RAPID REVISION BOOK

for Prelims - 2021

special edition

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Science and Technology



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With respect to the re-scheduled **Civil Services (Preliminary) Examination, 2021**, which is now dated on **10th October, 2021**, the time is ripe for more **targeted revision**.

In this regard, students usually search for a **complete revision material** addressing their needs in the **final preparation** for the examination. With time on your side, embark this journey with us through our **Rapid Revision Books**.

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RAPID REVISION BOOK-4
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- **Curation of content** as per relevance with the coming examination.
- **Covers finer and basic revision points.**
- **Covers relevant current affairs.**
- **Easy to understand.**
- **Optimum coverage within minimum pages.**

Hence, this book takes care of **basic knowledge of subject**, **facts**, **filtered current affairs** and **sound mix** of **relational understanding**.
The overall emphasis is on making students confident and mentally relaxed before the examination.

Now, start your final round of revision with **RAPID REVISION BOOKS** to emerge ahead from your fellow competitors.

Note: The final **Rapid Revision Book-5** is on **International Affairs**. Release date is **11th August, 2021**.

Stay connected.
Best of Efforts and Sound Luck!

From

Shield IAS

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SCIENCE AND TECHNOLOGY

(Special Edition for Prelims 2021)

SPACE

INTERNATIONAL SPACE STATION (ISS)

- The International Space Station (ISS) is a modular space station (habitable artificial satellite) in **low Earth orbit.**
- It is a multinational collaborative project involving five participating space agencies: **NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).**
- Originally called **Freedom in the 1980s** by U.S. Pres. Ronald Reagan, who authorized the National Aeronautics and Space Administration (NASA) to build it within 10 years, it was redesigned in the 1990s to reduce costs and expand international involvement, at which time it was renamed.
- In 1993, the United States and Russia agreed to merge their separate space station plans into a single facility, integrating their respective modules and incorporating contributions from the European Space Agency (ESA) and Japan.
- Assembly of the International Space Station (ISS) began with the launches of the **Russian control module Zarya on November 20, 1998, and the U.S.-built Unity connecting node** the following month, which were linked in orbit by U.S. space shuttle astronauts.
- In mid-2000 the Russian-built module Zvezda, a habitat and control centre, was added, and in November of that year the ISS received its first resident crew, comprising Russian cosmonauts Sergey Krikalev and Yuri Gidzenko and American astronaut William Shepherd, who flew up in a Soyuz spacecraft.
- A NASA microgravity laboratory called **Destiny** and other elements were subsequently joined to the station, with the overall plan calling for the assembly, over a period of several years, of a complex of laboratories and habitats crossed by a long truss supporting four units that held large solar-power arrays and thermal radiators.
- Much of the early research work by ISS astronauts was to focus on long-term life-sciences and material-sciences investigations in the weightless environment.
- The **ISS became fully operational in May 2009** when it began hosting a six-person crew; this required two Soyuz lifeboats to be docked with the ISS at all times. The six-person crew typically consisted of three Russians, two Americans, and one astronaut from either Japan, Canada, or the ESA.
- After completion of the ISS, the shuttle was retired from service in 2011. Thereafter the ISS was serviced by Russia's Progress, Europe's ATV, Japan's H-II Transfer Vehicle, and two commercial cargo vehicles, SpaceX's Dragon and Orbital Sciences Corporation's Cygnus.
- The station serves as a microgravity and space environment research laboratory in which scientific research is conducted in astrobiology, astronomy, meteorology, physics, and other fields.
- The ISS is suited for testing the spacecraft systems and equipment required for possible future long-duration missions to the Moon and Mars.

1967 OUTER SPACE TREATY

- The United States and its Western allies submitted proposals in 1957 on reserving space exclusively for "peaceful and scientific purposes," but the Soviet Union rejected these efforts because it was preparing to launch the world's first satellite and test its first intercontinental ballistic missile.
- **In 1963, the UN General Assembly approved two resolutions** on outer space that subsequently became the basis for the Outer Space Treaty. **UN Resolution 1884** called on countries to refrain from stationing WMD in outer space. **UN Resolution 1962** set out legal principles on outer space exploration, which stipulated that all countries have the right to freely explore and use space.
- The United States and Soviet Union submitted separate draft outer space treaties to the UN General Assembly in June 1966. A mutually agreed treaty text was worked out over the next six months, and the UN General Assembly gave its

approval of the treaty on December 19, 1966. The treaty opened for signature in Washington, Moscow, and London on January 27, 1967 and entered into force October 10, 1967.

- The **1967 Outer Space Treaty bans** the stationing of weapons of mass destruction (WMD) in outer space, prohibits military activities on celestial bodies, and details legally binding rules governing the peaceful exploration and use of space.
- The treaty entered into force Oct. 10, 1967, and has 110 states-parties, with another 89 countries that have signed it but have not yet completed ratification.

Treaty Terms

- The treaty **forbids countries from deploying** "nuclear weapons or any other kinds of weapons of mass destruction" in outer space.
- The term "weapons of mass destruction" is not defined, but it is commonly understood to include nuclear, chemical, and biological weapons.
- The treaty, however, **does not prohibit the launching of ballistic missiles**, which could be armed with WMD warheads, through space.
- The treaty repeatedly emphasizes that space is to be used for peaceful purposes, leading some analysts to conclude that the treaty could broadly be interpreted as prohibiting all types of weapons systems, not just WMD, in outer space.

The treaty's key arms control provisions are in **Article IV**. States-parties commit not to:

- Place in orbit around the Earth or other celestial bodies any nuclear weapons or objects carrying WMD.
- Install WMD on celestial bodies or station WMD in outer space in any other manner.
- Establish military bases or installations, test "any type of weapons," or conduct military exercises on the moon and other celestial bodies.

Other treaty provisions underscore that space is no single country's domain and that all countries have a right to explore it. These provisions state that:

- **Space should be accessible** to all countries and can be freely and scientifically investigated.
- **Space and celestial bodies are exempt from national claims** of ownership.
- Countries are to **avoid contaminating and harming space** or celestial bodies.
- **Countries exploring space are responsible and liable for any damage** their activities may cause.
- Space exploration is to be **guided by "principles of cooperation and mutual assistance,"** such as obliging astronauts to provide aid to one another if needed.
- Like other treaties, the Outer Space Treaty allows for amendments or member withdrawal.
- Article XV permits countries to propose amendments.
- An amendment can only enter into force if accepted by a majority of states-parties, and it will only be binding on those countries that approve the amendment.
- Article XVI states a country's withdrawal from the treaty will take effect a year after it has submitted a written notification of its intentions to the depositary states: the United States, Russia, and the United Kingdom.

STANDARD MODEL OF PHYSICS

- The standard model identifies elementary particles into Quarks, Leptons and Bosons.
- **ANTIMATTER:** Every known matter has an antimatter which has the same mass and volume; only difference being the inherent charge. Antimatter has an opposite charge when compared to its matter. While the Anti-matter of a proton is called **Anti-Proton**, the Antimatter of an electron is called **Positron.**

- **QUARKS**

- Quarks are elementary particles propounded in the standard model.
- They join to form **hadrons**, such as protons and neutrons, which are components of the nuclei of atoms.

- The antiparticle of a quark is the **antiquark**.
- There are 6 principal quarks and hence 6 anti quarks.
- Quarks and antiquarks are the only two fundamental particles that interact through all four **fundamental forces of physics**: **gravitation**, **electromagnetism**, and the **strong interaction** and **weak interactions**.
- A quark exhibits confinement, which means that the quarks are not observed independently but always in combination with other quarks.
- This makes determining the properties (mass, spin, and parity) impossible to measure directly.

- **LEPTONS**

- Like quarks, Leptons too are of 6 kinds. However, they do not have any fractional charge. The leptons are: ELECTRON, MUON, TAU and 3 Types OF NEUTRINOS
- Electron being a Lepton is a fundamental elementary particle.

- **FERMION**

- Fermions are particles which have half-integer spin and therefore are constrained by the **Pauli exclusion principle**.
- Particles with integer spin are called bosons. Fermions include electrons, protons, neutrons.
- Fermions include all quarks and leptons.
- The fact that electrons are fermions is foundational to the buildup of the periodic table of the elements since there can be only one electron for each state in an atom (only one electron for each possible set of quantum numbers).
- The fermion nature of electrons also governs the behavior of electrons in a metal where at low temperatures all the low energy states are filled up to a level called the Fermi energy.

- **BOSON:** Boson is a **collective name** given to particles that carry forces. It has been named after Indian scientist Satyendra Nath Bose. Gravity as a force of nature is yet not accepted by the Standard Model due to the failure to discover its Boson. Strong Nuclear Force is the strongest known force while gravity is the weakest.

GOD PARTICLE

- Peter Higgs suggested that particles did not have mass just after Big Bang. As the universe cooled and temperature fell below the critical point, an invisible force field got formed which has been termed the Higgs Field.
- The associated particles with the Higgs field have been termed the **Higgs Boson.** It has been theorized that any particle that interacted with these Higgs Boson got mass and those particles that were left out of the Higgs field remained massless.
- As these Higgs Bosons have the capability to grant mass, the primary condition for the existence of matter, they were termed as the God particle.
- The Big Bang Theory is the leading explanation about how the universe began. It talks about the universe as we know it starting with a small singularity, then inflating over the next 13.8 billion years to the cosmos that we know today.

NEUTRINOS

- They are produced by the **decay** of radioactive elements. After Photons(light carriers) they are the most abundant particles in the cosmos. They propagate over large distances even through solid matter.
- They **have** mass, but it is exceedingly small, a tiny fraction of the mass of a proton.
- There are 3 types of neutrinos, called **flavors**.
- One related to the electron, one related to muon and the third type is related to tau.
- The main difference between the neutrinos and their "relatives" is that neutrinos are electrically neutral, while the electron, muon, and tau are electrically charged.

- Neutrinos are difficult to detect, because they do not readily interact with other forms of matter. But using special equipment located in deep underground laboratories where no other cosmic particles can penetrate, scientists have detected neutrinos and discovered some of their properties.

Neutrinos Oscillation

- The earth receives majority of the neutrinos from the sun itself. For years' scientists were trying to figure out an anomaly between the observed and the theoretical data of the neutrinos observed.
- The studies held by the Super-Kamiokande detector in Japan showed that up to two thirds of number of neutrinos were missing in measurements performed on Earth.
- This was explained by the "metamorphosis" of the 3 neutrinos into one another called neutrino oscillation. This oscillation implies that Neutrinos have mass, however very small.

DARK MATTER & DARK ENERGY

Dark Matter

- It was in 1930s when Fritz Zwicky observed that many galaxies were moving faster than theoretical calculations. This implied that there was some mysterious gravitational pull towards the centre of those galaxies. The quantity of matter needed to exert such a pull far exceed the observed matter. This extra matter which invisible and undetected has been termed as Dark Matter.
- Gradually many astronomers started researching on dark matter. It was when the Andromeda Galaxy was observed to be moving faster than expected that dark matter took the centre stage of astronomical research.

Characteristics of Dark Matter

- It has not yet been observed yet directly. It doesn't interact with matter and is completely invisible to light and other forms of electromagnetic radiation making it impossible to detect.
- Scientists are confident it exists because of the gravitational effects it has on galaxies and galaxy clusters.
- The light from distant galaxies gets distorted and magnified by massive, invisible clouds of dark matter in the phenomenon known as **Gravitational Lensing**.
- There are 2 schools of thoughts on the existence of Dark Matter. While one school supports the idea of MACHOS (MAssive Compact Halo ObjectS) the other advocated WIMPS(Weakly Interacting Massive ParticleS).
- MACHOS are made up of Baryons(protons and neutrons) while WIMPS consists of Exotic particles which in turn are non-baryonic
- Dark matter responds to **2 of the Fundamental Forces**: Weak Nuclear Force and Gravitational Force.

Dark Energy: Roughly 68% of the universe is dark energy. it is a property of space so does not get diluted as space expands. As more space comes into existence, more of this energy-of-space appears. As a result, dark energy causes the universe to expand faster and faster.

Impacts of Dark matter and Dark Energy on Universe

- While Dark matter exerts a "pull" on the universe, Dark Energy has a contrasting expansionary effect. As is it evident, our universe is expanding, indicating that Dark Energy has a greater abundance than dark matter. By the laws of cosmology, the total amount of mass in the universe cannot increase. Hence while the amount of Dark matter remains constant, Dark Energy which is a property of space itself is bound to increase exponentially. Eventually, Dark energy would overcome the influence of dark matter and lead to further expansion of the universe.

BLACK HOLE

- **Don't let the name fool you**: a black hole is anything but empty space. Rather, it is a **great amount of matter packed into a very small area** - think of a star ten times more massive than the Sun squeezed into a sphere

approximately the diameter of a city. The result is a gravitational field so strong that nothing, not even light, can escape.

- A black hole is a place in space where gravity pulls so much that even light cannot get out. The gravity is so strong because matter has been squeezed into a tiny space. This can happen when a star is dying.
- Because no light can get out, people can't see black holes. They are invisible. Space telescopes with special tools can help find black holes. The special tools can see how stars that are very close to black holes act differently than other stars.
- The idea of an object in space so massive and dense that light could not escape it has been around for centuries. Most famously, black holes were predicted by **Einstein's theory of general relativity**, which showed that when a massive star dies, it leaves behind a small, dense remnant core. If the core's mass is more than about three times the mass of the Sun, the equations showed, the force of gravity overwhelms all other forces and produces a black hole.

How Big Are Black Holes?

- Black holes can be big or small. Scientists think the smallest black holes are as small as just one atom. These black holes are very tiny but have the mass of a large mountain. Mass is the amount of matter, or "stuff," in an object.
- Another kind of black hole is called **"stellar."** Its mass can be up to 20 times more than the mass of the sun. There may be many, many stellar mass black holes in Earth's galaxy. Earth's galaxy is called the Milky Way.
- The largest black holes are called "**supermassive.**" These black holes have masses that are more than 1 million suns together. Scientists have found proof that every large galaxy contains a supermassive black hole at its center. The supermassive black hole at the center of the Milky Way galaxy is called **Sagittarius A**. It has a mass equal to about 4 million suns and would fit inside a very large ball that could hold a few million Earths.

How Do Black Holes Form?

- Scientists think the smallest black holes formed when the universe began.
- **Stellar black holes are made when the center of a very big star falls in upon itself, or collapses**. When this happens, it causes a **supernova.** A supernova is an exploding star that blasts part of the star into space.
- Scientists think supermassive black holes were made at the same time as the galaxy they are in.

If Black Holes Are "Black," How Do Scientists Know They Are There?

- A black hole cannot be seen because strong gravity pulls all of the light into the middle of the black hole. But scientists can see how the strong gravity affects the stars and gas around the black hole. Scientists can study stars to find out if they are flying around, or orbiting, a black hole.
- When a black hole and a star are close together, high-energy light is made. This kind of light cannot be seen with human eyes. Scientists use satellites and telescopes in space to see the high-energy light.

Could a Black Hole Destroy Earth?

- Black holes do not go around in space eating stars, moons and planets. Earth will not fall into a black hole because no black hole is close enough to the solar system for Earth to do that.
- Even if a black hole the same mass as the sun were to take the place of the sun, Earth still would not fall in. The black hole would have the same gravity as the sun. Earth and the other planets would orbit the black hole as they orbit the sun now.
- The sun will never turn into a black hole. The sun is not a big enough star to make a black hole.

GRAVITATIONAL WAVES

- Gravitational waves are **'ripples' in space-time** caused by some of the most violent and energetic processes in the Universe.
- Albert Einstein predicted the **existence of gravitational waves in 1916 in his general theory of relativity**. Einstein's mathematics showed that massive accelerating objects (such as neutron stars or black holes orbiting each other)

would disrupt space-time in such a way that 'waves' of undulating space-time would propagate in all directions away from the source. These cosmic ripples would travel at the speed of light, carrying with them information about their origins, as well as clues to the nature of gravity itself.

- The strongest gravitational waves are produced by cataclysmic events such as **colliding black holes, supernovae (massive stars exploding at the end of their lifetimes), and colliding neutron stars**. Other waves are predicted to be caused by the rotation of neutron stars that are not perfect spheres, and possibly even the remnants of gravitational radiation created by the Big Bang.
- Though Einstein predicted the existence of gravitational waves in 1916, the first proof of their existence didn't arrive until 1974, 20 years after his death. In that year, two astronomers using the Arecibo Radio Observatory in Puerto Rico discovered a binary pulsar, exactly the type of system that general relativity predicted should radiate gravitational waves. Knowing that this discovery could be used to test Einstein's audacious prediction, astronomers began measuring how the stars' orbits changed over time. After eight years of observations, they determined that the stars were getting closer to each other at precisely the rate predicted by general relativity if they were emitting gravitational waves. For a more detailed discussion of this discovery and work, see Look Deeper.
- Since then, many astronomers have studied **pulsar radio-emissions** *(pulsars are neutron stars that emit beams of radio waves)* and found similar effects, further confirming the existence of gravitational waves. But these confirmations had always come indirectly or mathematically and not through direct contact.
- All of this changed on September 14, 2015, when LIGO physically sensed the undulations in spacetime caused by gravitational waves generated by two colliding black holes 1.3 billion light-years away. LIGO's discovery will go down in history as one of humanity's greatest scientific achievements.
- While the processes that generate gravitational waves can be extremely violent and destructive, by the time the waves reach Earth they are thousands of billions of times smaller! In fact, by the time gravitational waves from LIGO's first detection reached us, the amount of space-time wobbling they generated was a 1000 times smaller than the nucleus of an atom! Such inconceivably small measurements are what LIGO was designed to make.

LIGO

- It is the **world's largest gravitational** wave observatory.
- The acronym LIGO stands for **Laser Interferometer Gravitational-Wave Observatory.**
- It consists of a pair of huge interferometers, each having two arms which are 4 km long.
- Remarkable precision is needed to detect a signal as faint as a gravitational wave, and the two LIGO detectors work as one unit to ensure this.
- LIGO, unlike usual telescopes, does not “see” the incoming ripples in spacetime.

Possible sources of gravitational waves: *Mergers of black holes or neutron stars, rapidly rotating neutron stars, supernova explosions and the remnants of the disturbance caused by the formation of the universe, the Big Bang itself, are the strongest sources.*

Why does one study gravitational waves? *The study offers a new way to map out the universe, using gravitational-wave astronomy. Gravitational waves are an extreme illustration of general relativity. Detecting and analyzing the information carried by gravitational waves is now allowing us to observe the Universe.*

Types of gravitational waves

- **Continuous Gravitational Waves-** are thought to be produced by a single spinning massive object, like a neutron star**.**
- **Compact Binary Inspiral Gravitational Waves-** are produced by orbiting pairs of massive and dense ("compact") objects like white dwarf stars, black holes, and neutron stars.
- **Stochastic Gravitational Waves-** These small waves from every direction make up what is called a “Stochastic Signal”, so called because the word, 'stochastic' means having a random pattern that may be analyzed statistically but not predicted precisely.
- **Burst Gravitational Waves-**detection of such gravitational waves is currently difficult, however detecting them has the greatest potential to reveal revolutionary information about the Universe.

SOLAR ECLIPSE

An annular solar eclipse is witnessed on June 10, 2021.

- A solar eclipse occurs when the **moon gets between Earth and the sun**, and the moon casts a shadow over Earth. A solar eclipse can only take place at the phase of new moon, when the moon passes directly between the sun and Earth and its shadows fall upon Earth's surface.
- There are four types of solar eclipses: total, annular, partial and hybrid.

Total solar eclipses

- The sun's 864,000-mile diameter is fully 400 times greater than that of our moon, which measures just about 2,160 miles. But the moon also happens to be about 400 times closer to Earth than the sun (the ratio varies as both orbits are elliptical), and as a result, when the orbital planes intersect and the distances align favorably, the new moon can appear to completely blot out the disk of the sun.
- On the **average a total eclipse occurs somewhere on Earth about every 18 months.**
- There are actually two types of shadows: the **umbra i**s that part of the shadow where all sunlight is blocked out. The umbra takes the shape of a dark, slender cone. It is surrounded by the **penumbra**, a lighter, funnel-shaped shadow from which sunlight is partially obscured.
- During a total solar eclipse, the moon casts its umbra upon Earth's surface; that shadow can sweep a third of the way around the planet in just a few hours. Those who are fortunate enough to be positioned in the direct path of the umbra will see the sun's disk diminish into a crescent as the moon's dark shadow rushes toward them across the landscape.
- During the brief period of totality, when the sun is completely covered, the beautiful corona — the tenuous outer atmosphere of the sun — is revealed. Totality may last as long as 7 minutes 31 seconds, though most total eclipses are usually much shorter.

Partial solar eclipses

- A **partial solar eclipse occurs when only the penumbra (the partial shadow) passes over you**. In these cases, a part of the sun always remains in view during the eclipse. How much of the sun remains in view depends on the specific circumstances.
- Usually the penumbra gives just a glancing blow to our planet over the polar regions; in such cases, places far away from the poles but still within the zone of the penumbra might not see much more than a small scallop of the sun hidden by the moon. In a different scenario, those who are positioned within a couple of thousand miles of the path of a total eclipse will see a partial eclipse.
- The closer you are to the path of totality, the greater the solar obscuration. If, for instance, you are positioned just outside of the path of the total eclipse, you will see the sun wane to a narrow crescent, then thicken up again as the shadow passes by.

Annular solar eclipses

- An annular eclipse, though a rare and amazing sight, is far different from a total one.
- The sky will darken ... somewhat; a sort of weird twilight since so much of the sun still shows. The annular eclipse is a subspecies of a partial eclipse, not total. The maximum duration for an annular eclipse is 12 minutes 30 seconds.
- However, an annular solar eclipse is similar to a total eclipse in that the moon appears to pass centrally across the sun. The difference is, the moon is too small to cover the disk of the sun completely. Because the moon circles Earth in an elliptical orbit, its distance from Earth can vary from 221,457 miles to 252,712 miles. But the dark shadow cone of the moon's umbra can extend out for no longer than 235,700 miles; that's less than the moon's average distance from Earth.
- So if the moon is at some greater distance, the tip of the umbra does not reach Earth. During such an eclipse, the **antumbra**, a theoretical continuation of the umbra, reaches the ground, and anyone situated within it can look up past either side of the umbra and see an **annulus, or "ring of fire"** around the moon.

Hybrid solar eclipses

- These are also called **annular-total ("A-T") eclipses**. This special type of eclipse occurs when the moon's distance is near its limit for the umbra to reach Earth. In most cases, an A-T eclipse starts as an annular eclipse because the tip of the umbra falls just short of making contact with Earth; then it becomes total, because the roundness of the planet reaches up and intercepts the shadow tip near the middle of the path, then finally it returns to annular toward the end of the path.
- Because the moon appears to pass directly in front of the sun, total, annular and hybrid eclipses are also called **"central" eclipses** to distinguish them from eclipses that are merely partial.
- Of all solar eclipses, about 28% are total; 35% are partial; 32% annular; and just 5% are hybrids.

SpaceX

*SpaceX launched 4 astronauts to ISS on recycled rocket and capsule **as part of NASA's SpaceX Crew-2 mission.***

- **Space Exploration Technologies Corp. (SpaceX)** is an American aerospace manufacturer, space transportation services and communications company headquartered in Hawthorne, California.
- SpaceX was founded in 2002 by **Elon Musk** with the goal of reducing space transportation costs to enable the colonization of Mars.
- SpaceX manufactures the **Falcon 9 and Falcon Heavy launch vehicles**, several rocket engines, Dragon cargo, crew spacecraft and **Starlink** communications satellites.

SpaceX's achievements

- first privately funded liquid-propellant rocket to reach orbit (Falcon 1 in 2008),
- the first private company to successfully launch, orbit, and recover a spacecraft (Dragon in 2010),
- the first private company to send a spacecraft to the International Space Station (Dragon in 2012),
- the first vertical take-off and vertical propulsive landing for an orbital rocket (Falcon 9 in 2015),
- the first reuse of an orbital rocket (Falcon 9 in 2017),
- the first private company to send astronauts to orbit and to the International Space Station (SpaceX Crew Dragon Demo-2 in 2020).
- SpaceX has flown and reflown the Falcon 9 series of rockets over one hundred times.

New Developments

- SpaceX is developing a satellite megaconstellation named **Starlink** to provide commercial internet service. In 2020 the Starlink constellation became the largest satellite constellation in the world.
- SpaceX is also developing **Starship,** a privately funded, fully reusable, super heavy-lift launch system for interplanetary spaceflight. Starship is intended to become the primary SpaceX orbital vehicle once operational, supplanting the existing Falcon 9, Falcon Heavy and Dragon fleet.

ASTEROID 16 PSYCHE

- A recent study has found that **asteroid 16 Psyche, which orbits between Mars and Jupiter**, could be made entirely of metal and is worth an estimated $10,000 quadrillion — more than the entire economy of Earth.
- Scientists believe that the asteroid may be the leftover core of an earlier planet that lost its crust and mantle after multiple collisions during the creation of our solar system.

What is asteroid 16 Psyche?

- Located around 370 million kilometres away from Earth, asteroid 16 Psyche is one of the most massive objects in the asteroid belt in our solar system. The somewhat potato-shaped asteroid has a diameter of around 140 miles, according to NASA.

- It was first discovered on March 17, 1853, by the Italian astronomer Annibale de Gasparis and was named after the ancient Greek goddess of the soul, Psyche.
- Unlike most asteroids that are made up of rocks or ice, scientists believe that Psyche is a dense and largely metallic object thought to be the core of an earlier planet that failed in formation.
- Metal asteroids are not commonly found in the solar system, and scientists believe that studying 16 Psyche may offer a rare glimpse of what the inside of a planet really looks like.

What is known about NASA's Psyche mission?

- Scientists will only learn about the true composition of asteroid 16 Psyche if it is studied up close. NASA plans to do just that two years from now, when it will launch a SpaceX Falcon Heavy rocket from Cape Canaveral Air Force Station in Florida to orbit the asteroid for around 21 months.
- The unmanned spacecraft will reach the asteroid in January, 2026. The first objective of the mission is to capture a photograph of the metallic asteroid, after which the spacecraft will study and map it from a distance.
- Another objective of the mission is to determine whether the asteroid is, in fact, the core of an earlier planet or if it is merely made up of unmelted material. Based on the data collected, scientists will also ascertain the age and origins of the mammoth metallic asteroid.
- The mission was originally slated to take place in 2023, but was later moved up to 2022.

MARS MISSION

NASA's Mars 2020 Perseverance touched down on the Martian surface.

- Perseverance is the most advanced, most expensive and most sophisticated mobile laboratory sent to Mars. The results of the experiments on Perseverance will likely define the next couple of decades of Mars exploration – it will determine the course of search for life and a future manned mission to Mars.
- Mars was considered to be a dry planet in the 20th century. This changed in 2001, when the Gamma Ray Spectrometer on board the **Mars Odyssey spacecraft** detected a fascinating hydrogen signature that seemed to indicate the presence of water ice. But there was ambiguity – this was because hydrogen can be part of many other compounds as well, including organic compounds.
- To test for the presence of water, NASA sent a spacecraft to land near the Martian South Pole in 2007. The spacecraft studied the soil around the lander with its robotic arm and was able to establish, without any ambiguity, the presence of water on Mars for the first time.
- The **Curiosity rover carries an instrument called SAM** (or Sample Analysis at Mars), which contains a suite of spectrometers with the goal of detecting organic compounds on Mars. SAM has a mass spectrometer that can measure not just the elements, but the isotopes as well. This instrument has made the fascinating discovery of large chain **organic compounds on Mars**.
- It is not known how these organics form on Mars: the process would likely be inanimate, but there is a fascinating possibility that such complex molecules were formed by processes associated with life.

Why is Mars so interesting to scientists? And to the explorer-adventurer in all of us?

There are two primary reasons.

- **First,** Mars is a planet where life may have evolved in the past. Life evolved on Earth 3.8 billion years ago. Conditions on early Mars roughly around 4 billion years ago were very similar to that of Earth. It had a thick atmosphere, which enabled the stability of water on the surface of Mars. If indeed conditions on Mars were similar to those on Earth, there is a real possibility that microscopic life evolved on Mars.
- **Second,** Mars is the only planet that humans can visit or inhabit in the long term. Venus and Mercury have extreme temperatures – the average temperature is greater than 400 degree C, or hotter than a cooking oven. All planets in the outer solar system starting with Jupiter are made of gas – not silicates or rocks – and are very cold. Mars is comparatively hospitable in terms of temperature, with an approximate range between 20 degrees C at the Equator to minus 125 degrees C at the poles.

Mars Orbiter Mission

- MOM also called Mangalyaan is a space probe orbiting Mars since 24 September 2014. It was launched on 5 November 2013 by the Indian Space Research Organisation (ISRO).[
- It is India's first interplanetary mission and it made it the fourth space agency to achieve Mars orbit, after Roscosmos, NASA, and the European Space Agency. It made India the first Asian nation to reach Martian orbit and the first nation in the world to do so on its maiden attempt.
- The mission is a "technology demonstrator" project to develop the technologies for designing, planning, management, and operations of an interplanetary mission. It carries five scientific instruments.
- The spacecraft is currently being monitored from the Spacecraft Control Centre at ISRO Telemetry, Tracking and Command Network (ISTRAC) in Bengaluru with support from the Indian Deep Space Network (IDSN) antennae at Bengaluru, Karnataka.

AMAZONIA-1

- PSLV-C51, the first dedicated launch for NSIL, successfully launched Amazonia-1 and 18 Co-passenger satellites from Sriharikota
- After a flight of about 17 minutes 23 seconds, the vehicle injected the Amazonia-1 into its intended orbit and in the succeeding 1 hour 38 minutes, all the 18 co-passenger satellites successfully separated from the PSLV in a predetermined sequence.
- **Amazonia-1 is the optical earth observation satellite of National Institute for Space Research (INPE).** This satellite would further strengthen the existing structure by providing remote sensing data to users for monitoring deforestation in the Amazon region and analysis of diversified agriculture across the Brazilian territory.
- PSLV-C51/Amazonia-1 is the **first dedicated commercial mission of NewSpace India Limited (NSIL),** a Government of India company under Department of Space.
- The 18 co-passenger satellites onboard PSLV-C51 includes four from IN-SPACe and fourteen from NSIL. Out of 4 satellites from IN-SPACe, three were UNITYsats designed and built as a joint development by Jeppiaar Institute of Technology, Sriperumbudur (JITsat), G.H.Raisoni College of Engineering, Nagpur (GHRCEsat) and Sri Shakti Institute of Engineering and Technology, Coimbatore (Sri Shakthi Sat) and one was Satish Dhawan Sat (SDSAT) from Space Kidz India. The fourteen satellites from NSIL carried were the commercial satellites from India (1) and USA (13).
- PSLV-C51 is the 53rd flight of PSLV and 3rd flight of PSLV in 'DL' configuration (with 2 strap-on motors). This was the 78th launch vehicle mission from SDSC SHAR, Sriharikota.
- With this launch, the total number of customer satellites from foreign countries placed in orbit by PSLV is 342 satellites from 34 countries.

KESSLER SYNDROME

- In **1978, the NASA scientist Donald J. Kessler** proposed that a chain reaction of exploding space debris can end up making space activities and the use of satellites impossible for generations.
- He predicted that the number of objects that we keep launching into Low Earth Orbit (LEO) can create such a dense environment above the planet that inevitable collisions could cause a cascading effect. The space junk and shrapnel generated by one collision could make further collisions much more possible. And if you have enough collisions, the amount of space debris could overwhelm the orbital space entirely.
- What makes that situation possible is the fact that there are millions of micrometeoroids as well as man-made debris that is already orbiting Earth. The danger posed by even a small fragment that's traveling at high speeds is easy to see. As calculated by NASA, a 1-centimeter "paint fleck" traveling at 10km/s (22,000 mph) can cause the same damage as a 550-pound object traveling 60 miles per hour on Earth. If the size of the shard was increased to 10 centimeters, such a projectile would have the force of 7 kilograms of TNT. Now imagine thousands of such objects flying around at breakneck speeds and crashing into each other.

- If a chain reaction of exploding space junk did occur, filling the orbital area with such dangerous debris, the space program would indeed be in jeopardy. Travel that goes beyond the LEO, like the planned mission to Mars, would be made more challenging but still conceivably possible.
- What would, of course, be affected if the Kessler Syndrome's worst predictions came to pass, are all the services that rely on satellites. Core aspects of our modern life—GPS, television, military and scientific research—all of that would be under threat.
- NASA experienced a small-scale Kessler Syndrome incident in the 1970s when Delta rockets that were left in orbit started to explode into shrapnel clouds. This inspired Kessler, an astrophysicist, to show that there is a point when the amount of debris in an orbit gets to critical mass. At that point, the collision cascading would start even if no more things are launched into space. And once the chain of explosions begins, it can keep going until the orbital space can no longer be used.
- NASA says that its experts caution that we are already at critical mass in the low-Earth orbit, which is about 560-620 miles (900 to 1,000 kilometers) out.
- According to **NASA estimates**, the Earth's orbit currently has 500,000 pieces of space debris up to 10cm long, over 21,000 pieces of debris longer than 10cm, and more than 100 million pieces of space debris smaller than 1cm.

PLUTO

- Pluto is a dwarf planet in the Kuiper belt, a ring of bodies beyond Neptune. It was the first Kuiper belt object to be discovered.
- It is the largest known **trans-Neptunian object** by volume but is less massive than Eris, a dwarf planet in the scattered disc. Like other Kuiper belt objects, Pluto is primarily made of ice and rock and is relatively small—about one-sixth the mass of the Moon and one-third its volume.
- It has a moderately eccentric and inclined orbit around the Sun. This means that Pluto periodically comes closer to the Sun than Neptune, but a stable orbital resonance with Neptune prevents them from colliding.
- Pluto was discovered by Clyde Tombaugh in 1930, and was originally considered the ninth planet from the Sun. After 1992, its planethood was questioned following the discovery of several objects of similar size in the Kuiper belt.
- In 2005, Eris, which is more massive than Pluto, was discovered, which led the International Astronomical Union (IAU) to define the term "planet" formally for the first time the following year. This definition excluded Pluto and reclassified it as a member of the new "dwarf planet" category.
- Pluto has **five known moons**: Charon (the largest, with a diameter just over half that of Pluto), Styx, Nix, Kerberos, and Hydra.

EXOPLANET

- All of the planets in our solar system orbit around the Sun. Planets that orbit around **other stars are called exoplanets**. Exoplanets are very hard to see directly with telescopes. They are hidden by the bright glare of the stars they orbit.
- Scientists search for exoplanets by looking at the **effects these planets** have on the stars they orbit.
- One way to search for exoplanets is to look for **"wobbly" stars**. A star that has planets doesn't orbit perfectly around its centre. From far away, this off-center orbit makes the star look like it's wobbling.
- However, only big planets like Jupiter, or even larger can be seen this way. Smaller Earth-like planets are much harder to find because they create only small wobbles that are hard to detect.
- So **in 2009**, NASA launched a spacecraft called **Kepler** to look for exoplanets. Kepler looked for planets in a wide range of sizes and orbits. And these planets orbited around stars that varied in size and temperature.

IN-SPAce

In a historic step, the government has established IN-SPAce as the new space industry regulator in India.'IN-SPAce' (Indian National Space Promotion and Authorisation Centre), will be an autonomous organisation under the Department of Space with an aim to enhance private sector participation in the space industry.

- **Context**

- India currently holds a meagre 2% share in the global space industry worth $360 billions.
- In a bid to increase its footprint in the global space industry India as a part of Atma Nirbhar Bharat Abhiyan decided to throw open space sector to private sector entities.
- While private sector in India is currently involved in fabrication of rocket components, this move will enable private sector to make their own rockets and use ISRO's launch vehicle ports like one in Sharikota to launch their own rockets.
- Besides private sector participation will be leveraged in manufacturing of satellites and propellant technology and providing space-based services.
- Thus in order to provide a level-playing field to private sector entities the Union Cabinet has approved the establishment of IN-SPAce.

- **Need for Private Sector Participation: Commercialisation of Space industry**

- Commercial space activities can be categorised into:-

a. **Upstream Activities:** Those activities involved in building of rockets, launch of rockets;

b. **Downstream Activities**: Those activities involved in utilizing space-based assets for different applications including remote sensing, telecommunication, broadcasting, space-based internet, navigation, meteorology etc.

- Given the proliferation of space-based applications, private sector involvement in downstream activities is imperative if India has to gain from it.

- **Functions of IN-SPAce**

- Regulator of space industry in India.
- It will be responsible for granting approval to private sector entities to use space infrastructure of ISRO for space missions.
- Its decision will be binding on ISRO.
- It will also be responsible for building a conducive policy-ecosystem for commercialisation of space in India/
- It will hand-hold, promote and guide the private industries in space activities.

- **Benefits**

- **Greater pool of resources -** Public resources- land, labour, capital are limited. Private sector participation will open new pool of resources and talent. It will bring more funding, and experience into space exploration activities.
- **Human Capital**- Restricting space activities to ISRO, limits proper utilisation of talent all over the country. With demographic dividend, private sector participation can exploit the talent across the nation contributing a lot to space explorations in India.
- **Deep-space exploration by ISRO**- While private sector can focus more on downstream activities and satellite launches, ISRO can focus on deep space exploration.
- **Innovation** – Commercialisation will develop better technologies allowing integration of novel technologies like artificial intelligence propelling innovation in space exploration activities.
- **Risk Sharing:** Privatising helps in sharing the risk of cost factor. Failure costs will be distributed. Also with increased private participation, failures will reduce due to increased available human capital and mind.

- **Way forward**

- **Intellectual Property regulatory environment:** Currently, all Intellectual Property associated with space-related components are held by ISRO. The suppliers merely manufacture and supply the components. This has hampered product development ecosystem as private sector does not have incentive for innovation.
- **Legal environment**: We need to expedite the passing of Space Activities Bill which clearly lays down the eligibility criteria for potential licensees. In addition, the law should also provide for an adjudicating body like a tribunal for potential disputes.

- **Enabling Regulatory Regime:** The current regulatory ecosystem is complex with multiple regulations and multiple agencies guiding the relation between satellite communications, industry and the government making the entire process a time taking one. For example:-

- **Multiple Regulations:** SATCOM Norms 2000, The Indian Telegraph Act 1885 and The National Frequency Allocation Plan 2018

Multiple agencies: Department of Space, the Department of Telecommunications, the Ministry of Home Affairs, the Ministry of Defence, the Wireless Planning Commission (WPC), the Network Operation and Control Centre (NOCC), the Telecom Engineering Centre (TEC) and the satellite division of the Department of Telecom

BAWG

- Delegates from BRICS nations highlighted the importance of enhancing collaboration among astronomers from the countries at the the BRICS Astronomy Working Group Meeting.
- Under the Science, Technology, and Innovation track of the BRICS 2021 calendar, India hosted the seventh meeting of BRICS Astronomy Working Group (BAWG) meeting of Brazil, Russia, India, China, and South Africa, as well as astronomers from these countries in online mode in May 2021.
- From the Indian side, the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, and Department of Science and Technology (DST), Government of India coordinated the meeting. It witnessed participation of all five BRICS countries with more than 50 participants, including researchers, academicians, and government officials.
- The delegates deliberated on strategic and operational matters and recommended the networking of existing Telescopes in BRICS countries and create regional Data Network. They agreed to develop flagship project in this area. The members of the working group also indicated future directions of research in this area such as building network of intelligent telescope and data network, study of transient astronomical phenomena in universe, big data, artificial intelligence, machine learning application to process the voluminous data generated now a days due to enhance multi-wavelength telescope observatory.
- The BAWG which provides a platform for BRICS member countries to collaborate in the field of astronomy recommended that the focal points in each country should present the scientific results of the work being carried out in each country. This will help seek funding support to realize the flagship project whenever funding opportunity announced by BRICS funding agencies.
- BAWG noted the importance of enhancing collaboration among astronomers from the BRICS countries.

TECHNOLOGY

INTERNET GOVERNANCE

- **What is Internet Governance?** Refers to the rules, policies, standards and practices that coordinate and shape global cyberspace. Currently there is no global internet governance framework.
- **Need for Internet Governance Framework:** Internet has fundamentally changed the social, economic and political milieu of the world by its sheer reach. This has enabled one country to shape activities in another. Eg: Arab Spring was triggered by Social Media Platforms owned by US companies.
- **Cross-border nature:** Data is seen as the new engine of growth and thus where the data is produced, who owns the data and for what purpose have significant impact on the economies. Further with increasing deployment of digital technology the critical infrastructure of countries are vulnerable to attacks from across borders.
- **Power Struggle:** Internet is used by both state and non-state actors of one country to influence political and social life of another. E.g. Russia in US elections.
- **Equitable Use of Internet:** While the use of internet for development was discussed as early as 1998 in the UN there is no consensus among countries with regard to what constitutes internet governance. **For e.g.** Although the users of internet are spread across the world yet the infrastructure like undersea cables that fuel the internet is dominated by few countries.

- **Lack of uniform cyber laws:** Given the cross-border nature of data flow, countries lack jurisdiction over another. Thus, there is an increasing need for "cyber norms" that can balance the competing demands of national sovereignty and transnational connectivity.
- **Current Status on the actions taken for promoting Internet Governance.** As stated above**,** the 1st time the issue of use of internet for development was discussed at the UN platform in 1998. Accordingly, the UN set up a mechanism called **Group of Governmental Experts** to discuss the issue of internet governance. However, the problem is this body has limited membership and thus proven ineffective.
- For the 1st time in October 2019, this was made more inclusive by another mechanism called **Open-Ended Working Group** which included all 193 members.

INTERNET OF THINGS

- The Internet of things (IoT) is the extension of Internet connectivity into physical devices and everyday objects.
- Embedded with electronics, Internet connectivity, and other hardware like sensors, these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled by computers and smart phone.

Applications of internet of things:

- **Smart cities**: Cellular communication enabled Smart municipal bins will send alerts to municipal services when a bin needs to be emptied
- **Agriculture**: Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer are some simple uses of IoT.
- **Energy utilization**: Smart Grids will be able to detect sources of power outages, can automatically take inputs of solar panel, making possible distributed energy system
- **Healthcare**: Personalized analysis of an individual's health and tailor-made strategies to combat illness will be possible.
- **Manufacturing**: The IoT intelligent systems enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing production and supply chain networks, by networking machinery, sensors and control systems together.
- **Environmental monitoring**: to assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions. It can even include areas like monitoring the movements of wildlife and their habitats
- **Supply chain**: By placing RFID tags on individual products, the exact location of single items in a large warehouse can be shared, thus saving search time, streamlining infrastructure, and lowering labour costs.

MACHINE LEARNING

- Machine learning is an **application of artificial intelligence (AI)** that provides **systems the ability to automatically learn and improve from experience** without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves.
- The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.
- But, using the classic algorithms of machine learning, text is considered as a sequence of keywords; instead, an approach based on semantic analysis mimics the human ability to understand the meaning of a text.

Some Machine Learning Methods

- Machine learning algorithms are often categorized as supervised or unsupervised.
- **Supervised machine learning algorithms can apply what has been learned in the past to new data using labelled examples** to predict future events. Starting from the analysis of a known training dataset, the learning

algorithm produces an inferred function to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.

- In contrast, **unsupervised machine learning algorithms are used when the information used to train is neither classified nor labelled**. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabelled data. The system doesn't figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabelled data.
- **Semi-supervised machine learning algorithms** fall somewhere in between supervised and unsupervised learning, since they use both labelled and unlabelled data for training – typically a small amount of labelled data and a large amount of unlabelled data. The systems that use this method are able to considerably improve learning accuracy. Usually, semi-supervised learning is chosen when the acquired labelled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring unlabelled data generally doesn't require additional resources.
- Reinforcement machine learning algorithms is a learning method that interacts with its environment by producing actions and discovers errors or rewards. Trial and error search and delayed reward are the most relevant characteristics of reinforcement learning. This method allows machines and software agents to automatically determine the ideal behaviour within a specific context in order to maximize its performance. Simple reward feedback is required for the agent to learn which action is best; this is known as the reinforcement signal.
- Machine learning enables analysis of massive quantities of data. While it generally delivers faster, more accurate results in order to identify profitable opportunities or dangerous risks, it may also require additional time and resources to train it properly. Combining machine learning with AI and cognitive technologies can make it even more effective in processing large volumes of information.

Uses

- **Financial services:** Banks and other businesses in the financial industry use machine learning technology for two key purposes: to identify important insights in data, and prevent fraud. The insights can identify investment opportunities, or help investors know when to trade. Data mining can also identify clients with high-risk profiles, or use cyber-surveillance to pinpoint warning signs of fraud.
- **Health care:** Machine learning is a fast-growing trend in the health care industry, thanks to the advent of wearable devices and sensors that can use data to assess a patient's health in real time. The technology can also help medical experts analyse data to identify trends or red flags that may lead to improved diagnoses and treatment.
- **Oil and gas:** Finding new energy sources. Analysing minerals in the ground. Predicting refinery sensor failure. Streamlining oil distribution to make it more efficient and cost-effective. The number of machine learning use cases for this industry is vast – and still expanding.
- **Government:** Government agencies such as public safety and utilities have a particular need for machine learning since they have multiple sources of data that can be mined for insights. Analysing sensor data, for example, identifies ways to increase efficiency and save money. Machine learning can also help detect fraud and minimize identity theft.
- **Retail:** Websites recommending items you might like based on previous purchases are using machine learning to analyse your buying history. Retailers rely on machine learning to capture data, analyse it and use it to personalize a shopping experience, implement a marketing campaign, price optimization, merchandise supply planning, and for customer insights.
- **Transportation:** Analysing data to identify patterns and trends is key to the transportation industry, which relies on making routes more efficient and predicting potential problems to increase profitability. The data analysis and modelling aspects of machine learning are important tools to delivery companies, public transportation and other transportation organizations.

DARK NET

Instances of data leaks on the dark web/ dark net is on the rise. Dark web/ dark net is increasingly being used for various nefarious activities including data leaks, identity theft, illegal weapon sales, drug trafficking, cyber terrorism etc.

- Dark Net is a network of computers on the internet that are:- a) not accessible through the normal search engines and b) provide anonymity to the source of web content.

- In order to access the content of the dark net we need special software to get into this network of computers.
- In simple words web content on dark net is intentionally hidden in order to provide anonymity to service provider.

- **Understanding Dark Net**

- **Surface Web:** Whenever you search a webpage on a search engine like google the search engine has the ability to 'look for' and extract the content and present it in the form of a website/webpage. In order to do this the webpages are 'indexed' by the search engine. Only about 10-15% of all the web content are present on the surface web accessible by common searches.
- **Deep Web:** Deep Web on the other hand is a term used for all those web content or web pages that are there on the internet but are not indexed by search engines and therefore not discernible by conventional search engines. In other words these webpages on deepweb they do not show up in conventional search engines like Google, Bing, Yahoo etc. About 75-85% of the web content/web pages are on the deep web. Common examples of web content on deep web include financial data, bank account details, emails, personal data etc. that are password protected and the only way to access these web pages is through login.
- **Dark Net:** Dark net is a part of deep web that is intentionally hidden in order to provide anonymity. In order to do this, deep net uses a specialised network of computers called **relays** through which the information passes. Commonly, information on dark net passes through at least 3 relay computers between the source and destination. In addition, the dark net uses network technology that hides the location of these relay computers (IP address) in order to ensure anonymity of the users. Can be accessed through **TOR (Anonymity Network)**

- **Features**
- While it is hidden from a search engine, the web pages on dark net can be accessed and downloaded by anyone who has the exact address of the webpage
- Dark net does not provide any protection against malware, virus attack etc.
- Since the data is routed through a number of relay computers between source and destination the communication is slower in dark net.

- **Scope of Dark net:** Dark net is used for both legitimate and illegitimate activities.

1. **Legitimate Activities**
- By virtue of its ability to provide anonymity, dark net is used by human rights activists, free internet activists, media personnel etc. in countries where there are severe restrictions, censorship on internet usage like that in China, Iran, Saudi Arabia etc.
- Dark net is also used by whistle blowers in order to maintain anonymity. (Read about Edward Snowden)
- Besides in the aftermath of glaring revelations on surveillance by USA's security agency NSA the number of users using dark net has increased for the want of privacy.

2. **Illegitimate Activities**
- While use of dark net is not illegal per say it has increasingly turned into a platform for various nefarious activities including illegal weapon sale, drug trafficking, child pornography, data theft, data leaks, cyber terrorism, hacking, organised crime, money laundering etc.

HYBRID CLOUD

- Hybrid cloud is a solution that **combines a private cloud with one or more public cloud services,** with proprietary software enabling communication between each distinct service.
- A hybrid cloud strategy **provides businesses with greater flexibility** by moving workloads between cloud solutions as needs and costs fluctuate.

- Hybrid cloud services are powerful because they give businesses **greater control over their private data**. An organization can store sensitive data on a private cloud or local data center and simultaneously leverage the robust computational resources of a managed public cloud. A hybrid cloud relies on a single plane of management, unlike a multi-cloud strategy wherein admins must manage each cloud environment separately.
- Hybrid cloud infrastructure generally includes a public infrastructure as a **service (IaaS) platform**, a private **cloud or data center and access to a secure network**. Many hybrid models leverage local area networks (LAN) as well as wide area networks (WAN).

Hybrid cloud benefits

- The benefits of a hybrid cloud strategy stem from the solution's ability to give IT leaders **increased control over their data.** Essentially, the hybrid model provides the business with multiple options so that stakeholders can pick an environment that best suits each individual use case.
- Most businesses do not utilize the same level of computation power every day. In fact, an organization may find that its resource needs only balloon during one specific time of year. For instance, a health insurance application may need double the computing power during open enrollment. Rather than paying for those additional resources to sit idle for most of the year, an organization can save on costs by extending their private resources to a public cloud only when necessary.
- A hybrid model **requires much less space on-premises** compared to a strictly private model. A business can deploy a private network on-site to handle internal needs, then automatically extend to the private cloud when computational resources exceed local availability. This model can benefit startups that can't afford to invest in a huge private data center as well as established enterprises that need to scale in a cost effective manner.

Who uses hybrid cloud?

- **Businesses across the spectrum of industries** have moved toward hybrid solutions to reduce costs and strain on local resources. From the financial sector to the health care industry, hybrid cloud environments have proven to be effective at not only improving computing and storage power, but also optimizing the scarce resource of physical space. Many organizations simply don't have the room available to deploy servers on-site.
- In the **health care space,** data privacy is paramount, and privately held computation resources are lacking. A hybrid cloud model is an ideal solution because it allows medical groups to retain patient data in a secure, private server while simultaneously leveraging the advanced computational power of a public IaaS model. Simply put, any industry that benefits from public cloud applications can also benefit from the hybrid model.



Hybrid cloud benefits

Hybrid cloud computing enables an enterprise to deploy its most sensitive workloads in an on-premises cloud and to host less-critical resources on a third-party public cloud provider. This approach allows organizations to get the best of both private and public cloud models.

The core benefits of hybrid cloud include the following:

- **Flexibility.** Users work with various types of data in disparate environments and adjust their infrastructure. A company can build a hybrid cloud that works for its needs, using traditional systems as well as the latest cloud technology, without a full commitment to a vendor. Organizations savvy with a hybrid cloud setup can migrate workloads to and from their traditional infrastructure and a vendor's public cloud whenever necessary.
- **Cost management.** With a private cloud, organizations own and operate the data center infrastructure, which requires significant capital expense and fixed costs. Alternatively, the public cloud offers resources and services that are accounted as variable and operational expenses. Hybrid cloud users can choose to run workloads in whichever environment is more cost effective.
- **Agility and scalability.** Hybrid cloud offers more resource options via a public cloud provider vs. an organization's physical data center. This makes it easier to provision, deploy and scale resources to meet demand spikes. When demand exceeds capacity of the local data center, an organization can burst the application to the public cloud to access extra scale and capacity.
- **Resiliency and interoperability.** To increase resiliency, a business can run workloads redundantly in both private and public environments. Components of one workload can also run in both environments and interoperate.
- **Compliance.** Compliance restrictions on where data can reside mean organizations in highly regulated industries cannot move all workloads to the public cloud. With hybrid cloud, organizations can keep data in a private environment while operating workloads in the cloud, or they can operate workloads in a private data center and move data to and from the public cloud as needed. This allows companies to meet regulatory requirements and still benefit from the elasticity of the cloud.
- Other hybrid cloud advantages include consistency and support for greater standardization in IT management practices.

QUANTUM COMPUTER

- A quantum computer harnesses some of the almost-mystical phenomena of quantum mechanics to deliver huge leaps forward in processing power. Quantum machines promise to outstrip even the most capable of today's—and tomorrow's—supercomputers**.**
- The secret to a quantum computer's power lies in its ability to generate and manipulate **quantum bits**, or qubits.

What is a qubit?

- Today's computers use bits—a stream of electrical or optical pulses representing 1s or 0s. Everything from your tweets and e-mails to your iTunes songs and YouTube videos are essentially long strings of these binary digits.
- Quantum computers, on the other hand, use qubits, which are typically **subatomic particles such as electrons or photons.** Generating and managing qubits is a scientific and engineering challenge. Some companies, such as IBM, Google, and Rigetti Computing, use superconducting circuits cooled to temperatures colder than deep space. Others, like IonQ, trap individual atoms in electromagnetic fields on a silicon chip in ultra-high-vacuum chambers. In both cases, the goal is to isolate the qubits in a controlled quantum state.
- Qubits have some quirky quantum properties that mean a connected group of them can provide way more processing power than the same number of binary bits. One of those properties is known as **superposition** and another is called **entanglement.**

What is superposition?

- Qubits can represent numerous **possible combinations of 1 and 0** at the same time. This ability to simultaneously be in **multiple states is called superposition**. To put qubits into superposition, researchers manipulate them using precision lasers or microwave beams.

- Thanks to this counterintuitive phenomenon, a quantum computer with several qubits in superposition can crunch through a vast number of potential outcomes simultaneously. The final result of a calculation emerges only once the qubits are measured, which immediately causes their quantum state to "collapse" to either 1 or 0.

What is entanglement?

- Researchers can generate pairs of qubits that are "entangled," which means the two members of a pair exist in a single quantum state. Changing the state of one of the qubits will instantaneously change the state of the other one in a predictable way. This happens even if they are separated by very long distances.
- Nobody really knows quite how or why entanglement works. It even baffled Einstein, who famously described it as "spooky action at a distance." But it's key to the power of quantum computers. In a conventional computer, doubling the number of bits doubles its processing power. But thanks to entanglement, adding extra qubits to a quantum machine produces an exponential increase in its number-crunching ability.
- Quantum computers harness entangled qubits in a kind of quantum daisy chain to work their magic. The machines' ability to speed up calculations using specially designed quantum algorithms is why there's so much buzz about their potential.
- That's the good news. The bad news is that quantum machines are way more error-prone than classical computers because of **decoherence.**

What is decoherence?

- The interaction of qubits with their environment in ways that cause their quantum behaviour to decay and ultimately disappear is called **decoherence.** Their quantum state is extremely fragile. The slightest vibration or change in temperature—disturbances known as "noise" in quantum-speak—can cause them to tumble out of superposition before their job has been properly done. That's why researchers do their best to protect qubits from the outside world in those supercooled fridges and vacuum chambers.
- But despite their efforts, noise still causes lots of errors to creep into calculations. Smart quantum algorithms can compensate for some of these, and adding more qubits also helps. However, it will likely take thousands of standard qubits to create a single, highly reliable one, known as a "logical" qubit. This will sap a lot of a quantum computer's computational capacity.
- And there's the rub: so far, researchers haven't been able to generate more than 128 standard qubits (see our qubit counter here). So we're still many years away from getting quantum computers that will be broadly useful.
- That hasn't dented pioneers' hopes of being the first to demonstrate **"quantum supremacy."**

What is quantum supremacy?

- It's the point at which a **quantum computer can complete a mathematical calculation** that is demonstrably beyond the reach of even the most powerful supercomputer.
- It's still unclear exactly how many qubits will be needed to achieve this because researchers keep finding new algorithms to boost the performance of classical machines, and supercomputing hardware keeps getting better. But researchers and companies are working hard to claim the title, running tests against some of the world's most powerful supercomputers.
- There's plenty of debate in the research world about just how significant achieving this milestone will be. Rather than wait for supremacy to be declared, companies are already starting to experiment with quantum computers made by companies like IBM, Rigetti, and D-Wave, a Canadian firm. Chinese firms like Alibaba are also offering access to quantum machines. Some businesses are buying quantum computers, while others are using ones made available through cloud computing services.

Where is a quantum computer likely to be most useful first?

- One of the most promising applications of quantum computers is for **simulating the behaviour of matter down to the molecular level.** Auto manufacturers like Volkswagen and Daimler are using quantum computers to **simulate the chemical composition of electrical-vehicle batteries** to help find new ways to improve their performance. And

pharmaceutical companies are leveraging them to **analyze and compare compounds that could lead to the creation of new drugs**.

- The machines are also great for optimization problems because they can crunch through vast numbers of potential solutions extremely fast. Airbus, for instance, is using them to help **calculate the most fuel-efficient ascent and descent paths for aircraft**. And Volkswagen has unveiled a service that calculates the optimal routes for buses and taxis in cities in order to minimize congestion. Some researchers also think the machines could be used to accelerate artificial intelligence.
- It could take quite a few years for quantum computers to achieve their full potential. Universities and businesses working on them are facing a shortage of skilled researchers in the field—and a lack of suppliers of some key components. But if these exotic new computing machines live up to their promise, they could transform entire industries and turbocharge global innovation.

5G TECHNOLOGY

- **Key Features:** The three essential features of 5G network include: -
- **eMBB** – Enhanced Mobile Broadband with data rates up to 2 Gbps and indoor of up to 20 Gbps.
- **mMTC** – Massive Machine Type Communications (1million connections per square kilometre) supporting a large number of connected devices called Internet of Things (IoT),
- **uRLLC** – Ultra-reliable and Low Latency Communications (1 milli second) enabling applications such as tactile Internet, emergency response, collaborative robotics, intelligent transportation, eHealth, drones, and public safety.

- **Applications**
- 5G technologies will enhance infrastructure efficiencies like 'vehicle platooning'. Platooning can double vehicle density in roads promoting efficient and safer use of the limited road infrastructure.
- In manufacturing, 5G will enable use of robotics for precision manufacturing.
- 5G can also enable better logistics to track goods from raw materials to product delivery.
- In agriculture, 5G can enable improvement in the entire value-chain, from precision farming, smart irrigation, improved soil and crop monitoring to livestock management.
- In the energy sector, 'smart grids' and 'smart metering' can be efficiently supported enabling growth of alternate energy technologies.
- In healthcare, 5G can enable more effective tele-medicine delivery, tele-control of surgical robotics and wireless monitoring of vital statistics.
- 5G will be used in in key government projects such as smart cities and Digital India.

- **Mobile Networks: 1G to 4G**

1G

- Mobile phones began with 1G technology in the 1980s.
- 1G is analog technology that supported only voice communications.
- The maximum speed is 2.4 Kbps.

2G

- First launched in 1991.
- For the 1st time radio signals became digital rather than analog.
- 2G phones are used for data also along with voice.
- Thus 2G telephone introduced call and text encryption, SMS, picture messages, and MMS.
- Maximum speed under 2G networks with General Packet Radio Service (GPRS) was 50 kilobits per second.
- With Enhanced Data Rates for GSM Evolution (EDGE) the speed went up to 1mbps.

GPRS

- Launched in 2000.
- Bridge between 2G and 3G.
- It marks the coming of data transmission besides voice communication.
- General Packet Radio Service enabled mobile devices to send and receive e-mails and pictures.
- GPRS used EDGE and GSM standards for both voice and data transmission.
- GPRS had operating speeds of up to 115kbit/s.
- It increased to a maximum of 384kbit/s by using EDGE.

3G

- The introduction of 3G networks in 1998 ushered in faster data-transmission speeds.
- Maximum speed of 3G is estimated to be around 2 Mbps for non-moving devices and 384 Kbps in moving vehicles.
- Further, a 3G phone cannot communicate through a 4G network, but a 4G phone can communicate through a 3G or even 2G networks.
- Under both 2G to 3G technologies, data and voice transmission over the different networks using GSM or CDMA technology.

4G

- It is a different technology as compared to 3G.
- 4G uses LTE which allows us to communicate with voice and data simultaneously over the same network.
- Applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing.
- The max speed of a 4G network when the device is moving is 100 Mbps or 1 Gbps for low mobility communication like when stationary or walking.

GEOSPATIAL DATA

Geospatial definition: Any data that is indicated by or related to a geographic location. Geospatial technology collects and analyzes the geospatial data.

What is Geospatial Data?

- Geospatial data, also known as **geodata**, has locational information connected to a dataset such as address, city or ZIP code. Geospatial data can also come from Global Positioning System (GPS) data, geospatial satellite imagery, telematics devices, IoT and geotagging.

What are the Types of Geospatial Data?

The two main types of geospatial data are **vector data** and **raster data**.

- **Vector Data**: Uses **geometric shapes to show the location and shape of geographic features**. Points, lines and polygons can represent things like cities, roads and waterways. Vector data is scalable, has small file sizes and ideal for depicting boundaries.
- **Raster Data**: Represents **data through a digital image** such a scanned map or photograph. It also includes aerial and satellite imagery. Raster data uses a cell-based format called stairsteping to record data as pixels or grids with an image. Spatial analysis depends heavily on raster datasets.

What is Geospatial Technology?

- Geospatial technology is used to collect, analyse and store geographic information. It uses software to map geographic locations while analysing the impact of human activity.

- Geographic Information System (GIS) uses digital software to combine maps and datasets about environmental events and socioeconomic trends.
- GIS creates layered maps to better analyse complex data. The layering is possible because each data point is connected to a precise location on Earth. Other forms of geospatial technology include GPS, remote sensing, and geofencing.

A Brief History of Geospatial

- One of the biggest moments in geospatial history was the launch of Google Maps in 2005. It made mapping technology available to a mass audience.
- But the seeds for what we know of geospatial technology today were first planted in 1832. During a cholera outbreak in Paris that year, French cartographer Charles Picquet created one of the first heat maps to show where the incidents of illness were concentrated.
- When cholera struck London in 1854, physician John Snow built upon the Paris example. In addition to making a map that depicts the location of cholera deaths, he used spatial analysis of the data to show the connection between contaminated water sources and cholera.
- By the early 1900s, photozincography was invented. It was a form of map printing with separate layers. Each layer could visually represent data on the map.
- In the 1960s, Roger Tomlinson pioneered the concept of a Geographic Information System (GIS) that took traditional cartography to a new level. The advent of satellites focused on national security, scientific, and commercial ventures provided images of the Earth's surface and human activity for the first time, opening up more ways to visualize data. A GIS combines a base map with the capture, manipulation and management of data. A GIS map can contain unlimited amounts of data. This geospatial data not only lets users visualize and analyze the data, it helps users better understand trends, relationships and patterns.
- GIS was further refined until the early 2000s when Google Maps produced a user-friendly version for the masses in 2005.
- Since then, geospatial technology has evolved from the desktop to a cloud-based system. Geospatial databases used to be proprietary but open source software has changed that, making access to this type of information more widespread.

Geospatial Technologies: Geospatial technologies provide data for a number of industries that include the military, utility companies, urban planners and industrial engineers. The application of geospatial data is useful for biodiversity conservation, forest fire suppression, agricultural monitoring, humanitarian relief and any field that could benefit from better visualization and analysis of geographic data.

- **Remote Sensing**: Space or airborne camera and sensor platforms provide imagery and data at great detail. Images that can zoom into less than one meter are available on some commercial satellites.
- **Geographic Information System (GIS):** Offers software that can map a specific geographic location anywhere on Earth and analyze geospatial data. GIS geospatial can also detect patterns in the data.
- **Global Positioning System (GPS):** Provides coordinate locations for military and civilian use.
- **Internet Mapping Technologies**: Google Earth and Microsoft Virtual Earth are examples of geospatial software and geospatial mapping tools that makes it easier for people to view and share geospatial data.

Future of Geospatial Technology: The future of geospatial technology largely involves the further integration of machine learning and AI. Mapping as a service, drones and autonomous vehicles are growth areas driving geospatial technology adoption.

- **Geospatial AI**: Places a geographic component on machine learning. App users can provide real-time information about traffic or other conditions in their surroundings. Myriads of contributors improve the accuracy of geospatial data, allowing for better predictions when managing things like traffic flow. Also known as Geo AI.
- **Autonomous Vehicles**: The eye of an autonomous vehicle is **LiDAR (Light Detection and Ranging),** which is a sensing method that uses pulsed laser light to measure variable distances. Geospatial technology make LiDAR possible and mapping companies will take it to the next level to make autonomous driving safer and more accessible.

- **Mapping as a Service**: Not every map found online is high-resolution. But geospatial mapping technology can make on-demand maps of any location desired. The maps can be created based on customer needs and used for any number of industries, including construction. Geospatial imagery and the Mapping as a Service market could reach $8 billion by 2025.
- **Drones:** Drones used for aerial mapping will become more common. Combined with GIS and high precision sensors, the drone-capture images can fly over acres of land to gather data to influence everything from farming to urban planning.

CRISPR - Cas9

- **CRISPR** – Clustered, regularly interspaced, short palindromic repeats, is the technology and Cas9 is the protein that acts like a scissor.
- CRISPR technology is basically a gene-editing technology that can be used for the purpose of altering genetic expression or changing the genome of an organism.
- This technique is based on the natural defence mechanism found in some bacteria.
- It **uses a specific enzyme — Cas9 — to identify and eliminate predetermined genes and DNA sequences.**
- The technology can be used for targeting specific stretches of an entire genetic code or editing the DNA at particular locations.
- Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops.
- **It is a cheaper, more** effective, and endlessly adaptable form of gene manipulation, and it seems to work in every model organism.

How CRISPR - Cas9 technology works?

- In bacteria, Cas9 carries crRNA — the genetic information of viruses to identify where to make their cuts.
- The specific location of the genetic codes that need to be changed, or "edited", is identified on the DNA strand, and then, using the Cas9 protein, which acts like a pair of scissors, that location is cut off from the strand. A DNA strand, when broken, has a natural tendency to repair itself.
- **If Cas9 is assigned a specific RNA sequence and delivered to cells, it will hunt down corresponding sequences in the cellular DNA housed in the nuclei and perform a double-strand cut, severing the entire helix at a predetermined point.**
- Scientists intervene during this auto-repair process, supplying the desired sequence of genetic codes that binds itself with the broken DNA strand.

BIOROCK TECHNOLOGY

The Zoological Survey of India (ZSI), with help from Gujarat's forest department, is attempting for the first time a process to restore coral reefs using biorock or mineral accretion technology.

- **Location:** A biorock structure was installed one nautical mile off the Mithapur coast in the Gulf of Kachchh. The location for installing the biorock had been chosen keeping in mind the **high tidal amplitude in the Gulf of Kachchh**. The low tide depth where the biorock has been installed is four metres, and at high tide it is about eight metres.
- **Need:** Coral reefs were the most diverse ecosystem on the earth. They are getting degraded across the world and also in India by threats posed both by climate change induced acidification as well as by anthropogenic factors. India has four major coral reefs areas: Andaman and Nicobar Islands, Lakshadweep, Gulf of Mannar and the Gulf of Kachchh.
- **What is Biorock?** It is the name given to the substance formed by **electro accumulation of minerals dissolved in seawater on steel structures** that are lowered onto the sea bed and are connected to a power source, in this case solar panels that float on the surface.

- **What is Biorock Technology?**

- Biorock Technology, or **mineral accretion technology** is a method that applies **safe, low voltage electrical currents through seawater, causing dissolved minerals to crystallize on structures, growing into a white limestone** similar to that which naturally makes up coral reefs and tropical white sand beaches. This material has a strength similar to concrete. It can be used to make robust artificial reefs on which corals grow at very rapid rates.
- The change in the environment produced by e**lectrical currents accelerates formation and growth of both chemical limestone rock and the skeletons of corals** and other shell-bearing organisms.
- Biorock methods speed up coral growth in damaged areas and restore authentic coral reef habitat and species. Biorock structures become rapidly colonized by a full range of coral reef organisms, including fish, crabs, clams, octopus, lobster, sea urchins.
- Species typically found in healthy reef environments are given an electrical advantage over the weedy organisms which often overgrow them in reefs stressed by humans. The advantages corals gain from mineral accretion are cancelled if they no longer receive current, at which point weeds will overgrow the corals. If the current is maintained, coral reefs can often be restored even in areas where water quality would prevent their recovery by any other method.

Possibilities: Ongoing initiative of coral restoration using biorock technology could potentially help to sustain faster revival of corals. The technology helps corals, including the highly sensitive branching corals, to counter the threats posed by global warming.

BLOCKCHAIN TECHNOLOGY

- It is a foundational technology or a platform that allows d**esigning a secure way to record transactions and circulate it among signatories,** or any kind of target group with an Internet connection. At its core it is an extremely democratic ledger that cannot be arbitrarily manipulated and easily shareable.
- Blockchain's appeal is that it achieves this **without a central authority**.
- Blockchain burst into public consciousness because of its association with Satoshi Nakamoto, a mysterious individual or cabal that laid out a white paper on how blockchain could be applied to bitcoin, a virtual currency wrought from the principles of blockchain. Having money free of the fiat of Central governments raised utopian possibilities especially in a world where democracies complain of being subverted and labour and capital continue to be entangled in the elusive quest for equilibrium. Thereafter, it spawned its own hype-cycle, imitation currencies, association with the sordid and Dark Net. While cryptocurrencies have a bad reputation, Silicon Valley tech giants and investment banks are trying to salvage the underlying promise of blockchain and use it for other collaborations.
- **Every block in a blockchain** is a record of transactions and the more of the latter, the longer the chain. Just as worthless paper transforms into valuable currency with the signature of the RBI governor, blocks are great because they provide an unalterable document of the history of every transaction. In the **context of currency, it stores the place, time, value (rupee, for example) and location of a purchase.** There is minimal identifying information and every block is linked to a unique 'digital signature' of the transacting participants. Every block is distinguished from another through a unique code which is a string of numbers. When you use your debit or credit card to make a transaction, VISA or MasterCard employ their technology to verify your bank account, connect with banks and process a transaction.
- In blockchain applications, this verifying role is **outsourced to several computers on a network** — each has the exact same copy of the block. These computers verify the genuineness of transaction by solving mathematical problems.
- In the case of bitcoin, the computers are rewarded with bitcoin. This is stored in digital wallets and may be used like money provided there are sellers of real world goods who would accept bitcoins. Nowadays, they are frequently traded as another speculative, volatile asset.

- **Where can it be used?**

- Facebook launched **Libra,** a kind of blockchain-backed digital currency. According to report in a 2017 issue of the Harvard Business Review (HBR), "Bank of America, JPMorgan, the New York Stock Exchange, Fidelity Investments, and Standard Chartered are testing blockchain technology as a replacement for paper-based and manual

transaction processing in such areas as trade finance, foreign exchange, cross-border settlement, and securities settlement"

- **Ethereum** is another blockchain-based startup that looks to decentralise online information. Its ambition is beyond overturning online banking and it claims that if it were to work as envisioned, it will give users control over their data unlike the present where a lot of our privacy is ceded to Google and Amazon's servers. Some plan to apply blockchain to trace the origin of food and where it is grown and yet others to journalism and 'fact- checking' applications. Unlike blockchain's distributed computing philosophy, all these applications ultimately store information on a coalition of repositories.

Future scenario Technology has always proved to be disruptive, creating new opportunities and jobs and destroying old ones. If blockchain's appeal lies in its appeal to destroy intermediaries — banks, courts, lawyers — it is unlikely to be smooth sailing. Moreover, there is already serious theorising by economists that shows how blockchain has its own vulnerabilities and susceptibility to creating new hegemons, power networks, cartels and challenges to global energy consumption.

DESALINATION TECHNOLOGY

- To convert **salt water into freshwater**, the most prevalent technology in the world is **reverse osmosis (RO).** A plant pumps in salty or brackish water, filters separate the salt from the water, and the salty water is returned to the sea. Fresh water is sent to households.
- RO desalination came about in the late 1950s. While the principle is simple, engineering such plants have to factor in various constraints, for instance, salt levels in the source water that is to be treated, the energy required for the treatment and disposing of the salt back into the sea.
- **Osmosis involves** 'a solvent (such as water) naturally moving from an area of low solute concentration, through a membrane, to an area of high solute concentration. A **reverse osmosis system** applies an external pressure to reverse the natural flow of solvent and so seawater or brackish water is pressurised against one surface of the membrane, causing salt-depleted water to move across the membrane, releasing clean water from the low-pressure side'.
- Seawater has Total Dissolved Solids (TDS) — a measure of salinity — close to **35,000 parts per million (ppm)**, or equivalent to 35 g of salt per one litre/kg of water. An effective network of RO plants **reduces this down to about 200-500 ppm**.
- There are about 18,000 desalination plants in the world across 150 countries and nearly half of Israel's water is sourced through desalination.

In India

- Years of water crises in Chennai saw the government set up two desalination plants between 2010 and 2013. Buoyed by the success of these plants, the city's water authorities are planning to install two more plants with capacities of 150 Million Litres per Day (MLD) and 400 MLD.
- Gujarat announced plans of setting up a 100 MLD RO plant at the Jodiya coast in Jamnagar district. Other plants of a similar size are expected to come up in Dwarka, Kutch, Dahej, Somnath, Bhavnagar and Pipavav, which are all coastal places in Gujarat. For now, India's real-world experience with desalination plants is restricted to Chennai.

Problems with RO plants

1. Because RO plants convert seawater to fresh water, the major environmental challenge they pose is the **deposition of brine** (highly concentrated salt water) along the shores.
2. Ever since the Chennai plants have started to function, fishermen have complained that the brine being deposited along the seashore is triggering **changes along the coastline** and **reducing the availability of prawn, sardine and mackerel**.
3. Environmentalists second this saying that **hyper salinity along the shore affects plankton**, which is the main food for several of these fish species.

4. Moreover, the **high pressure motors needed to draw in the seawater end up sucking in small fish and life forms**, thereby crushing and killing them — again a loss of marine resource.
5. Another unexpected problem, an environmentalist group has alleged, was that the construction of the RO plants **required troves of groundwater**. This was freshwater that was sucked out and has since been replaced by salt water, rendering it unfit for the residents around the desalination plants.
6. On an average, it costs **about ₹900 crores to build a 100 MLD-plant and about five years for a plant to be set up**.
7. To remove the salt required, there has to be a **source of electricity**, either a power plant or a diesel or battery source. Estimates have put this at **about 4 units of electricity per 1,000 litres of water**.

- **Technological alternatives**

1. **Low-temperature thermal desalination (LTTD) technique:** LTTD technique works on the principle that water in the ocean 1,000 or 2,000 feet below is about 4º C to 8º C colder than surface water. So, salty surface water is collected in a tank and subject to high pressure (via an external power source). This pressured water vapourises and this is trapped in tubes or a chamber. Cold water plumbed from the ocean depths is passed over these tubes and the vapour condenses into fresh water and the resulting salt diverted away.

   The **National Institute of Ocean Technology (NIOT),** a research organisation based in Chennai, has been working on this technology. In 2005, it set up a 100,000 litre-a-day plant in Kavaratti, Lakshwadeep islands and this has been providing water to about 10,000 residents. Other than the plant at Kavaratti, there are plants of similar capacity proposed at Minicoy and Agatti islands. There are also 1.5 lakh litres a day plants proposed at Amini, Androth, Chetlat, Kadamat, Kalpeni and Kiltan islands.
2. **Ocean thermal energy conversion (OTEC) for desalination**: Ocean thermal energy conversion (OTEC) is a process or technology for producing energy by harnessing the temperature differences (thermal gradients) between ocean surface waters and deep ocean waters.

   Energy from the sun heats the surface water of the ocean. In tropical regions, surface water can be much warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water. Ocean Thermal Energy Conversion (OTEC) systems **use a temperature difference to power a turbine to produce electricity**. Warm surface water is pumped through an evaporator containing a working fluid. The vaporized fluid drives a turbine/generator. The vaporized fluid is turned back to a liquid in a condenser cooled with cold ocean water pumped from deeper in the ocean. OTEC systems using seawater as the working fluid **can use the condensed water to produce desalinated water**.

CARBON CAPTURE AND STORAGE TECHNOLOGY

- Carbon capture and storage technology (CCS) has been hailed as a key component in the **world's shift towards renewable energy.**
- With global CO2 emissions hitting a historic high, growing by more than 1.3% to a record of more than 33 billion tonnes, the need for tools that can help limit pollution has never been greater.
- The Global CCS Institute claims CO2 emissions from fossil fuel combustion in the energy sector contribute roughly 30% to the amount of the pollutant present in the EU, specifically.
- Renewable energy presents a possible solution to this, but its ability to cater the world's power demand, which is expected to rise by 50% by 2030, according to the UK's Carbon Capture and Storage Association (CCSA), is up for debate – this is where CCS comes in.
- The International Energy Agency recently concluded that, to meet the goals of the Paris Agreement, CCS will need to contribute 32% of the extra effort to move from a 2C scenario to well below 2C.
- The Intergovernmental Panel on Climate Change (IPCC) has estimated that without CCS, the cost of trying to meet global climate change goals will increase by almost 140%.

  Here we take a closer look at CCS and how it works.

What is carbon capture and storage technology?

- CCS is a technology reportedly capable of **capturing up to 90% of the CO2 emissions produced by the burning of fossil fuels** to generate electricity, as well as those used in industrial processes, and prevent it from polluting the atmosphere.
- Fossil fuel power plants can be built with the **technology already integrated** or it can also be **combined with renewable biomass to create a "carbon-negative"** mode the goes one step further by actually removing CO2 from the planet.
- The Global CCS Institute says there are 18 large-scale CCS facilities currently in operation, with an additional five under construction.
- Some carbon storage facilities date back multiple decades, such as the Sleipner project in the North Sea, while others remain under construction, like the Gorgon project in Western Australia.
- **First,** CCS involves capturing CO2, before transporting it to be stored in geological rock formations thousands of metres below the Earth's surface.
- The initial part of the process involves separating CO2 from the gasses produced in power generation and industrial processes, such as manufacturing cement or steel, by pre-combustion capture, post-combustion capture or oxy-fuel combustion.
- The pollutant is then transporting using either a pipeline or a ship in much the same way the millions of tonnes of CO2 are transported each year for various commercial purposes, chiefly by countries such as the US.
- It is then stored in depleted oil and gas fields or deep saline aquifer formations, which the Intergovernmental Panel on Climate Change (IPCC) says can retain 99% of the pollutant over a 1000-year period.
- At every point in the CCS chain, from production to storage, industry has at its disposal a number of process technologies that are well understood and have excellent health and safety records
- The commercial deployment of CCS will involve the widespread adoption of these techniques, combined with robust monitoring techniques and government regulation.

Capturing CO2

Pre-combustion capture

- Pre-combustion systems, as provided by manufacturing companies such as British engineering firm **Costain**, convert solid, liquid or gaseous fuel into a blend of hydrogen and CO2 using processes like "**gasification" or "reforming".**
- This can then be used to fuel electricity production, and the CCSA claims it will be able to power vehicles and provide heating, with extremely low emissions, in the future.

Post-combustion capture

- Post-combustion capture involves capturing the CO2 from the exhaust of a combustion system and absorbing it into a solvent, before removing and compressing the pollutant elements.
- CO2 can also be separated using high-pressure membrane filtration, as well as cryogenic separation processes.

Oxy-fuel combustion

- Using oxy-fuel combustion, oxygen is separated from the air before combustion, with the fuel then being combusted in oxygen using recycled flue-gas.
- This creates an atmosphere full of oxygen and nitrogen with flue-gases comprising CO2 and water, allowing for easier purification of the former.

Transporting CO2

- Transporting captured CO2 involves many of the same techniques as used for oil and natural gas, including road tankers, ships and pipelines.
- Many of the networks in use today have been operational for more than 30 years, providing safe and regulation-consistent methods of getting the pollutant from A to B.

- The CCSA says: "There is significant potential for the development of local and regional CCS pipeline infrastructure, leading to CCS 'clusters' where CO2-intensive industries could locate".
- Developing clusters, where infrastructure can be shared by a number of industrial sources of carbon dioxide emissions, will result in the most cost-effective way to deliver CCS infrastructure development and ultimately lower costs to consumers.

Storing CO2

- Storage sites for captured CO2 range from **defunct oil and gas fields to underground saline formations, porous rocks filled with salt water, while it can also injected into depleting oil fields** to increase their output.
- After being injected into such a formation, the CO2 is trapped by a layer of impermeable rock, known as the cap rock, preventing it from entering and polluting the atmosphere above in a process referred to as "structural storage."
- Deep saline aquifers offer the greatest storage capacity over the long term, according to the CCSA, but remain a relative unknown in many areas.

DRS TECHNOLOGY

- The Decision Review System(DRS) is a technology based system in cricket to assist the match officials with their decision making.
- Using UDRS (Umpire's Review) the on-field umpire can take help of Third Umpire and players may request the Third Umpire to consider a decision of the on field umpires using DRS (Player's Review).
- The technologies used in Decision Review System are Television Replays, The Ball Tracking technology used to track the path of the ball, Microphones, Snickometer, Infra-Red imaging to detect temperature changes as the ball hits the pad or the bat. The Technologies Used in Decision Review System are:

1. **TELEVISION REPLAYS**: including Slow Motion which is mainly used to check whether the catch is cleanly taken or not.
2. **HAWK EYE:** Ball Tracking technology that plots the **trajectory of a bowling delivery** that has been interrupted by the batsmen/batswomen often by the pad and predict whether it would have hit the stumps or not. This technology is mainly used for **Leg Before Wicket(LBW) decisions** where the umpire can check whether the impact of the ball is in line to the stumps, whether the ball is hitting the stumps, and whether the ball is pitching outside the leg stump or not. These three conditions are mandatory for LBW decision which is reviewed using Hawk Eye Technology.
3. **SNICKOMETER:** Directional microphones to detect small sounds made as the ball passes the bat or the pad. It is mainly used for caught behind and LBW decisions. If the Snickometer shows spikes while passing the bat then it indicates that the ball has hit the bat which can be used for both caught behind and LBW decisions.
4. **HOTSPOT:** Infra-Red imaging system that shows where the ball has been in contact with the pad or the bat. It mainly shows the point of contact between the ball, bat and pad. It is mandatorily used to check whether the ball has hit the pad or the bat first in case of LBW and checks whether the ball has hit the bat or not in case of caught behind. It can be said as a substitute to Snickometer.

3D PRINTING

- 3D printing or **additive manufacturing is a process of making three dimensional solid objects** from a digital file.
- The creation of a 3D printed object is achieved using additive processes. In an **additive process an object is created by laying down successive layers of material until the object is created**. Each of these layers can be seen as a thinly sliced cross-section of the object.
- 3D printing is the **opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal** or plastic with for instance a milling machine.
- 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.
- The first 3D printer was created by **Charles W. Hull in the mid-1980s**.

How Does 3D Printing Work?

1. Much like traditional printers, 3D printers use a variety of technologies. The most commonly known is **fused deposition modeling (FDM), also known as fused filament fabrication (FFF).** In it, a filament—composed of acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), or another thermoplastic—is melted and deposited through a heated extrusion nozzle in layers.
2. Another technology used in 3D printing is **stereolithography.** In it, a UV laser is shined into a vat of ultraviolet-sensitive photopolymer, tracing the object to be created on its surface. The polymer solidifies wherever the beam touches it, and the beam "prints" the object layer by layer per the instructions in the CAD or CAM file it's working from.
3. In a variation on that, you also have **digital light projector (DLP) 3D printing**. This method exposes a liquid polymer to light from a digital light processing projector. This hardens the polymer layer by layer until the object is built, and the remaining liquid polymer is drained off.
4. **Multi-jet modeling** is an inkjet-like 3D printing system that sprays a coloured, glue-like binder onto successive layers of powder where the object is to be formed. This is among the fastest methods, and one of the few that supports multicolour printing.

What Are the Benefits of 3D Printing?

- With 3D printing, designers have the ability to quickly turn concepts into 3D models or prototypes (a.k.a. "rapid prototyping"), and implement rapid design changes.
- It lets manufacturers **produce products on demand** rather than in large runs, improving inventory management and reducing warehouse space. People in remote locations can fabricate objects that would otherwise be inaccessible to them.
- From a practical standpoint, 3D printing can save money and material versus subtractive techniques, as very little raw material is wasted. And it promises to change the nature of manufacturing, eventually letting consumers download files for printing even complex 3D objects—including, for example, electronics devices—in their own homes.

What Can 3D Printers Make?

- Designers use 3D printers to quickly create product models and prototypes, but they're increasingly being used to make final products, as well. Among the items made with 3D printers are shoe designs, furniture, wax castings for making jewelry, tools, tripods, gift and novelty items, and toys.
- The automotive and aviation industries use 3D printers to make parts. Artists can create sculptures, and architects can fabricate models of their projects. Archaeologists are using 3D printers to reconstruct models of fragile artifacts, including some of the antiquities that in recent years have been destroyed.

The Benefits of 3D printing for Automotive

- **Faster product development**: Prototyping has become a key part of the product development process, offering a means to test and validate parts before they are manufactured. 3D printing offers a quick and cost-effective approach to designing and producing parts. Since the need for tooling is eliminated, product teams can significantly accelerate product development cycles.
- **Greater design flexibility**: The ability to produce designs quickly gives designers greater flexibility when testing multiple design options. 3D printing enables designers to make quick design changes and modifications in a fraction of the time.
- **Customisation**: 3D printing offers automakers a cost-effective and flexible way to produce customised parts. Within the luxury and motorsports segment of the industry, companies are already using the technology to produce personalised parts for both the interior and exterior parts of a vehicle.
- **Create complex geometries**: With the majority of car components requiring complex geometries like internal channels (for conformal cooling), thin walls and fine meshes, AM enables highly complex parts to be produced that are still lightweight and durable.

SCRAMJET ENGINE

- The scramjets are a variant of a category of jet engines **called the air breathing engines**. The ability of engines to handle **airflows of speeds in multiples of speed of sound**, gives it a capability of operating at those speeds.
- **A ramjet operates** by combustion of fuel in a stream of air compressed by the forward speed of the aircraft itself, as opposed to a normal jet engine, in which the compressor section (the fan blades) compresses the air. The air flow through a ramjet engine is subsonic, or less than the speed of sound. Ramjet-propelled vehicles operate from about Mach 3 to Mach 6.
- A **scramjet (supersonic-combustion ramjet) is a ramjet engine in which the airflow through the engine remains supersonic,** or greater than the speed of sound. Scramjet powered vehicles are envisioned to operate at speeds up to at least Mach 15.

- **Advantages of scramjet engine**
- Does not have to carry oxygen tank.
- No rotating parts makes it easier to manufacture.
- Less weight and simple design.
- As the hydrogen is used as a propellant and combustion is carried out at supersonic velocity with the help of oxygen from the atmosphere.
- As a result of that, steam (H2O) is being exhaust gas which is eco-friendly in nature.

- **Need of Scramjet Engines**
- Presently, satellites are launched into orbit by multi-staged satellite launch vehicles that can be used only once (expendable). These launch vehicles carry oxidiser along with the fuel for combustion to produce thrust. Nearly 70% of the propellant (fuel-oxidiser combination) carried by launch vehicles consists of oxidiser. Launch vehicles designed for one-time use are expensive and their efficiency is low because they can carry only 2-4% of their lift-off mass to orbit. **Thus, there is a worldwide effort to reduce the launch cost**.
- Hence the next generation launch vehicles must use a propulsion system which can utilise the atmospheric oxygen during their flight through the atmosphere which will considerably reduce the total propellant required to place a satellite in orbit.
- Ramjet and Scramjet and are the concepts of air-breathing engines which are being developed by various space agencies.

- **More about Ramjet and Scramjet Engine**
- **Ramjet**
- A ramjet is a form of **air-breathing jet engine** that uses the vehicle's forward motion to compress incoming air for combustion without a rotating compressor. **Fuel is injected in the combustion chamber** where it mixes with the hot compressed air and ignites.
- A ramjet-powered vehicle requires **assisted take-off** like a rocket assist to accelerate it to a speed where it begins to produce thrust.
- Ramjets work **most efficiently at supersonic speeds around Mach 3** (three times the speed of sound) and can operate up to speeds of Mach 6. However, the **ramjet efficiency starts to drop when the vehicle reaches hypersonic speeds**.

- **Scramjet**
- A scramjet engine is an **improvement over the ramjet engine.**
- Uniqueness about the scramjet technology is that **it draws oxygen from the air** when the rocket travels through the atmosphere.

- Ordinary rockets do the same. They also draw the oxygen from air but they use compressor to draw in air, compress and ignite to burn the fuel. the scramjet's heating and compression is done by movement of rocket itself as it is moving at supersonic speed. Thus, it is known as Supersonic Combustion Ramjet, or Scramjet.

DEEP OCEAN MISSION

- Oceans, which cover 70 per cent of the globe, remain a key part of our life. About 95 percent of Deep Ocean remains unexplored.
- For India, with its three sides surrounded by the oceans and around 30 per cent of the country's population living in coastal areas, ocean is a major economic factor supporting fisheries and aquaculture, tourism, livelihoods and blue trade.
- Oceans are also storehouse of food, energy, minerals, medicines, modulator of weather and climate and underpin life on Earth.
- Considering importance of the oceans on sustainability, the United Nations (UN) has declared the decade, **2021-2030 as the Decade of Ocean Science for Sustainable Development**.
- India has a unique maritime position. Its 7517 km long coastline is home to nine coastal states and 1382 islands. The Government of India's **Vision of New India by 2030** enunciated in 2019 highlighted the **Blue Economy** as one of the ten core dimensions of growth.
- On this, the Cabinet Committee on Economic Affairs has approved the proposal of Ministry of Earth Sciences (MoES) on "Deep Ocean Mission", with a view to explore deep ocean for resources and develop deep sea technologies for sustainable use of ocean resources.
- The estimated cost of the Mission will be Rs. 4077 crore for a period of 5 years to be implemented in a phase-wise manner. The estimated cost for the first phase for the 3 years (2021-2024) would be Rs.2823.4 crore.
- Deep Ocean Mission with be a mission mode project to support the Blue Economy Initiatives of the Government of India. **Ministry of Earth Sciences (MoES)** will be the nodal Ministry implementing this multi-institutional ambitious mission.
- The Deep Ocean Mission consists of the following six major components:

1. **Development of Technologies for Deep Sea Mining, and Manned Submersible**: A manned submersible will be developed to carry three people to a depth of 6000 metres in the ocean with suite of scientific sensors and tools. Only a very few countries have acquired this capability. An Integrated Mining System will be also developed for mining Polymetallic Nodules from 6000 m depth in the central Indian Ocean. The exploration studies of minerals will pave way for the commercial exploitation in the near future, as and when commercial exploitation code is evolved by the International Seabed Authority, an UN organization. This component will help the Blue Economy priority area of exploring and harnessing of deep sea minerals and energy.
2. **Development of Ocean Climate Change Advisory Services**: A suite of observations and models will be developed to understand and provide future projections of important climate variables on seasonal to decadal time scales under this proof of concept component. This component will support the Blue Economy priority area of coastal tourism.
3. **Technological innovations for exploration and conservation of deep-sea biodiversity**: Bio-prospecting of deep sea flora and fauna including microbes and studies on sustainable utilization of deep sea bio-resources will be the main focus. This component will support the Blue Economy priority area of Marine Fisheries and allied services.
4. **Deep Ocean Survey and Exploration**: The primary objective of this component is to explore and identify potential sites of multi-metal Hydrothermal Sulphides mineralization along the Indian Ocean mid-oceanic ridges. This component will additionally support the Blue Economy priority area of deep sea exploration of ocean resources.
5. **Energy and freshwater from the Ocean**: Studies and detailed engineering design for offshore Ocean Thermal Energy Conversion (OTEC) powered desalination plant are envisaged in this proof of concept proposal. This component will support the Blue Economy priority area of off-shore energy development.
6. **Advanced Marine Station for Ocean Biology**: This component is aimed as development of human capacity and enterprise in ocean biology and engineering. This component will translate research into industrial application and product development through on-site business incubator facilities. This component will support the Blue Economy priority area of Marine Biology, Blue trade and Blue manufacturing.

MICROBIAL FUEL CELL

- The concept behind **microbial fuel cells** is that these rely on bacteria to generate an electrical current.
- These fuel cells have broad usage possibilities and are one of the **cleanest known energy sources.**
- Powered by living microorganisms with clean and sustainable features; they can generate electricity from broad range of organic substrates under natural conditions.
- Microbial fuel production is probably the only technology, in which the electricity is being generated from oxidation of organic compounds in room temperature.
- There is no need to burn anything, and the process is not depending on sunlight
- **Application**-MFC technology is unique because of its multifunctional application: for example, wastewater and slime, collected in wastewater treatment plants can be also used as food for bacteria.
- Although the idea that microorganisms can generate electricity was introduced in 1911, it became more actively investigated in the 2000s. Groups of researchers around the world are working with the MFC technology, attempting to improve the efficiency of the cells.
- **What about the Future?** It is envisaged that the microbial fuel cell (MFC) technology could one day be used in the Developing World in areas lacking sanitation and installed in homes in the Developed World to help clean waste before it flows into the municipal sewerage network, reducing the burden on water companies to treat effluent.

SALINITY GRADIENT ENERGY

*Salinity gradient power is the **energy created from the difference in salt concentration between two fluids**, commonly fresh and salt water, e.g., when a river flows into the sea. There are two technologies for which demonstration projects are running and both use membranes.*

1. **Pressure Retarded Osmosis (PRO)** uses a membrane to separate a concentrated salt solution (like sea water) from freshwater. The freshwater flows through a semipermeable membrane towards the sea water, which increases the pressure within the seawater chamber. A turbine is spun as the pressure is compensated and electricity is generated.
2. **Reversed Electro Dialysis (RED)** uses the transport of (salt) ions through membranes. RED consists of a stack of alternating cathode and anode exchanging perm selective membranes. The compartments between the membranes are alternately filled with sea water and freshwater. The salinity gradient difference is the driving force in transporting ions that results in an electric potential, which is then converted to electricity.

- **Two main applications exist**: as standalone plants in estuaries where freshwater rivers run into the sea; and as hybrid energy generation processes recovering energy from high salinity waste streams. his could be for example, brine from desalination or salt mining, as well as waste water treatment plants. A possible third application is salinity gradient technologies applied to land based saltwater lakes or other types of salt water reserves.

GM CROPS

- GM is a technology that involves **inserting DNA into the genome of an organism**. To produce a GM plant, **new DNA is transferred into plant cells**. Usually, the cells are then grown in tissue culture where they develop into plants. The seeds produced by these plants will inherit the new DNA.
- The characteristics of all living organisms are determined by their genetic makeup and its interaction with the environment. The **genetic makeup of an organism is its genome,** which in all plants and animals is made of DNA. The genome contains genes, regions of DNA that usually carry the instructions for making proteins. It is these proteins that give the plant its characteristics. For example, the colour of flowers is determined by genes that carry the instructions for making proteins involved in producing the pigments that colour petals.
- Genetic modification of plants **involves adding a specific stretch of DNA into the plant's genome, giving it new or different characteristics**. This could include changing the way the plant grows, or making it resistant to a particular disease. The new DNA becomes part of the GM plant's genome which the seeds produced by these plants will contain.

- The **first stage** in making a GM plant requires **transfer of DNA into a plant cell**. One of the methods used to transfer DNA is to coat the surface of small metal particles with the relevant DNA fragment, and bombard the particles into the plant cells.
- Another method is to **use a bacterium or virus.** There are many viruses and bacteria that transfer their DNA into a host cell as a normal part of their life cycle. For GM plants, the bacterium most frequently used is called **Agrobacterium tumefaciens**.
- The gene of interest is transferred into the bacterium and the bacterial cells then transfer the new DNA to the genome of the plant cells. The plant cells that have successfully taken up the DNA are then grown to create a new plant. This is possible because individual plant cells have an impressive capacity to generate entire plants. On rare occasions, the process of DNA transfer can happen without deliberate human intervention. For example the sweet potato contains DNA sequences that were transferred thousands of years ago, from Agrobacterium bacteria into the sweet potato genome.
- There are other ways to change the genomes of crops, some of which are long established, such as mutational breeding, and others of which are new, such as genome editing.

GM RUBBER

- World's First Genetically Modified Rubber Planted In Guwahati.
- The crop was developed in **Kerala Rubber Research Institute of India**. Dismissing the apprehension over GM crops, the officials said that the it was developed only after taking bio-safety measures into consideration.
- The GM rubber has additional copies of the **gene MnSOD, or manganese-containing superoxide dismutase**, inserted in the plant, which is **expected to tide over the severe cold conditions during winter in the northeast**.
- The MnSOD gene has the ability to protect plants from the adverse effects of severe environmental stresses such as cold and drought.

Need:

- Natural rubber is a native of warm humid Amazon forests and is not naturally suited for the colder conditions in the Northeast, which is one of the largest producers of rubber in India.
- Growth of young rubber plants remains suspended during the winter months, which are also characterised by progressive drying of the soil. This is the reason for the long immaturity period of this crop in the region.

India's National Rubber Policy:

- The Department of Commerce brought out the **National Rubber Policy in March 2019**.
- The policy includes several provisions to support the Natural Rubber (NR) production sector and the entire rubber industry value chain.
- It covers new planting and replanting of rubber, support for growers, processing and marketing of natural rubber, labour shortage, grower forums, external trade, Centre-State integrated strategies, research, training, rubber product manufacturing and export, climate change concerns and carbon market.
- It is based on the short term and long term strategies identified by the Task Force constituted on the rubber sector for mitigating problems faced by rubber growers in the country.
- Developmental and research activities for supporting the NR sector for the welfare of growers are carried out through Rubber Board by implementing the scheme Sustainable and Inclusive Development of Natural Rubber Sector in the Medium Term Framework (MTF) (2017-18 to 2019-20).
- The developmental activities include financial and technical assistance for planting, supply of quality planting materials, support for grower forums, training and skill development.

BIOSECURITY

- Biosecurity is defined by the Food and Agriculture Organization of the United Nations (FAO) as a strategic and **integrated approach that encompasses the policy and regulatory frameworks** (including instruments and activities) for analysing and managing relevant risks to human, animal and plant life and health, and associated risks to the environment.
- During these past years, biosecurity as a concept has evolved with its application and it has a great variability in meaning in different countries when used in various national instruments and primary laws. This, in the context of an increasing public awareness of the impact of adverse health and environmental practices fuelled by technological advances in detection and management of hazards to life and health, together with the often unresolved scientific debate that surrounds the potential of very low levels of hazards to result in adverse health or environmental impact.
- Biosecurity covers **food safety, zoonoses, the introduction of animal and plant diseases and pests, the introduction and release of living modified organisms (LMOs) and their products (e.g. genetically modified organisms or GMOs), and the introduction and management of invasive alien species.**
- Thus, biosecurity is a holistic concept of direct relevance to the sustainability of agriculture, and wide-ranging aspects of public health and protection of the environment, including biological diversity.

Why developing biosecurity tools?

Interest in managing these risks through biosecurity has risen considerably over the last 20 years with the rise of several trends:

- The increasing trade in food, plant and animal products, more international travel, new outbreaks of transboundary disease affecting animals, plants and people;
- The awareness of biological diversity and greater attention to the environment and the impact of agriculture on environmental sustainability;
- Changes in the way food, plants and animals are produced, processed and distributed, and the use of new technologies,
- The need to comply with global agreements governing the trade in agricultural and food products.

During the past 20 years, some governments have moved towards such integrated approach to biosecurity that harmonizes and rationalizes policy, legislation and core roles and responsibilities as a means to better manage relevant risks in food and agriculture. However, most countries continued to manage biosecurity along traditional, sector-oriented lines, resulting in a lack of strategic focus, inefficient use of scarce resources and less than optimal results.

What constitutes a biosecurity hazard?

Depending on the sector involved and as illustrated in the figure, there are various descriptions as to what constitutes a biosecurity hazard, All significant effects, positive and negative (hazards), should be systematically identified and their relative magnitudes considered in decision-making.

Box 1.4. Definitions of a hazard as applicable to different biosecurity sectors

Food safety	A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect (CAC).
Zoonoses	A biological agent that can be transmitted naturally between wild or domestic animals and humans (OIE).
Animal health	Any pathogenic agent that could produce adverse consequences on the importation of a commodity (OIE).
Plant health	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (IPPC).*
Plant health quarantine	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (IPPC).
"Biosafety" in relation to plants and animals	A living modified organism (LMO) that possesses a novel combination of genetic material obtained through the use of modern biotechnology that is likely to have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health (Cartagena Protocol on Biosafety).
"Biosafety" in relation to food	A recombinant DNA organism directly effecting or remaining in a food that could have an adverse effect on human health (Cartagena Protocol on Biosafety).
Invasive alien species	An invasive alien species outside its natural past or present distribution whose introduction and/or spread threatens biodiversity (CBD).

** IPPC does not usually use the term "hazard" but instead uses the term "pest". For a pest to be subject to pest risk analysis (PRA), it has to satisfy the criteria for definition of a quarantine pest*

What is the rationale for a harmonized and holistic approach of biosecurity?

- Human, animal and plant life, health and protection of the environment but also agriculture and health are inextricably linked in many ways. Biosecurity hazards of various types exist in each sector and have high potential to move between sectors. For example, many animal pathogens readily infect humans; animal feed may be contaminated with mycotoxins and plant toxins.
- Changes in the environment, such as the loss of biological diversity and contamination of food and water sources, the size and scope of the global trade in animal feed and animal feed ingredients are examples of the immense potential for biosecurity hazards to move between and within countries.
- Further, international events may superimpose requirements for more integrated and harmonized approaches. In particular, there is an increased recognition of the potential for wide-scale food-borne threats to public or animal health from acts of terrorism is a new consideration in modern biosecurity systems.
- The merging of policies and values with science in biosecurity risk management presents considerable challenges and has different expression in different countries. As underlined in the FAO Toolkit, both risk assessment and risk management should thus be wrapped in a "sea of communication" that includes all stakeholders as appropriate.
- Core decisions should involve the balancing of scientific findings against questions of life and health expectations, likely economic and social impacts, but also the technical feasibility and cost-effectiveness of controls. The increasing number and stringency of sanitary and phytosanitary requirements, the recognition of the high cost of regulation and acknowledgement of limited public resources are other drivers of these holistic changes. On top of this, there are increasing demands from industry for better cost-effectiveness of biosecurity systems and greater accommodation of new technologies.

HEALTH SCIENCE

DNA and RNA

Parameter	DNA	RNA
Structure	DNA is a double-stranded molecule consisting of a long chain of nucleotides. B type of helix.	It is a single-stranded helix consisting of a short chain of nucleotides. A type of helix.
Function	Transmits genetic information to make other cells and new organisms. Long-term storage of genetic information	It transfers the genetic code from the nucleus to the ribosomes to make proteins.
Propagation	DNA is self-replicating.	Synthesized from DNA.
Composition	Deoxyribose sugar phosphate backbone adenine, guanine, cytosine, thymine bases.	Ribose sugar phosphate backbone adenine, guanine, cytosine, uracil bases.
Location	In the nucleus of a cell and in the mitochondria.	Located in the cytoplasm, nucleus, and in the ribosome.
Nitrogenous Bases and	GC(Guanine pairs with Cytosine) A-	GC(Guanine pairs with Cytosine) A-

Pairing	T(Adenine pairs with Thymine).	U(Adenine pairs with Uracil)
Molecular Weight	2 to 6 million	25,000 to 2 million
Stability	DNA is a more stable molecule than RNA. DNA is stable under alkaline conditions.	Much more reactive than DNA and is not stable in alkaline conditions.
Ultraviolet (UV) Sensitivity	DNA is vulnerable to damage by ultraviolet light.	Much more resistant to damage from UV light than DNA.

GENOME

A genome is an organism's complete set of genetic instructions. Each genome contains all of the information needed to build that organism and allow it to grow and develop.

- Our bodies are made up of millions of cells, each with their own complete set of instructions for making us, like a recipe book for the body. This set of instructions is known as our genome and is made up of DNA. Each cell in the body, for example, a skin cell or a liver cell, contains this same set of instructions:

- The instructions in our genome are made up of DNA.
- Within DNA is a unique chemical code that guides our growth, development and health.
- This code is determined by the order of the four nucleotide bases that make up **DNA, adenine, cytosine, guanine and thymine, A, C, G and T for short**.
- DNA has a twisted structure in the shape of a double helix.
- Single strands of DNA are coiled up into structures called **chromosomes.**
- Your chromosomes are located in the nucleus within each cell.
- Within our chromosomes, sections of DNA are "read" together to form genes.
- Genes control different characteristics such as eye colour and height.
- All living things have a unique genome.
- The human genome is made of **3.2 billion bases of DNA** but other organisms have different genome sizes.

GENOME MAP

- A genome map helps scientists navigate around the genome. Like road maps and other familiar maps, a genome map is a set of landmarks that tells people where they are, and helps them get where they want to go.
- The landmarks on a genome map might include **short DNA sequences**, regulatory sites that turn genes on and off, and genes themselves. Often, genome maps are used to **help scientists find new genes**.
- Road maps chart well-known territory surveyed with astonishing precision, but a genome map is a map of a new frontier.
- Some parts of the genome have been mapped in great detail, while others remain relatively uncharted territory. It may turn out that a few landmarks on current genome maps appear in the wrong place or at the wrong distance from other landmarks. But over time, as scientists continue to explore the genome frontier, maps will become more accurate and more detailed. A genome map is a work in progress.

What does a genome map look like?

- Most everyday maps have length and width, latitude and longitude, like the world around us. But a genome map is **one-dimensional—it is linear**, like the DNA molecules that make up the genome itself. A genome map looks like a straight line with landmarks noted at irregular intervals along it, much like the towns along the map of a highway.

The landmarks are usually inscrutable combinations of letters and numbers that stand for genes or other features—for example, D14S72, GATA-P7042, and so on.

What is the difference between a genome map and a genome sequence?

- Both are portraits of a genome, but a genome map is less detailed than a genome sequence. A sequence spells out the order of every DNA base in the genome, while a map simply identifies a series of landmarks in the genome.
- Sometimes mapping and sequencing are completely separate processes. For example, it's possible to determine the location of a gene—to "map" the gene—without sequencing it. Thus, a map may tell you nothing about the sequence of the genome, and a sequence may tell you nothing about the map.
- Genome maps help scientists find genes, particularly those involved in human disease. This process is much like a scientific game of hot and cold. Scientists study many families affected by a disease, tracing the inheritance of the disease and of specific genome landmarks through several generations. Landmarks that tend to be inherited along with the disease are likely to be located close to the disease gene and become "markers" for the gene in question.
- Once they have identified a few such markers, scientists know the approximate location of the disease gene. In this way, they narrow down their search from the entire 3-billion-base-pair genome to a region of the genome a few million base pairs long.

EPIGENETICS

- Epigenetics is the **study of how your behaviours and environment can cause changes that affect the way your genes work.** Unlike genetic changes, epigenetic changes are reversible and do not change your DNA sequence, but they can change how your body reads a DNA sequence.
- Gene expression refers to how often or when proteins are created from the instructions within your genes. While genetic changes can alter which protein is made, **epigenetic changes affect gene expression to turn genes "on" and "off**." Since your environment and behaviours, such as diet and exercise, can result in epigenetic changes, it is easy to see the connection between your genes and your behaviours and environment.

How Does Epigenetics Work?

Epigenetic changes affect gene expression in different ways. Types of epigenetic changes include:

- **DNA Methylation:** DNA methylation works by **adding a chemical group to DNA**. Typically, this group is added to specific places on the DNA, where it blocks the proteins that attach to DNA to "read" the gene. This chemical group can be removed through a process called demethylation. Typically, methylation turns genes "off" and demethylation turns genes "on."
- **Histone modification**: DNA wraps around proteins called histones. DNA wrapped tightly around histones cannot be accessed by proteins that "read" the gene. Some genes are wrapped around histones and are turned "off" while some genes are not wrapped around histones and are turned "on." Chemical groups can be added or removed from histones and change whether a gene is unwrapped or wrapped ("on" or "off").
- **Non-coding RNA:** Your DNA is used as instructions for making coding and non-coding RNA. Coding RNA is used to make proteins. Non-coding RNA helps control gene expression by attaching to coding RNA, along with certain proteins, to break down the coding RNA so that it cannot be used to make proteins. Non-coding RNA may also recruit proteins to modify histones to turn genes "on" or "off."

How Can Your Epigenetics Change?

Your epigenetics change as you age, both as part of normal development and aging and in response to your behaviours and environment.

- **Epigenetics and Development**: Epigenetic changes begin before you are born. All your cells have the same genes but look and act differently. As you grow and develop, epigenetics helps determine which function a cell will have, for example, whether it will become a heart cell, nerve cell, or skin cell.
- **Epigenetics and Age**: Your epigenetics change throughout your life. Your epigenetics at birth is not the same as your epigenetics during childhood or adulthood.

- **Epigenetics and Reversibility**: Not all epigenetic changes are permanent. Some epigenetic changes can be added or removed in response to changes in behavior or environment.

Epigenetics and Health: Epigenetic changes can affect your health in different ways:

- **Infections:** Germs can change your epigenetics to weaken your immune system. This helps the germ survive.
- **Cancer:** Certain mutations make you more likely to develop cancer. Likewise, some epigenetic changes increase your cancer risk. For example, having a mutation in the BRCA1 gene that prevents it from working properly makes you more likely to get breast and other cancers.
- **Nutrition During Pregnancy**: A pregnant woman's environment and behavior during pregnancy, such as whether she eats healthy food, can change the baby's epigenetics. Some of these changes can remain for decades and might make the child more likely to get certain diseases.

CHOANOFLAGELLATES

- The choanoflagellates are a group of free-living unicellular and colonial flagellate eukaryotes considered to be the closest living relatives of the animals.
- They help to reconstruct animal origins and elucidate core mechanisms underlying animal cell and developmental biology.
- In the beginning, the environment of Earth was devoid of oxygen. It was high in methane, was not fit for animal life.
- At the same time, it could 'host' microorganisms which could cope with the incoming sunlight and use it to generate energy for living. This was around 3.4 billion years ago.
- In the process, these microorganisms **generated the gaseous waste product called oxygen**.
- About 2 Byr, later the amount of oxygen on Earth became an important component of the Earths' surface, and amenable for animal life.
- Choanoflagellates are the closest living relatives of animals that appeared nearly a billion years ago.
- Over time, animal cells also evolved to produce increased amounts of molecules called **reactive oxygen species (ROS),** which are involved in many essential cell activities but toxic at high levels.
- In addition, more complexity necessitates a substantial increase in the genome size of the animal with concomitant increase in all transactions in the cell: DNA, the genetic material in the cells of the various organs, their transcription of the information to messenger RNA (mRNAs), then translation of these into the amino acid sequences that make individual proteins in the cells through what are called tRNAs — at least one per amino acid.
- If a wrong interpretation of the genetic code at the protein level occurs, it will lead to functional disorders and even diseases.

MUCORMYCOSIS

- Mucormycosis (sometimes called zygomycosis) is a serious but rare fungal infection caused by a group of molds called **mucormycetes.** These fungi live throughout the environment, particularly in soil and in decaying organic matter, such as leaves, compost piles, or rotten wood.

- People get mucormycosis by coming in **contact with the fungal spores** in the environment. For example, the lung or sinus forms of the infection can occur after someone breathes in spores. These forms of mucormycosis usually occur in people who have health problems or take medicines that lower the body's ability to fight germs and sickness.
- Mucormycosis can also develop on the skin after the fungus enters the skin through a cut, scrape, burn, or other type of skin trauma.

Types of mucormycosis

- **Rhinocerebral (sinus and brain) mucormycosis** is an infection in the sinuses that can spread to the brain. This form of mucormycosis is most common in people with uncontrolled diabetes and in people who have had a kidney transplant.

- **Pulmonary (lung) mucormycosis** is the most common type of mucormycosis in people with cancer and in people who have had an organ transplant or a stem cell transplant.
- **Gastrointestinal mucormycosis** is more common among young children than adults, especially premature and low birth weight infants less than 1 month of age, who have had antibiotics, surgery, or medications that lower the body's ability to fight germs and sickness.
- **Cutaneous (skin) mucormycosis**: occurs after the fungi enter the body through a break in the skin (for example, after surgery, a burn, or other type of skin trauma). This is the most common form of mucormycosis among people who do not have weakened immune systems.
- **Disseminated mucormycosis** occurs when the infection spreads through the bloodstream to affect another part of the body. The infection most commonly affects the brain, but also can affect other organs such as the spleen, heart, and skin.

Types of fungi that most commonly cause mucormycosis

Examples are: Rhizopus species, Mucor species, Rhizomucor species, Syncephalastrum species, Cunninghamella bertholletiae, Apophysomyces species, and Lichtheimia (formerly Absidia) species.

Symptoms of rhinocerebral (sinus and brain) mucormycosis include:

- One-sided facial swelling
- Headache
- Nasal or sinus congestion
- Black lesions on nasal bridge or upper inside of mouth that quickly become more severe
- Fever

Symptoms of pulmonary (lung) mucormycosis include:

- Fever
- Cough
- Chest pain
- Shortness of breath
- Cutaneous (skin) mucormycosis can look like blisters or ulcers, and the infected area may turn black. Other symptoms include pain, warmth, excessive redness, or swelling around a wound.

Symptoms of gastrointestinal mucormycosis include:

- Abdominal pain
- Nausea and vomiting
- Gastrointestinal bleeding
- Disseminated mucormycosis typically occurs in people who are already sick from other medical conditions, so it can be difficult to know which symptoms are related to mucormycosis. Patients with disseminated infection in the brain can develop mental status changes or coma.

Treatment

Common antifungal medications that doctor may prescribe for mucormycosis include:

- amphotericin B (given through an IV)
- posaconazole (given through an IV or orally)
- isavuconazole (given through an IV or orally)

MUTATIONS OF COVID-19

*Multiple SARS-CoV-2 variants are circulating globally. One of these is the B.1.617 lineage, detected in India earlier this year. Early evidence suggests that its sub-lineage B.1.617.2, known as the **Delta variant**, is more transmissible than contemporary lineages.*

- All viruses – including SARS-CoV-2, the virus that causes COVID-19 – evolve over time. When a virus replicates or makes copies of itself, it sometimes changes a little bit, which is normal for a virus. These changes are called **"mutations".**
- A virus with **one or more new mutations is referred to as a "variant"** of the original virus.

What causes a virus to change to a new variant?

- When a virus is widely circulating in a population and causing many infections, the likelihood of the virus mutating increases. The more opportunities a virus has to spread, the more it replicates – and the more opportunities it has to undergo changes.
- Most viral mutations have little to no impact on the virus's ability to cause infections and disease. But depending on where the changes are located in the virus's genetic material, they may affect a virus's properties, such as **transmission** (for example, it may spread more or less easily) or **severity** (for example, it may cause more or less severe disease).

What impact do the new variants of the COVID-19 virus have on vaccines?

- The COVID-19 vaccines that are currently in development or have been approved are expected to provide at least some protection against new virus variants because these vaccines elicit a broad immune response involving a range of antibodies and cells.
- Therefore, changes or mutations in the virus should not make vaccines completely ineffective.
- In the event that any of these vaccines prove to be less effective against one or more variants, it will be possible to change the composition of the vaccines to protect against these variants.

What is WHO doing to monitor and understand the impact of virus variants on the efficacy of COVID-19 vaccines?

- WHO has also established a **SARS-CoV-2 Risk Monitoring and Evaluation Framework** to identify, monitor and assess variants of concern.
- It will involve components like surveillance, research on variants of concern, and evaluation of the impact on diagnostics, therapeutics and vaccines.
- The framework will serve as a guide for manufacturers and countries on changes that may be needed for COVID-19 vaccines.

How can we prevent future new variants of the COVID-19 virus?

- **Stopping the spread at the source remains key**. Current measures to reduce transmission – including frequent hand washing, wearing a mask, physical distancing, good ventilation and avoiding crowded places or closed settings – continue to work against new variants by reducing the amount of viral transmission and therefore also reducing opportunities for the virus to mutate.
- **Scaling up vaccine manufacturing and rolling out vaccines as quickly** and widely as possible will also be critical ways of protecting people before they are exposed to the virus and the risk of new variants. Priority should be given to vaccinating high-risk groups everywhere to maximize global protection against new variants and minimize the risk of transmission. Moreover, ensuring equitable access to COVID-19 vaccines is more critical than ever to address the evolving pandemic. As more people get vaccinated, we expect virus circulation to decrease, which will then lead to fewer mutations.

PLASMA

Plasma is the often forgotten part of blood. White blood cells, red blood cells, and platelets are important to body function. But plasma also plays a key role. This **fluid carries the blood components throughout the body.**

Facts about plasma

- Plasma is the **largest part of your blood.** It, makes up **more than half (about 55%)** of its overall content. When separated from the rest of the blood, plasma is a light yellow liquid. Plasma carries **water, salts and enzymes**.
- The main role of plasma **is to take nutrients, hormones, and proteins to the parts of the body** that need it. Cells also put their waste products into the plasma. The plasma then helps remove this waste from the body. Blood plasma also carries all parts of the blood through your circulatory system.

How does plasma keep you healthy?

- Plasma is a critical part of the treatment for many serious health problems. This is why there are blood drives asking people to donate blood plasma.
- Along with water, salt, and enzymes, plasma also contains important components. These include **antibodies, clotting factors, and the proteins albumin and fibrinogen**. When you donate blood, healthcare providers can separate these vital parts from your plasma. These parts can then be concentrated into various products. These products are then used as treatments that can help save the lives of people suffering from burns, shock, trauma, and other medical emergencies.
- The proteins and antibodies in plasma are also used in therapies for rare chronic conditions. These include autoimmune disorders and hemophilia. People with these conditions can live long and productive lives because of the treatments. In fact, some health organizations call plasma "the gift of life."

PULSE OXIMETER

- A pulse oximeter is a small, lightweight device used to monitor the amount of oxygen carried in the body.
- This non-invasive tool attaches painlessly to your fingertip.
- Once the oximeter finishes its assessment, its screen will display the percent of oxygen in your blood coming from your heart—as well as your current pulse rate.

Blood Oxygen Saturation (SpO2)

- Your SpO2 reading is an **estimation of the amount of oxygen in your blood**.
- An SpO2 reading of 95% or greater is generally considered to be a normal oxygen level.
- **However, an SpO2 reading of 92% or less (at sea level) suggests that your blood is poorly saturated.**
- Insufficient saturation can cause a range of adverse health conditions—including chest pain, shortness of breath and increased heart rate.

Acceptable range of Oxygen in the blood:

- Acceptable normal ranges for patients without pulmonary pathology are from 95 to 99 percent.
- For a patient breathing room air at or near sea level, an estimate of arterial pO2 can be made from the blood-oxygen monitor "saturation of peripheral oxygen" (SpO2) reading.

How Pulse Oximeter works?

- A blood-oxygen monitor displays the percentage of blood that is loaded with oxygen.
- More specifically, it measures what percentage of haemoglobin, the protein in blood that carries oxygen, is loaded.

- **Actual Mechanism**

- A typical pulse oximeter uses an electronic processor and a pair of small light-emitting diodes (LEDs) facing a photodiode through a translucent part of the patient's body, usually a fingertip or an earlobe.
- One LED is red, with wavelength of 660 nm, and the other is infrared with a wavelength of 940 nm.

- Small beams of light pass through the blood in the finger, measuring the amount of oxygen. It does this by measuring changes of light absorption in oxygenated or deoxygenated blood. This is a painless process. The pulse oximeter will thus be able to tell you your oxygen saturation levels along with your heart rate.

  In general, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness. For some people, a pulse rate below 60 bpm indicates abnormally slow heart action, also known as bradycardia. Bradycardia can cause a number of problematic symptoms—including fainting, fatigue, chest pains and memory problems.

HEPATITIS

- Hepatitis is a term used to describe **inflammation (swelling) of the liver.**
- It can be caused due to viral infection or when liver is exposed to harmful substances such as alcohol.
- The disease may occur with limited or no symptoms, but often leads to jaundice, anorexia (poor appetite) and malaise.
- **Hepatitis is of 2 types: acute and chronic**.
- Hepatitis B infection at a young age turns chronic, causing over 1,00,000 premature deaths annually from liver cirrhosis or liver cancer.
- The most common types of hepatitis are:
- **Hepatitis A-** It is the **most common type of viral hepatitis**. It is generally seen in the areas where sanitation and sewage disposal are poor.
- **Hepatitis B** - caused by the **hepatitis B virus.** It is common in India and other parts of the world, such as China, Central and Southeast Asia and sub-Saharan Africa.
- **Hepatitis C**- It is particularly concentrated in the blood, so it is usually transmitted through blood-to-blood contact.
- One of the major reason of prevalence of this disease is the low coverage of birth dose vaccination.

DIPHTHERIA

- Diphtheria is an infectious disease caused by the bacterial microorganism known as **Corynebacterium diphtheriae.** Some strains of this bacterium produce a toxin, and it is this toxin that causes the most serious complications of diphtheria. The bacteria produce a toxin because they themselves are infected by a certain type of virus called a **phage.**
- **The toxin that is released:**
  - inhibits the production of proteins by cells;
  - destroys the tissue at the site of the infection;
  - leads to membrane formation;
  - gets taken up into the bloodstream and distributed around the body's tissues;
  - causes inflammation of the heart and nerve damage;
  - can cause low platelet counts, or thrombocytopenia, and produce protein in the urine in a condition called proteinuria.

- **Diphtheria is an infection spread only among humans. It is contagious by direct physical contact with:**
  - droplets breathed out into the air;
  - secretions from the nose and throat, such as mucus and saliva;
  - infected skin lesions;
  - objects, such as bedding or clothes an infected person has used, in rare cases;
  - The infection can spread from an infected patient to any mucous membrane in a new person, but the toxic infection most often attacks the lining of the nose and throat.

- **Early features of the infection, before the pseudomembrane appears, include:**

- low fever, malaise, and weakness.
- swollen glands on the neck
- Swelling of soft tissue in the neck, giving a 'bull neck' appearance
- nasal discharge
- fast heart rate

- **Children with a diphtheria infection in a cavity behind the nose and mouth are more likely to have the following early features:**

- nausea and vomiting
- chills, headache, and fever

ALZHEIMER'S DISEASE

- Alzheimer's disease is a condition that **affects the brain**. The symptoms are mild at first and become more severe over time. It is named after **Dr. Alois Alzheimer**, who first described the condition in 1906.
- Common symptoms of Alzheimer's disease include **memory loss, language problems**, and **impulsive or unpredictable behaviour.**
- **Dementia** is an umbrella term for a range of conditions that involve a loss of cognitive functioning.
- Alzheimer's disease is the most common type of dementia. It involves plaques and tangles forming in the brain. Symptoms start gradually and are most likely to include a decline in cognitive function and language ability.
- Other types of dementia include **Huntington's disease**, **Parkinson's disease**, and **Creutzfeldt-Jakob disease**. A person can have more than one type of dementia.
- These features mean that information cannot pass easily between different areas of the brain or between the brain and the muscles or organs.
- As the symptoms worsen, it becomes harder for people to remember recent events, to reason, and to recognize people they know. Eventually, a person with Alzheimer's disease may need full-time assistance.
- According to the National Institute on Aging, Alzheimer's disease is the sixth leading cause of death in the U.S. However, other recent estimates suggest that it may be the third leading cause of death, just behind heart disease and cancer.

Symptoms

- Alzheimer's disease is a progressive condition, meaning that the symptoms get worse over time. Memory loss is a key feature, and this tends to be one of the first symptoms to develop.
- The symptoms appear gradually, over months or years. If they develop over hours or days, a person may require medical attention, as this could indicate a stroke.

Symptoms of Alzheimer's disease include:

Memory loss: A person may have difficulty taking in new information and remembering information. This can lead to:

- repeating questions or conversations
- losing objects
- forgetting about events or appointments
- wandering or getting lost

Cognitive deficits: A person may experience difficulty with reasoning, complex tasks, and judgment. This can lead to:

- a reduced understanding of safety and risks
- difficulty with money or paying bills

- difficulty making decisions
- difficulty completing tasks that have several stages, such as getting dressed

Problems with recognition: A person may become less able to recognize faces or objects or less able to use basic tools. These issues are not due to problems with eyesight.

- Problems with spatial awareness: A person may have difficulty with their balance, trip over, or spill things more often, or they may have difficulty orienting clothing to their body when getting dressed.
- Problems with speaking, reading, or writing: A person may develop difficulties with thinking of common words, or they may make more speech, spelling, or writing errors.

Personality or behaviour changes: A person may experience changes in personality and behavior that include:

- becoming upset, angry, or worried more often than before
- a loss of interest in or motivation for activities they usually enjoy
- a loss of empathy
- compulsive, obsessive, or socially inappropriate behaviour.

AMYOTROPHIC LATERAL SCLEROSIS (ALS)

- It is a group of **rare neurological diseases** that mainly involve the nerve cells (neurons) responsible for controlling voluntary muscle movement.
- It belongs to a wider group of disorders known as **motor neuron diseases**, which are caused by gradual deterioration (degeneration) and death of **motor neurons**.
- **Motor neurons** are nerve cells that extend from the brain to the spinal cord and to muscles throughout the body. These motor neurons initiate and provide vital communication links between the brain and the voluntary muscles.
- ALS is progressive, meaning the symptoms get worse over time. Currently, there is no cure for ALS and no effective treatment to halt, or reverse, the progression of the disease.
- It is also known as **Lou Gehrig's disease,** it causes lethal respiratory paralysis within several years of diagnosis.

BROWN FAT

- **Brown adipose tissue (BAT) or brown fat** makes up the adipose organ together with white adipose tissue (or white fat).
- Brown adipose tissue is found in almost all mammals.
- It is especially **abundant in new-borns** and in **hibernating mammals**, also present and metabolically active in adult humans, but its prevalence decreases as humans age.
- Brown fat contains **many more mitochondria** than does white fat.
- These mitochondria are the “engines” in brown fat that burn calories to produce heat.
- Because of brown fats ability to burn calories, scientists are looking for ways to **exploit its power to help fight obesity**.
- In adults exposed to cold temperatures, brown fat may serve as an ‘internal heating jacket’ to keep blood warm as it flows back to the heart and brain from our chilly extremities.
- Brown fat helps babies — who do not have the ability to shiver — to stay warm.
- It offers potential to combat the **Metabolic syndrome conditions**.
- **Metabolic syndrome conditions** IS cluster of conditions that includes -increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels — that occur together, increasing risk of heart disease, stroke and diabetes.

SICKLE CELL ANAEMIA

- It is a major **genetic disease** that affects most countries in the **African Region**.
- In sickle cell disease, the normal round shape of red blood cells become like **crescent moons**.
- Round red blood cells can move easily through the blood vessels but sickled shaped cells interconnect and can result in **blood clots.**
- These blood clots can cause extreme pain in the back, chest, hands and feet.
- The disrupted blood flow can also cause damage to bones, muscles and organs.
- People with sickle cell disease often feel weak, tired and look pale.
- At the moment the only remedy available for the disease is a dangerous and expensive bone marrow transplant.
- **Regions:** In countries such as Cameroon, Republic of Congo, Gabon, Ghana and Nigeria the prevalence is between 20% to 30% while in some parts of Uganda it is as high as 45%.

ANTIMICROBIAL RESISTANCE

- Antimicrobial resistance (AMR) is a global health and development threat. It requires urgent multisectoral action in order to achieve the Sustainable Development Goals (SDGs).
- WHO has declared that AMR is one of the top 10 global public health threats facing humanity.
- **Misuse and overuse of antimicrobials** are the main drivers in the development of drug-resistant pathogens.
- **Lack of clean water and sanitation and inadequate infection prevention and control** promotes the spread of microbes, some of which can be resistant to antimicrobial treatment.
- The cost of AMR to the economy is significant. In addition to death and disability, prolonged illness results in longer hospital stays, the need for more expensive medicines and financial challenges for those impacted.
- Without effective antimicrobials, the success of modern medicine in treating infections, including during major surgery and cancer chemotherapy, would be at increased risk.

What are antimicrobials?

- Antimicrobials – including antibiotics, antivirals, antifungals and antiparasitics – are medicines used to prevent and treat infections in humans, animals and plants.

What is antimicrobial resistance?

- Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death.
- As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat.

Why is antimicrobial resistance a global concern?

- The emergence and spread of drug-resistant pathogens that have acquired new resistance mechanisms, leading to antimicrobial resistance, **continues to threaten our ability to treat common infections**. Especially alarming is the rapid global spread of multi- and pan-resistant bacteria (also known as "superbugs") that cause infections that are not treatable with existing antimicrobial medicines such as antibiotics.
- The **clinical pipeline of new antimicrobials is dry**. In 2019 WHO identified 32 antibiotics in clinical development that address the WHO list of priority pathogens, of which only six were classified as innovative. Furthermore, a lack of access to quality antimicrobials remains a major issue. Antibiotic shortages are affecting countries of all levels of development and especially in health- care systems.
- Antibiotics are becoming increasingly ineffective as drug-resistance spreads globally leading to more difficult to treat infections and death. **New antibacterials are urgently needed** – for example, to treat carbapenem-resistant gram-negative bacterial infections as identified in the WHO priority pathogen list. However, if people do not change the

way antibiotics are used now, these new antibiotics will suffer the same fate as the current ones and become ineffective.

- The cost of **AMR to national economies and their health systems is significant as it affects productivity of patients or their caretakers** through prolonged hospital stays and the need for more expensive and intensive care.
- Without effective tools for the prevention and adequate treatment of drug-resistant infections and improved access to existing and new quality-assured antimicrobials, the number of people for whom treatment is failing or who die of infections will increase. Medical procedures, such as surgery, including caesarean sections or hip replacements, cancer chemotherapy, and organ transplantation, will become more risky.

What accelerates the emergence and spread of antimicrobial resistance?

- AMR occurs naturally over time, usually through genetic changes. Antimicrobial resistant organisms are found in people, animals, food, plants and the environment (in water, soil and air).
- They can spread from person to person or between people and animals, including from food of animal origin. The main drivers of antimicrobial resistance include the misuse and overuse of antimicrobials; lack of access to clean water, sanitation and hygiene (WASH) for both humans and animals; poor infection and disease prevention and control in health-care facilities and farms; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; and lack of enforcement of legislation.

ELEMENTS

RARE EARTH ELEMENTS

China's dominance in these minerals, key to the future of manufacturing, is a cause for concern for the West.

- In 2019, the U.S. imported 80% of its rare earth minerals from China.
- The EU gets 98% of its supply from China.
- Amid the transition to green energy, in which rare earth minerals are sure to play a role, China's market dominance is enough to sound an alarm in western capitals.

What if China were to cut off the U.S. and Europe from access to rare minerals that are essential to electric vehicles, wind turbines and drones?

REE

- The rare earth elements (REE) are a set of **seventeen metallic elements**. These include the fifteen lanthanides on the periodic table plus scandium and yttrium.
- Rare earth elements are an essential part of many **high-tech devices**.
- Rare-earth elements (REE) are necessary components of more than 200 products across a wide range of applications, especially high-tech consumer products, such as cellular telephones, computer hard drives, electric and hybrid vehicles, and flat-screen monitors and televisions.
- Significant defense applications include electronic displays, guidance systems, lasers, and radar and sonar systems. Although the amount of REE used in a product may not be a significant part of that product by weight, value, or volume, the REE can be necessary for the device to function. For example, magnets made of REE often represent only a small fraction of the total weight, but without them, the spindle motors and voice coils of desktops and laptops would not be possible.
- The Japanese call them "the seeds of technology." The US Department of Energy calls them "technology metals."
- In 1993, 38 percent of world production of REEs was in China, 33 percent was in the United States, 12 percent was in Australia, and five percent each was in Malaysia and India. Several other countries, including Brazil, Canada, South Africa, Sri Lanka, and Thailand, made up the remainder. However, in 2008, China accounted for more than 90 percent of world production of REEs, and by 2011, China accounted for 97 percent of world production. Beginning in 1990 and beyond, supplies of REEs became an issue as the Government of China began to change the amount of the

REEs that it allows to be produced and exported. The Chinese Government also began to limit the number of Chinese and Sino-foreign joint-venture companies that could export REEs from China.

HELIUM

- Helium (He), chemical element, **inert gas of Group 18 (noble gases)** of the periodic table.
- The **second lightest element** (only hydrogen is lighter), helium is a **colourless, odourless, and tasteless gas** that **becomes liquid at −268.9** °C (−452 °F).
- The **boiling and freezing points of helium are lower than those of any other known substance**.
- Helium is the only element that cannot be solidified by sufficient cooling at normal atmospheric pressure; it is necessary to apply pressure of 25 atmospheres at a temperature of 1 K (−272 °C, or −458 °F) to convert it to its solid form.
- Helium was discovered in the gaseous atmosphere surrounding the Sun by the French astronomer Pierre Janssen.
- The British chemist Sir William Ramsay discovered the existence of helium on Earth in 1895.
- Helium **constitutes about 23 percent of the mass of the universe** and is thus second in abundance to hydrogen in the cosmos. Helium is concentrated in stars, where it is synthesized from hydrogen by nuclear fusion.
- Although helium occurs in Earth's atmosphere only to the extent of 1 part in 200,000 (0.0005 percent) and small amounts occur in radioactive minerals, meteoric iron, and mineral springs, great volumes of helium are found as a component (up to 7.6 percent) in natural gases in the United States (especially in Texas, New Mexico, Kansas, Oklahoma, Arizona, and Utah). Smaller supplies have been discovered in Algeria, Australia, Poland, Qatar, and Russia. Ordinary air contains about 5 parts per million of helium, and Earth's crust is only about 8 parts per billion.

Production and Uses

- Helium gas (98.2 percent pure) is isolated from natural gas by liquefying the other components at low temperatures and under high pressures. **Adsorption of other gases on cooled, activated charcoal yields 99.995 percent pure helium.** Some helium is supplied from **liquefaction of air on a large scale**; the amount of helium obtainable from 1,000 tons (900 metric tons) of air is about 112 cubic feet (3.17 cubic metres), as measured at room temperature and at normal atmospheric pressure.
- **Uses:** Helium is **used as an inert-gas atmosphere for welding metals** such as aluminum; in **rocket propulsion** (to pressurize fuel tanks, especially those for liquid hydrogen, because only helium is still a gas at liquid-hydrogen temperature); in **meteorology** (as a lifting gas for instrument-carrying balloons); in **cryogenics** (as a coolant because liquid helium is the coldest substance); and in high-pressure **breathing operations (**mixed with oxygen, as in scuba diving and caisson work, especially because of its low solubility in the bloodstream). **Meteorites and rocks** have been analyzed for helium content as a means of dating.

BENZENE

- Benzene is **a colorless, sweet-smelling chemical** that can be derived from natural gas, crude oil, or coal.
- Benzene is primarily used as a feedstock, or raw material, to make other industrial chemicals, such as ethylbenzene, cumene and cyclohexane. Benzene is also used as a solvent in the chemical and pharmaceutical industries.
- Most benzene exposure **comes from the air from a number of sources, including forest fires, auto exhaust and gasoline** from fueling stations. Benzene in cigarette smoke is a major source of exposure. Very low levels of benzene have been detected in fruits, vegetables, nuts, dairy products, eggs and fish. Most people are exposed to only very tiny amounts of benzene from water and food.

Uses & Benefits

- As a building block chemical, benzene is reacted with other chemicals to produce a variety of other chemistries, materials and, ultimately, consumer goods.
- Benzene is used to **make other chemicals** like ethylbenzene, cumene and cyclohexane, which are then reacted and used in the **manufacture of a variety of materials and plastics** such as polystyrene, ABS, and nylon. There can be

many steps in the process that starts with the benzene molecule and ends with a completed material or consumer product. For example, benzene is a building block used to make ethylbenzene, which is then used to make styrene, which is used to make polystyrene. The end material, polystyrene, is a completely different material chemically than benzene.

- For consumer products where benzene is used as a building block or intermediate, the benzene is typically fully reacted in a closed system, with little to no benzene remaining in the finished consumer product.
- Benzene also is used to make some types of lubricants, rubbers, dyes, detergents, drugs, explosives and pesticides.
- Benzene is **naturally found in crude oil**. Crude oil is refined into gasoline by using heat, pressure and chemicals in the refinery to separate the spectrum of petroleum products from crude oil. The refining process yields gasoline and a number of other petroleum products, including diesel and jet fuels, solvents, lubricating oils, many of which include small amounts of benzene.

VANADIUM

- **Vanadium (V), chemical element, silvery white soft metal of Group 5 (Vb)** of the periodic table. It is alloyed with steel and iron for high-speed tool steel, high-strength low-alloy steel, and wear-resistant cast iron.
- Vanadium was discovered (1801) by the Spanish mineralogist **Andrés Manuel del Río**, who named it erythronium but eventually came to believe it was merely impure chromium. The element was rediscovered (1830) by the Swedish chemist Nils Gabriel Sefström, who named it after Vanadis, the Scandinavian goddess of beauty and youth, a name suggested by the beautiful colours of vanadium's compounds in solution. The English chemist Henry Enfield Roscoe first isolated the metal in 1867 by hydrogen reduction of vanadium dichloride, VCl_2, and the American chemists John Wesley Marden and Malcolm N. Rich obtained it 99.7 percent pure in 1925 by reduction of vanadium pentoxide, V_2O_5, with calcium metal.
- Found combined in various minerals, coal, and petroleum, vanadium is the **22nd most abundant element in Earth's crust**. Some commercial sources are the minerals **carnotite, vanadinite, and roscoelite**. (Deposits of the important vanadium-bearing mineral patronite occurring in coal at Mina Ragra, Peru, have been materially depleted.) Other commercial sources are vanadium-bearing magnetite and flue dust from smokestacks and boilers of ships burning certain Venezuelan and Mexican oils. China, South Africa, and Russia were the leading producers of vanadium in the early 21st century.
- Vanadium is obtained from ores as **vanadium pentoxide (V_2O_5)** through a variety of smelting, leaching, and roasting processes. The pentoxide is then reduced to ferrovanadium or vanadium powder. The preparation of very pure vanadium is difficult because the metal is quite reactive toward oxygen, nitrogen, and carbon at elevated temperatures.
- Vanadium metal, sheet, strip, foil, bar, wire, and tubing have found use in high-temperature service, in the chemical industry, and in bonding other metals. Because the major commercial use of vanadium is in **steel and cast iron,** to which it lends ductility and shock resistance, most of the vanadium produced is used with iron as ferrovanadium (about 85 percent vanadium) in making vanadium steels.
- Vanadium (added in amounts between 0.1 and 5.0 percent) has two effects upon steel: **it refines the grain of the steel matrix, and with the carbon present it forms carbides.** Thus, vanadium steel is especially strong and hard, with improved resistance to shock. When the very pure metal is required, it may be obtained by processes similar to those for titanium.
- Very pure vanadium metal resembles titanium in being quite corrosion resistant, hard, and steel grey in colour.

GRAPHENE

- Graphene consists of a single layer of carbon atoms arranged in a hexagonal lattice, each atom bound to its neighbours by chemical bonds.
- The elasticity of these bonds produces resonant vibrations known as **phonons.**
- Graphene has been described as wondrous stuff — of being the strongest material ever tested, almost 300 times stronger than steel.
- It is also the best heat- and electricity-conducting material to be discovered.

- It could also become a valuable aid in filtering water.

Graphene has a number of properties which makes it interesting for several different applications such as:

- ✓ It is an ultimately thin, mechanically very strong, transparent and flexible conductor.
- ✓ Its conductivity can be modified over a large range either by chemical doping or by an electric field.
- ✓ The mobility of graphene is very high, which makes the material very interesting for **electronic high frequency applications**.
- ✓ Since graphene is a transparent conductor it can be used in applications such as touch screens, light panels and solar cells, where it can replace the rather fragile and expensive Indium-Tin-Oxide (ITO).
- ✓ Flexible electronics and gas sensors are other potential applications.
- ✓ New types of composite materials based on graphene with great strength and low weight could also become interesting for use in satellites and aircraft

BIO-POLYMER

- It is a generic term used to describe a very **long molecule consisting of structural units and repeating units** connected by **covalent chemical bonds**.
- Modern polymers are very useful. For instance, they can be used as:

- ✓ New packaging materials;
- ✓ Waterproof coatings for fabrics (e.g. for outdoor clothing);
- ✓ Fillings for teeth;
- ✓ Dressings for cuts;
- ✓ Hydrogels (e.g. for soft contact lenses and disposable nappy liners);
- ✓ Smart materials (e.g. shape memory polymers for shrink-wrap packaging).

What is Bio-Polymer? It is a polymer that is developed from living beings. It is a biodegradable chemical compound that is regarded as the most organic compound in the ecosphere. The name "Biopolymer" indicates that it is a bio-degradable polymer.

- Some Biopolymer **examples are:** Proteins, Carbohydrates, DNA, RNA, Lipids, Nucleic acids, Peptides
- These polymers play an essential role in nature. They are extremely useful in performing functions like storage of energy, preservation and transmittance of genetic information and cellular construction.
- These polymers are carbon neutral and can always be renewed. These are sustainable as they are composed of living materials.
- Starch based biopolymers can be used for creating conventional plastic by extruding and injection moulding.

MISCELLANEOUS

GEOGRAPHICAL INDICATION (GI)

- A geographical indication is a sign used on goods that have a specific geographical origin and possess qualities or a reputation **due** to that place of origin.
- India enacted the **Geographical Indications of Goods (Registration & Protection)Act, 1999** and came into force with effect from 15th September 2003.
- It helps in protection and increase in exports of a product. A geographical indication consists of the name of the place of origin of the goods.
- Under Articles 1(2) and 10 of the **Paris Convention for the Protection of Industrial Property**, geographical indications are covered as an element of IPRs. They are also covered under Articles 22 to 24 of the **Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement** of the WTO.

Difference between a Geographical Indication and a Trademark

- A trademark is a sign used by a company to distinguish its goods and services from those produced by others. It gives its owner the right to prevent others from using the trademark.
- A geographical indication guarantees to consumers that a product was produced in a certain place and has certain characteristics that are due to that place of production. It may be used by all producers who make products that share certain qualities in the place designated by a geographical indication.

ETHANOL PRODUCTION

- Ethanol is a renewable biofuel because it is made from biomass.
- Ethanol is a clear, colorless alcohol made from a variety of biomass materials called feedstocks (the raw materials used to make a product).
- Ethanol can also be made from **grasses, trees, and agricultural and forestry residues** such as corn cobs and stocks, rice straw, sawdust, and wood chips. Ethanol is made from these feedstocks in several ways.
- Ethanol **(CH3CH2OH)** has the same chemical formula regardless of whether it is produced from starch- or sugar-based feedstocks.

Fermentation is the most common method for producing fuel ethanol

- The most common ethanol production processes today use yeast to **ferment the starch and sugars in corn, sugar cane, and sugar beets**. Corn is the main feedstock for fuel ethanol in the United States because of its abundance and relatively low price historically. The starch in corn kernels is fermented into sugar, which is then fermented into alcohol.
- **Sugar cane and sugar beets** are the most common feedstocks used to make fuel ethanol in other parts of the world. Because alcohol is made by fermenting sugar, sugar crops are the easiest ingredients to convert into alcohol.
- Brazil, the world's second-largest fuel ethanol producer after the United States, makes most of its fuel ethanol from sugar cane. Most of the cars in Brazil can run on pure ethanol or on a blend of gasoline and ethanol.

Cellulosic ethanol is a large potential source of fuel ethanol.

- Ethanol can also be produced by breaking down **cellulose in plant fibers**. This cellulosic ethanol is considered an advanced biofuel and involves a more complicated and costly production process than fermentation. However, there are large potential non-food crop sources of cellulosic feedstocks. Trees, grasses, and agricultural residues are potential feedstocks for cellulosic ethanol production. Trees and grasses require less energy, fertilizers, and water to grow than grains do, and they can also be grown on lands that are not suitable for growing food crops.
- Scientists have developed fast-growing trees that grow to full size in 10 years. Many grasses can produce two harvests a year for many years without annual replanting. Despite the technical potential for cellulosic ethanol production, economical production has been difficult to achieve and only relatively small amounts of cellulosic fuel ethanol have been produced United States.
- Ethanol has a **higher octane number than gasoline**, providing premium blending properties. Minimum octane number requirements for gasoline prevent engine knocking and ensure drivability. Lower-octane gasoline is blended with 10% ethanol to attain the standard 87 octane.

History of ethanol

In the 1850s, ethanol was a major lighting fuel. During the Civil War, a liquor tax was placed on ethanol to raise money for the war. The tax increased the price of ethanol so much that it could no longer compete with other fuels such as kerosene. Ethanol production declined sharply because of this tax, and production levels did not begin to recover until the tax was repealed in 1906.

ELECTRONIC WASTE

- **Mobile phones, tablets, laptops**: the proliferation of digital devices is becoming a problem for the planet because once they come to the end of their useful lives — every year almost 50 million tons of technological scrap is generated — their recycle rate is poor. Improving it is vital to slowing climate change and avoiding harm to the environment.
- The **Organisation for Economic Co-operation and Development (OECD)** defines electronic waste as any device powered by electrical energy that has reached the end of its working life. So we're not just talking about mobiles. Let's have a look at some of the types of WEEE (Waste Electrical Electronic Equipment) that are around:
- Fridges, freezers and other cooling equipment.
- Computers and telecommunications equipment.
- Consumer electronic devices and solar panels.
- TVs, monitors and screens.
- LED bulbs.
- Vending machines.

The problem of technological waste in the world

- According to a UN report, the world generated 48.5 million tons of electronic waste in 2018. This figure highlights the growing importance of recycling, which also throws up some worrying statistics: a mere 20% of this waste is recycled. If we carry on like this, the UN estimates that we could reach 120 million tons of electronic scrap by 2050.
- The volume of e-waste produced worldwide and bad recycling management present a danger to the environment. Among the most common substances found in these discarded items are **cadmium, lead, lead oxide, antimony, nickel and mercury**. These toxic elements pollute rivers, lakes and seas, and release gases into the atmosphere that upset ecosystems. So reverting to a production and consumption model that reduces the amount of electronic waste cannot be put off any longer.
- Responsible consumption, capable of lengthening useful life and slowing the growth of this refuse is one of the answers to the problem. The reuse of technological devices has become the only option, in the face of an inefficient recycling system, to reduce the levels of electronic waste. In 2014 this French company opted for electronic refurbishment and was considered to be one of the most innovative in Europe.

How can we reduce technological garbage?

Let's take a look at some of them:

Reduce: We are using more and more devices and replacing them more often. Changing this habit depends as much on the consumer — who should be less susceptible to marketing strategies that encourage consumption — as on manufacturers who are increasingly adopting policies like ecodesign.

Reuse: The experts in electronic recycling recommend that friends or family inherit devices that still work, or that they be offered on the second hand market. There is also the possibility of donating them to specialised charities.

Recycle: When the item no longer works and there is no chance of it being used by someone close, recycling should be the option. One option for the consumer is to hand the old device in to the shop where the new one is being purchased, or to some company that specialises in electronic refurbishment.

UN Sustainable Development Goal (SDG) 12 talks of the necessity to "ensure sustainable consumption and production patterns". Referring to discarded electronic devices, this means achieving ecologically acceptable management throughout their life cycle, as well as reducing the release of poisons into the atmosphere, water and soil to minimise their negative impact on health and the environment.

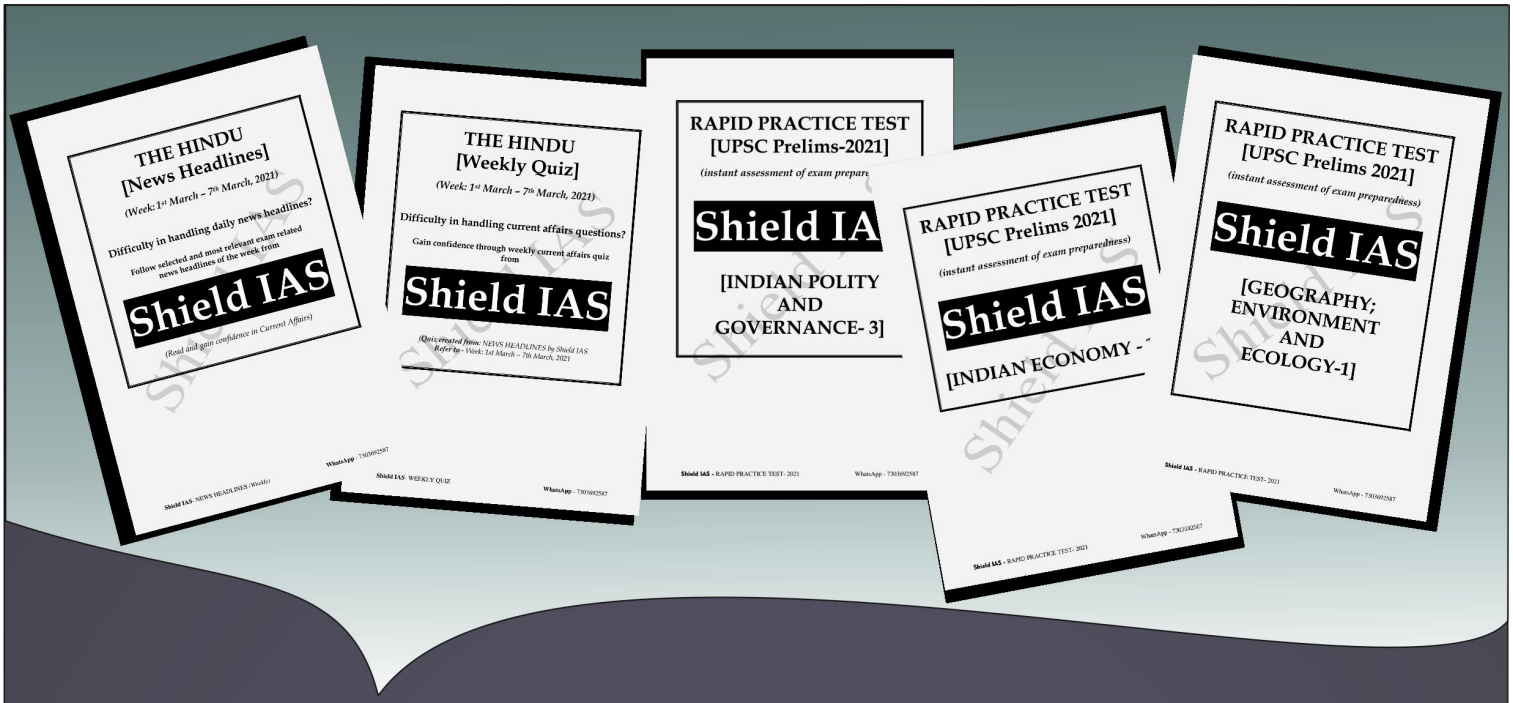
The benefits of recycling technological waste

- According to a report, it is 13 times more costly to extract minerals from natural deposits than it is to recover them from technological waste for the manufacture of new devices. Obtaining minerals like platinum, copper and palladium does not just involve digging them up and processing them, it also requires the use of huge quantities of

water and energy. This is where the concept of the circular economy comes in, based on the use of materials from recycled items and less dependence on the virgin resources extraction.

- Recycling electronic gadgets doesn't just improve the quality of the environment, it also brings other benefits. The International Telecommunication Union (ITU) reckons that these items, correctly recycled, could generate opportunities worth over $62.5 billion annually and create millions of new jobs worldwide. With this in mind, both this organisation and the UN have set themselves a target to increase global recycling to 30% and to reach 50% in countries with legislation on e-waste.
- Bad practices in the processing of e-waste are a handicap and, paradoxically, these abound in those countries that have the most of it. We are talking here about developing countries — SE Asia and Sub-Saharan Africa — which are generating a negative environmental impact through lack of the right infrastructures. Principal among the illegal methods is so-called "informal recycling", which consists of using toxic products in the open air and acid baths.

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