societal challenges.
- Local enterprises, startups, researchers, and universities in India will experiment and build prototypes on AWS Cloud, and contribute along with the global CIC community dedicated to accelerating societal innovation.

RAISE 2020

Context

- Recently, Global Virtual Summit on Artificial Intelligence (AI), RAISE 2020- **'Responsible AI for Social Empowerment 2020, was held.**

About RAISE 2020:

- RAISE 2020 is a first-of-its-kind global meeting of minds on Artificial Intelligence.
- It is to drive India's vision and roadmap for social transformation, inclusion and empowerment through responsible AI.
- The event witnessed robust participation from global industry leaders, key opinion makers, Government representatives and academia.

Organizers

- The **MEITY and NITI Aayog** are organising the Mega Virtual Summit.

Aim and Objective

- To kick-start discussion on the creation of robust AI-powered public infrastructure that benefits all, not just in India but across the world.
- India, one of the founding members of the Global Partnership on Artificial Intelligence, aims to implement AI-based solutions around the world so that these lead to widespread social empowerment and prosperity.
- **#AIForAll** is at the core of India's AI strategy and the focus is to build responsible AI for social empowerment, transformation and inclusion.

 Artificial Intelligence	 Machine Learning	 Deep Learning
Artificial intelligence originated around 1950s.	Machine learning originated around 1960s.	Deep learning originated around 1970s.
AI represents simulated intelligence in machines.	Machine Learning is the practice of getting machines to make decisions without being programmed.	Deep Learning is the process of using Artificial Neural Networks to solve complex problems.
AI is a subset of Data Science.	Machine learning is a subset of AI & Data Science	Deep learning is a subset of Machine learning, AI & Data Science.
Aim is to build machines which are capable of thinking like humans.	Aim is to make machines learn through data so that they can solve problems.	Aim is to build neural networks that automatically discover patterns for feature detection.

Future prospects & Conclusion

- India is developing AI-based solutions for social empowerment across spheres like healthcare, education, finance, agriculture and governance.
- India can become the AI laboratory of the world, delivering intuitive solutions to a wide range of societal issues.
- From agriculture to fin-tech and healthcare to infrastructure, India is at the cusp of rapid development in artificial intelligence.

National Supercomputing Mission (NSM)

Context

- The third part of the **National Supercomputing Mission (NSM)** wills kickstart in January- Department of Science and Technology.

About NSM

- It is a first of its kind Mission to boost the country's computing power.
- The mission was set up to provide the country with supercomputing infrastructure to meet the increasing computational demands of academia, researchers, MSMEs, and startups by creating the capability design, manufacturing, of supercomputers indigenously in India.

Agencies involved

- The National Super Computing Mission is steered jointly by the Ministry of Electronics and IT (MeitY) and Department of Science and Technology (DST).

- It is being implemented by the Centre for Development of Advanced Computing (C-DAC), Pune and the Indian Institute of Science (IISc), Bengaluru.

Target

- The target of the mission was set to establish a network of supercomputers ranging from a few Tera Flops (TF) to Hundreds of Tera Flops (TF).
- Plus, three systems with greater than or equal to 3 Peta Flops (PF) in academic and research institutions of National importance across the country by 2022.

Supercomupters

- Supercomputer, are a class of extremely powerful computers.
- They refer to the fastest high-performance systems available at any given time.
- Such computers have been used primarily for scientific and engineering work requiring exceedingly high-speed computations.
- Common applications for supercomputers include testing mathematical models for complex physical phenomena or designs, such as climate and weather, evolution of the cosmos, nuclear weapons and reactors, new chemical compounds (especially for pharmaceutical purposes), and cryptology.

Supercomputers in India

- As of June 2020, India is ranked 23rd in the world in terms of number of supercomputers.
- Cray XC40-based Pratyush is the fastest supercomputer in India. Mihir ranks 67 in the world.
- The first supercomputer of India assembled indigenously, called Param Shivay, was installed in IIT (BHU).
- 11 new systems are likely to be set up soon. By 2022, the government aims to install 73 indigenous supercomputers across the country.
- Pratyush and Mihir are the fastest supercomputer in India with a maximum speed of 6.8 PetaFlops
- The world's fastest supercomputer today, Titan, is capable of 20 petaflops.

Param Siddhi-Ai And Mihir

Context

- Two supercomputers from India — PARAM Siddhi-AI and Mihir — have made it to the TOP500 list of the world's most powerful supercomputers.

PARAM Siddhi-AI

- PARAM Siddhi-AI has an Rpeak capacity of 5.267 Petaflops.
- The system, jointly built by the Department of Science and Technology and Ministry of Electronics and IT under the National Supercomputing Mission.
- This Artificial Intelligence-based system's wide applications including education, space, agriculture, defence and national security, computational chemistry and astrophysics, drug design and preventive healthcare systems, as well as flood forecasting in major cities like Delhi, Mumbai, Chennai, Patna and Guwahati.

Mihir

- 'Mihir' is a 2.8 Petaflop supercomputer.
- It has helped improve India's forecasting skills.
- A petaflop is one thousand trillion, or one quadrillion, operations per second, and represents an extremely fast computing speed for a single machine. "Flop" stands for floating-point operations per second.

DigiBoxx

Context

- DigiBoxx, a Made-in-India digital asset management and storage platform has been launched in India.

About

- The service is priced competitively, as the company is offering free 20GB cloud storage and 100GB space per month to those who pay just Rs 30.

- The plans offer features such as integration with Gmail, real-time multi-user file collaboration, advanced real-time collaboration, web document previews and automated account backups.
- The service supports smart tags and users will be able to find any file within seconds.
- One can share any document, photo or videos from the platform without downloading them again on their device.
- DigiBoxx is currently available for Android users only.
- The service has connection encryption and all the files stored on its platform are encrypted at a database level.

Significance

- The platform is the first of its kind 'Make in India, Store in India' digital asset management SaaS product that is in line with the country's national security and data localisation priorities.
- This cloud storage and file sharing service will give a boost to Prime Minister Narendra Modi's vision of 'Atmanirbhar Bharat'.

Fully-Automated Driverless Train

Context

- Prime Minister Narendra Modi recently flagged off the country's first ever fully-automated driverless train service on the Magenta Line of the Delhi Metro.

About

- The service will be available on Delhi Metro's 38-km long Magenta Line which connects Janakpuri West in West Delhi to Botanical Garden in Noida.
- The train will be fully automated, eliminating the possibility of human error.
- The driverless metro trains will switch to what is called the Driverless Train Operation (DTO) mode.

Project Loon

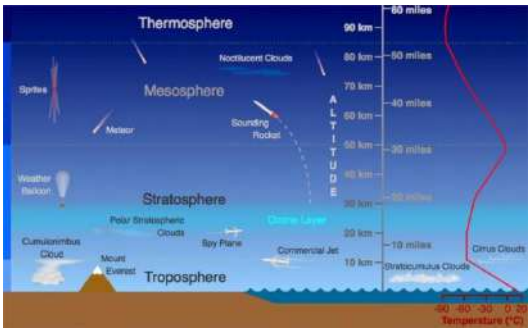
Context

- Google's Project Loon which comprises of helium-filled balloons set a new record by staying in the stratosphere for 312 days, which means almost a year.

What is Loon?

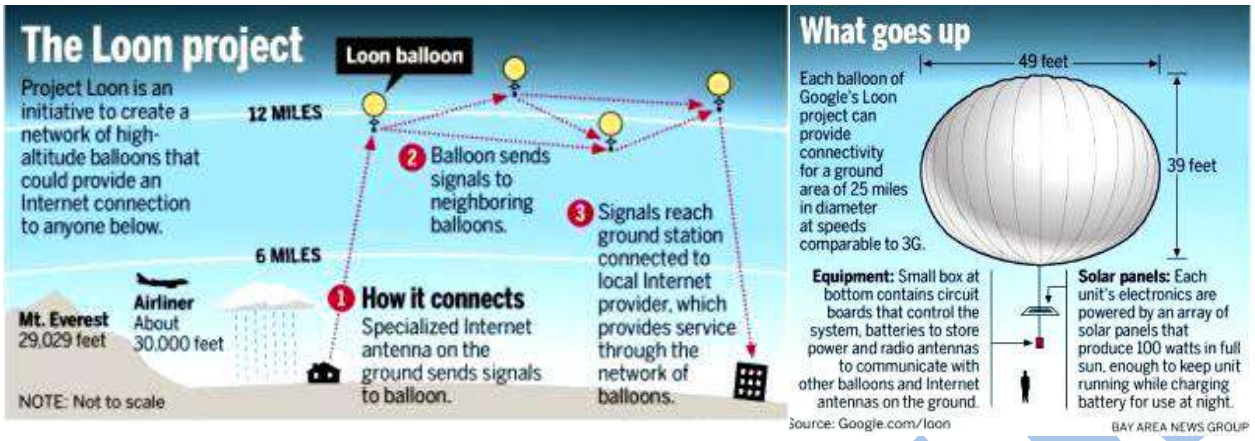
- Loons are high altitude balloons that provide internet to remote areas.
- It is the third layer of connectivity ecosystem to help places with minimum reach receives connectivity with the rest of the world.
- These balloons that reach the stratosphere and provide internet connections to regions that were once thought unservable.

About Loon



- These are manufactured by Alphabet, Google's parent company.
- These tennis courts sized balloons reach up to 20 km above the Earth into the stratosphere. It's floating and direction is based on the wind movement.
- They are powered by solar panels (so no electricity is used) and are controlled by software on the ground.
- The balloons beam internet down to the earth to provide connectivity to remotest of areas
- It delivers 4G LTE and 5G connectivity and is capable of covering 200 times more areas than land cell towers and provides internet connection to approximately a diameter of 40 kms in ground areas

- As of now, it is tested and launched in countries like Sri Lanka, USA, Brazil, New Zealand and now in India too.



Quantum Computing

Context

- Chinese scientists claim to have built a quantum computer that is able to perform certain computations nearly 100 trillion times faster than the world's most advanced supercomputer.

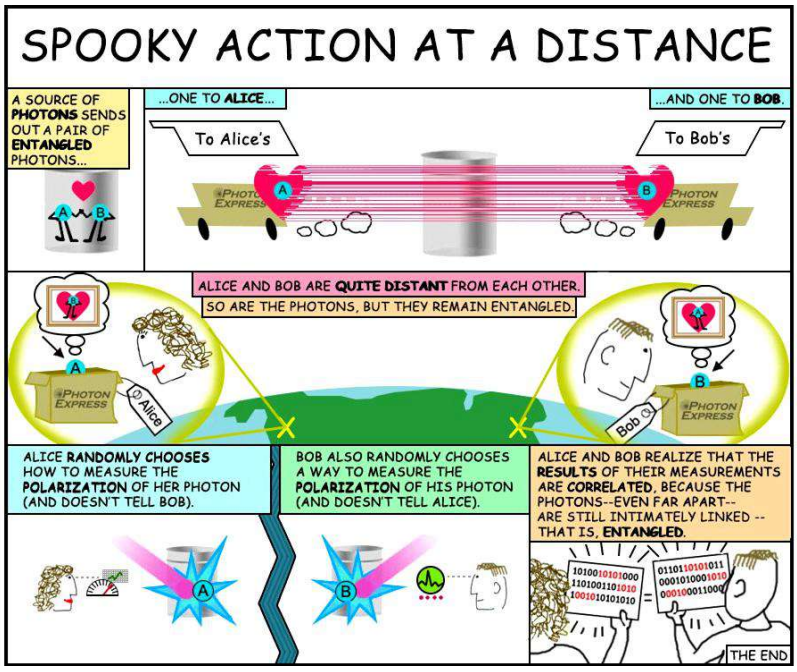
Do you know?

- Kenya has already received the first commercial deployment of Loon this year. It would initially provide a 4G LTE network connection spread across 31,000-square-mile of central and western Kenya, including Nairobi.
- Soon, Loon would begin its journey in the Amazon with the collaborative efforts of Telefónica.
- The balloons have previously been used only in emergency situations. These were used successfully in Puerto Rico in 2017 after Hurricane Maria destroyed all the land cell towers.
- By allowing phone companies to extend their coverage wherever needed, Loons would be able to offer countries with a cheaper option than laying cables or building cell towers.
- This could be effective in third world countries like Africa, where only 28 per cent of the continent's 1.3 billion people were registered to be using the internet in 2019.

What is quantum computing?

Let's start with the basics.

- An ordinary computer chip uses bits. These are like tiny switches that can either be in the off position – represented by a zero – or in the on position – represented by a one.
- Every app we use, website we visit and photograph we take is ultimately made up of millions of these bits in some combination of ones and zeroes.
- This works great for most things, but it doesn't reflect the way the universe actually works.
- In nature, things aren't just on or off. They're uncertain. And even our best supercomputers aren't very good at dealing with uncertainty. That's a problem.
- So, for scientists to accurately simulate



any of those things, they need a better way of making calculations that can handle uncertainty. Enters - Quantum Computers.

Quantum Entanglement

- Quantum entanglement is a physical phenomenon that occurs when a pair or group of particles is generated, interact, or share spatial proximity in a way such that the quantum state of each particle of the pair or group cannot be described independently of the state of the others, including when the particles are separated by a large distance.
- Measurements of physical properties such as position, momentum, spin, and polarization performed on entangled particles can, in some cases, be found to be perfectly correlated.
- Quantum entanglement has direct application in Quantum Computing.

Classical Computer	Quantum Computer
It is large scale integrated multi-purpose computer(CPU)	It is high speed parallel computer based on quantum mechanics.
Information storage is bit based on voltage/charge etc.	Information storage is Quantum bit based on direction of an electron spin.
Computer runs on bits that have a value of either 0 or 1.	Quantum bits or "qubits" are similar in that for practical purposes we read them as a value of 0 or 1, but they can also hold much more complex information, or even be negative values. Before we read their value they are in an indeterminate state called superposition and can be influenced by other qubits(this is called entanglement). Qubits can be
Discrete number of possible states: 0 or 1. Deterministic: repeated computations on the same input will lead to the same output.	Infinite (continuous) number of possible states. Probabilistic: measurements on superposed states yield probabilistic answers (our confidence in these answers builds up through repeated computations) then reduced to 0 or 1.
Information processing is carried out by logic gates e.g. NOT, AND, OR etc in sequential basis	Information processing is carried out by Quantum logic gates in parallel basis
Only specifically defined results are available, inherently limited by an algorithm's design	Quantum answers (which are in quantity called amplitudes) are probabilistic, meaning that because of superposition and entanglement multiple possible answers are considered in a given computation.
Circuit behaviour is governed by classical physics.	Circuit behaviour is governed explicitly by quantum mechanics.
Operations are defined by Boolean Algebra.	Operations are defined by linear algebra over Hilbert Space and can be represented by unitary matrices with complex elements.
No restrictions exist on copying or measuring signals	Severe restrictions exist on copying and measuring signals
Circuits are easily implemented in fast, scalable and macroscopic technologies such as CMOS.	Circuits must use microscopic technologies that are slow, fragile and not yet scalable e.g. NMR (Nuclear magnetic resonance).

ARTPARK

Context

- An AI & Robotics Technologies Park (ARTPARK) set up in Bengaluru will promote technology innovations in AI (Artificial Intelligence) & Robotics leading to societal impact by executing ambitious mission mode R&D projects in healthcare, education, mobility, infrastructure, agriculture, retail and cyber-security focusing on problems unique to India.

About ARTPARK

- ARTPARK, is a unique not-for-profit foundation established by Indian Institute of Science (IISc), Bengaluru with support from AI Foundry in a public-private model.

Function

- ARTPARK will develop AI & Robotics facilities to support technology innovations as well as capacity building through advanced skills training of students and professionals in these areas.
- Some of these facilities will be key enablers for whole new sets of technologies, products and services.
- It will develop DataSetu - that will enable confidentiality and privacy-preserving framework to share data and run analytics spurring the data-sharing ecosystem and create a data marketplace, boosting AI applications and solutions. One such service will be BhashaSetu.

BhashaSetu

- BhashaSetu will enable real-time Indic language translation, both of speech to speech and speech to text.
- This will further unlock the economic potential of the country, and enable all Indian citizens to equitably participate in the economic progress, regardless of their language.

Some other initiatives under ARTPARK

Avtaar Robotics

- Avtaar robotics allows emotive robotic nurses such as "Asha" to transport healthcare professionals' skills across the globe. Connecting avatar robots to remote human workflows with 5G & Wifi 6 can create jobs in the developing world.

Akashmarg

- Drone Skyways, roads in the skies for autonomous drones, just like we have roads on the ground.We are building the open standards for such drone-skyways.

Project Eklavya

- Remote Learning Labs for millions of school kids in India who don't have access to good schools and labs. Enabled by tele robotics, this can create equal access to learning for millions of young learners in the developing world.

Narrow Band-Internet of Things

In news

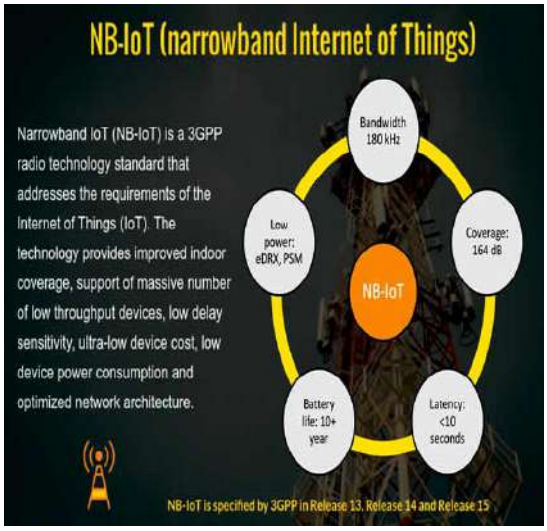
- BSNL has partnered with Skylotech India for satellite-based NB-IoT (Narrow Band-Internet of Things).
- This will enable it to provide connectivity for millions of unconnected machines, sensors and industrial IoT devices across the country.
- This solution, will connect with BSNL's satellite-ground infrastructure and provide pan-India coverage, including Indian seas.

What is Narrowband IoT?

- Narrowband IoT (also known as NB-IoT or LTE-M2) is a Low Power Wide Area Network (LPWAN) radio technology standard developed by 3GPP to enable a wide range of cellular devices and services. It doesn't operate in the licensed LTE construct. Instead, it works in one of three ways:
  - ✓ Independently
  - ✓ In unused 200-kHz bands that have previously been used for GSM (Global System for Mobile Communications)
  - ✓ On LTE base stations allocating a resource block to NB-IoT operations or in their guard bands.

The 3rd Generation Partnership Project (3GPP) is an umbrella term for a number of standards organizations which develop protocols for mobile telecommunications. Its best known work is the development and maintenance of:

- GSM and related 2G and 2.5G standards, including GPRS and EDGE
- UMTS and related 3G standards, including HSPA and HSPA+
- LTE and related 4G standards, including LTE Advanced and LTE Advanced Pro
- 5G NR and related 5G standards
- An evolved IP Multimedia Subsystem (IMS) developed in an access independent manner



Comparison of LTE-M and NB-IoT Capabilities

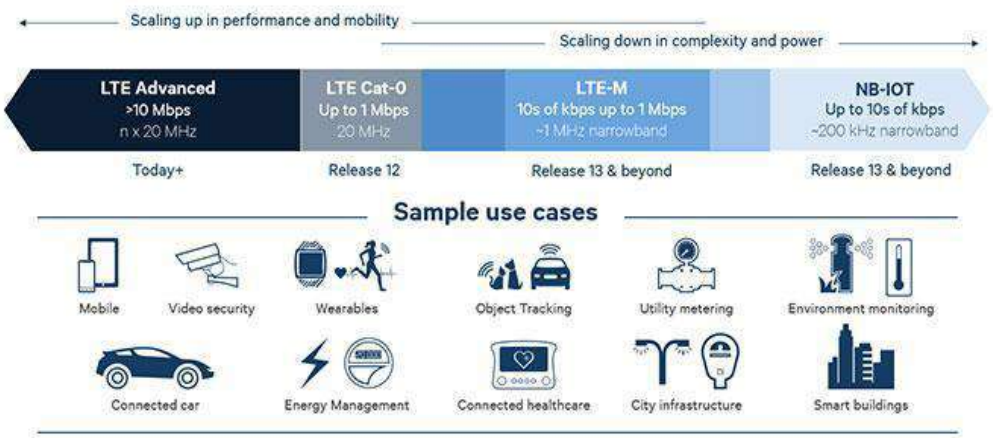
	LTE-M	NB-IoT
Also known as	eMTC, LTE Cat-M1	LTE Cat-NB1
Specification	Based on LTE	Based on a subset of LTE
Bandwidth	1.08 MHz (equivalent to an LTE channel)	180 kHz (fits into a GSM channel)
Max throughput	360 kbps	30/60 kbps
Network deployment	Relatively easy for operators to add to existing LTE networks	Easier for operators with GSM networks to incorporate
Frequency deployment	LTE in-band	LTE in-band, LTE guard band and GSM repurposing
Voice/data support	Voice and data	Data only
Range	Up to 4x	Up to 7x
Mobility/cell reselection	Yes	Limited
Module size	Suitable for wearables	
Power consumption	Up to 10 years of battery lifetime	

Why we need NBIoT and LTEM?

- LTEM (Long Term Evolution for Machines) and NBIoT (narrowband Internet of Things) are standards that fall under the category of machine-to-machine (M2M) communication, also known as machine-type communications (MTC).
- They help enable applications such as smart cities, environmental monitoring, asset tracking and more.
- But LTEM and NBIoT are different because they're specifically designed and optimized for IoT devices that communicate small amounts of data over long periods of time.
- So they're simpler than other cellular standards, with much less overhead.
- This translates into:
  - ✓ Very low power consumption, allowing device battery life of up to 10 years. That's why these networks are also sometimes called low power wide area networks (LPWANs).
  - ✓ Long range and very wide coverage — several times better than LTE.
  - ✓ Low-cost hardware, due to the reduced complexity and economies of scale.
  - ✓ Up to 100,000 or even more devices per base station, because each device has very low data-throughput requirements and because optimized software techniques let base stations communicate with very large numbers of IoT devices.

NB-IoT Applications

- **NB-IoT applications can cross many service categories. These include:**
- Smart metering (electricity, gas, and water)
- Facility management services
- Intruder and fire alarms for homes & commercial properties
- Connected personal appliances measuring health parameters
- Tracking of persons, animals or objects
- Smart city infrastructures such as street lamps or dustbin.
- Connected industrial appliances such as welding machines or air compressors.



National Internet Exchange of India

Context

- Recently, the National Internet Exchange of India, has announced that it will offer a free Internationalized Domain Name, IDN in any of the preferred 22 official Indian language along with every IN domain booked by the registrant.

National Internet Exchange of India

- The National Internet Exchange of India (NIXI) is a non-profit Company incorporated under Section 25 of the India Companies Act, 1956
- It has an objective of facilitating improved internet services in the country.
- Its primary purpose is to facilitate exchange of domestic Internet traffic between the peering ISP, Content players and any other organizations with their own AS number.
- This enables more efficient use of international bandwidth, saving foreign exchange and also improves the Quality of
- Services (QoS) for Internet users by avoiding multiple international hops and thus reducing latency.

HEALTH

African Swine Fever

- Recently, the outbreak of African swine fever (AFS) has claimed more than 2,900 domestic pigs in Assam.
- African swine fever virus (ASFV) is a large, double-stranded DNA virus in the Asfarviridae family.
- It is the causative agent of African swine fever (ASF). The virus causes a hemorrhagic fever with high mortality rates in domestic pigs.
- **It does not cause disease in humans**. ASFV is endemic to sub-Saharan Africa.

Hog Cholera

- Classical swine fever (CSF) or hog cholera is a highly contagious disease of pigs. It is caused by a virus of the genus Pestivirus of the family **Flaviviridae**.
- It is mentioned as a potential bioweapon. Hog cholera occurs in Europe, Asia, Latin America, and Africa. (eradicated in US)
- It affects only pigs and has no detrimental effects on other animals or humans.

Aarogyapath

- The Council of Scientific and Industrial Research (CSIR) has launched a web-based solution for the healthcare supply chain portal 'Aarogyapath', to provide real-time availability of critical healthcare supplies for manufacturers, suppliers and customers.
- It can help customers in tackling a number of routinely experienced issues like dependence on limited suppliers, time-consuming processes to identify good quality products, limited access to suppliers etc.

Plasma Bank

Context

- Recently, India's first plasma bank was inaugurated at the Institute of Liver and Biliary Sciences (ILBS), Delhi.

What is Plasma?

- Plasma is a clear, straw-colored liquid portion of blood that remains after red blood cells, white blood cells, platelets and other cellular components are removed.
- It is the single largest component of human blood, **comprising about 55 percent** and contains **water, salts, enzymes, antibodies and other proteins.**

Plasma vs. Blood Donation

- In plasma donation, only plasma is extracted and the other components of blood are returned to the body. This is not the case in Blood Donation.
- All plasma proteins lost due to donation **are formed again in 24-72 hours.**
- **500 ml of plasma can be donated every two weeks**, while half-liter blood can be donated once in three months.
- Plasma **can be stored for a year**, as frozen plasma will still have antibodies.

Magnetic Hyperthermia-Mediated Cancer Therapy (MHCT)

- It is a non-invasive cancer treatment.
- It involves the delivery and localisation of magnetic materials within the targeted tumour site followed by subsequent application of an alternating magnetic field(AMF) thereby generating heat at the tumour site.
- It can efficiently act against deep-seated inaccessible solid tumours and is highly thermo-sensitive towards normal cells with minimal toxicity against healthy cells.
- But Scientists are always on the lookout for new materials which can make this treatment more efficient.
- Institute of Nano Science & Technology - an autonomous institute of Department of Science and Technology (DST), has synthesised different magnetic nano-transducers like Stevioside-coated magnetite nanoparticles; Citric acid-coated Magnetic nanoclusters and Manganese and Zinc doped magnetite nanoparticles for successful application as magnetic hyperthermia agents for cancer therapy with minimum side-effects to the normal cells.

Wolbachia Method

- According to scientists "Wolbachia method" could be used to significantly reduce the incidence of dengue fever.
- ***Wolbachia pipientis***bacteria naturally occur in 60 per cent of insect species but not in the ***Aedes aegypti*** mosquitoes, which are carriers of diseases like dengue, Zika, chikungunya and yellow fever.
- Scientists have claimed that infecting mosquitoes with a naturally-occurring bacterium can help curb the spread of dengue by 77 per cent.
- One theory is that the bacterium prevents dengue viruses from replicating in mosquito cells.

Oxy2

- OXY2 is a newly designed AI based device can easily monitor health parameters of an individual such as heart rate, temperature, oxygen saturation and respiration rate clinically accurate.
- The device is completely self-contained, portable, wireless, and can be clipped on to the patient's finger and data is streamed to a mobile phone (via Bluetooth) or central monitoring system(from phone to system via the internet). This is of much significance amid COVID-19.

Plasmodium Vivax

What is in news?

- The parasite *Plasmodium vivax*, which is responsible for 7.5 million malaria cases worldwide, remains understudied.
- Not much is known about its dormant stage in the liver.
- However, recently, an international team has developed a system to breed these parasites in the lab and then infect cultured human liver cells with it. This can help establish a robust liver stage assay in P. vivax-endemic regions such as India.

Table of differences between the various types of parasites that cause malaria

Plasmodium type	Type that causes malaria	Endemic area	Febrile seizures period	Involvement and severity
Falciparum	tropical malaria	In all endemic areas	Irregular Crisis	Very serious It can cause death if not treated quickly and effectively.
Vivax	tertian malaria	South America and Asia	Every 2 days	Grave, but with a delayed onset.
malariae	quartan malaria	South America and Asia	Every 3 days	Moderate, less frequently.
Ovale	tertian malaria	Africa	Every 2 days	Moderate, less frequently.
Knowlesi	It is mistaken with quartan malaria	Malaysia, Thailand and Cambodia	Every 24 hours	It can cause death if not treated quickly and effectively.

Plasmodium vivax

- *Plasmodium vivax* is a protozoal parasite and a human pathogen.
- This parasite is the most frequent and widely distributed cause of recurring malaria.
- Although it is less virulent than *Plasmodium falciparum*, the deadliest of the five human malaria parasites, P. vivax malaria infections can lead to severe disease and death.
- P. vivax is carried by the female Anopheles mosquito; the males do not bite.

Brain Atlas

Context

- Recently, NIMHANS developed new Indian Brain Templates, brain atlas.

Details

- The neuroscientists studied over 500 brain scans of Indian patients to develop
  - ✓ five sets of Indian brain templates and
  - ✓ a brain atlas for five age groups covering late childhood to late adulthood (six to 60 years).

Need for a new Atlas

- We currently use the **Montreal Neurological Index (MNI) template**. It is based on Caucasian brains.
- The MNI template was made by averaging 152 healthy brain scans from just a small slice of the city's population in North America.
- But Caucasian brains are different from Asian brains. While some countries have their own scale to measure the brain, we are still dependent on the Caucasian brain template.
- What we have developed now is a scale that will measure an Indian brain.

Significance

- The templates and atlas will provide more **precise reference maps for individual patientswith neurological disorders** like strokes, brain tumours, and dementia.
- These templates and atlas **will also help pool information in group studies of the human brain and psychological functions.**
- It will aid in our understanding of psychiatric illnesses like Attention Deficit Hyperactivity Disorder (ADHD), autism, substance dependence, schizophrenia, and mood disorders.
- When most brain scans (MRI) are taken, they need to be compared to a standard brain template — a model or standard for making comparisons.
- This **helps researchers identify parts of the brain.** A challenge for researchers is that brain size and shape differs across ages, and across regions and ethnicities, and even greatly within any population.
- The vast majority of these differences is structural and is not associated with intelligence or behavior.
- But they do present a practical challenge of matching up similar regions in brain across populations, which is necessary for accurate measurements.
- These new population- and age-specific Indian brain templates **will allow more reliable tracking of brain development and ageing.**

National Immunogenicity And Biologics Evaluation Centre

Context

- The National Immunogenicity and Biologics Evaluation Centre (NIBEC) was recently inaugurated.

Aim

- For assessing clinical immunogenicity of viral vaccines, especially the ones in the pipeline for COVID-19.

Who established it?

- The facility was established jointly by the Department of Biotechnology (DBT) and Bharati Vidyapeeth University (BVU), Pune.
- The facility has been established through BVU"s constituent unit Interactive Research School for Health Affairs (IRSHA) and BIRAC.

About BIRAC

- Biotechnology Industry Research Assistance Council (BIRAC) is a **not-for-profit**, Public Sector Enterprise, set up by Department of Biotechnology (DBT).
- It is an agency to empower the emerging Biotech enterprise to undertake strategic research and innovation.
- It aims to address nationally relevant product development needs.

About National Biopharma Mission

- The National Biopharma Mission (NBM) is an **industry-Academia Collaborative Mission** for accelerating biopharmaceutical development in the country.
- NBM is **50% co-funded by the World Bank**& is being implemented at Biotechnology Research Assistance Council (BIRAC).
- This program is **dedicated to deliver affordable products to the nation** with an aim to improve the health standards of India's population.
- Vaccines, medical devices, diagnostics and biotherapeutics are few of its most important domains.
- Besides this it focuses on, strengthening the clinical trial capacity and building technology transfer capabilities in the country.
- Under NBM the Government has launched **Innovate in India (i3) Programme.**
- i3 aims to create an enabling ecosystem to promote entrepreneurship and indigenous manufacturing in the sector.

About IRSHA

- Interactive Research School for Health Affairs (IRSHA) is a constituent unit of Bharati Vidyapeeth (Deemed to be University), totally dedicated to research.
- The institute was established in 2001. It is mandated to conduct research in priority areas of human health in co-ordination with other constituents of the university like Medical, Ayurveda, Homeopathy, Dental colleges etc.
- The core area of research includes Mother and child health, Cancer, Diabetes, Obesity, Osteoarthritis & Herbal medicine.

Cat Que Virus

- ICMR scientists have found another virus from China, the 'Cat Que Virus,' which has the potential to spread diseases across India.
- CQV **is a arbovirus**and it may cause **febrile illnesses, meningitis, and paediatric encephalitis among humans.**
  - ✓ Arboviral disease is a general term used to describe infections caused by a group of viruses spread to people by the bite of infected arthropods (insects) such as mosquitoes and ticks.
- Its **natural host is a mosquito.** Domestic pigs are the primary mammalian host of CQV and anti-CQV antibodies have been reported in swine reared locally in China.
- As per the ICMR study, Indian mosquitoes are susceptible to CQV, which could also become a public health pathogen.

ICMR

- The Indian Council of Medical Research (ICMR), is the apex body in India for the formulation, coordination and promotion of biomedical research.
- It is one of the oldest and largest medical research bodies in the world.
- The ICMR is **funded by the Government of India** through the Department of Health Research, Ministry of Health and Family Welfare.

Brucellosis

Context

- Thousands of people in China have tested positive for a disease, called brucellosis. It was leaked from a laboratory.

About

- Brucellosis is a bacterial infection that spreads from animals to people.
- The disease, also known as Malta fever or Mediterranean fever, can cause symptoms including headaches, muscle pain, fever and fatigue.
- Human-to-human transmission is extremely rare.
- Brucellosis affects many wild and domestic animals, including: Cattle, Goats, Sheep, Pigs and wild hogs, Dogs, Deer, Elk, Bison, Camels etc.
- Spreads through: Eating raw dairy products, Inhaling contaminated air, Touching blood and body fluids of infected animals.
- Avoiding raw dairy products and taking precautions when working with animals or in a laboratory can help prevent brucellosis.

Mass Spectrometry

Context

- Using mass spectrometer, researchers have been able to detect novel coronavirus with 95% sensitivity and 100% specificity with respect to RT-PCR (reverse transcription polymerase chain reaction).

Mass spectrometry

- Mass spectrometry (MS) is an analytical technique that **measures the mass-to-charge ratio of ions.**

Details

- The new method can **directly detect the virus without amplifying the RNA for detection**, as is the case with RT-PCR. So, we do not need the viral RNA to be intact after sample collection.
- Instead of amplifying the genetic material of the Sars-CoV-2 virus that causes Covid-19, the technique uses mass spectrometry to detect two peptides (building blocks of the viral protein)
- Mass spectrometry can detect the presence and quantity of various organic and inorganic compounds by detecting the ions released by them.
- The method **eliminates the need for a biosafety lab**, which makes it possible for it to be used at airports and railway stations to test passengers before they board a plane or a train.
- This new method of testing that is **faster, cheaper, and almost as accurate** as the Reverse Transcription-Polymerase Chain Reaction (RT-PCR) test.

African Trypanosomiasis

Context

- Togo has become the first country in Africa to eliminate human **African Trypanosomiasis** or sleeping sickness.

About

- African Trypanosomiasis, is caused by microscopic parasites of the species *Trypanosoma brucei.*
- It is transmitted by the **tsetse fly (Glossina species),** which is **found only in sub-Saharan Africa.**
- Two morphologically indistinguishable subspecies of the parasite cause distinct disease patterns in humans:
  i. ***T. b. gambiense*** **:** It causes a slowly progressing African trypanosomiasis in western and central Africa and;
  ii. ***T. b. rhodesiense*** : It causes a more acute *African trypanosomiasis* in eastern and southern Africa.
- Sleeping sickness is curable with medication but is fatal if left untreated.

Congo Fever

Context

- Recently, the Palghar administration asked authorities to remain alert against a possible spread of the Congo fever in the Maharashtra district.

About

- Crimean-Congo haemorrhagic fever is a viral haemorrhagic fever usually transmitted by ticks and livestock animals.

- It can also be contracted through contact with viraemic animal tissues (animal tissue where the virus has entered the bloodstream) during and immediately post-slaughter of animals.
- Human-to-human transmission can occur resulting from close contact with the blood, secretions, organs or other bodily fluids of infected persons.
- It is endemic in all of Africa, the Balkans, the Middle East and in Asia.
- The disease was first described in the Crimea in 1944 and given the name Crimean haemorrhagic fever.
- In 1969 it was recognized that the pathogen causing Crimean haemorrhagic fever was the same as that responsible for an illness identified in 1956 in the Congo.
- The linkage of the two place names resulted in the current name for the disease and the virus.
- There is no vaccine available for either people or animals.
- Signs and symptoms include: Headache, high fever, back pain, joint pain, stomach pain, and vomiting. Jaundice, and in severe cases, changes in mood and sensory perception.

Evin Network

Context

- The eVIN network is being repurposed for the delivery of the COVID-19 vaccine.

About

- **eVIN (Electronic Vaccine Intelligence Network)** is an indigenously developed technology system in India.
- The network digitizes vaccine stocks and monitors the temperature of the cold chain through a smartphone application.
- It aims to strengthen the evidence base for improved policy-making in vaccine delivery, procurement and planning for new antigens in India.

Implementation

- The technological innovation is implemented by the United Nations Development Programme (UNDP) in partnership with Ministry of Health & Family Welfare under National Health Mission.

NHM

- The National Health Mission (NHM) encompasses its two Sub-Missions, the National Rural Health Mission (NRHM) and the National Urban Health Mission (NUHM).
- NHM envisages achievement of **universal access to equitable, affordable & quality healthcare services** that are accountable and responsive to people's needs.

Tubarial Salivary Gland

Context

- Researchers from the Netherlands Cancer Institute have discovered a new pair of salivary glands hidden between the nasal cavity and throat. It has been named as Tubarial Salivary Gland.

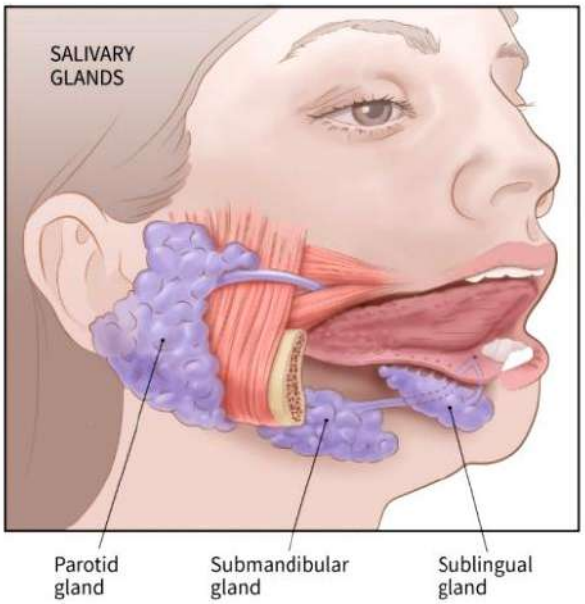
About

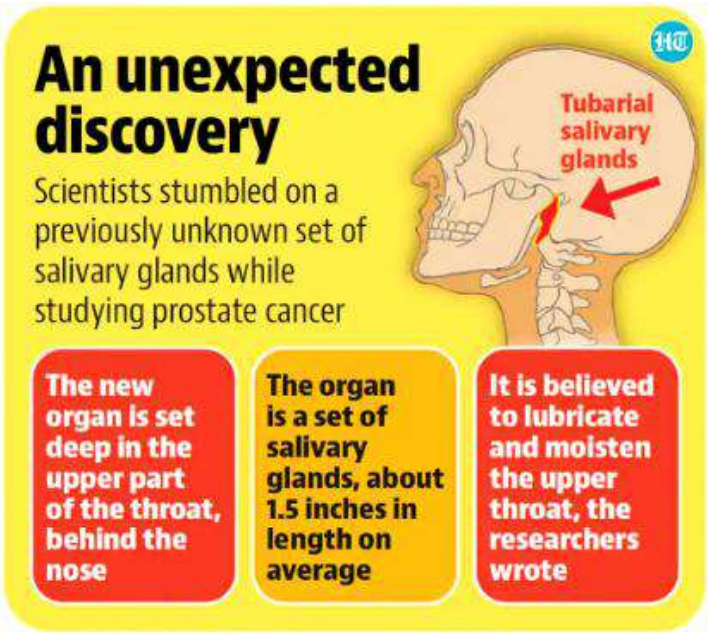
- The team proposed the name "tubarial glands" as it was found draped over the torus tubarius - the structure that supports the entrance of the auditory tube.
- The glands were about 3.9 centimeters in length on average.

Physiological Function

- The assumption of the physiological function is the moistening and lubrication of the nasopharynx and oropharynx.

Until Now:





'Saviour Sibling' Experiment

Context

- India's first 'saviour sibling' experiment is a success, say doctors.

About

- Under this experiment a one-year-old sibling saved her brother's life who was suffering from Thalassemia by donating her bone marrow.

Thalassemia

- Thalassemia is a chronic blood disorder.
- It is a genetic disorder due to which a patient cannot make enough hemoglobin found in Red Blood Cells (RBC's).
- This leads to anemia and patients need to acquire blood transfusions every two to three weeks to survive.
- Thalassemia's are inherited disorders passed from parents to children through genes.

Thalassemia patients often suffer from:

- Anemia
- Weak bones
- Delayed or slow growth
- Iron overload in the body
- Poor appetite
- Enlarged spleen or liver
- Pale skin

There are two main types of thalassemia:

- Alpha thalassemia occurs when a gene or genes related to the alpha globin protein are missing or changed (mutated).
- Beta thalassemia occurs when similar gene defects affect production of the beta globin protein.

Standard Treatments

- Blood Transfusions

- Iron Chelation Therapy: aims to balance the rate of iron accumulation from blood transfusion by increasing iron excretion in urine and or faces with chelators.
- Folic Acid Supplements
- Blood and Marrow Stem Cell Transplant

Facts and Figures

- India is the thalassemia capital of the world with 40 million carriers and over 1,00,000 thalassemia majors under blood transfusion every month.
- Over 1,00,000 patients across the country die before they turn 20 due to lack of access to treatment.
- The first case of thalassemia in India was reported in 1938
- Every year 10,000 children with thalassemia major are born in India.

Tinnitus

Context

- New Research has found that tinnitus is being exacerbated by Covid-19 – and also by the measures against the infection.
- 40% of those displaying symptoms of Covid-19 simultaneously experience a worsening of their tinnitus.

About

- Tinnitus is a common condition that causes the perception of noise or ringing in the ears and head. It involves the sensation of hearing sound when no external sound is present.
- Tinnitus affects about 15 to 20 percent of people.
- Tinnitus isn't a condition itself – it's a symptom of an underlying condition, such as age-related hearing loss, ear injury or a circulatory system disorder.
- Tinnitus usually isn't a sign of something serious. Although it can worsen with age, for many people, tinnitus can improve with treatment.

Guillain-Barre Syndrome

Context

- In a rare complication, some patients infected with Covid-19 have been found suffering from Guillain Barre Syndrome (GBS). In India, such cases have been reported since August.

About

- Guillain-Barre syndrome is a rare disorder in our body's immune system attacks our nerves.
- The syndrome's first symptoms are a tingling or itching sensation in the skin, followed by muscle weakness, pain and numbness.
- These sensations can quickly spread, eventually paralyzing your whole body.

Link with COVID

- Here, the immune system, in an attempt to kill the coronavirus, accidentally starts attacking the peripheral nervous system.
- The peripheral nervous system is a network of nerves that lead from the brain and spinal cord to different parts of the body. Attacking them can affect limb functions.

Chapare Virus

Context

- Chapare Virus can spread through human-to-human transmission- CDC(USA)

About

- Chapare hemorrhagic fever (CHHF) is a viral hemorrhagic fever caused by infection with Chapare virus. The Chapare virus is in the arenavirus family.
- **Transmission:** either through direct or indirect contact with the saliva, urine, and droppings of infected rodents.
- **Symptoms:** fever, headache, joint and muscle pain, pain behind the eyes, stomach pain, vomiting, diarrhea, bleeding gums, rash, irritability.
- There is currently no treatment for CHHF. Supportive therapy is important for recovery from and survival of CHHF.
- Improving rodent control in and around homes and buildings can help to reduce exposure to rodents that may be infected with arenaviruses.

Duchenne Muscular Dystrophy

Context

- Sandeep Eswarappa, Assistant Professor Indian Institute of Science (IISc), Bengaluru has proposed to suppress the disease Duchenne Muscular Dystrophy-using genetic process that initiates these diseases.

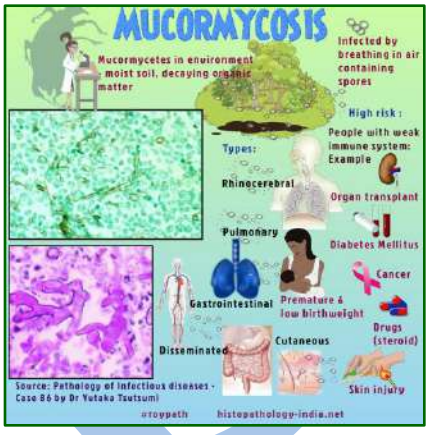
About

- Duchenne muscular dystrophy is a genetic disorder characterized by the progressive loss of muscle.
- It is a multi-systemic condition, affecting many parts of the body, which results in deterioration of the skeletal, heart, and lung muscles.
- Duchenne is caused by a mutation in the gene that encodes for dystrophin, a protein that is essential to the proper functioning of our muscles.
- Without dystrophin, muscles are not able to function or repair themselves properly.
- Because the dystrophin gene is found on the X-chromosome, it primarily affects males, while females are typically carriers. However, some females can manifest varying ranges of physical symptoms of Duchenne and are therefore called "manifesting carriers".
- As of now, there is no known cure for duchenne muscular dystrophy. Treatments usually aim to control symptoms to improve quality of life.

Mucormycosis Fungus

Context

- Doctors at Sir Ganga Ram hospital have witnessed more than 12 cases of COVID-19 triggered Mucormycosis fungus.



Black Fungus

- Black Fungus or Mucormycosis, previously called zygomycosis, is a serious but rare fungal infection caused by a group of molds called mucormycetes which exist in the environment.
- Mucormycosis mainly affects people who have health problems or take medicines that lower the body's ability to fight germs and sickness.
- It most commonly affects the sinuses or the lungs after inhaling fungal spores from the air, or the skin after the fungus enters the skin through a cut, burn, or other type of skin injury.

Plasmodium Ovale

Context

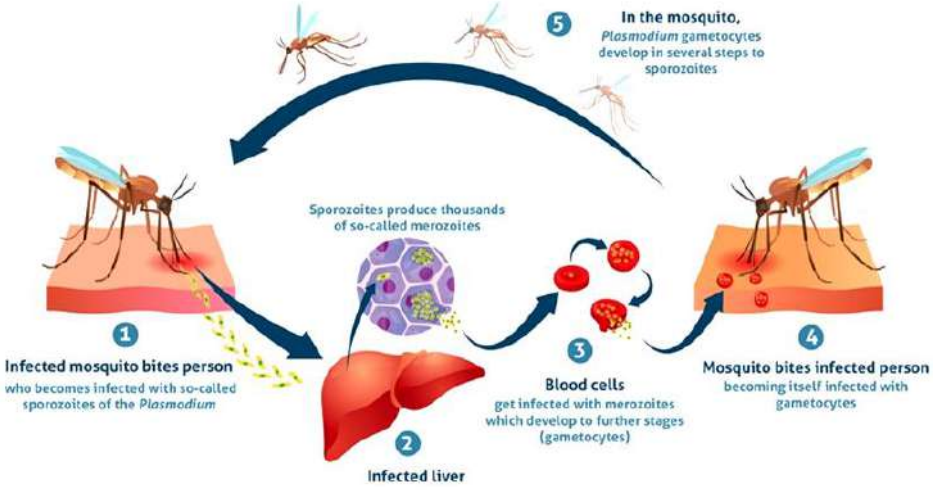
- A not very common type of malaria, *Plasmodium Ovale*, has been identified in a Jawan in Kerala.

About Malaria

- Malaria is caused by the bite of the female Anopheles mosquito, if the mosquito itself is infected with a malarial parasite.
- There are five kinds of malarial parasites – *Plasmodium falciparum, Plasmodium vivaxPlasmodium malariae, Plasmodium ovale and Plasmodium knowlesi.*

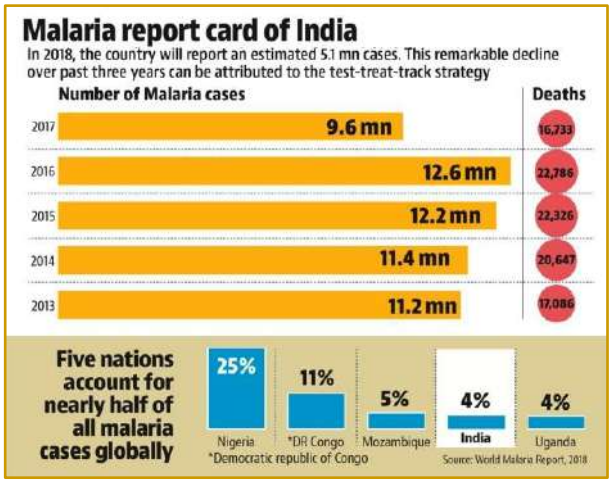
Plasmodium ovale

- It is termed ovale as about 20% of the parasitised cells are oval in shape.
- P ovale malaria is endemic to tropical Western Africa.
- P ovale is relatively unusual outside of Africa and, where found, comprises less than 1% of the isolates. It has also been detected in the Philippines, Indonesia and Papua New Guinea, but is still relatively rate in these areas.



India and Malaria

- India recorded largest reductions in malaria cases in South-East Asia from 20 million in 2000 to about 5.6 million in 2019: World Malaria Report 2020.
- Gaps in access to life-saving tools are undermining global efforts to curb the disease, and the COVID-19 pandemic is expected to set back the fight even further.



Shigella Bacterial Infection

Context

- North Kerala has been put on high alert after an 11-year-old boy died and 20 suspected cases of shigella bacterial infection were reported in Kozhikode.

About

- Shigella is a genus of bacteria that is **Gram-negative, facultativeanaerobic, non-spore-forming, nonmotile, rod-shaped** and genetically closely related to E. coli.
- The genus is named after Kiyoshi Shiga, who first discovered it in 1897.
- The causative agent of human shigellosis, Shigella causes disease in primates, but not in other mammals.
- It is only naturally found in humans and gorillas.
- During infection, it typically causes dysentery.
- Shigella is one of the leading bacterial causes of diarrhea worldwide, causing an estimated 80–165 million cases.
- The number of deaths it causes each year is estimated at between 74,000 and 600,000.
- It is one of the top four pathogens that cause moderate-to-severe diarrhea in African and South Asian children.

Mock Egg

Context

- IIT-Delhi's scientist receives UNDP first prize for innovation of plant-based mock egg.

About

- The vegan egg liquid from split green gram or moong dal, and it is going to be available for retail real soon.
- The substance has the same taste, cooking procedure and protein level as chicken eggs, but with zero animal ingredients.
- The eggs have been created using protein isolation technology.
- The plant based textured foods which resemble egg, fish and chicken have been developed with an aim to address the longstanding battle for malnutrition and clean protein food for people.
- The mock egg has been developed from very simple farm-based crop proteins, which not only looks and tastes like egg but also very close in nutritional profile to a poultry egg,

Significance

- The development of the mock egg meets the protein needs of the diet-specific, health conscious, vegan and vegetarian people.
- This innovation addresses SDG 2 and 3 (zero hunger and good health and well-being).

Leprosy

Context

- Health workers in Himachal Pradesh are screening the state's entire population for symptoms of leprosy, in a door-to-door surveillance campaign.

Naegleria Fowleri

Context

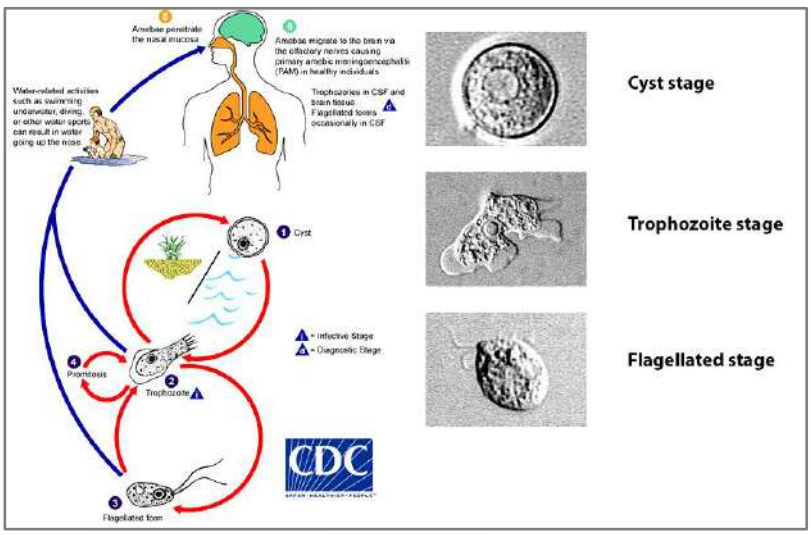
- A deadly brain-consuming amoeba — *Naegleria fowleri* — is crawling its way northward from the southern states of the US.

About

- *Naegleria fowleri* is a free-living microscopic amoeba.
- It can cause a rare and devastating infection of the brain called **primary amebic meningoencephalitis** (PAM).
- The amoeba is commonly found in warm freshwater and soil.
- *Naegleria fowleri* usually infects people when contaminated water enters the body through the nose.
- Once the amoeba enters the nose, it travels to the brain, where it causes PAM, which is usually fatal.
- Infection typically occurs when people go swimming or diving in warm freshwater places, like lakes and rivers.
- In very rare instances, Naegleria infections may also occur due to contaminated water from other sources.

Treatment

- The treatment of choice is an intravenous drug called amphotericin B. Amphotericin B may also be instilled directly into the brain.
- Because treatment with amphotericin B alone usually fails, other drugs are often added.
- Miltefosine is a drug that has shown promise, and it is available through the Centers for Disease Control and Prevention.
- Treatment should be initiated as rapidly as possible, and immediate



consultation with an infectious-diseases expert is highly recommended.
- More than 99% of cases of PAM are fatal despite treatment.

Shine Trial

Context

- According to health officials, a four-month long treatment regimen of drugs works as effectively as a six-month one for children with mild cases of TB.

What is SHINE?

- SHINE stands for "Shorter Treatment for Minimal Tuberculosis in Children"
- SHINE is the first randomized controlled trial to assess the length of treatment needed for children with TB.
- Until now, treatment for children with TB has been based on trials in adults.
- However, two thirds of children with TB have a less severe form of the disease.
- This led researchers to run the SHINE trial, to find out if these children could have a shorter treatment.

Hypothermia

Context

- In an impact-based advisory, the IMD urged residents of India's northernmost states to protect themselves from the biting cold by avoiding alcohol.

Why avoid alcohol?

- According to a study jointly conducted by the Thermal Physiology and the Medicine Division, US Army Research Institute of Environmental Medicine, alcohol can decrease the core temperature of the body and increase the risk of hypothermia during cold exposure.

What is Hypothermia?

- Hypothermia is a severe medical condition where the body loses heat before it can generate it, resulting in a dangerously low body temperature.
- While normal body temperature lies at around 37 degrees Celsius, the body temperature of a person suffering from hypothermia drops to below 35 degrees Celsius.
- Common signs include shivering, slow rate of breathing, slurred speech, cold skin and fatigue.

Alcohol and Hypothermia

- Heavy alcohol consumption is often linked to an increased risk of hypothermia and other conditions linked to extreme cold weather.
- Alcohol has psychological and behavioural effects, which can impact a person's ability to correctly perceive how cold it is.
- Hence, cases of people succumbing to hypothermia after drinking heavily and passing out outdoors are very commonly reported in places with extreme cold weather.
- According to the American Association of Family Physicians, a retrospective study in 2004 showed that alcohol consumption is associated with 68 per cent of accidental hypothermia cases.

Alcohol and Body Temperature

- Alcohol is a vasodilator, which means that it causes blood vessels to relax and dilate or open.
- So after consuming alcohol, the volume of blood brought to the skin's surface increases, making us feel warmer as a result.
- This is also what causes an intoxicated person to look flushed.
- As the body begins to believe that it is warm, we also start to sweat — a reaction that automatically reduces overall body temperature.
- Drinking copious amounts of alcohol may affect our body's ability to detect the cold properly, which is in place to protect you from frostbite and hypothermia.
- However, experts say drinking moderately in temperate environments does not significantly affect the core temperature of the body.

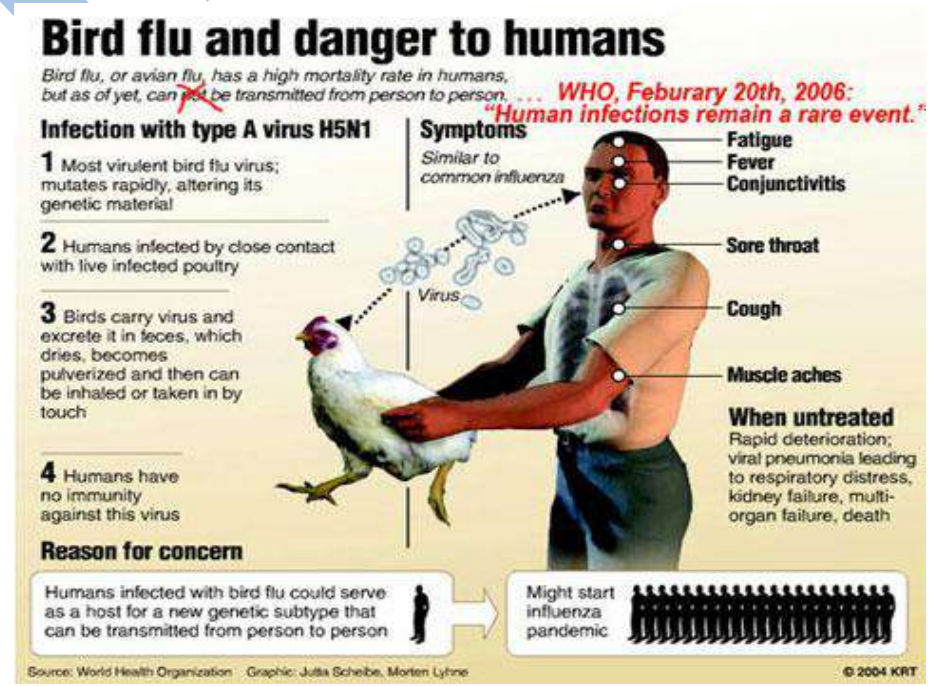
Bird Flu

Context

- Recently, a bird flu outbreak, has been reported at 12 epicenters in four states -- Kerala, Rajasthan, Madhya Pradesh and Himachal Pradesh.

Bird/ Avian Flu

- Bird flu or Avian Influenza is a contagious disease of bird raging from mild to serve form of illness.
- Some forms of bird flu infections can cause illness to humans.
- Bird flu is caused by influenza A virus.
- There are three main subtypes of avian flu, including H5, H7, and H9. The subtypes H5 and H7 are the most deadly, while the H9 subtype is less dangerous.
- It can also cause severe infection in humans.
- Typically, it's transmitted between birds, but it can be passed from bird to human. It **does not appear to spread from person to person.**



History

- First identified in Italy in 1878, highly pathogenic avian influenza is characterized by sudden onset of severe disease, rapid contagion, and a mortality rate that can approach 100% within 48 hours.
- Human deaths from avian influenza were unknown until 1997, when six people in Hong Kong died from the particularly virulent H5N1 strain.

Etiologic Agent

- The causative agent is the avian influenza (A1) virus. A1 viruses all belong to the influenza virus, a genus of the Orthomyxoviridae family and are negative-stranded, and segmented.

Modes of Transmission

- Avian influenza spreads in the air and in manure.
- Wild fowl often acts as resistant carrier spreading it to more susceptible domestic stocks.
- It can also be transmitted through contaminated feeds, water, equipment, and clothing.
- Cats are also thought to be possible infection vectors for avian flu.
- While avian influenza spreads rapidly among birds, it does not infect humans easily, and there is no confirmed evidence of human-to-human transmission. Of the 15 subtypes known, only subtypes H5 and H7 are known to be capable of crossing the species barrier.

Is it safe to eat chicken, poultry products and other wild game birds?

- Yes, it is safe to eat properly prepared and cooked poultry and game birds. The virus is sensitive to heat. Normal temperatures used for cooking (so that food reaches 70°C in all parts) will kill the virus.

Incubation Period

- The incubation period is three to five days.

Signs and Symptoms

- The symptoms of Bird flu infection may include fever (often high fever, > 38°C) and malaise, cough, sore throat, and muscle aches.
- Other early symptoms may include abdominal pain, chest pain and diarrhea.
- The infection may progress quickly to severe respiratory illness (for example, difficulty breathing or shortness of breath, pneumonia, Acute Respiratory Distress Syndrome) and neurologic changes (altered mental status or seizures).

Treatment

- The antiviral medicine oseltamivir can reduce the severity of illness and prevent death, and should be used in all cases.
- Candidate vaccines to prevent Bird Flu infection have been developed, but they are not ready for widespread use.

H5N8

- In the recent outbreak presence of the H5N8 subtype of the Influenza A virus was reported in ducks in parts of Kerala.
- H5N8 is a subtype of the Influenza A virus (sometimes called bird flu virus).
- Although H5N8 is considered one of the less pathogenic subtypes for humans, it is beginning to become more pathogenic. H5N8 has previously been used in place of the highly pathogenic H1N1 in studies.
- While H5N8 presents only a low risk to humans, it is highly lethal to wild birds and poultry.

Lumpy Skin Disease

Context

- Lumpy skin disease has taken root among India's bovines.

About

- Lumpy skin disease (LSD) is a poxviral disease with significant morbidity in cattle.
- Lumpy skin disease virus causes a severe disease in cattle characterized by nodules in the skin.
- Although the mortality rate is generally low, economic losses result from loss of condition, decreased milk production, abortions,

infertility and damaged hides.
- Lumpy skin disease virus (LSDV) is a member of the genus Capripoxvirus and the family Poxviridae.
- It is closely related antigenically to sheeppox virus and goatpox virus. Although these three viruses are considered to be distinct viral species, they cannot be distinguished by routine serological tests.
- The causative virus spreads mainly by blood-feeding insects, such as certain species of flies and mosquitoes or ticks, and outbreaks can be widespread and difficult to control.
- There is no evidence that LSDV can infect humans.
- LSD was first reported in Asia and the Pacific region in 2019 in north-west China, Bangladesh and India.

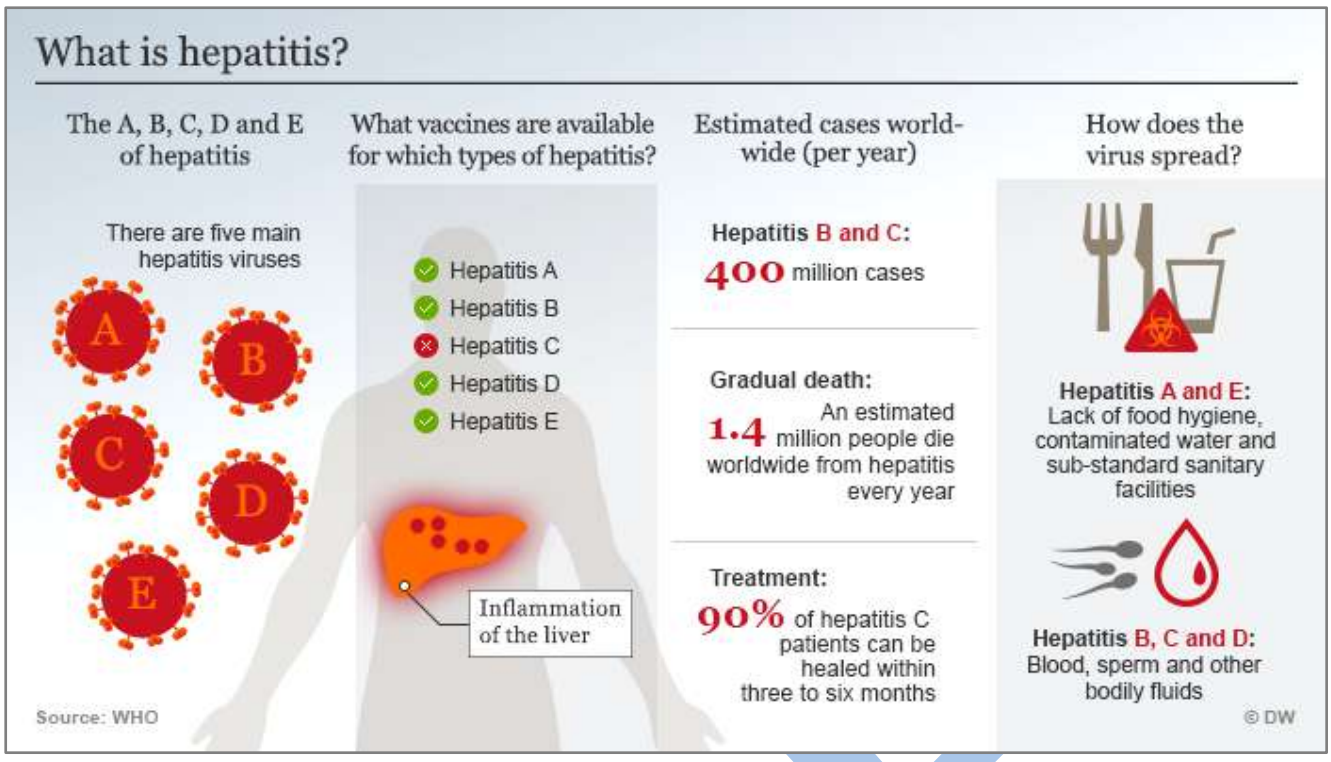
Treatment
- There is no treatment for the virus, so prevention by vaccination is the most effective means of control.
- Secondary infections in the skin may be treated with Non-Steroidal Anti-Inflammatories (NSAIDs) and also antibiotics (topical +/- injectable) when appropriate.

Prevention
- Control and prevention of lumpy skin disease relies on four tactics –
  - ✓ movement control (quarantine),
  - ✓ vaccination,
  - ✓ slaughter campaigns and
  - ✓ management strategies.
- Specific national control plans vary between countries and so advice should be sought from the relevant authorities and veterinarians.
- Vaccination is the most effective means of control.
- Tracing the source of infection plays a critical role in containing the spread of any contagious infection.
- The disease can be checked if the animal is treated within the initial few days.

Nobel Prize for Medicine or Physiology
Context
- Americans Harvey J Alter and Charles M Rice, and British scientist Michael Houghton were awarded the Nobel Prize for Medicine or Physiology on Monday for the discovery of the Hepatitis C virus.

Observations made by the Nobel Committee
- Nobel Committee noted that the trio's work helped explain a major source of blood-borne hepatitis that couldn't be explained by the hepatitis A and B viruses.
- It makes possible blood tests and new medicines that have saved millions of lives.
- Highly sensitive blood tests for the virus are now available.
- These have essentially eliminated post-transfusion hepatitis in many parts of the world, greatly improving global health.
- Their discovery also allowed the rapid development of antiviral drugs directed at hepatitis C.
- For the first time in history, the disease can now be cured, raising hopes of eradicating hepatitis C virus from the world population.

Hepatitis C Virus
- Hepatitis C is a viral infection that causes liver inflammation, sometimes leading to serious liver damage.
- The hepatitis C virus (HCV) spreads through contaminated blood.



Feature	Hepatitis A	Hepatitis B	Hepatitis C	Delta	Hepatitis E
Incubation period (wk)	2–6 (avg. 4)	4–26 (avg. 13)	2–20	4–8	—
Virus	RNA	DNA	RNA	Incomplete RNA (needs presence of HBsAg)	RNA

Scrub Typhus

Context

- An outbreak of scrub typhus, a bacterial disease, has claimed the lives of five people in Nagaland's Noklak district bordering Myanmar.

Other name of Scrub Typhus	Bush typhus,
Causal organism	*Orientia tsutsugamushi*(Gram-negative Bacteria)
Spread	Through bites of infected chiggers (larval mites).
Symptoms	Fever, headache, body aches, and sometimes rash
Vaccines	Unavailable. Treated with antibiotics

ALTERNATE ENERGY

Aditya

- India's **first solar-powered ferry**, Aditya, is among 12 such ferries that have been shortlisted for the Gustave Trouvé Award. It is the **sole entrant from Asia.**
  - Gussies Electric Boat Awards were instituted in memory of Gustave Trouvé, a French electrical engineer and pioneer in electric cars and boats.

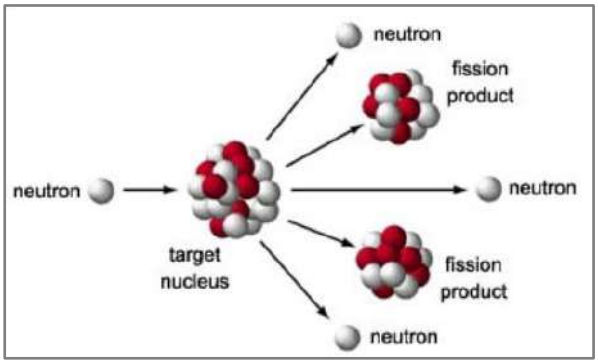
Kakrapar Atomic Power Plant

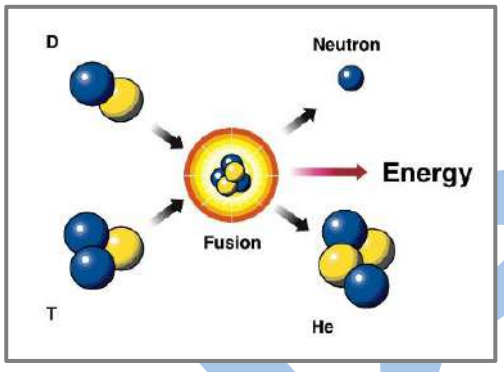
Context

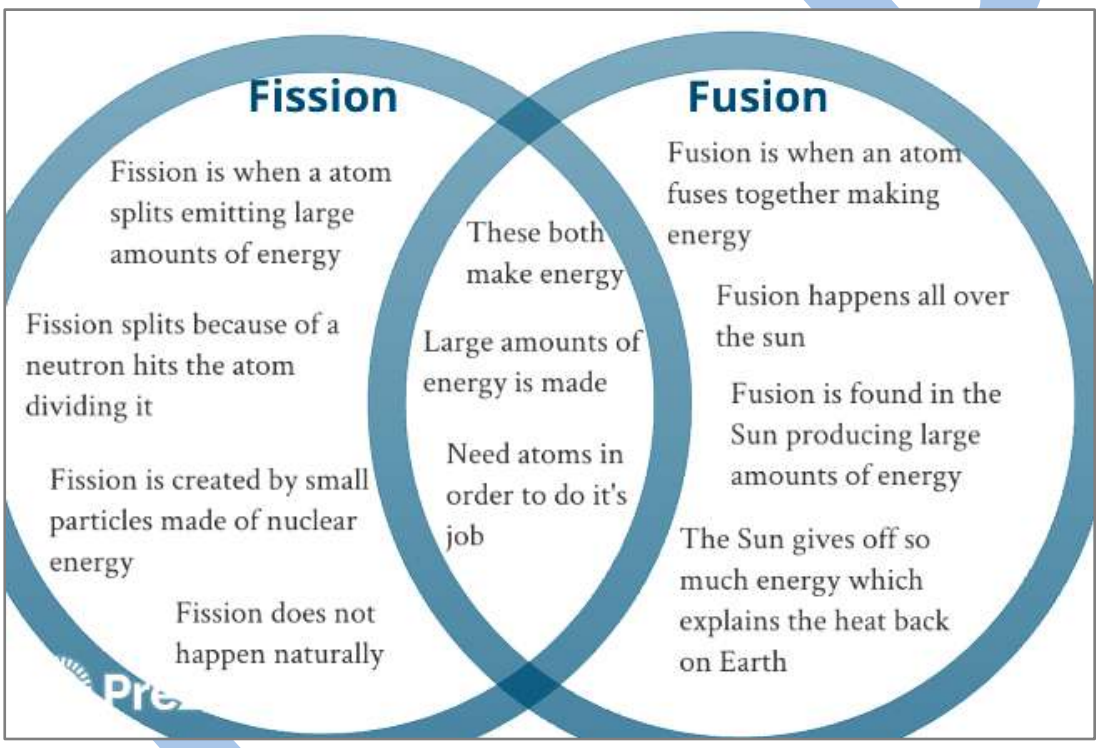
- The third reactor of Kakrapar Atomic Power Plant **has achieved criticality.**
- First **Pressurised Heavy Water Reactor** (PHWR) of the plant was commissioned on May 6, 1993.

Nuclear/Atomic Power Plant

- Nuclear power generation utilizes nuclear reactions that release nuclear energy to generate heat.
- This heat is then used in steam turbines to produce electricity in a nuclear power plant.
- Nuclear power can be obtained from **nuclear fission, nuclear decay and nuclear fusion reactions.**
- Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of **uranium and plutonium**.







A pressurized heavy water reactor (PHWR) is a nuclear power reactor, commonly used**unenriched natural uranium as its fuel** that uses **heavy water (deuterium oxide D2O) as its coolant and moderator**. The heavy water coolant is kept under pressure, allowing it to be heated to higher temperatures without boiling, much as in a typical pressurized water reactor. While heavy water is significantly **more expensive than ordinary light water, it yields greatly enhanced neutron economy, allowing the reactor to operate without fuel enrichment facilities** (mitigating the additional capital cost of the heavy water) and enhancing the ability of the reactor.

Criticality

- Criticality means that a reactor is controlling a sustained fission chain reaction, where each fission event releases a sufficient number of neutrons to maintain an ongoing series of reactions.
- **This is the normal state of nuclear power generation**. And the power plant is ready to generate energy.
- Thus, **Criticality is a desirable and necessary state** for a nuclear power plant producing a consistent and steady stream of energy.

What Is Super criticality?

- Initially, the nuclear reactor is briefly put into a state that produces more neutrons than are lost.
- This condition is called the **supercritical state**, which allows the neutron population to increase and more power to be produced.
- When the desired power production is reached, adjustments are made to place the reactor into **the critical state** that sustains neutron balance and power production.
- **Subcritical state**: At times, such as for maintenance shutdown or refueling, reactors are placed in a **subcritical state,** so that neutron and power production decrease.

Pyrolisis

- According to a new study, plastic from used personal protective equipment (PPE) can be transformed into renewable liquid fuels using chemical a process called pyrolysis.
- The word pyrolysis is coined from the Greek words "pyro" which means fire and "lysis" which means separating.
- Pyrolysis is a process of chemically decomposing organic materials at elevated temperatures in the absence of oxygen.
- The process typically occurs at temperatures above 430 °C (800 °F) and under pressure.
- It simultaneously involves the change of physical phase and chemical composition and is an irreversible process.
- In this PPE case, Pyrolysis breaks down plastic at high temperature – between 300-400°C for an hour – without oxygen.

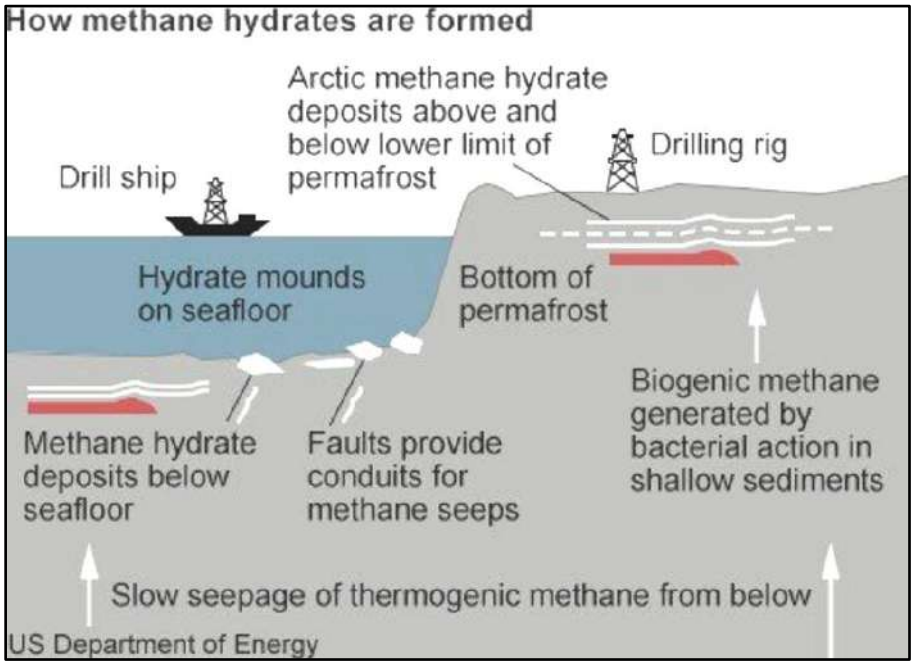
Methane Hydrate

Context

- Recently, a study has found that the methane hydrate deposits are located in the Krishna-Godavari (KG) basin are of biogenic origin.
  - ✓ Biogenic : produced by living organisms **biogenic** methane formation.

About Methane Hydrate

- Methane hydrate is a **crystalline solid** that consists of a **methane molecule** surrounded by a cage of interlocking water molecules.
- It is an "ice" that **only occurs naturally in subsurface deposits** where temperature and pressure conditions are favorable for its formation.
- It starts burning when an open flame is brought close to it. Hence, it is called **"Fiery Ice".**
- Only water is left after combustion.
- Methane is the **primary component of natural gas,** and the development of methane hydrate follows almost the same procedure as that for natural gas.



Where Are the Methane Hydrate Deposits?

- Four Earth environments have the temperature and pressure conditions suitable for the formation and stability of methane hydrate. These are:
  i. **sediment and sedimentary rock units below Arctic permafrost**;

ii. **sedimentary deposits along continental margins;**
iii. **deep-water sediments of inland lakes and seas; and,**
iv. **under Antarctic ice**. .

- With the exception of the Antarctic deposits, methane hydrate accumulations are not very deep below Earth's surface.
- In most situations the methane hydrate is within a few hundred meters of the sediment surface.

The enormous potential of Methane Hydrate

- Methane Hydrate has a huge potential as an energy resource and for their role in global climate change.
- One cubic metre of the compound releases about 160 cubic metres of gas, making it **a highly energy-intensive fuel.**
- There is more energy in methane hydrates than in all the world's oil, coal and gas put together.
- The enormous amounts of methane hydrate under the ocean and beneath arctic permafrost represent an estimated 53% of all fossil fuel (coal, oil, natural gas) reserves on earth, about 10,000 gigatons.

Krishna Godavari Basin

- The Krishna Godavari Basin is a petroliferous basin of continental margin located on the east coast of India.
- The Krishna-Godavari Basin expands from Rajahmundry seaward to the Bay of Bengal.
- Large reserves of Natural Gas and coal have been discovered in the Krishna Godavari river basin.
- Krishna Godavari Dhirubhai 6 (KG-D6) was Reliance's first offshore gas field development and its first underwater discovery.
- It was also India's largest deposit of natural gas and the largest such discovery in the world in 2002.
- KG inland and offshore basins have good prospects of tight oil and tight gas reserves.
  - ✓ Tight Oil is **light crude oil** contained in **petroleum-bearing formations of low permeability**, often shale or tight sandstone.
  - ✓ It requires the same hydraulic fracturing and often uses the **same horizontal well technology** used in the production of shale gas.
  - ✓ While sometimes called "shale oil", **tight oil should not be confused with oil shale.**
  - ✓ Oil shale is the term given to very fine-grained sedimentary rock containing relatively large amounts of kerogen. Oil shale is a misnomer because **kerogen isn't crude oil**, and the rock holding the kerogen often isn't even shale.
  - ✓ Kerogen **is solid, insoluble organic matter in** sedimentary rocks. Consisting of an estimated 1016 tons of carbon, it is the most abundant source of organic compounds on earth, exceeding the total organic content of living matter by 10,000-fold.
  - ✓ It is insoluble in normal organic solvents and it does not have a specific chemical formula.
  - ✓ Upon heating, kerogen converts in part to liquid and gaseous hydrocarbons. **Petroleum and natural gas form from kerogen.**
- KGB is home to olive ridley sea turtle, a vulnerable species.

HCNG

What is in news?

- The **Ministry of Road Transport and Highways** has allowed use of H-CNG (18% mix of hydrogen) in CNG engines.
- The Ministry has been notifying various alternate fuels under Clean Fuels for transportation.
- The Bureau of Indian Standards (BIS) has also developed specifications of Hydrogen enriched Compressed Natural Gas (H-CNG) for automotive purposes, as a fuel.

What is HCNG?

- HCNG is a hydrogen-enriched compressed natural gas (CNG). In Delhi, instead of physically blending hydrogen with CNG, hygrogen spiked CNG will be produced using compact reforming process patented by Indian Oil Corporation.

What are its benefits?

- It is cleaner and more economical.
- Power output of HCNG is also better than CNG ones.
- HCNG means four per cent more fuel economy than CNG.
- At a time of emission norms being uppermost on the minds of the policy makers, HCNG will ensure 70% more reduction in carbon monoxide emissions compared to CNG.
- It requires only small hydrogen storage and a column for the mixing of hydrogen with natural gas at existing CNG stations.
- Safety components are similar to the CNG. HCNG is easier and safer to use than hydrogen as it contains very low energy content from hydrogen i.e., up to 30% by volume.
- HCNG reduces the engine's unburned hydrocarbon emissions and speeds up the process of combustion.
- The engine's fuel efficiency is improved by blending the CNG from hydrogen which lowers the fuel consumption of the vehicle.
- The thermal efficiency and fuel economy is also increased by HCNG.

HL-2M Tokamak

Context

- China has successfully powered up its "artificial sun" nuclear fusion reactor for the first time.

About

- The HL-2M Tokamak reactor is China's largest and most advanced nuclear fusion experimental research device.

Potential

- The device can potentially unlock a powerful clean energy source.
- It uses a powerful magnetic field to fuse hot plasma and can reach temperatures of over 150 million degrees Celsius. (ten times hotter than the core of the sun).
- Located in southwestern Sichuan province and completed late last year, the reactor is often called an "artificial sun" on account of the enormous heat and power it produces.

Collaboration with ITER

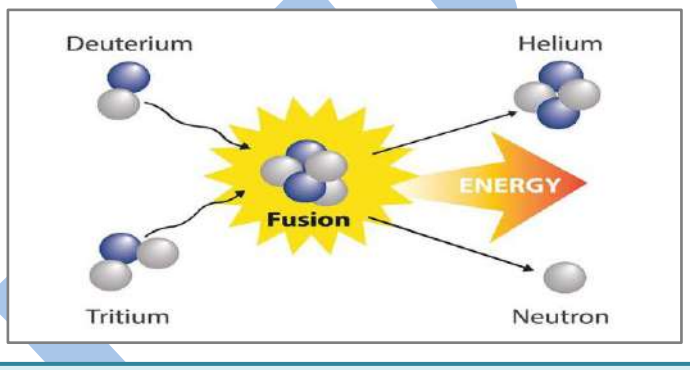
- China's HL-2M Tokamak is planning to collaborate with scientists working on the International Thermonuclear Experimental Reactor.

What is ITER?

- ITER is an international nuclear fusion research and engineering megaproject based in France.
- It will be the world's largest magnetic confinement plasma physics experiment.
- The ITER Members include—China, the European Union, India, Japan, Korea, Russia and the United States.

Significance of HL-2M Tokamak

- The development of nuclear fusion energy is a way to solve China's strategic energy needs.
- It also has great significance for the future sustainable development of China's energy and national economy.



Fusion

- Fusion is the process that powers the sun and the stars.
- It is the reaction in which two atoms of hydrogen combine together, or fuse, to form an atom of helium. In the process tremendous amounts of energy is released.

DEFENCE TECHNOLOGY

Missile Park Agneeprastha

- Foundation Stone for a **Missile Park "AGNEEPRASTHA"** was laid at INS Kalinga.
- 'AGNEEPRASTHA' aims to capture glimpses of Missile History of INS Kalinga since 1981 till date. 'AGNEEPRASTHA' will also provide a one-stop arena for motivation and stimulation of inquisitive minds regarding the missiles and related technologies, from schoolchildren to Naval personnel.
  - ✓ INS Kalinga is an Indian Navy establishment reporting to the Eastern Naval Command. It is responsible for preparing, storing and delivering advanced missiles to ships of the Eastern Fleet. INS Kalinga was commissioned on 21 November 1985.

Cruise Missile Vs Ballistic Missiles

Cruise Missile

- A cruise missile locates its target, or **has a preset target**, and navigates there.
- Cruise missiles generally consist of **a guidance system, payload, and aircraft propulsion system**.
- Cruise missiles that can be launched from various platforms whether from Land, Sea (Submarine, Ship) or Air
- They are known **specifically for the low-level flight** which is staying relatively close to the surface of the earth to avoid detection from anti-missile systems and are designed to carry large payloads with high precision.

- Cruise missiles can be categorized by size, speed (subsonic or supersonic), and range, and whether launched from land, air, surface ship, or submarine.
- Land attack missiles (LACM), are the cruise missiles which are designed to hit stationary or moving targets on land.

Ballistic Missile

- The ballistic missile is targeted as a projectile from a single launch force with not much-added guidance.
- It is launched directly into the high layers of the earth's atmosphere.
- It travels well outside the atmosphere and then the warhead detaches and falls back to earth. It follows the path of a ball thrown upwards which falls down.
- Since it depends on gravity to reach its target, it's called a ballistic missile.
- Ballistic missiles that fly above the atmosphere have a much longer range than cruise missiles of the same size.
- Ballistic missiles can travel extremely quickly along their flight path. An Inter Continental Ballistic Missile can strike a target within a 10,000 km range in about 30 to 35 minutes.
- With speeds of over 5,000 m/s, ballistic missiles are much harder to intercept than cruise missiles, due to the much shorter time available.
- Ballistic missiles are some of the most feared weapons available, despite the fact that cruise missiles are cheaper, more mobile, and more versatile.
- Tactical, short- and medium-range missiles are often collectively referred to as tactical and theatre ballistic missiles, respectively.
- Long- and medium-range ballistic missiles are generally designed to deliver nuclear weapons because their payload is too limited for conventional explosives to be cost-effective.
  - ✓ Payload is the **carrying capacity of an aircraft or launch vehicle**, usually measured in terms of weight.

Table 1 – Key characteristics of ballistic and cruise missiles

Characteristics	Ballistic missiles	Cruise missiles
Range	From low to very high *Up to 15 000 km*	Mostly around 1 000 km *Up to 4 000 km*
Altitude	High *Easily detectable*	Low *Hard to detect*
Precision	Low – around a few hundred metres *Fit for large targets*	High – a few metres *Fit for small and mobile targets*
Speed	Up to 25 000 km/h at impact *Very hard to intercept*	Around 1 000 km/h *Possibility to intercept*

Data source: EPRS.

C32 LH2

Context

- Hindustan Aeronautics Limited has delivered the biggest cryogenic propellant tank (C32 LH2) ever fabricated by the company to ISRO.

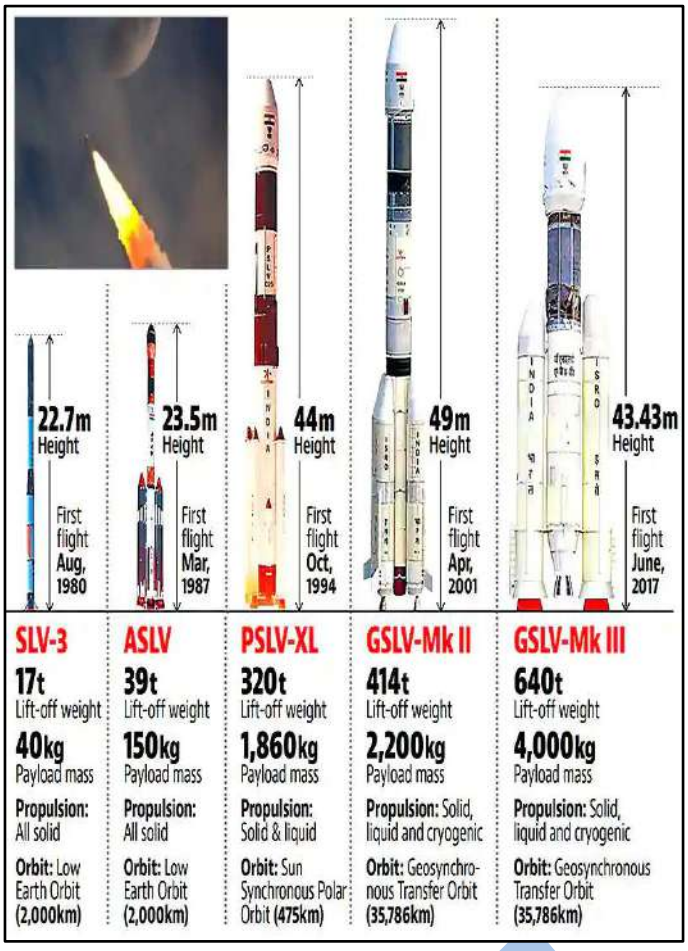
About

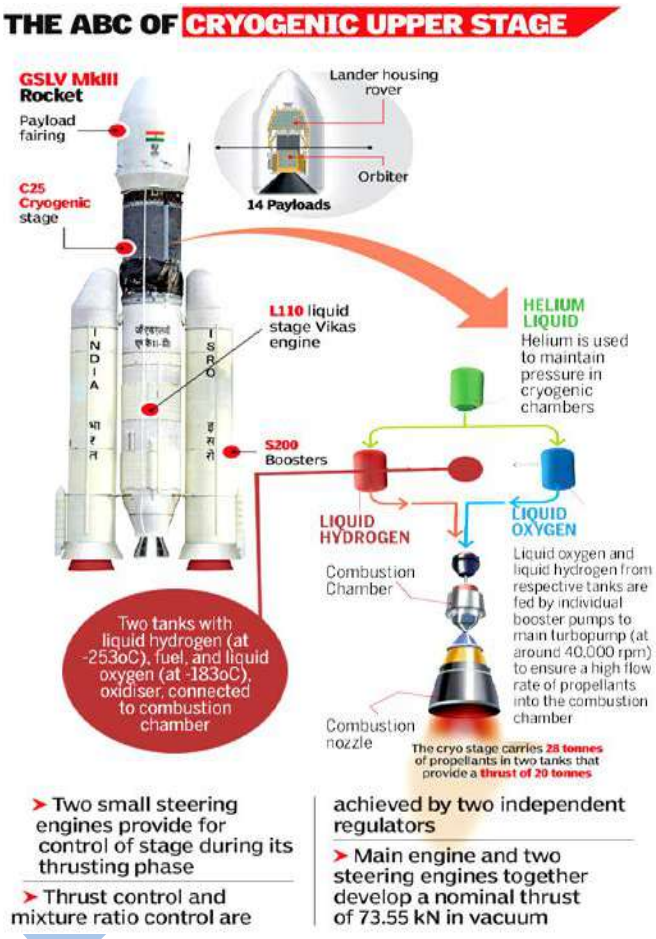
- The C32-LH2 tank is a developmental cryogenic propellant tank of aluminium alloy designed for improving the payload capability of GSLV MK-III launching vehicle.
- The four metre diametric tank is of eight-metre length to load 5,755 Kg propellant in the 89 cubic-metre volume.

- A cryogenic engine/ cryogenic stage are the last stage of space launch vehicles which makes use of Cryogenics.
- Cryogenics is the study of the production and behavior of materials at extremely low temperatures (below -150 degree centigrade) to lift and place the heavier objects in space.
- Cryogenic stage is technically a much more complex system with respect to solid or liquid propellant (stored on earth) stages due to the usage of propellants at extremely low temperatures.
- 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.
- Cryogenic engine makes use of Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) as propellants which liquefy at -183 deg C and -253 deg C respectively. LOX and LH2 are stored in their respective tanks.
- From there they are pumped in to turbo pump by individual booster pumps to ensure a high flow rate of propellants inside the combustion/thrust chamber.
- The major components of a cryogenic rocket engine are combustion/thrust chamber, igniter, fuel injector, fuel cryo pumps, oxidizer cryo pumps, gas turbine, cryo valves, regulators, the fuel tanks and a rocket engine nozzle.
- Cryogenic fuels are fuels that require storage at extremely low temperatures in order to maintain them in a liquid state. These fuels are used in machinery that operates in space (e.g. rocket ships and satellites) because ordinary fuel cannot be used their due to the very low temperatures often encountered in space, and due to absence of an environment that supports combustion (on Earth, oxygen is abundant in the atmosphere, whereas human-explorable space is a vacuum where oxygen is virtually non-existent). Cryogenic fuels most often constitute liquefied gases such as liquid hydrogen.
- Quite often, liquid oxygen is mistakenly called cryogenic fuel, though it is actually an oxidizer and not a fuel.

Applications of Cryogenic Technology

- In Rocket Engine
- Frozen Food
- Blood Banking
- Infrared Sensors
- Electronics
- X-Rays
- Preservation of Bodies
- Grinding
- Superconductivity





MISCELLANEOUS & NEW DISCOVERY

Energy-Efficient Photodetector

Context

- Indian Scientists have fabricated an economical and energy-efficient photo detectorusing gold – silicon interface, for security applications.

Photo Detectors

- Photo detectors devices are used for detection of light.

Applications

- Controlling automatic lighting in supermarkets to detecting radiation from outer galaxy as well as security-related applications.

Challenge

- The material cost and the intricate fabrication processes involved make the detectors unaffordable for day-to-day applications.

How Is The New Invention Feasible Then?

- In this case, scientists have fabricated gold (Au) – silicon (n-Si) interface, which show high sensitivity towards light.
- The Au–Si interface has been brought about by galvanic deposition - a technique for electroplating metals.
- In this, water-based solutions (electrolytes) are used, which contain the metals to be deposited as ions.

- Being a solution-based technique, the method is highly economical and enabled large-area fabrication without compromising the detector response.
- It could even detect weak scattered light as an indication of unwanted activity.
- The detector exhibits a rapid response of 40 microseconds.
- Notably, the **detector operates in self-powered mode**, which means the device does not require external power for its operation, thus **making it energy efficient.**

UV Light

Context

- Scientists are studying the use of **ultraviolet germicidal radiation (UVGI)** to detect the Corona virus in public places.
- Through this method, ultraviolet (UV) lights would be able to disinfect contaminated public spaces to stop the transmission of the virus.

Uv Light

- Ultraviolet (UV) is a form of electromagnetic radiation withwavelength from10 nm to 400 nm.
- They are shorter than that of visible light but longer than X-rays.
- It is not visible to the naked eye. The full spectrum of UV radiation is sourced from the sun and can be subdivided into UV-A, UV-B and UV-C rays.

UV-C

- Short-wavelength UV-C is the most damaging type of UV radiation.
- However, it is completely filtered by the atmosphere and does not reach the earth's surface.

UV-B

- Medium-wavelength UV-B is very biologically active but cannot penetrate beyond the superficial skin layers.
- It is responsible for delayed tanning and burning; skin ageing and development of skin cancer. Most solar UVB is filtered by the atmosphere.

UV-A

- The long-wavelength UV-A accounts for approximately 95 per cent of the UV radiation reaching the Earth's surface.
- It can penetrate into the deeper layers of the skin and is responsible for the immediate tanning effect. Furthermore, it also contributes to skin ageing and wrinkling.

Melamine-Milk Adulterant

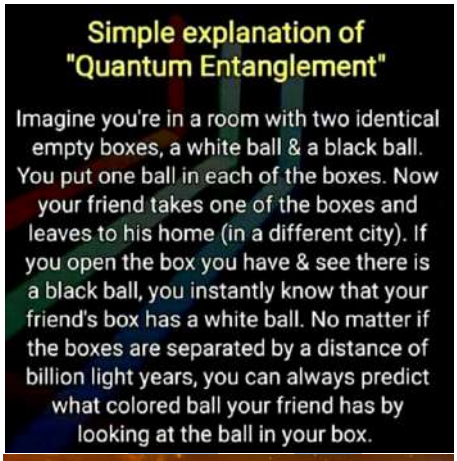
- Researchers have developed a **low-cost, hand-held device** to detect the presence of **melamine in milk** and dairy products.
- **Melamine is a compound that is used to adulterate milk and dairy products.**
- It can lead to kidney-related diseases and kidney failure.

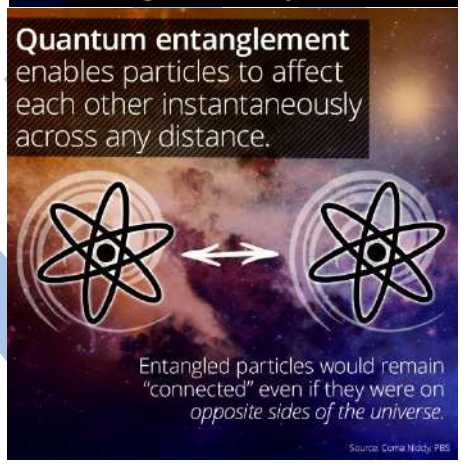
Lightweight Carbon Foam

- CSIR is developing a **porous carbon material**, which has the potential to replace lead grid in lead-acid batteries.
- It can also be useful for heat sinks in power electronics, electromagnetic interference shielding in aerospace, hydrogen storage and electrode for lead-acid batteries and water purification systems.
- The present grid-scale energy-storage sector is dominated by lithium-ion batteries.
- **Concerns:** Safety risk, limited resource supply, high cost, and lack of recycling infrastructure.
- The lightweight carbon foam is highly resistive to corrosion, has good electrical and thermal conductivity with high surface area. It could be an efficient alternative battery system.

Quantum Entanglement

- **Quantum entanglement** is a physical phenomenon that occurs when a pair or group of particles is generated, interact, or share spatial proximity in a way such that the quantum state of each particle of the pair or group cannot be described **independently** without knowing the state of the others, including when the particles are separated by a large distance.
- **Applications-**superdense coding and quantum teleportation. quantum computing, quantum cryptography etc.
    - Superdense coding is the underlying principle of **secure quantum secret coding.**
    - Quantum teleportation is a process in which quantum information (e.g. the exact state of an atom or photon) can be transmitted (exactly, in principle) from one location to another, with the help of classical communication and previously shared quantum entanglement between the sending and receiving location.
    - Quantum cryptography is the science of exploiting quantum mechanical properties to perform cryptographic tasks.(secure communication)





Champions

Context

- Recently, Prime Minister Narendra Modi launched the technology platform CHAMPIONS.
- It stands for **Creation and Harmonious Application of Modern Processes for Increasing the Output and National Strength.**

Aim

- The portal is a one-stop-shop solution of MSME (Micro-Small and Medium Enterprise) Ministry.
- It is basically for making the smaller units big by solving their grievances, encouraging, supporting, helping and handholding.

Detailed Objectives Of CHAMPIONS

- **Grievance Redressal:** To resolve the problems of MSMEs including those of finance, raw materials, labor, regulatory permissions etc. particularly in the COVID 19 created difficult situation;
- **To help them capture new opportunities:** Including manufacturing of medical equipments and accessories like PPEs, masks etc. and supply them in National and International markets;
- **To identify and encourage the sparks:** i.e. the potential MSMEs who are able to withstand the current situation and can become national and international champions.

India's First Online Waste Exchange

- Recently, **Andhra Pradesh** launched India's first online waste exchange programme.
- The program is launched for **safe disposal of toxic wastes and to promote recycling and reuse of toxic wastes.**
- The platform is to track, audit, scrutinize the waste and encourage proper utilization of the waste.

- The platform launched is to comply the **principles of6Rs namely Reuse, Recycle, Reduce, Redesign, Refurbish and Remanufacture.**

Magnetocaloric Materials

- Magnetocaloric effect (MCE) is a phenomenon where the application and removal of a magnetic field causes certain materials to get warmer and cooler, respectively.
- This effect normally occurs near its Curie temperature.
  - **Curie temperature** (TC) is the **temperature** at which certain materials lose their permanent magnetic properties, to be replaced by induced magnetism.
- Magnetocaloric effect is **utilized in magnetic refrigeration**, which is an environmentally friendly technology to obtain cooling efficiency nearly 60 % compared to the conventional gas-compression refrigerators (40 %).

Anthropause Period

- Researchers in the UK are set to study the "anthropause".
- Anthropause refers to the **corona virus-induced lockdown period and its impact on other species.**
- The reduced human activities mainly due to restrictions in travel, led to reports of unusual animal behavior in this period.
- That can help to provide insights that may be useful in preserving global biodiversity, maintaining the integrity of ecosystems and predicting global zoonoses and environmental changes.

LIDAR-Light Detection and Ranging

- It is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth.
- These light pulses—combined with other data recorded by the airborne system — generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.
- A lidar instrument principally consists of a laser, a scanner and a specialized GPS receiver.
- Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas.
- Two types of LIDAR are there
  - **Topographic LIDAR** typically uses a **near-infrared laser to map the land**.
  - **Bathymetric LIDAR** uses **water-penetrating green light to measure seafloor and riverbed elevations.**
- LIDAR systems allow scientists and mapping professionals to examine both natural and manmade environments with accuracy, precision, and flexibility.
- Scientists are using LIDAR to produce
  - ✓ more accurate **shoreline maps**,
  - ✓ make digital elevation models for use in geographic information systems,
  - ✓ to assist in emergency response operations.

Nature Index 2020

- The Nature Index 2020 highlighted the institutions and **countries that dominated high quality research in the natural sciences.** The Journal Nature Research released the Index.
- US, China and Germany are the top 3 countries.
- Three of the autonomous institutions of the Department of Science & Technology, Government of India have found their place among top 30 Indian Institutions in the world.
- These are the
  - ✓ Indian Association for the Cultivation of Science (IACS),Kolkata;
  - ✓ Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore and
  - ✓ S. N. Bose National Centre for Basic Sciences, Kolkata.

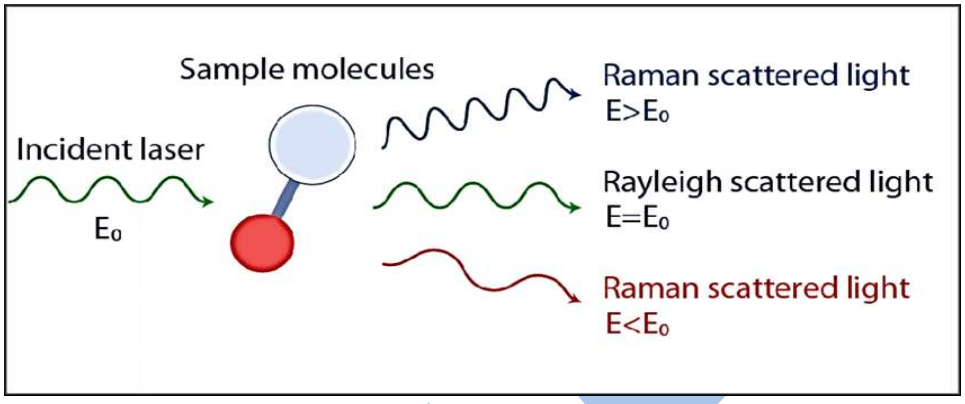
Raman Spectroscopy

Context

- Indian researchers have used Raman Spectroscopy to detect RNA viruses present in saliva samples.

What Is Raman Spectroscopy?

- Raman spectroscopy is an analytical technique where scattered light is used to measure the vibrational energy modes of a sample.
- It is named after the Indian physicist C. V. Raman who, together with his research partner K. S. Krishnan, was the first to observe Raman scattering in 1928.
- It can provide both chemical and structural information, as well as the identification of substances through the detection of Raman scattering from the sample.



Raman Scattering

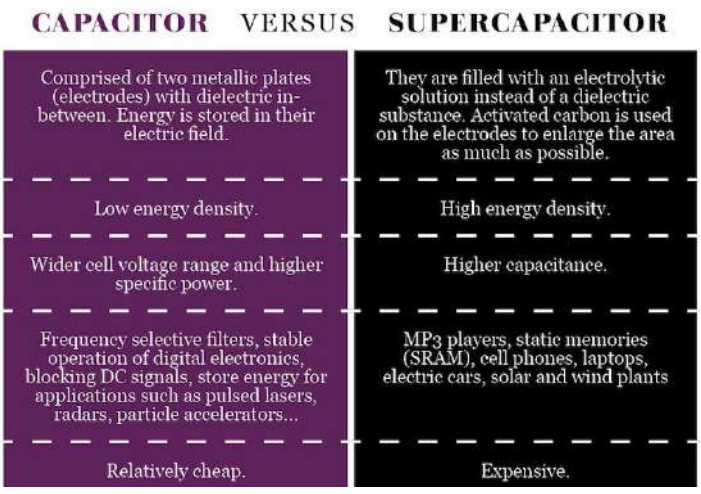
- When a beam of light traverses a dust-free, transparent sample of a chemical compound, most of this scattered light is of unchanged wavelength. This is called **Rayleigh Scattering.**
- A small part, however, has **different wavelengths and emerges in different directions from that of the incident light.** Its presence is a result of the **Raman Effect**.
  - **Raman Effect** is a change of wavelength exhibited by some of the radiation scattered in a medium. The effect is specific to the molecules, which cause it, and so can be used in spectroscopic analysis.

Metamaterials

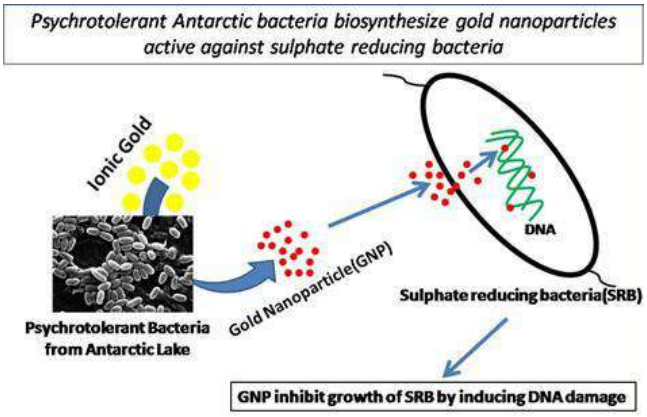
- Metamaterials are **artificially crafted composite materials** that derive their electrical properties from internal microstructure, rather than chemical composition found in natural materials.
- By engineering the arrangement of these nanoscale unit cells into a desired architecture or geometry, one can tune the refractive index of the metamaterial to positive, near-zero or negative values.
- Thus, metamaterials can be endowed with properties and functionalities unattainable in natural materials.
- Potential applications of metamaterials are diverse and include optical filters, medical devices, remote aerospace applications, sensor detection and infrastructure monitoring, smart solar power management, crowd control, high-frequency battlefield communication, improving ultrasonic sensors, and even shielding structures from earthquakes.

Super Capacitor

- A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals.
- A supercapacitor is a high-capacity capacitor with capacitance values much higher than normal capacitors but lower voltage limits.
  - ✓ Capacitance- the ability of a system to store an electric charge.
- They can store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors



Gold Nano Particles



- The **National Centre for Polar and Ocean Research (NCPOR)** and the Goa University (GU) have successfully synthesized gold nanoparticles (GNPs).
- They have used **psychrotolerant Antarctic bacteria** through a non-toxic, low-cost, and eco-friendly way to synthesize it.
  - ✓ Gold nanoparticles are small gold particles with a **diameter of 1 to 100 nm** which, once dispersed in water, are also known as colloidal gold.
  - ✓ Psychrophiles are defined as organisms that can grow only in low temperatures **up to a maximum of 20C**.
  - ✓ Psychrotolerant organisms are like mesophiles (growing at 20-40C), but are able to tolerate lower temperatures albeit with slower growth rates.
- GNPs can be used as composite therapeutic agent clinical trials, especially in anti-cancer, anti-viral, anti-diabetic, and cholesterol-lowering drugs.
- GNPs are also found to be useful in the electronics industry.
- **NCPOR-** It is an autonomous Institution of the Department of Ocean Development (DOD), Ministry of Earth Sciences, which is responsible for administering the Indian Antarctic Programme and maintains the Indian government's Antarctic research stations, **Bharati and Maitri.**

Polyoxymetalates

- Scientists from the Institute of Nano Science & Technology- an autonomous institute of the Department of Science and Technology, have synthesized a novel inorganic-organic hybrid compound.
- The compound can inhibit breast, lung, and liver cancer cells, opening up new possibilities for metallodrugs.
- The solid compound belongs to the Polyoxometalates (POMs) family, which had earlier been identified to have antitumor potential.
- In chemistry, a polyoxometalate is a polyatomic ion, usually an anion that consists of three or more transition metal oxyanions linked together by shared oxygen atoms to form closed 3-dimensional frameworks.

Cobotics

- The Department of Science of Technology (DST) is set to develop a technology innovation hub on Collaborative Robotics (Cobotics).
- A collaborative robot, or cobot, is a type of robot intended to physically interact with humans in a shared workspace.
- Collaborative robots are experiencing rapid market growth in this sector of the robotics industry. The primary driving force behind this growth is a consistently decreasing price.

Atal Innovation Mission

- Atal Innovation Mission (AIM) is Government of India's flagship initiative to promote a culture of innovation and entrepreneurship in the country.

Objective

- To develop new programmes and policies for fostering innovation in different sectors of the economy.
- To provide platform and collaboration opportunities for different stakeholders, create awareness and create an umbrella structure to oversee innovation ecosystem of the country.

Major Initiatives

- **Atal Tinkering Labs-**Creating problem solving mindset across schools in India.
- **Atal Incubation Centers-**Fostering world class startups and adding a new dimension to the incubator model.

- **Atal New India Challenges-**Fostering product innovations and aligning them to the needs of various sectors/ministeries.
- **Mentor India Campaign-** A national Mentor network in collaboration with public sector, corporates and institutions, to support all the intiatives of the mission.
- **Atal Community Innovation Center-** To stimulate community centric innovation and ideas in the unserved /underserved regions of the country including Tier 2 and Tier 3 cities.
- **ARISE-**To stimulate innovation and research in the MSME industry.

7.17. Ammonium Nitrate

Context

- Recently, a catastrophic explosion at **Beirut port**, Lebanon killed at least 100 people and injured around 4,000.
- It was caused by over 2,700 tonnes of ammonium nitrate kept in storage for over six years.
- Lebanon a mountainous country in the Levant with a **coastline on the eastern Mediterranean Sea.**
- Lebanon borders Israel in the south, Syria in the north t. The country also shares maritime borders with Cyprus. Capital- Beirut

AMMONIUM NITRATE	PROPERTIES & DETAILS
Colour & Structure	White, Crystalline Chemical
Solubility	Soluble in Water
Nature	Hygroscopic
Used in	Fertilizers and Explosives
Pure ammonium nitrate	Not an explosive
Explosion	When mixed with ingredients like fuel & Oil & detonated. (acts as a source of oxygen)

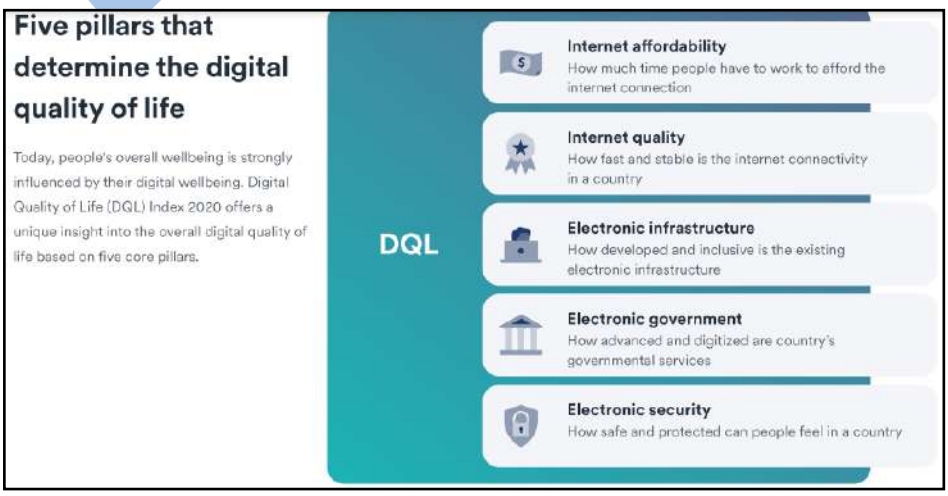
Digital Quality Of Life Index 2020

Context

- As per the "Digital Quality of Life Index 2020", India occupies **79th place**, ranking below countries including Guatemala and Sri Lanka.
- The Digital Quality of Life (DQL) index is published annually based on research conducted by the privacy protection company Surfshark.

Findings

- India makes it into the top 10 in terms of Internet affordability. With a ranking of nine, it outperforms countries such as the U.K., the U.S. and China.
- India occupies the 15th place globally in e-governance, just below countries like New Zealand and Italy.
- But India's Internet quality is one of the lowest across 85 countries. In position 78, India is at the bottom of the pillar with unstable and slow mobile Internet dragging it down in the overall Internet quality index.



Global Innovation Index 2020

Context

- Recently, the 13th edition of the **Global Innovation Index (GII) 2020** was released.

Who releases GII?

- World Intellectual Property Organization (WIPO) & Cornell University and INSEAD.

2020 Theme

- Who Will Finance Innovation?

Findings

- The COVID-19 crisis hit the innovation landscape at a time when innovation was flourishing.
- The money to fund innovative ventures is drying up.
- The impact of this shortage in innovation finance will be uneven, with the **negative effects felt more heavily by early-stage Venture Capital (VC),** by R&D-intensive start-ups, and in countries that are not typically VC hotspots.
- The COVID-19 crisis has already catalyzed innovation in many new and traditional sectors, such as health, education, tourism and retail.

WIPO

- WIPO is one of the 15 specialized agencies of the United Nations (UN)
- WIPO was created to promote and protect intellectual property (IP) across the world by cooperating with countries as well as international organizations.
- WIPO's two main objectives are:- (i) to promote the protection of intellectual property worldwide; and (ii) to ensure administrative cooperation among the intellectual property Unions established by the treaties that WIPO administers.

INSEAD

- It is a graduate business school with locations in Europe, Asia, the Middle East, and North America.

Top Rankers

- Switzerland, Sweden, the United States of America, the United Kingdom, and the Netherlands.
- The top-performing economies in the GII are still almost exclusively from the high-income group.

India's Performance

- India has for the **first time made it to the top 50 countries** in the Global Innovation Index (GII) 2020.
- India has become the **third-most innovative lower-middle-income economy in the world.**
- India ranks in the top 15 indicators such as information and communications technology (ICT) services exports, government online services, graduates in science and engineering, and research and development (R&D)-intensive global companies.

Nidhi Programme

Context

- Recently, a brochure featuring Entrepreneurs in Residence (EIR) under the National Initiative for Developing and Harnessing Innovations (NIDHI) programme was launched by Department of Science & Technology.

EIR

- Entrepreneurs-in-Residence (EIR) Programme is under National Initiative for Developing and Harnessing innovations (NIDHI) of Department of Science and Technology.
- It supports aspiring or budding entrepreneur of considerable potential for pursuing a promising technology business idea over a period up to 18 months with a subsistence grant up to Rs 30000 per month with a maximum cap for total support of Rs 3.6 lakh to each EIR over a maximum of 18 months.

NIDHI

- NIDHI (National Initiative for Development and Harnessing Innovations), is an umbrella program is pioneered by the Department of Science & Technology (DST).

Aim

- To nurture ideas and innovations (knowledge-based and technology-driven) into successful startups.

Objectives

- To take forward student innovations.
- To promote student startups.
- To accelerate the journey of idea to prototype by providing initial funding assistance.

Real Mango

- The Railway Protection Force (RPF) of Indian Railways has disrupted the operation **of illegal software named Real Mango.**

About

- The Real Mango Software is illegal software developed for booking Tatkal ticket over the IRCTC website.
- The software was earlier with the name 'Rare Mango'.
- While booking the tickets, the agent logs into the IRCTC website and bypasses the captcha code with the help of the software.
- The software syncs with the bank OTP and automatically fills the information of the passenger to book the tickets.
- It is mainly used by the agent to book the tatkal ticket by illegal means and sell it to the customer at a high price.
- The software logs in to the official website of IRCTC through multiple IRCTC Ids
- This illegal software is sold through a 5-tiered structure (system admin of the software along with his team, mavens, super sellers, sellers as well as agents)
- The payment is received by the system admin in bitcoins.

Gyan Circle Ventures

Context

- Recently, Union Minister for Education virtually inaugurated the Gyan Circle Ventures.

About

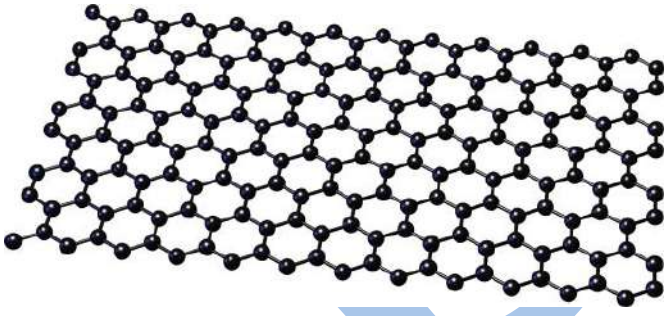
- It is a MeitY funded technology business incubator (TBI).
  - ✓ A business incubator is a company that helps new and startup companies to develop by providing services such as management training or office space.
- Gyan Circle Ventures would function as a technology incubation and development of entrepreneurs (TIDE 2.0) incubation center as approved by the Ministry of Information Technology (MeitY).
- Gyan Circle Ventures will serve as a hub for innovation and startups by providing support, in various phases, via investments, infrastructure and mentoring.
- The incubator would leverage the institutions' entrepreneurial spirit via utilizing its intellectual capital.
- It will also engage in using emerging technologies such as Artificial Intelligence (AI), Blockchain, Cyber Physical Systems (CPS), Cyber Security, Internet of Things (IoT), Robotics, etc.
- TBI would have an advisory committee comprising leading industrialists, entrepreneurs and technical experts.
- The incubator will serve as a catalyst for the advancement of society-conscious entrepreneurship and fuel job creation.

Graphene Masks

Context

- Recently, the researchers from Hong Kong have produced a laser-induced form of graphene masks that demonstrated potential in deactivating coronaviruses.

What is Graphene?



- Graphene is a **single layer (monolayer) of carbon atoms,** tightly bound in a hexagonal honeycomb lattice.
- It is an allotrope of carbon in the form. Layers of graphene stacked on top of each other form graphite.

Properties of Graphene

- Graphene is the thinnest compound known to man at one atom thick.
- The lightest material known
- The strongest compound discovered (between 100-300 times stronger than steel)
- Best conductor of heat at room temperature
- Best conductor of electricity
- uniform absorption of light across the visible and near-infrared parts of the spectrum
- It is also 97.7 percent transparent and has an extremely low permeability rate, with even helium atoms being unable to penetrate it.
- Graphene has the highest thermal conductivity ever recorded, standing at 10 times higher than copper.

Range of Applications of Graphene

- In Solar Cells, Batteries, Nuclear Power Plants, Thermoelectric, Alcohol Distillation, Fuel Cells, Drug Delivery, In Cancer Treatment, Gene Delivery, Photothermal Therapy, Diabetes Monitoring, Dialysis, Bone and Teeth Implantation, Tissue Engineering Cell Therapy, UV Sensors, For the Brain, HIV Diagnosis, Biosensors, Bactericide, Birth Control, Deaf-Mute Communication, Body Scans, Generating Light, Transistors, Waterproof Electronics, Wearable Electronics, Touchscreens, Flexible Screens, Hard Drives and Memories, Elastic Robots, Superconductor, Optoelectronics, Optical Sensors, Security Sensors, Food Packaging, Water Purification, Water Filtration, Desalination, Crop Protection, Food Security, Shoes, Helmets, Tires, Clothes, Rackets, Insulation, Construction, Photography, Automotive, Airplanes, Paints, Ballistics, Bulletproof vests, protective clothing weapons, Military Protective Equipment, Thermal and Infrared Vision, Machinery Lubricants, Corrosion Protection for Glass, Radiation Shielding, Anti-corrosion Oil and Gas Pipes

**No need to memorize. Just take a glance at the applications*

Room-Temperature Superconductor

Context

- Scientists have reported the discovery of the first room-temperature superconductor, after more than a century of waiting.

Superconductor

- A superconductor is a substance that **conducts electricity without resistance** when it becomes colder than a "critical temperature."
- At this temperature, electrons can move freely through the material.
- This means heat, sound or any other form of energy would not be released from the material when it has reached "critical temperature" (Tc), or the temperature at which the material becomes superconductive.
- Superconductors are different from ordinary conductors.
- Ordinary conductors lose their resistance slowly as they get colder. In contrast, superconductors lose their resistance all at once.
- This is an example of a phase transition. High magnetic fields destroy superconductivity and restore the normal conducting state.

- Prominent examples of superconductors include aluminium, niobium, magnesium diboride, cuprates such as yttrium barium copper oxide and iron pnictides.

About the Room Temperature Superconductor

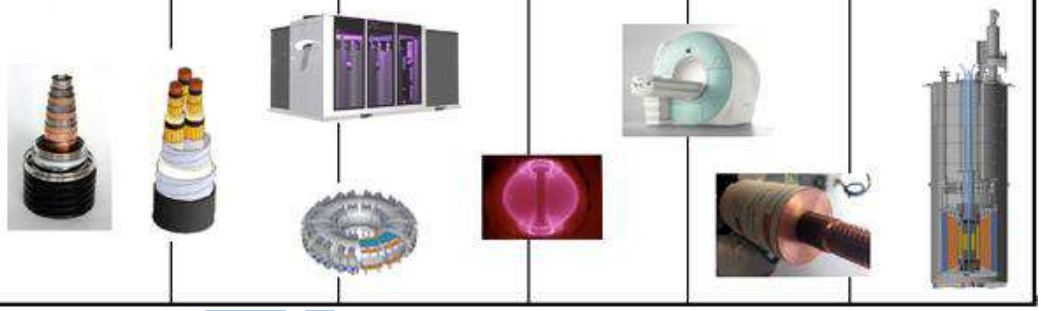
- This superconductor was produced by squeezing carbon, hydrogen and sulfur between the tips of two diamonds and hitting the material with laser light to induce chemical reactions.
- At a pressure about 2.6 million times that of Earth's atmosphere, and temperatures below about 15° C, the electrical resistance vanished.
- The material is superconducting below temperatures of about 15° Celsius (59° Fahrenheit).
- However, the new material's superconducting superpowers appear only at extremely high pressures, limiting its practical usefulness.

Significance

- All superconductors previously discovered must be cooled, many of them to very low temperatures, making them impractical for most uses.
- This would not be the case anymore.

Applications of Supercomputers

Energy	Defense	Transportation	Industrial	Medical	Science/ Research
• Cables • FCLs • Generators • Transformers • SMES • Fusion Reactors	• Motors • Cables	• Maglev • Motors	• Induction Heaters • Motors • Generators • Magnetic Separation • Bearings	• MRI • Particle Therapy • Current Leads	• HF Magnets • NMR • Accelerators • Neutron and X-ray Scattering • Undulators



Desalination Plant

Context

- Mumbai is all set to get its first desalination plant.

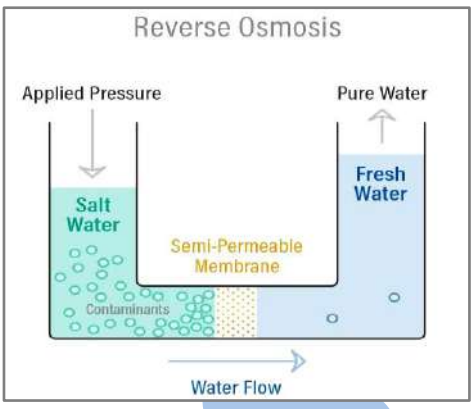
What are desalination plants?

- A desalination plant turns salt water into water that is fit to drink.
- The technology used for the process is reverse osmosis where an external pressure is applied to push solvents from an area of high-solute concentration to an area of low-solute concentration through a membrane.
- The microscopic pores in the membranes allow water molecules through but leave salt and most other impurities behind, releasing clean water from the other side.
- These plants are mostly set up in areas that have access to sea water.

Desalination Plants in India

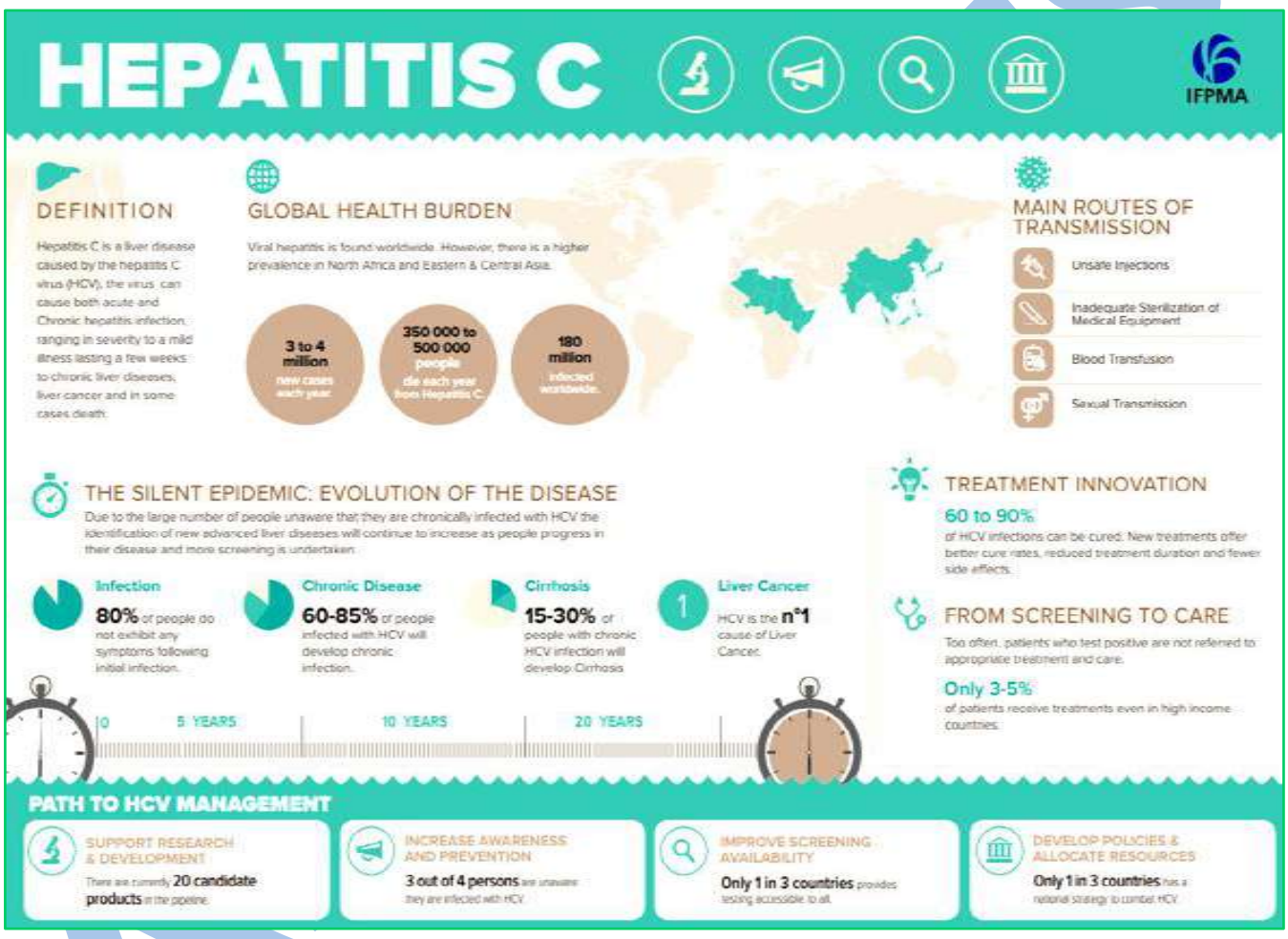
- Desalination has largely been limited to affluent countries in the Middle East, United States and Australia.

- In India, Tamil Nadu has been the pioneer in using this technology, setting up two desalination plants near Chennai in 2010 and then 2013.



Concerns

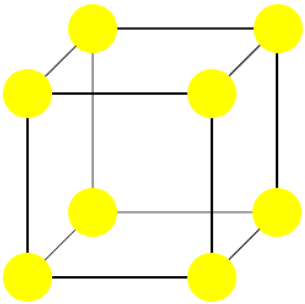
- Desalination is an expensive way of generating drinking water as it requires a high amount of energy.
- The other problem is the disposal of the byproduct — highly concentrated brine — of the desalination process.
- While in most places brine is pumped back into the sea, there have been rising complaints that it ends up severely damaging the local ecology around the plan.



'Damaru' Inspired Lattice

Context

- IIT Kanpur Researchers have developed 'Damaru' Inspired Lattice that finds applications in stealth submarines,high speed trains.



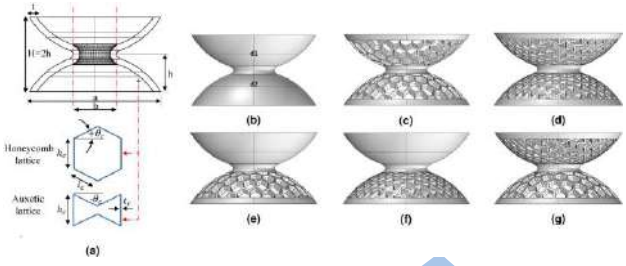
What is a Lattice?

- A lattice is an ordered array of points describing the arrangement of particles that form a crystal.
- The unit cell of a crystal is defined by the lattice points. The unit cell is the smallest part of a crystal that repeated regularly through translation in three dimensions creates the whole crystal.

- For example, the image shown here is the unit cell of a primitive cubic structure.

About Damaru' Inspired Lattice

- IIT Kanpur researchers have demonstrated how with the use of a micro-structured hour-glass shaped metastructure in the lattice unit, one can get a wider variation of propagation and stop bands.



Application

- Lattice based meta-structures have shown tremendous application in electro-magnetic and sonic wave absorption which could in principle create 'invisibility' of an object either in optical or in acoustic domain.
- Existing lattice and crystal based phononic materials have however, practical limitations in terms of customizability and hence, they can be generally used in a narrow band of frequency.

Inspiration

- Inspiration of the lattice they developed has come from a two-headed drum called 'Dambaru' or 'Damaru' which is used in ancient Hinduism and Tibetan Buddhism.
- IIT Kanpur researchers have shown the nature of stiffness of a vibrating medium could be altered drastically by controlling the lattice micro-structure from regular honeycomb to auxtetic honeycomb structure.
- This has wide applications in the field of vibration isolation in high speed trains, stealth submarines and helicopter rotors.

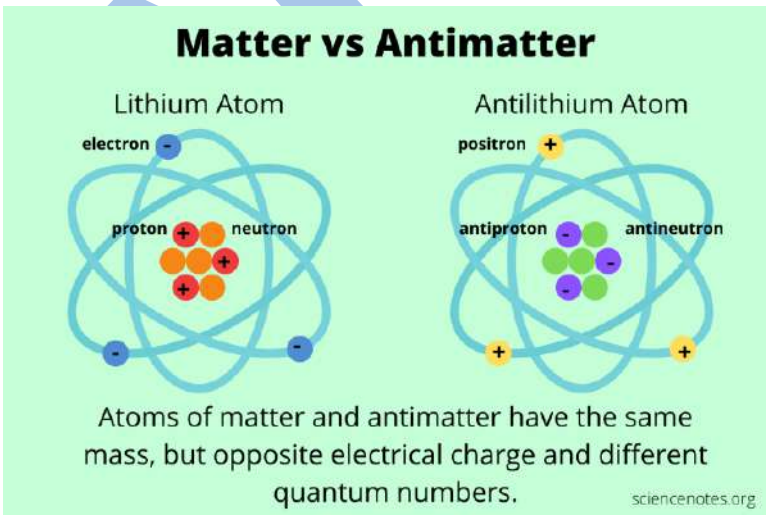
Antimatter

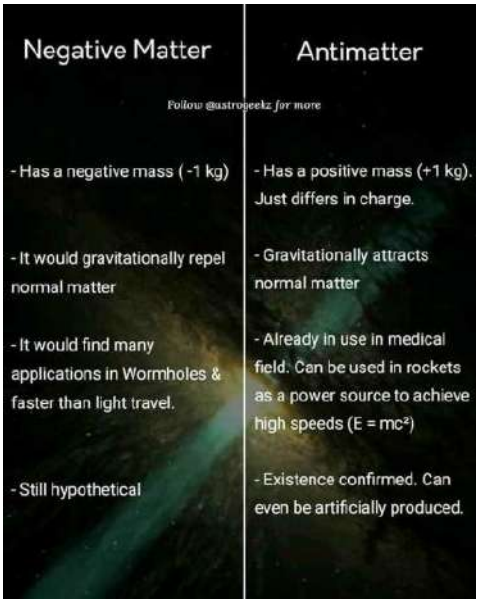
Context

- A new experiment at the world's most powerful particle collider sheds light on an enduring cosmic mystery---- Why Is There More Matter than Antimatter?

About

- Antimatter particles are created in ultra high speed collisions.
- In the first moments after the Big Bang, only energy existed.
- As the universe cooled and expanded, particles of both matter and antimatter were produced in equal amounts.
- Antimatter is the opposite of normal matter. Why matter came to dominate is a question that scientists have yet to discover.
- More specifically, the sub-atomic particles of antimatter have properties opposite those of normal matter.
- The electrical charge of those particles is reversed.

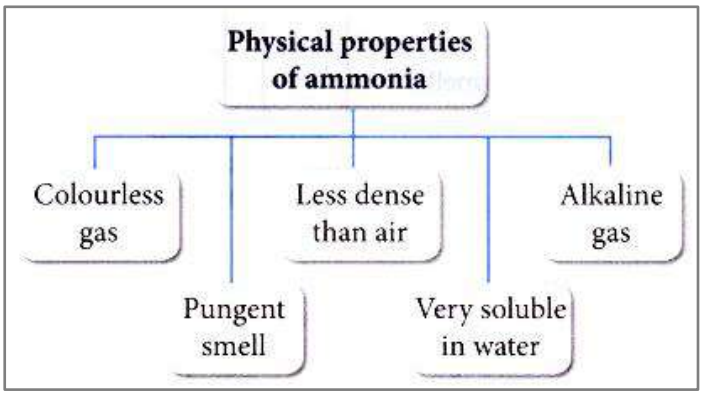


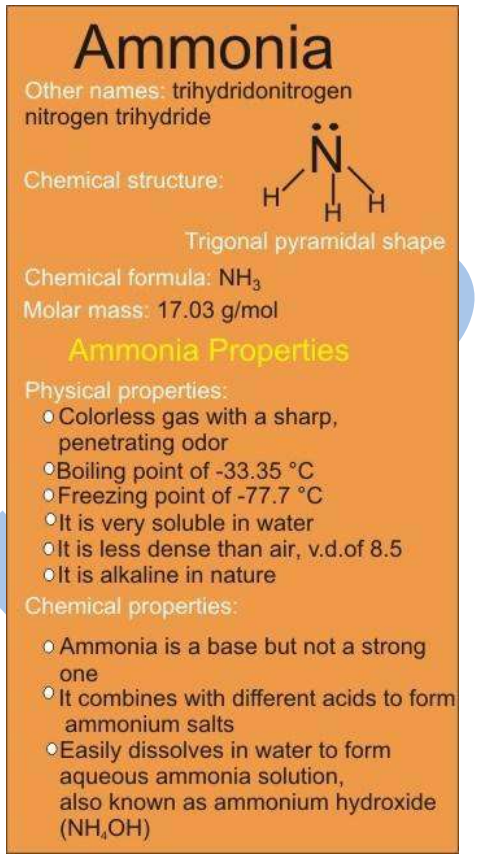


Ammonia

Context

- Two persons died and several took ill in a major ammonia gas leakage at the Indian Farmers Fertilizer Cooperative Limited (IFFCO) unit at Prayagraj.





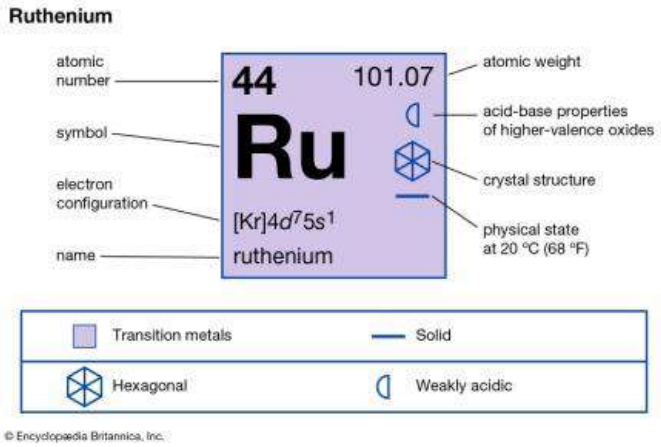
Ruthenium 106

Context

- Bhabha Atomic Research Centre (BARC) Mumbai has developed Eye Cancer therapy in the form of the first indigenous Ruthenium 106 Plaque for treatment of Ocular Tumours.

What is Ruthenium-106?

- Ruthenium-106 is a radioactive form of the rare heavy metal ruthenium, which is a "platinum group" metal similar to platinum.
- Radioactive isotopes or forms of elements naturally decay into other elements, giving off radiation in the process.



Source

- Ruthenium-106 is produced from the fission or splitting of uranium-235, the type of uranium used in nuclear fission reactors, so it's found in spent nuclear fuel.
- It's also used in medicine for cancer radiation therapy, especially for eye and skin tumours, so it may be produced for that purpose.
- And it's used in radioisotope thermoelectric generators that power satellites, says BfS, the German federal office for radiation protection.

Radiation

- Ruthenium-106 gives off radiation in the form of high energy electrons called beta particles as it decays into rhodium-106 and then into palladium-106, which isn't radioactive.
- Ruthenium-106 has a half life of 373.6 days, or around a year. That means after a year, half of it would have decayed and only half would remain.

Atal Tinkering Labs

Context

- Atal Innovation Mission, NITI Aayog and Indian Space Research Organization (ISRO) announced that ISRO will be adopting 100 Atal Tinkering Labs across the country.

ATL

- Atal Tinkering Lab (ATL) is a program run by Atal Innovation Mission (AIM) under NITI Aayog to foster curiosity and innovative mindset in young students across India to encourage research and innovation in schools across the country
- **Vision:** to 'Cultivate one Million children in India as Neoteric Innovators'.

Objectives

- To foster curiosity, creativity and imagination in young minds and inculcate skills such as design mind - set, computational thinking, adaptive learning, physical computing, rapid calculations, measurements etc.
- Young children will get a chance to work with tools and equipment to understand what, how and why aspects of STEM (Science, Technology, Engineering and Math).

Key Features of ATL

- ATL is a work space where young minds can give shape to their ideas through hands on do-it-yourself mode; and learn innovation skills.
- Young children will get a chance to work with tools and equipment to understand the concepts of STEM (Science, Technology, Engineering and Math).
- ATL would contain educational and learning 'do it yourself' kits and equipment on – science, electronics, robotics, open source microcontroller boards, sensors and 3D printers and computers. Other desirable facilities include meeting rooms and video conferencing facility.
- In order to foster inventiveness among students, ATL can conduct different activities ranging from regional and national level competitions, exhibitions, workshops on problem solving, designing and fabrication of products, lecture series etc. at periodic intervals.

Financial Support

- AIM will provide grant-in-aid that includes a one-time establishment cost of Rs. 10 lakh and operational expenses of Rs. 10 lakh for a maximum period of 5 years to each ATL.

Eligibility

- Schools (minimum Grade VI - X) managed by Government, local body or private trusts/society to set up ATL.
- The applicant school would have to provide at least 1,500 Sq. Ft. of built up space. Applicant schools from hilly /Himalayan and island states, UTs would have to provide atleast 1,000 Sq. Ft. of built up space.
- The existing facilities for meeting rooms and video conferencing among others can be used to supplement the laboratory.

National Innovation Foundation

Context

- The Union Minister for Science & Technology, Earth Sciences, and Health & Family Welfare recently dedicated an Innovation Portal, developed by National Innovation Foundation (NIF) – India.

NIF

- It is an autonomous body of the Department of Science and Technology (DST), Government of India.

NIP

- The National Innovation Portal (NIP) is currently home to about 1.15 lakh innovations scouted from common people of the country, covering Engineering, Agriculture, Veterinary and Human Health.
- In terms of domain areas, presently the innovations cover Energy, mechanical, automobile, electrical, electronics, household, chemical, civil, textiles, Farm/cultivation practice, storage practice, plant variety, plant protection, poultry, livestock management, nutraceuticals etc.
- Herbal practices which stem from tribal areas and is one of the key highlights of the Innovation Portal.

Significance

- This Innovation Portal will help institutionalize new ideas by common people towards finding solutions to local problems.

Active Matter Systems

Context

- Scientists have found a clue to dynamical origin of fluctuations in systems like fish schools, swarm of insects, flocking birds and bacterial colonies, which are called active matter systems.

About

- Active matter systems are made up of units that consume energy.
- Active matter exhibits a wide range of emergent non-equilibrium phenomena.
- Active matter encompasses synthetic and living systems, including active gels and the cytoskeleton, cells and tissues, Nano robots and micro robots, synthetic and biological micro swimmers, and animal herds.
- Physicists group flocks of birds, molecular motors and layers of vibrating grains together in this category because they all extract energy from their surroundings at a single particle level and transform it into mechanical work.
- Due to continuous energy input, such systems are driven far from equilibrium and exhibit, fascinating collective behaviors, like clustering, "giant" mass fluctuations and anomalous transport.
- By studying the anomalous behaviors that emerge, our understanding of these systems can be enhanced and new frameworks for investigating the statistical physics of out-of-equilibrium systems can be built.

Example

- The anomalous behavior of such systems can be understood by considering a cup of coffee, stirred with a spoon.
- If one stops stirring, the coffee will eventually come to rest, due to the internal viscous forces, which resist the fluid motion.
- In contrast, imagine "stirring" a bacterial solution, which, under suitable conditions (bacterial concentration), can exhibit perpetual or unceasing collective directed motion; in that case, the viscosity would vanish in such "active" bacterial fluids.
- Probing into this anomalous behavior, scientists studied a toy model of self-propelled particles and explained the dynamical origin of 'giant' mass fluctuations in the system, providing insights into the emergent properties of such active matters in general.