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SECTION 1

PHYSICS & SPACE EXPLORATION

PARTICLE PHYSICS

►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 types**. 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.
- Recently, Scientist at CERN observed the Higgs boson decaying to fundamental particles known as **bottom quarks**.

►COSMIC INFLATION

Alan Guth in 1981 gave his theory of Cosmic Inflation. According to this theory, just after the Big Bang, there was a **phase of very rapid expansion of universe at a speed greater than light** which sent ripples (primordial gravitational waves) that are responsible for the polarization

of the universe causing stretching and squeezing of the cosmic space.

►COSMIC MICROWAVE BACKGROUND RADIATION

- It is a thermal radiation left over from the Big Bang. The Planck Spacecraft of the European Space Agency was able to successfully prepare the all sky map of Cosmic Microwave Background. The **Planck mission** has imaged the oldest light in our universe, called the **cosmic microwave background**. It fills the universe in every direction. Its presence in itself is the proof of the Big Bang theory and consequently an expanding universe.
- The cosmic microwave background radiation has provided an insight into the composition of the universe. The CMB has observed that most of our universe is made up of dark energy, a mysterious force that is driving the expansion of the universe, and Dark Matter which interacts with the rest of the universe only through its gravity.

►RED SHIFT

- The light from distant stars and more distant galaxies has distinct spectral characteristics. When these spectra are examined, they are found to be shifted toward the red end of the spectrum.
- The **Red spectra is of a larger wavelength** under VIBGYOR. This shift indicates that essentially all of the galaxies are moving away from us.
- A related phenomenon in which distant objects appear to be coming closer to the observer is the **Blue shift**.

►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

- 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.
- 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.
- 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 HOLES

- A black hole is a region in space where the pulling force of gravity is so strong that light is not able to escape. The strong gravity occurs because matter has been pressed into a tiny space.
- A black hole cannot be seen because of the strong gravity that is pulling all of the light into the black hole's center. A black hole's gravity can sometimes be strong enough to pull off the outer gases of the star. As gas spirals into the black hole, the gas heats to very high temperatures and releases X-ray light in all directions. Black holes are detected by these X-rays.
- Our sun does not have enough mass to collapse into a black hole. In billions of years, when the sun is at the end of its life, it will become a red giant star. Then, when it has used the last of its fuel, it will throw off its outer layers and turn into a glowing ring of gas called a planetary nebula. Finally, all that will be left of the sun is a cooling white dwarf star.

►GRAVITATIONAL WAVES

- Gravitational waves are **small ripples in space-time curvature** that are believed to travel across the universe at the speed of light. They were predicted to exist by Albert Einstein in 1916 as a consequence of his General Theory of Relativity.
- Massive accelerating objects such as neutron stars or black holes orbiting each other disrupt space-time in such a way that 'waves' of distorted space radiate from the source (like the movement of waves away from a stone thrown into a pond). These ripples travel at the speed of light through the Universe, carrying with them information about their cosmic origins, as well as clues to the nature of gravity itself.
- The strongest gravitational waves are produced by catastrophic events such as colliding black holes and supernova. They transport energy in the form of gravitational radiation, pass through matter without interacting with it.
- These are measured by LIGO Interferometers.

►LIGO

- The LIGO observatories are funded by the National Science Foundation (NSF), and were conceived, built, and are operated by Caltech and MIT.
- LIGO has a pair of ground-based observatories in Hanford, Washington, and Livingston, Louisiana.
- The LIGO has detected the gravitational twice now, the second time witnessing the merging of a second black hole pair. The signal from this merger was weaker than the the 1st observed gravitational waves. Hence a special technique called matched filtering was adapted for gravitational wave data analysis which was developed at IUCAA (Inter-University Centre for Astronomy and Astrophysics), Pune.
- LIGO has recently been able to not just detect but also produce Gravitational Waves too! Although these waves are far too feeble to be detected directly, the radiation could be used to detect weird quantum mechanical effects among large objects.

►LIGO-INDIA

- IndIGO (Indian Initiative in Gravitational-wave Observations) is a consortium of Indian gravitational-wave physicists to set up advanced experimental gravitational-wave observatory facilities in India.
- LIGO-India is a planned advanced gravitational-wave observatory to be located in India as part of the worldwide network.
- LIGO-India is planned as a collaborative project between a consortium of Indian research institutions and the LIGO Laboratory in the USA, along with its international partners Australia, Germany and the UK.
- To establish this, a site near Aundha Nagnath in the Hingoli District, Maharashtra has been selected

►EUROPEAN COUNCIL FOR NUCLEAR RESEARCH (CERN)

- Founded in 1952 as a provisional body is the world's largest nuclear and particle physics laboratory with the mandate of establishing a world-class fundamental physics research organization along the Franco-Swiss border near Geneva.
- At CERN, fundamental particles of matter are made to collide together at the speed of light giving the physicists clues about how the particles interact at such high speeds and provides insights into the moment of creation of our universe through recreating big bang.
- CERN has 22 member states, 4 associate member states, 4 observer states and 3 observer international organizations.
- Indian scientists have been part of research since early 1960s with the support of Department of Atomic Energy (DAE) and Department of Science and Technology (DST).
- Recognizing India's significant contributions, India was awarded the Observer status of CERN in 2003. India was invited to join CERN as an Associate Member in 2016.
- CERN will enhance participation of young scientists and engineers in various projects and bring back knowledge for deployment in the domestic programmes.
- It will also provide opportunities to Indian industries to participate directly in CERN Projects.

►THE LARGE HADRON COLLIDER (LHC)

- World's largest and most powerful particle accelerator started up on 10 September 2008.
- The LHC consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.
- Inside the accelerator, two high-energy particle beams travel in opposite direction at close to the speed of light before they are made to collide.
- Particle beams inside the LHC are made to collide at four locations around the accelerator ring, corresponding to the positions of four particle detectors namely ATLAS, CMS, ALICE and LHCb.

SPACE EXPLORATION

- Space activities in the country were initiated with the setting up of **Indian National Committee for Space Research (INCOSPAR)** in 1962. In the same year, work on **Thumba Equatorial Rocket Launching Station (TERLS)** near Thiruvananthapuram was also started. **Indian Space Research Organisation (ISRO) was established in August, 1969.** The Space Commission was constituted and established the Department of Space (DOS) in June, 1972 and brought ISRO under DOS in 1972.
- Space Commission formulates the policies and oversees the implementation of the Indian space programme to promote the development and application of space science and technology for the socio-economic benefit of the country.

►ISRO

- The Indian Space Research Organization, formed in 1969, is the space agency of the government of India. It launches satellites from the Satish Dhawan Space Centre, Sriharikota, Andhra Pradesh located on the East coast of India.
- Apart from launching satellites, ISRO has also successfully launched Chandrayan-1, Mars Orbiter Mission (mangalyaan) and Astrosat.
- ISRO's products, services and technologies are promoted by a PSU, **ANTRIX corporation** limited. It is wholly owned by GOI under the administration of Department of Science.
- Antrix is the commercial arm of ISRO headquartered at Bangalore.

►TYPE OF ORBITS

- Satellites are generally characterized by their orbit i.e. the distance at which they revolve around the Earth.
- They are: 1. **LEO Satellite** (Lower Earth Orbit) 2.**MEO Satellite** (Middle Earth Orbit) 3.**GEO satellite** (Geo-Synchronous Earth Orbit and Geo-Stationary Earth Orbit)
- The **Geo-synchronous satellite is at a distance of 35786 Km**. This height allows the satellite to revolve around the earth in 24 hours, the time earth itself takes to complete one day. Hence a GEO satellite always returns to the same position in the sky after each day. When observed from earth, a Geo-Synchronous Orbit appears to form "8" (eight).
- The **Geostationary Satellite is a special form of Geo-synchronous Satellite which orbits the earth over the equator.** This kind of satellite has a circular orbit around the earth. When observed from the Earth, such kind of satellite appears to be fixed or hung all the time. They provide continuous service over a large area.
- The orbits may also be classified into Polar and Equatorial.
- Polar orbits revolve the earth as the name suggests at an inclination close to 90 degrees close to poles. Such Orbits may be "sun-synchronous" too, which implies that these satellites pass over a section of the earth at the same time every day.
- On the other-hand Equatorial orbits are closer to the equator. A satellite in this orbit can cover almost half of earth.

►LAUNCH VEHICLES IN INDIA

Satellite Launch Vehicles(SLV) are generally characterized by their payload (the weight which they can successfully launch) and designated orbit. In India, ISRO launches these satellites using its various Space Launch Vehicles PSLV and GSLV.

PSLV	GSLV
• The Polar Satellite Launch Vehicle (PSLV) is the most successful SLV of India. This SLV is used to launch satellites into LEO, MEO as well as GEO. (please note that though primarily meant for launching satellites into polar orbits, PSLV also has the capability to launch geo-synchronous satellites!) • Most of the notable missions of ISRO like Chandrayan, Mangalyaan, Astrosat	• The Geosynchronous Satellite Launch Vehicle (GSLV) was primarily developed to launch INSAT class of satellites into Geosynchronous Transfer Orbits. GSLV is being used for launching GSAT series of satellites. • GSLV is a three stage launcher that uses one solid rocket motor stage, one Earth storable liquid stage and one cryogenic stage. • The most recent flight of GSLV, the GSLV-D5, placed GSAT-14 into its planned orbit and marked the first

and NAVIC have been launched by PSLV.

- PSLV has a **4-stage rocket engine** (solid-liquid-solid-liquid).
  While the "core alone" version of PSLV has no strap-on motors, PSLV-G and PSLV-XL have 6 strap-on motors.

successful flight of the indigenous cryogenic stage. Earlier, GSLV had launched various communication satellites among which EDUSAT is notable, being India's first satellite built exclusively to serve the educational sector through satellite based distance education.

► CRYOGENIC ENGINE

- A Cryogenic rocket stage is more efficient and provides more thrust for every kilogram of propellant it burns compared to solid and earth-storable liquid propellant rocket stages.
- However, cryogenic stage is technically a very complex system compared to solid or earth-storable liquid propellant stages due to its use of propellants at extremely low temperatures and the associated with thermal problems.
- Oxygen liquefies at -183 deg C and Hydrogen at -253 deg C. The propellants, at these low temperatures are difficult to pump. It also entails complex ground support systems like propellant storage and filing systems, cryo engine and stage test facilities, transportation and handling of cryo fluids and related safety aspects.
- ISRO has successfully developed an indigenous Cryogenic Engine after years of delay and eventual cancellation of the supply of technology by Russia.

► GEOSTATIONARY TRANSFER ORBIT (GTO)

- A geosynchronous / geostationary transfer orbit (GTO) is an **elliptical orbit,** with an apogee (high point) of 35,784 kilometres, a perigee (low point) of a few hundred kms.
- Its inclination is **roughly equal to the latitude of the launch site**, into which a spacecraft is initially placed before being transferred to a geosynchronous or geostationary orbit.

► LIQUID APOGEE MOTOR (LAM)

- A liquid apogee engine (LAE), or apogee engine, refers to a type of chemical rocket engine typically used as the main engine in a spacecraft.
- It is basically a propeller used to put the satellite in the desired orbit.

► CARTOSAT-2

- The Cartosat-2 series Satellite is second-generation remote sensing satellite.
- The imagery sent by the satellite is useful for:
  - cartographic applications
  - urban and rural applications
  - coastal land use and regulation
  - utility management like road network monitoring
  - water distribution
  - creation of land use maps
  - various other land Information Systems (LIS) as well as Geographic Information System (GIS).

► SPACE DEBRIS

- Space debris can be both **natural (meteoroid)** and **artificial (man-made)** particles.
- Meteoroids are in **orbit around the sun**, while most artificial debris are in **orbit around the Earth**.
- The artificial space debris is called **orbital debris**.
- Space junk are **pieces of damaged and destroyed space-crafts** that travel around the Earth at very fast speeds (up to 17,500 Miles per hour). At such speeds, even a small piece could damage an entire satellite.
- With more and more nations sending even more space shuttles outside Earth, there is a rise in space debris. This has increased the potential danger to all space vehicles.

►KESSLER SYNDROME

- First **proposed by NASA scientist Donald Kessler** in 1978, the Kessler Syndrome is a **cascading chain of impacts**. It could make the orbital space inaccessible.
- **First,** impact with debris disintegrates a spacecraft into a large number of fragments. Some of the new debris strikes

other spacecraft, which disintegrate and cause still more impacts, until a chain reaction is created.

- **Eventually**, Low-Earth orbit would become too hazardous for human or satellite travel.

►SPACE VISION 2025

Prepared under the aegis of Vikram Sarabhai Space Centre, the Space vision 2025 aims at the following:

- Satellite based communication and navigation systems for rural connectivity, security needs and mobile services
- Enhanced imaging capability for natural resource management, weather and climate change studies
- Space science missions for better understanding of solar system and universe Planetary exploration
- Development of Heavy lift launcher
- Reusable Launch Vehicles - Technology demonstrator missions leading to Two Stage To Orbit (TSTO)
- Human Space Flight

►ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES) TELESCOPE

- Satellite based communication and navigation systems for rural connectivity, security needs and It is Asia's largest (3.6 metres optical telescope located at Devasthal in Uttarakhand.
- A result of close collaboration between scientists from the two countries, especially between the teams of ARIES in India, and AMOS (Advanced Mechanical and Optical Systems) in Belgium.
- It is a state-of-the-art world class fully steerable optical telescope, which will contribute to observations for several frontline scientific applications.

►GADANKI IONOSPHERIC RADAR INTERFEROMETER (GIRI)

- The National Atmospheric Research Laboratory (NARL) at Gadanki is an autonomous research institute of the Department of Space engaged in fundamental and applied research in the field of Atmospheric Sciences.
- NARL has established a 30 MHz radar system for ionospheric, meteor and space weather research in a comprehensive way.
- GIRI consists of a rectangular antenna array antenna arranged in a matrix six digital receivers including data processing systems, a radar controller, and a host computer.
- It will improve the skill in Equatorial Plasma Bubble (EPB) forecasting, as EPB is detrimental for satellite based navigation/communication applications.

►EQUATORIAL PLASMA BUBBLES

- Equatorial plasma bubbles are an ionospheric phenomenon near the Earth's geomagnetic equator at night time. They affect radio waves by causing varying delays.
- They **degrade the performance of GPS** different times of the year and location have different frequencies of occurrence.
- Plasma bubbles form after dark when the sun stops ionising the ionosphere. The ions recombine, forming a lower density layer. This layer can rise through the more ionised layers above via convection, which makes a plasma bubble. The bubbles are turbulent with irregular edges.

►MULTI APPLICATION SOLAR TELESCOPE (MAST)

- A telescope for the detailed study of the Solar activity including its magnetic field.
- It has recently been operationalised at the Udaipur Solar Observatory (USO) of Physical Research Laboratory (PRL), an autonomous unit of the Department of Space.
- The USO is situated on an island in the middle of the Lake Fatehsagar of Udaipur, Rajasthan, India. The sky conditions at Udaipur are quite favourable for solar observations. The large water body surrounding the telescopes decreases the amount of heating of the surface layers. This decreases the turbulence in the air mass and thereby improves the image quality and seeing.
- The main objective of obtaining the high spatial and temporal resolution observations of solar photospheric and chromospheric activity is to understand the various dynamic phenomena occurring on the surface of the Sun.

►NISAR

- NASA-ISRO Synthetic Aperture Radar (NISAR) mission is a dual frequency (L & S Band) Radar Imaging Satellite to be launched in 2020.
- In this joint mission, NASA will be responsible for design & development of L-band Synthetic Aperture Radar(LAR), GPS system and data recorder.
- ISRO will be responsible for design & development of S-band SAR, Spacecraft Bus, data transmission system, Spacecraft integration & testing, launch using GSLV and on-orbit operations.
- The mission will help in exploring newer application areas using L and S band microwave data, especially in natural resources mapping & monitoring, estimating agricultural biomass over full duration of crop cycle, assessing soil moisture, monitoring of floods and oil slicks, coastal erosion, coastline changes and variation of winds in coastal waters, assessment of mangroves; surface deformation studies due to seismic activities and others.

►DEEP SPACE NETWORK

- The Deep Space Network (DSN) is NASA's international array of giant radio antennas that supports interplanetary spacecraft missions.
- The DSN also provides radar and radio astronomy observations that improve the understanding of the solar system and the larger universe.
- The DSN is operated by NASA's Jet Propulsion Laboratory (JPL), which also operates many of the agency's interplanetary robotic space missions.
- The DSN consists of three facilities spaced equidistant from each other – approximately 120 degrees apart in longitude – around the world. These sites are at California, Spain and Australia.
- The strategic placement of these sites permits constant communication with spacecraft as our planet rotates – before a distant spacecraft sinks below the horizon at one DSN site, another site can pick up the signal and carry on communicating.

►INTERNATIONAL SPACE STATION (ISS)

ISS is a space station, or a habitable artificial satellite, in the low Earth orbit.

CONSTRUCTION

- For constructing it, ISS components were launched by Russian Proton and Soyuz rockets, and American Space Shuttles.
- Its first component was launched into orbit in 1998, the last pressurised module was fitted in 2011, and the station is expected to be used until 2028.

OBJECTIVE

It serves as a microgravity and space environment research laboratory in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology, and other fields.

COLLABORATION

It is a joint project among five participating space agencies: NASA, Roscosmos (Russia), JAXA (Japan), ESA, and CSA (Canada).

►ATOMIC CLOCK

- Every atom is composed of a nucleus, which contains the atom's protons and neutrons (collectively known as nucleons). Orbiting that nucleus are the atom's electrons, which occupy different orbits, or energy levels.
- By absorbing or releasing exactly the right amount of energy, the electrons can 'jump' from one energy level to another. This is called a transition.
- The electrons absorb energy to move to a higher energy level (away from the nucleus), and release energy to move down an energy level (towards the nucleus). The energy released or absorbed in these transitions takes the form of electromagnetic radiation (e.g. visible light or microwaves). The same amount of energy is released every time the same transition occurs, no matter where or how many times it is measured.
- As with all waves, the radiation has a certain frequency which can be measured. Atomic clock uses the frequency of an electron's transition energy in an atom. The caesium atom defines the SI second.

CURRENT affairs& relatedconcepts

►INDIA-BASED NEUTRINO OBSERVATORY (INO)

- The India-based Neutrino Observatory (INO) Project is a multi-institutional effort aimed at building a world-class underground laboratory with a rock cover of approx.1200 m for non-accelerator based high energy and nuclear physics research in India.
- The project includes:
  - construction of an **underground laboratory** and associated surface facilities
  - construction of an **Iron Calorimeter (ICAL) detector** for studying neutrinos, which will include the world's largest magnet
  - setting up of **National Centre for High Energy Physics at Madurai**, for the operation and maintenance of the underground laboratory, human resource development and detector R&D along with its applications.
- The initial goal of INO is to study neutrinos.
  - Neutrinos are fundamental particles belonging to the lepton family. They come in three flavours, one associated with electrons and the others with their heavier cousins the muon and the Tau.
- According to standard model of particle physics, they are mass less. However recent experiments indicate that these charge-neutral fundamental particles, **have finite but small mass which is unknown.**
  - Determination of neutrino masses and mixing parameters is one of the most important open problems in physics today.
- An underground neutrino facility in India offers the unique possibility of locating a neutrino detector near the Earths equator. This can have some very interesting consequences for solar neutrinos which would then pass through the core of the Earth in their passage to the detector from the Sun at night.
- The INO decided on a site in Bodi West Hills(BWH) region near Pottipuram village in Theni district of Tamilnadu to install this observatory.

ABOUT NEUTRINOS

Neutrinos are mysterious particles that could hold key to

- Initially, the neutrinos were considered massless
- Experiments have revealed that Neutrinos exist in three states, or flavors, and can transform from one flavor into another.
  - Electron neutrino
  - Muon neutrino
  - Tau neutrino
- Each flavor of neutrino is considered a fundamental particle, or one of the basic building blocks of our universe that can't be broken down into any smaller pieces. They are associated with three similarly named fundamental particles, electron, muon and tau. When a neutrino interacts, its partner particle often shows up. That helps scientists identify what flavor neutrino the particle was before it interacted. Scientists never actually see the neutrino itself, instead, they see other particles that are made when a neutrino interacts in a detector.

ANTI-MATTER

- Matter is built up of protons, neutrons and electrons, each of which has a mass and a charge. Antimatter particles look almost like their matter twins. They have same masses, but they have opposite charges. For ex.

1) Electron has negative charge - Positron (Anti-electron) has a positive charge
2) Proton (+ve charge) - Antiproton (-ve charge)

- Antimatter particles such as antiprotons and positrons can get together to form antiatoms the same way protons and electrons form atoms. However, most of what we see in the universe is made of matter rather than antimatter. Scientists aren't sure where all of the antimatter is. When

matter and antimatter meet, they annihilate in a fiery burst of light.

- An antineutrino is thus simply as 'opposite version' of a neutrino.

►NEW SOURCE OF NEUTRINOS

The **IceCube observatory** at the **South Pole** has discovered that **a "blazar", a galaxy** with a supermassive black hole at its centre, also produces neutrinos.

ABOUT ICECUBE

- The IceCube experiment at the South Pole is a **cubic kilometre in size** and uses deep arctic ice as a target for the neutrinos.
- Neutrinos can produce a charged particle when they occasionally do interact with the fundamental particles that make up ice.
- In IceCube, this resulting particle travels through the ice and produces a trail of faint light.

►COSMIC MICROWAVE BACKGROUND (CMB) BHARAT

Project CMB-Bharat was undertaken during a workshop held at ICTS-TIFR (International Centre for Theoretical Sciences-Tata Instt. of Fundamental Research), Bengaluru. The objective of this project is to hear faintest murmurs of the early universe.

ABOUT CMB-BHARAT

- CMB-Bharat is a proposal for comprehensive next generation Cosmic Microwave Background (CMB) mission in international collaboration with major Indian contribution.
- The project will work on following:
  - It will reveal the first clear signature of quantum gravity and ultrahigh energy physics in the early stage of universe.
  - It will aim at discovering more about the neutrino species (their mass and mass hierarchy).
  - It will also improve probe of the cosmological model by a factor of over 10 million and to generate rich galactic and extragalactic astrophysics datasets.

ABOUT CMB

- The CMB was discovered in 1965 and it **represents entire radiation content** of the universe.
- CMB frequency ranges of 100-230 GHz are observed in the sky maps and these contain very rich and vital cosmological as well as astrophysical information waiting to be extracted.
- It is thought to be leftover radiation from the Big Bang, or the time when the universe began. As the theory goes, when the universe was born it underwent a rapid inflation and expansion. (The universe is still expanding today, and the expansion rate appears different depending on where you look). The CMB represents the heat left over from the Big Bang.
- Most of the cosmological information in the CMB temperature fluctuations has been harvested by different space missions:- Like Planck mission (ESA, 2009), COBE DMR (NASA, 1989) and WMAP (NASA, 2001).
- CMB- BHARAT is a 4th generation mission aims to tap these untapped energies.

U.S. MISSIONS

►NASA'S VOYAGER 2

NASA's Voyager 2 has entered interstellar space, **leaving behind the solar system**.

ABOUT VOYAGER 2

- Voyager 2 is **the only probe ever to study Neptune and Uranus** during planetary flybys.
- Voyager 2 is the **only spacecraft** to have **visited all four gas giant planets —** Jupiter, Saturn, Uranus and Neptune.
- It is **the second man-made object to leave our solar system**. It is now 11 billion miles from Earth, following behind it's sister spacecraft, Voyager 1, which is 6 years ahead of it.

ABOUT VOYAGER MISSION

- The Voyager mission was launched in the **1970's**, and the probes sent by NASA were only meant to explore the outer planets – but they just kept on going.
- Voyager 1 departed Earth on 5 September 1977, a few days after Voyager 2 and left our solar system in 2013.

INTERSTELLAR SPACE

- Scientists use the **heliopause** to mark where interstellar space begins.
- Although depending on how you define our solar system it can stretch all the way to the Oort Cloud, which begins 1,000 times farther away from the sun than Earth's orbit.

HELIOSPHERE

- The heliosphere is a **bubble around the sun** created by the outward flow of the solar wind from the sun and the opposing inward flow of the interstellar wind.
- It is the region influenced by the dynamic properties of the sun that are carried in the solar wind–such as magnetic fields, energetic particles and solar wind plasma.
- The **heliopause** marks the **end of the heliosphere** and the beginning of interstellar space.

►SEISMIC EXPERIMENT FOR INTERIOR STRUCTURE (SEIS)

The US space agency's, NASA's unmanned Mars **Insight lander**, which touched down on the Red Planet, has successfully deployed its key, quake-sensing instrument- **Seismic Experiment for Interior Structure**– on the alien world's surface.

ABOUT SEIS

- The seismometer, known as the Seismic Experiment for Interior Structure, or SEIS, was made by the **French space agency**, CNES.
- The tool aims to help scientists better understand the interior of Earth's neighboring planet by studying ground motion, also known as **marsquakes**.
- **Main Job**: To measure the pulse of Mars by studying waves created by marsquakes, thumps of meteorite impacts, and even surface vibrations generated by activity in Mars' atmosphere and by weather phenomena such as dust storms.

ABOUT INSIGHT MISSION:

- InSight is part of **NASA's Discovery Program**
- It is the **first mission** to peer deep beneath the Martian surface, studying the planet's interior by measuring its heat output and listening for marsquakes, which are seismic events similar to earthquakes on Earth.
- It will use the seismic waves generated by marsquakes to **develop a map** of the planet's deep interior

►TESS

- Transiting Exoplanet Satellite (TESS) is an MIT-led NASA mission for surveying transiting exoplanets.
- TESS was launched in 2018 and has discovered a new planet 53 light years away from our solar system. The planet is named HD 21749b, orbits a bright, nearby dwarf star about 53 light years away, in the constellation Reticulum.
- The planet discovered by TESS is possibly rocky, hot sub-Neptune-sized exoplanet.
- The objective of TESS mission is to search for 50 small sized rocky planets transiting small stars.
- It will discover thousands of planet by transit methodology. It will scan the northern hemisphere and southern hemisphere.

ABOUT 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.

►KEPLER SPACE PROBE

NASA's Kepler space telescope, which has discovered 70 percent of the 3,800 confirmed alien worlds to date, has run out of fuel.

EXPLAINED

- Kepler can **no longer reorient itself to study cosmic objects** or beam its data home to Earth.
- Currently orbiting the sun 156 million km from the earth, the spacecraft will drift further from our planet when mission engineers turn off its radio transmitters.
- The spacecraft **was launched in March 2009**, on a mission to gauge how common Earth- like planets are throughout the Milky Way galaxy.
- Exoplanet is a planet which orbits a star outside the solar system.

- Kepler discovered **earth like planets using the "transit method,"** finding the brightness dips caused when a planet crosses its star's face from the spacecraft's perspective.

►ICESAT-2

NASA satellite named **'Ice, Cloud and Land Elevation Satellite-2 (ICESat-2)**', was launched.

ABOUT ICESAT-2

- It is the benchmark **Earth Observing System mission** for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics.
- ICESat-2 continues key elevation observations of the cryosphere begun by the original ICESat mission (2003 to 2009) and **Operation IceBridge** airborne efforts (2009 through present), to provide a continuous long-term record of change in the beginning of the 21st century.

SIGNIFICANCE

- ICESat-2 data will help researchers **narrow that range of possibilities to forecast sea level rise** with greater certainty, allowing communities to be better prepared.
- Beyond the cryosphere, ICESat-2 will also survey heights of the world's forests, lakes, urban areas, cloud cover and more, **adding a detailed third dimension to flat images of Earth** from space.

►ULTIMA THULE

A NASA space ship has recently crossed the farthest and possibly the oldest cosmic body ever photographed by mankind, known as Ultima Thule.

ABOUT THE PROBE

- Ultima Thule (Pronounced as TOO-lee), means 'beyond Thule', is named for a mythical, far-northern island in medieval literature and cartography.
- It is **trans-Neptunian object** located in the Kuiper Belt and is a contact binary (A small solar system body that have gravitated towards each other until they touch).
- Ultima Thule was discovered in June 2014 by astronomers using the Hubble Space Telescope.

THINGS TO KNOW

- The **Kuiper Belt** (also known as the Edgeworth–Kuiper belt) is a region of the Solar System that exists beyond the eight major planets, extending from the orbit of Neptune (at 30 Astronomical Unit (AU) to approximately 50 AU from the Sun. It is similar to the asteroid belt, in that it contains many small bodies, all remnants from the Solar System's formation.
- **Astronomical Unit (AU)** is the average distance between Earth and the Sun, which is about 93 million miles or 150 million kilometers. Astronomical units are usually used to measure distances within our Solar System.

►JPSS-1

It was launched by NASA.

WHAT IS JPSS-1?

- Joint Polar Satellite System
- Advanced weather satellite
- Launched by NASA and NOAA (National Oceanic and Atmospheric Administration)

PURPOSE

- Track paths of hurricanes
- Assess damage post disaster
- Advance disaster prediction mechanism
- Monitor weather patterns that impact El-Nino and La-Nina

►PARKER SOLAR PROBE

NASA would launch Parker solar probe mission to study the outer atmosphere of the Sun.

FACTS

- Parker depend upon the gravity of Venus to enter its final orbit
- This mission study the outer atmosphere of the Sun
- It studies the transmission of Heat and energy from Corona of the Sun.
- It also studies the generation and acceleration of Solar Winds.
- It would be the closest possible spacecraft to the Sun.

WHAT ARE SOLAR WINDS?

- Ionized gases that originate from the Sun
- They move past the Earth at the speed of 500 KM per second
- Solar winds are present deep into the Solar System way beyond Earth

►WFIRST

Wide Field Infrared Survey Telescope (WFIRST) - it is a NASA observatory designed for research into

- Dark Energy
- Dark Matter
- Search for and Image exoplanets
- It has a telescope with the same size as Hubble's, but with a view of100 times greater.
- It will have two instruments:
  - **Wide Field Instrument:** Will have a field of view that is 100 times greater than Hubble infrared instrument, capturing more of the sky with less observing time.
  - **Coronagraph Instrument:** Will perform high contrast imaging and spectroscopy of individual

►VISIONS-2 MISSION

- It is a Misison of **NASA.**
- The VISIONS-2 mission (Visualizing Ion Outflow via Neutral Atom Sensing-2) is **looking at atmospheric escape**, the process whereby Earth is slowly leaking its atmosphere into space.
- Understanding atmospheric escape on Earth has applications all over the Universe — from predicting which far off planets might be habitable, to piecing together how Mars became the desolate, exposed landscape it is today.
- VISIONS-2 hopes to acquire a great deal of data about a single oxygen outflow event.

►GRACE-FO MISSION

- The Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission is a partnership between NASA and the German Research Centre for Geosciences (GFZ).
- GRACE-FO is a **successor to the original GRACE mission**, which orbited Earth from 2002-2017.
- The data obtained from the GRACE-FO satellites is used to gain deep insights into the **underground water resources, variations in gravitational field, and glaciers spread across the planet**.
- The GRACE-FO mission will last for five years and provide an updated **measurement of Earth's gravitational field** by generating a new map every 30 days.
- Each satellite (There are two) also creates up to 200 profiles a day of temperature diffusion and water-vapour content in the atmosphere and the ionosphere. The satellites simultaneously capture day and night sides of the Earth.

►ICESAT-2

- It is a part of **NASA's** earth observation system.
- ICESat-2 (Ice, Cloud and land Elevation Satellite-2) will orbit Earth carrying a photon-counting laser altimeter, **ATLAS** (Advanced Topographic Laser Altimeter System).
- This instrument will measure height by determining **how long it takes photons to travel from the spacecraft to Earth and back**.
- The laser will measure the slope and height of the ice, not just the area it covers.
- The new laser will fire 10,000 pulses of green light in one second, compared to the original ICESat which fired 40 times a second.
- With this incredibly fast pulse rate, ATLAS can take measurements every 2.3 feet (0.7 metres) along the satellite's ground path.
- ICESat-2 will also survey heights of the **world's forests, lakes, urban areas, cloud cover and more, adding a detailed third dimension to flat images of Earth from space**.

►SPHEREX

- It is a future **near-infrared space observatory of NASA**.
- The Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx) mission will survey **the sky in optical as well as near-infrared light** which, serves as a powerful tool for answering cosmic questions.
- Astronomers will use the mission to gather data on **more than 300 million galaxies, as well as more than 100 million stars in our own Milky Way**.
- SPHEREx will survey hundreds of millions of galaxies near and far, some so distant their light has taken 10 billion years to reach Earth.
- In the Milky Way, the mission will search for **water and organic molecules** - essentials for life, as we know it - in stellar nurseries, regions where stars are born from gas

and dust, as well as disks around stars where new planets could be forming.

- The mission will create **a map of the entire sky in 96 different color bands**, far exceeding the color resolution of previous all-sky maps.
- It also will identify targets for more detailed study by future missions, such as NASA's James Webb Space Telescope and Wide Field Infrared Survey Telescope.

►IMAP MISSION

- It is a proposed mission of **NASA**.
- **The Interstellar Mapping and Acceleration Probe** (IMAP) mission will help researchers better understand the **boundary of the heliosphere**, a sort of magnetic bubble surrounding and protecting our solar system.
- This region is where the constant flow of particles from our Sun, called the solar wind, collides with material from the rest of the galaxy. This collision limits the amount of harmful cosmic radiation entering the heliosphere. **IMAP will collect and analyze particles that make it through**.
- Another objective of the mission is to learn more about the **generation of cosmic rays in the heliosphere**.
- Cosmic rays created locally and from the galaxy and beyond affect human explorers in space and can harm technological systems, and likely play a role in the presence of life itself in the universe.
- The spacecraft will be positioned away from Earth towards the Sun at the **first Lagrange point or L1**.
- This will allow the probe to maximize use of its instruments to monitor the interactions between solar wind and the interstellar medium in the outer solar system.

►LUCY: MISSION TO JUPITER'S TROJAN

It is **NASA's mission to Jupiter's swarms of Trojan Asteroids.**

JUPITER'S TROJAN

- Jupiter's swarms of **Trojan asteroids** may be remnants of the primordial material that formed the outer planets, and serve as time capsules from the birth of our Solar System more than 4 billion years ago.
- The Trojans orbit in **two loose groups that orbit the Sun**, with one group always ahead of Jupiter in its path, the other always behind.

LUCY MISSION

- Lucy will be the first space mission to study the Trojans. The mission takes its name from the **fossilized human ancestor (called "Lucy")** whose skeleton provided unique insight into humanity's evolution.
- Lucy will launch in October 2021 and, with boosts from Earth's gravity, will complete a 12-year journey to seven different asteroids — **a Main Belt asteroid and six Trojans, the last two members of a "two-for-the-price-of-one" binary system**.
- Lucy's complex path will take it to both clusters of Trojans and give us our first close-up view of all three major types of bodies in the swarms **(so-called C-, P- and D-types)**.
- **The dark-red P- and D-type Trojans** resemble those found in the Kuiper Belt of icy bodies that extends beyond the orbit of Neptune.
- **The C-types** are found mostly in the outer parts of the Main Belt of asteroids, between Mars and Jupiter.

►JUPITER'S MOON IO

NASA's solar-powered Juno spacecraft has beamed back new images of volcanic plume on Jupiter's moon Io, captured during the mission's 17th flyby of the gas giant.

EXPLAINED

- Io's volcanoes were discovered by **NASA's Voyager spacecraft in 1979**. Io's gravitational interaction with Jupiter drives the moon's volcanoes, **which emit umbrella-like plumes of SO2 gas and produce extensive basaltic lava fields**.
- Launched in **2011, Juno** orbits Jupiter every 53 days, studying its **auroras, atmosphere and magnetosphere**.
- The solar-powered Juno features eight scientific instruments designed to study **Jupiter's interior structure, atmosphere and magnetosphere**.

►OSIRIS REX & BENNU ASTEROID

EXPLAINED

- NASA's **OSIRIS-REx spacecraft is traveling to Bennu**, a carbonaceous asteroid whose regolith may **record the earliest history** of our solar system.

- Bennu may contain the **molecular precursors to the origin of life** and the Earth's oceans.
- Bennu is also one of the **most potentially hazardous asteroids**, as it has a relatively high probability of impacting the Earth late in the 22nd century.
- **OSIRIS-REx will determine Bennu's physical and chemical properties**, which will be critical to know in the event of an impact mitigation mission.

OSIRIS-REX'S KEY SCIENCE OBJECTIVES INCLUDE

- Return and analyze a sample of Bennu's surface
- Map the asteroid
- Document the sample site
- Measure the orbit deviation caused by non-gravitational forces **(the Yarkovsky effect).**
- Compare observations at the asteroid to ground-based observations.

ABOUT BENNU

- The asteroid could hold the evidence which may clear the beginning of our solar system 4.5 Billion years ago.
- Bennu orbits the Sun at roughly the same distance as the Earth. There is concern among scientists about the possibility of Bennu impacting earth late in the 22nd century.

ABOUT ASTEROIDS

- Asteroids are among the leftover debris from the solar system's formation some 4.5 billion years ago.
- Recent studies have shown that some celestial bodies in our solar system have, or used to have, water in some form.
- Asteroids are considered to be one of the candidates that brought water to Earth.
- Atomic-level analysis of samples from asteroids such as Bennu could provide key evidence to support that hypothesis.

►DEBRISAT

- **DebriSat is a satellite that's a double for**

a) A modern **low-Earth orbit spacecraft** in terms of its components, materials used, and fabrication procedures.

b) The spacecraft will be the **target of a future hypervelocity impact experiment** to **examine** the physical characteristics of **debris created when two satellites collide**.

- As a modern satellite target, obliterating DebriSat is expected to improve the NASA standard satellite breakup model.

►DAWN MISSION

NASA's Dawn spacecraft has gone silent. The spacecraft has etched its name in the history of space exploration by exploring two of the largest objects in the asteroid belt.

EXPLAINED

- Dawn's shell is still in that **last orbit around the dwarf planet Ceres**. Without fuel, it can't hold itself steady enough to harvest energy from its solar panels or turn its transmitter back to Earth.
- **Dawn was launched in 2007**, with the mission **to study Vesta and Ceres**, the two largest objects in the asteroid belt.
- **Vesta had an iron core** and a pitted surface that boasted craters, including one with a mountain twice the size of Mount Everest at its center.
- Ceres also had a peak, a towering mountain that **researchers think was an ice volcano, driven by salty water and mud instead of magma**.
- **While Vesta was all rock and metal, Dawn found that Ceres had rock and ice,** studded with bright spots that indicated the presence of salts or carbonates. It even had organic materials on its surface.

CHINA'S MISSIONS

►CHANG'E-4 MISSION

China launched Chang'e-4, a **first probe ever** to explore the dark side of the Moon.

DARK SIDE OF THE MOON

- Hemisphere of the Moon that **always faces away from Earth**.
- The dark side's terrain is rugged with a multitude of impact craters
- Both sides of the Moon experience two weeks of sunlight followed by two weeks of night; the far side is sometimes called the "dark side of the Moon", meaning **unseen rather than lacking light**.

ABOUT THE MISSION

- The Chang'e-4 has entered a planned orbit "to prepare for the **first-ever soft landing** on the far side of the moon".

- Previous spacecraft have seen the far side of the Moon, but none has landed on it.
- Chang'e 4 is the fourth mission in the country's lunar mission series which is being named after the **Chinese moon goddess**.

OBJECTIVES OF CHANG'E-4

- low-frequency radio astronomical observation,
- surveying the terrain and landforms,
- detecting the mineral composition, and
- measuring the neutron radiation and neutral atoms to study the environment on the far side of the moon.

►BEIDOU

China has added new satellites to its BeiDou Constellation. BeiDou is the Navigation Satellite System of China

FACTS

- China is currently developing the 3rd generation of BeiDou.
- It has already launched BeiDou-1 and BeiDou-2.
- BeiDou-1 and BeiDou-2 were regional in nature.
- BeiDou-3 would have global coverage
- It would be more accurate than US based Global Positioning System (GPS)
- BeiDou-3 would have a constellation of 35 satellites.

►TIANGONG-1

Tiangong-1, which means **"celestial place-1"**, was the china's first prototype space station and it orbited Earth from September 2011 to **April 2018.**

EXPLAINED

- The space station acted **as a manned laboratory and experimental test bed** for the Chinese space program.
- The ground station lost control over the space station and Tiangong-1 **re-entered earth's atmosphere and was destroyed**.

►GAOFEN 11

China has launched an optical remote sensing satellite as part of her China High-Resolution Earth Observation System (CHEOS).

EXPLAINED

- Gaofen-11 satellite will be utilized for land survey, urban planning, road network design, agriculture and disaster relief.
- The data provided by the Gaofen 11 will be used for China's ambitious Belt and Road Initiative as well.
- Under the Gaofen project China has planned to launch seven high definition observation satellites and these satellites will circle earth at low orbits (600 to 700 kms).

►YUTU-2

IN NEWS

China has named the lunar rover, successfully deployed on Thursday to carry out a string of experiments on the far side of the moon, as 'Yutu-2'. It is part of **China's Change 3 mission to moon.**

EXPLAINED

- China's lunar probe is part of its **'Made in China-2025' project**, which focuses on advanced technology, including space applications.
- The rover has been programmed to **launch ground penetration radar** that would help **map the moon's inner structures**.
- It would also **analyse soil and rock samples for minerals**, apart from activating a radio telescope to search for possible signals from deep space.
- It follows the **BeiDou Navigation Satellite System** — China's homegrown Global Positioning System that started worldwide service last month.
- It is said that China is **considering mining there for helium-3**, a rare substance on earth that can be used as a fuel in nuclear fusion power generation.

INDIA'S MISSIONS

►HYPERSPECTRAL IMAGING SATELLITE (HYSIS)

- ISRO's PSLV C43 launched **India's first Hyperspectral Imaging Satellite (HysIS)** along with 30 foreign satellites from Satish Dhawan Space Centre, Sriharikota.
- HysIS is an **earth observation satellite** built around ISRO's Mini Satellite-2 (IMS-2) bus.

ABOUT HYPERSPECTRAL IMAGING

- It combines the power of **digital imaging and spectroscopy** to attain both spatial and spectral information from an object.
- This result can be then used to identify, measure and **locate different materials and their chemical and physical properties.**
- Hyperspectral images provide much more detailed information about the scene by dividing the spectrum into **many more bands than a normal color camera**, which only acquires three different spectral channels corresponding to the visual primary colors red, green and blue.

APPLICATION

- Hyperspectral remote sensing is used for a range of applications like agriculture, forestry, soil survey, geology, coastal zones, inland water studies, environmental studies, detection of pollution from industries and the **military for surveillance** or anti-terror operations.
- Other utilities include online **industrial monitoring**/ sorting/classification to laboratory measurements, clinical instruments for medical diagnostic and airborne and **satellite based remote sensing** tools.

►GSAT-29 LAUNCH

Recently, ISRO launched satellite-**GSAT-29** through the launcher **GSLV-Mk III D2**.

ABOUT GSLV-MK III D2

- It is the **fifth generation, India's heaviest launch vehicle** designed to place satellites of up-to **4,000 kg into Geosynchronous Transfer Orbit (GTO)** or satellites weighing about 10,000 kg to a Low Earth Orbit (LEO).
- It is the **second launch of GSLV-Mk III,** which earlier in 2017 carried GSAT-19 satellite as the first development flight.
- It is a **three-stage heavy-lift rocket** with two solid fuel strap-on engines in the first stage, a **liquid propellant** core as second stage and a **cryogenic engine** for the third stage.
- India is among six nations — apart from the US, Russia, France, Japan and China — to possess cryogenic engine technology.

ABOUT GSAT-29

- With a lift-off mass of 3423 kg, GSAT 29 is a multi-beam, multiband communication satellite of India and is the **heaviest satellite** launched **from India**.
- It will **bridge the digital divide** of users including those in Jammu & Kashmir and North Eastern regions of India.

►GSAT-11

India's **heaviest** and most advanced satellite GSAT-11 was launched from the Guiana Space Centre at Kourou in **French Guiana**.

ABOUT GSAT-11

- ISRO's heaviest satellite ever built and weighs about 5854 kilograms.
- Will use **a 'multi-spot' approach** to maximize its coverage area in the Indian mainland and islands — a far superior communication technology than existing INSATs and GSATs.
- The satellite has 32 K**u-band** transponders and 8 **Ka-band** hubs on board.
- The Ku- and Ka-bands are different **frequencies of microwaves** in the electromagnetic spectrum.

IMPORTANCE

- GSAT-11 will bring far greater speeds (**16 Gbps** of it, no less) and capacity to meet growing demand for mobile and internet in households, businesses, and public organisations.
- Under Digital India's BharatNet project GSAT-11 will boost access to **voice and video streaming** in most, if not all, of rural India.
- With India moving fast towards implementing 'Smart Villages and Cities', they can be efficiently linked through a large communication satellite.

►GSAT-7A

ISRO launched GSAT-7A, launched by GSLV-Mk-II since it began using the indigenous cryogenic engine.

FEATURES

- It is an advanced communication satellite with a Gregorian Antenna and other new technologies.
- **Aim-** The satellite is expected to add a new space-based dimension to the way Indian Air Force interlinks, operates

and communicates with its aircraft as they fly and with command centres on ground.

- GSAT-7A is the **first satellite built primarily for the IAF** to qualitatively unify its assets and improve combined, common intelligence during operations.
- It will do this by connecting many of the ground radar stations, airbases and aircrafts operated by the IAF, and is also expected to boost some of their network-dependant warfare and drone capabilities.
- GSAT-7A is the 35th Indian communication satellite weighing 2,250 kg.
- GSAT-7A satellite using Ku band will enable superior real-time aircraft-to-aircraft communication; and between planes that are in flight and their commanders on the ground.

►GSAT-6A

GSAT-6A was launched by ISRO from the Satish Dhawan Space Centre at Sriharikota.

FEATURES

- Launch marked the **12th flight of Geosynchronous Satellite Launch Vehicle GSLV-F08** and sixth flight with the **indigenous Cryogenic upper stage**.
- GSAT-6A, similar to GSAT-6, is a high powered **S-band communication** satellite.
- It would help improve **mobile communications to handheld devices**, as well as network management techniques useful **in satellite- based mobile communication applications.**
- However, ISRO **lost contact with its communication satellite** GSAT-6A.

►GSAT-19

Heaviest satellite of India launched from Indian soil.

FEATURES

- **Launch Vehicle**- GSLV MK-III. It is a launch vehicle developed by India to lift the satellites of upto 4,000 KGs. It uses the indigenous cryogenic upper stage engine.
- **GSAT-19**: Weight – 3,136 KGs. Launch of GSAT-19 marks the launch of the heaviest satellite from India till date.
- Till now, the satellites weighing more than 2.5 ton were being launched from Kourou, French Guiana.

►EXOPLANET DISCOVERY

Recently Indian scientists discovered a **sub-Saturn or super-Neptune sized exoplanet.**

ABOUT DISCOVERY

- The discovery was made **by measuring the mass of the planet** using the indigenously designed PARAS (PRL Advance Radial-velocity Abu-Sky Search) spectrograph integrated with a 1.2m telescope at Gurushikar Observatory in Mount Abu.
- The name of the host star is EPIC 211945201 or K2-236 and the planet will be known as **EPIC 211945201b or K2-236b.**
- It put India into a select league of countries which has discovered planets around stars.

►EXSEED SAT 1

With the launch of ExseedSAT 1, Exseed Space has become the **first Indian privately-funded** startup to successfully send a satellite into space.

ABOUT EXSEED SAT-1

- ExseedSAT 1 was launched into space by **Space X** along with 63 other satellites from 17 countries.
- The mini communication satellite weighing **just a kg**
- Double the size of a **Rubik's cube** (10 cm x 10 cm x 10 cm)
- Made up of **aluminium alloy**.

APPLICATION

- The satellite looks to serve the amateur **radio community.**
- The satellite would provide a big boost to private radio operators and help in **coordinating messages** among them and help the country in time of disaster.

►IRNSS-1I SATELLITE

ISRO launched the IRNSS-1I satellite from Satish Dhawan Space Centre, Sriharikota, through its **PSLV-C41.**

ABOUT SATELLITE

- It is the **eighth satellite** to join the IRNSS satellite constellation.
- IRNSS-1I will **replace IRNSS-1A**, the first of the seven navigation satellites, which has become ineffective after its three **rubidium atomic clocks** failed.

- It will be placed in a **sub-geosynchronous transfer orbit** and at its closest point will be 284 km above the Earth and at its farthest will be 20,650 km above the Earth.
- Like all other IRNSS satellites, IRNSS-1I will also carry two payloads –
  - **navigation payload** (determines position, velocity and time)
  - **ranging payload** (determines the frequency range of the satellite).

ABOUT NAVIC

- **NAVIC or IRNSS (Indian Regional Navigation Satellite System)** is an independent **indigenous regional system** developed by India on par with the US-based Global Positioning System (GPS), Glonass of Russia, Galileo by Europe, BeiDou by China and Quasi-Zenith Satellite System (QZSS) by Japan**.**
- IRNSS provides basically two types of services:
  - **Standard Positioning Service** (SPS) for civilian users
  - **Restricted Service (RS),** is an encrypted service provided only to specific users

APPLICATION OF NAVIC

It offers services like

- terrestrial and marine navigation,
- disaster management,
- vehicle tracking and fleet management,
- **navigation aide for hikers** and travellers,
- visual and voice navigation for drivers
- marine & aerial navigation for **India and its neighbourhood.**

►ADITYA L1

India is set to launch its **first solar mission** Aditya-L1 in 2021.

ABOUT ADITYA L1

- The Aditya L1 will be placed **in a halo orbit around a vantage point in space known as L1 Lagrange point.**
- The point L1 has the major advantage of viewing the sun without any occultation/ eclipses.
- The mission will carry seven payloads including the main payload the **Visible Emission Line Coronagraph (VLEC).**

APPLICATION

- Aditya L1 is to be the **first satellite to study the magnetic field** of the sun's corona.
- The Aditya L1 is expected to help study that why the **photosphere**, the deeper layer of the sun is at much lower temperature than the corona.
- It will also study aspects that affect space weather, the **origin of solar wind ions,** their reaction to coronal mass ejections, the distribution of these in the heliosphere- the space around the sun that extends up to Pluto.

CONCEPTS

- **Halo Orbit:** It is periodic, three-dimensional orbit near the L1, L2 and L3 lagrange point (unstable) in a three body system.
- **Lagrange Point:** It is the point where the **combined gravitational force of two large bodies is equal to the centrifugal force** that is felt by a third body which is relatively smaller.
- There are about 5 such points in a two body system.
- **Corona:** The outer layers of the Sun, extending to thousands of km above the disc (photosphere) is termed as the corona.
- It has a temperature of **more than a million degree Kelvin** which is much higher than the solar disc temperature of around 6000K.

►GAGANYAAN

ISRO will be sending its **first human spaceflight** mission into the space by 2022.

BACKGROUND

- ISRO has successfully demonstrated some of the technologies required for the mission such as
  - Space Capsule Recovery Experiment (SRE-2007),
  - Crew module Atmospheric Reentry Experiment (CARE-2014),
  - GSLV Mk-III (2014),
  - Reusable Launch Vehicle- Technology Demonstrator (RLV-TD),
  - Crew Escape System (July 2018)
  - Pad Abort Test (2018).
- ISRO also recently unveiled a **space capsule** (crew module) and **Space suit prototype**.

- ISRO has also finalized the layout and design of **Environmental Control & Life Support System (ECLSS)** which
  - maintains a steady cabin pressure and air composition,
  - removes carbon dioxide and other harmful gases,
  - controls temperature and humidity, and
  - manages parameters like fire detection and suppression, food and water management, and emergency support.

SPECIFICATIONS

- GSLV Mk-III launch vehicle will be used to launch Gaganyaan.
- Two unmanned Gaganyaan missions will be undertaken prior to sending humans, with first unmanned flight within 30 months.
- The mission will aim to send a three-member crew to space for a period of **five to seven days.**
- The spacecraft will be placed in a **low earth orbit of 300-400km**.
- It will comprise of a crew module and service module that constitute an **orbital module**.
- The crew will do **microgravity experiment** during the mission.

►CARTOSAT C40

The Cartosat-2 Series Satellite is the primary satellite that was carried by PSLV-C40.

ABOUT SATELLITE

- It is a **remote sensing satellite** similar to the earlier six satellites of the Cartosat-2 series launched with the **purpose to augment data services** to the users.
- **Trajectory**: The satellite was injected into a 505 km polar Sun Synchronous Orbit by PSLV-C40. Launched by PSLV-C40.
- Once the satellite is brought on to operational configuration, it will begin providing regular remote sensing services using its Panchromatic and **Multispectral** cameras.
- **Utility:** The imagery sent by the satellite **will be useful for** cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, change detection to bring out geographical and manmade features and various other Land Information System (LIS) as well as Geographical Information System (GIS) applications.

►SAARC SATELLITE

South Asian Satellite (Also known as the SAARC satellite) was launched by ISRO.

ABOUT

- **Features**: Name: GSAT-9, Communication Satellite, 2,230 KGs.
- **Launch Vehicle:** GSLV MARK-II
- GSAT-9 is a gift from India to all the SAARC members as a part of the Neighbourhood First Policy of India. All the SAARC members, except Pakistan, would receive the communication services from this communication satellite.
- Pakistan backed off from receiving the services from this satellite.

►GSAT-31

India's telecommunication satellite, GSAT-31 was successfully launched from Kourou launch base, French Guiana by Ariane-5 VA-247.

EXPLAINED

- GSAT-31 is a **high-throughput telecommunication satellite** developed by the Indian Space Research Organisation (ISRO).
- The satellite **main communication payload is Ku band** and act as a **replacement of the aging INSAT-4CR**.
- The satellite will provide advance **tele-communication to Indian subcontinent**.
- It will be used for **VSAT networks, television uplinks, digital signage new gathering, DTH services and other communication systems**.
- This is the 40th communication satellite launched by ISRO and the 22nd launch of ISRO satellite by Arianespace.

►KALAMSAT V2

- It is the **world's lightest satellite, made by Indian students.** It weighed only 1.26 kg.
- It was successfully launched by ISRO on PSLV.

- The satellite was desgined and built by students who work with a private organisation called **'Space Kidz India'** in Chennia.
- Kalamsat is the first to use the PSLV's fourth stage an an orbital platform.

►SPACE ACTIVITIES BILL 2017

The government of India has come up with **Space Activities Bill 2017**, a draft law meant to regulate the space sector.

ABOUT BILL

The draft law includes provisions such as

- providing **non-transferable licence** to carry out commercial space activity,
- supporting such activities professionally ad technically,
- regulating their operations,
- **penal provisions** for undertaking such activities without authorization etc.

SIGNIFICANCE

- It is needed **to encourage the participation of private sector agencies** in space activities in India.
- This will **supplement the manpower requirement of ISRO**.

►GROWTH-INDIA

- It is **India's first robotic telescope** and the first one designed to observe dynamic or transient events in the universe. It is a 0.7 m telescope.
- It is located at the Indian Astronomical Observatory (IAO) at Hanle, Ladakh.
- It is **a joint project of Indian Institute of Astrophysics (IIA) and IIT Bombay.**
- The project has been **fully funded by Science and Engineering Research Board (SERB)** of the Department of Science and Technology (DST) under the PIRE project, administered by Indo US Science and Technology Forum.
- It is also is programmed to directly communicate with different ground based and space based surveys searching for transient sources.
- It plans to study electromagnetic counterparts to gravitational wave sources, young supernovae and near earth asteroids.

OTHER FACILITIES AT HANLE, LADAKH

- Himalayan chandra telescope
- Gamma ray array telescope (HAGAR)
- Imaging Cherenkov telescope (MACE)

ABOUT GROWTH

- It is part of a multi country collaborative initiative called **'Global Relay of Observatories Watching Transients Happen' (GROWTH)** to observe transient events in the universe.
- Fully robotic optical research telescope is designed to capture cosmic events occurring in timescales much shorter than light years - years, days, and even hours.
- Universities and research institutes from US, UK, Japan, India, Germany, Taiwan and Israel are part of the initiative. The primary objective of the project is time domain astronomy, which involves study of explosive transients and variable sources in the universe.

►CHANDRYAAN-2

Chandrayaan -2 will be India's second lunar exploration mission after Chandrayaan-1. The mission is developed by the Indian Space Research Organisation (ISRO)

EXPLAINED

- It is planned that the Chandrayaan-2 will be launched by a **Geosynchronous Satellite Launch Vehicle Mark III** (GSLV Mk III)**.**
- Chandrayaan-2 includes a **lunar orbiter, lander and rover,** all developed by India.
- Chandrayaan-2 will attempt to **soft land a lander and rover** in a high plain between two craters**, Manzinus C and Simpelius N.**
- The wheeled rover will perform **on-site chemical analysis.** The data will be relayed to Earth through the Chandrayaan-2 orbiter**.**

►LUNAR LANDER FOR CHANDRAYAAN-2

ISRO will conduct Lander sensor performance test for chandrayaan-2 at the artificial Lunar Site challkere, Karnataka.

EXPLAINED

- Chandrayan-2 lander is the first from India to have soft landing on moon

- India will become 4th country to do so after USA, USSR and China

►PSLV-C-45

PSLV C-45/ Emisat mission is ISRO's first attempt to place payload in three different orbits.

EXPLAINED

- The chief payload — the 436 kg Emisat — will be injected into a 749 km orbit. EMISAT stands for electromagnetic spectrum measurements.
- Emisat would serve as the country's roving device for detecting and gathering electronic intelligence from enemy radars across the borders as it circles the globe roughly pole to pole every 90 minutes or so.
- After that, the fourth stage of the rocket will be manoeuvred to a 504 km orbit for releasing 28 international satellites. The 28 international customer satellites are from four countries, viz. Lithuania, Spain, Switzerland and USA. All these satellites are being launched under commercial arrangements.
- Once that job is over, the fourth stage will be restarted and guided to an altitude of 485 km, to serve as an as an orbital platform for space-based experiments, for next six months. This is another first for the ISRO. Normally, the spent stage simply becomes space junk.
- The orbital platform will also sport solar panels, which too is a first, official sources said.

THE THREE EXPERIMENTS ON BOARD

- IIST's (Indian institute of space science and technology) Advanced Retarding Potential Analyser for Ionospheric Studies (ARIS). ARIS will study the structure and composition of the ionosphere.
- IIST's stands for Indian institute of space science and technology, an autonomous institute under the department of space, GOI, situated in Thiruvananthapuram.
- The other one is the Automatic Identification System (AIS), an ISRO payload for maritime satellite applications,
- and the third is, Automatic Packet Repeating System (APRS), meant to assist amateur radio operators.

►SOLID PROPELLANT "MRINAL"

ISRO has celebrated 50 years of its first composite solid propellant "MRINAL" used for the fist successful test flight of an indigenous sounding rocket RH-75 from Thumba.

EXPLAINED

- In the early stage, **free standing propellants** were used to propel test rockets at Thumba.
- **Dr. VR Gowarikar** was the brain behind the development of composite solid propellant through the **Propellant Engineering Division** (PED) located at Veli.
- The fuel was **named after Mrinalini Sarabhai**, noted dancer and wife of Vikram Sarabhai.

►VIKAS ROCKET ENGINE

Vikas rocket engine belongs to a family of liquid fuelled designed by Liquid Propulsion System Centre.

- The **design** of the Vikas engine is based on **Viking engine licensed from France**.
- The engine is used in the **Polar Satellite Launch vehicles (second stage)** and **Geosynchronous Satellite Launch Vehicle (second stage)**.
- The engine uses **Unsymmetrical Dimethylhydrazine (UDMH)** as fuel and **Nitrogen tetroxide** (N_2O_4) as oxidizer to generate thrust.

►PSLV-C42

- PSLV-C42 Successfully Launched two foreign satellites from Satish Dhawan Space Centre (SDSC), SHAR, Sriharikota.
- This mission was designed to launch two earth observation satellites, **NovaSAR and S1-4**. Both the satellites were injected into **583 km Sun Synchronous Orbit**.
- NovaSAR is a **S-Band Synthetic Aperture Radar satellite** intended for **forest mapping, land use & ice cover monitoring, flood & disaster monitoring**.
- S1-4 is a high resolution **Optical Earth Observation Satellite**, used for **surveying resources, environment monitoring, urban management and for the disaster monitoring**.
- The PSLV C-42 rocket had **four stages**; each one was **self-contained**, with its **own propulsion system**, thereby capable of **functioning independently**.
- The first and third stages used **composite solid propellants**, while the third and fourth stage used **earth-storable liquid propellants**.

►SPYLITE MINI UNMANNED ARIEL VEHICLE (UAV)

- Indian army has placed order for **SpyLite mini UAV for high altitude aerial surveillance**. The UAV is an advanced, combat proven, electric fully autonomous aerial system.
- SpyLite can **fly for 4-5 hours** in one go and has the **altitude ceiling of around 30,000 feet**.
- It can deliver high quality **day and night videos** and has **low visual and acoustic signature** which gives it an edge in conducting covert operations.

MISCELLANEOUS

►IBUKI-2 (GOSAT 2)

- GOSAT 2 (Greenhouse Gases Observing Satellite 2) **JAXA's** next generation satellite to monitor the greenhouse gases like carbon dioxide in the Earth's atmosphere. It is the follow on to the GOSAT (Ibuki) mission.
- It will monitor the greenhouse gases **carbon dioxide, methane, carbon monoxide** with increased accuracy to continue and improve GOSATs work.
- The observation accuracy is 0.5 ppm for carbon dioxide and 5 ppb for methane at a 500-km mesh over land.
- Mitsubishi Electric (MELCO) was selected as the prime contractor for the spacecraft and the instruments.

►X-CALIBUR TELESCOPE

- Scientists shave successfully launched **a telescope from Antarctica that analyses X-rays** arriving from distant neutron stars, black holes and other exotic celestial bodies.
- The X-Calibur instrument, launched by Washington University in the US from the McMurdo Station in Antarctica, is carried aloft on a **helium balloon intended to reach an altitude of 130,000 feet**.
- Scientists' main observation target is **Vela X-1**, a neutron star in binary orbit with a supergiant star.
- Neutron stars are objects of very small radius (typically 30 km) and very high density, composed predominantly of closely packed neutrons.
- Neutron stars are thought to form by the gravitational collapse of the remnant of a massive star after a supernova explosion, provided that the star is insufficiently massive to produce a black hole.

►AEOLUS SATELLITE

- It a **European Space Agency's** Earth Observation Satellite.
- Aeolus is an Earth Explorer satellite and carries a revolutionary instrument, which comprises a powerful laser, a large telescope and a very sensitive receiver.
- It works by emitting short, powerful pulses –50 pulses per second –of ultraviolet light from a laser down into the atmosphere.
- The instrument then measures **the backscattered signals from air molecules, dust particles and water droplets** to provide vertical profiles that show the speed of the world's winds in the lowermost 30 km of the atmosphere.
- These measurements are needed to improve **weather forecasts. Scientists have been taking similar measurements from an aircraft carrying an airborne version of Aeolus' instrument**.
- The pilot flies the plane under the satellite as it orbits above so that measurements of wind can be compared.

►BEPICOLOMBO MISSION

- It is a joint mission of the **European Space Agency and the Japan Aerospace Exploration Agency** to the planet Mercury.
- It is Europe's first mission to Mercury and set off in 2018 on a journey to the smallest and least explored terrestrial planet in our Solar System.
- When it arrives at Mercury in late 2025, it will endure temperatures in excess of 350 °C and gather data during its 1 year nominal mission, with a possible 1-year extension.
- **The mission comprises two spacecraft:**
  - the Mercury Planetary Orbiter (MPO) and
  - the Mercury Magnetospheric Orbiter (MMO).
- BepiColombo is a joint mission between ESA and the Japan Aerospace Exploration Agency (JAXA), executed under ESA leadership.

►EXTRA MOONS OF EARTH

- Research by Hungarian Scientists has confirmed that Earth has two extra moons made of dust. These were first spotted by Polish astronomer Kazimierz Kordylewski. Thus, the two moons have been called **Kordylewski Clouds.**
- These moons have been found at L4 and L5 points between Earth and Moon. At these points, the gravitational pull of Earth and the Moon stabilises the clouds orbits, so they constantly circle the Earth.
- The clouds are large however they are made of small particles, hence when the light of the sun falls on it, there is only a faint shine.

►FAST RADIO BURSTS (FRB)

15 FRBs were detected by astronomers working for '**BREAKTHROUGH LISTEN'**.

ABOUT FRB

- High energy signal
- Found outside Milkyway Galaxy
- Bright; Appear to come from a point source
- Time Duration – few milliseconds
- Broadband – Contains large number of radio frequencies.
- **Sources**: Neutron stars, Black Hole, Extra-terrestrial Communication

WHAT IS BREAKTHROUGH LISTEN?

- Project initiated by Stephen Hawking
- To look for extra-terrestrial communication
- Based on Radio Waves and Visible light

►SARASWATI: SUPERCLUSTER OF GALAXY

- The newly discovered Saraswati supercluster is 4000 million light years away.
- When seen in the sky, Super cluster Saraswati lies in the Stripe 82 of the **Sloan Digital Sky Survey (SDSS)** is in the constellation of Pisces.

ABOUT SDSS

- SDSS is an ambitious plan to make a digital 3D map of the universe.
- It started in 2000 and has found nearly 50 million galaxies so far.
- It uses a 2.5-m wide-angle optical telescope situated in New Mexico, USA.
- SDSS has **played** an integral part of the reshaping of astrophysics.
- SDSS data have helped to demonstrate that the Universe is dominated by unseen dark matter and dark energy.

GALAXY

- Galaxies are the building blocks of the universe.
- They contain huge number of stars (around 100 billion!).
- Galaxy groups can have 3 to 20 galaxies at the same time.
- Those galaxy systems which have several hundred galaxies are called Clusters.

SUPER GALAXY

- Superclusters are clusters of clusters. Generally, superclusters have just two to four clusters. Saraswati has 42 clusters.
- Super galaxies are the largest coherent structures seen in the universe.

►WORLD'S FIRST PRIVATELY FUNDED MOON MISSION – BERESHEET

The World's first privately funded spacecraft to Moon, Beresheet has recently crashed.

DETAILS

- It was the first Israeli spacecraft and the first privately-operated mission to attempt to land on the Moon.
- If it was successful, Israel would have become the 4th country to have achieved a controlled touchdown on the moon's surface. So far, only three other countries have carried out controlled "soft" landings on the moon – the United States, the former Soviet Union and China.
- The Beresheet spacecraft was built by Israeli non-profit agency, SpaceIL.
- It was launched atop SpaceX Falcon 9 rocket.

►IMAGE OF BLACKHOLE IS CAPTURED – POWEHI

WHERE WAS THE IMAGE CAPTURED?

- From a giant galaxy Messier 87 in the constellation Virgo.

HOW WAS IT CAPTURED?

- The image emerged from two years of computer analysis of observations from a network of radio antennas called the Event Horizon Telescope.

- In all, eight radio observatories on six mountains and four continents observed the galaxy in Virgo on and off for 10 days in April 2017.

WHAT IT REVEALED?

A black hole about seven billion times more massive than the sun is unleashing a violent jet of energy some 5,000 light years into space.

WHY IS IT SIGNIFICANT?

The image offered a final affirmation Einstein's General Theory of Relativity.It is the greatest breakthrough of the century.

WHAT IS A BLACKHOLES?

- A black hole is a region of spacetime exhibiting such strong gravitational effects that nothing—not
- even particles and electromagnetic radiation such as light—can escape from inside it.The theory of general relativity predicts that a sufficiently compact mass can deform spacetime toform a black hole.The boundary of the region from which no escape is possible is called the event horizon.
- In many ways a black hole acts like an ideal black body, as it reflects no light
  - Black holes form at the end of some stars' lives.
  - The energy that held the star together disappears and it collapses in on itself producing a magnificent explosion.
  - All of that material left over from the explosion, many times the mass of our Sun, falls into an infinitely small point.
  - Black holes can form in many ways though, and large black holes can have tens to millions of times the mass of our sun trapped in a point smaller than the tip of a pin! Some black holes trap more and more material as their mass increases.
  - The point where all that mass is trapped is called a singularity.
  - It may be infinitely small, but its influence is enormous. Imagine a circle with a singularity in the middle. The gravity on the inside of the circle is so strong that nothing can escape—it sucks in everything, even light. That's why it's black! This boundary region is known as the **event horizon.**

WHY IS IT DIFFICULT TO DETECT?

Light enters into Event Horizon but cannot escape from it. Hence no light is emitted and that is why it is difficult to detect. It cannot be observed directly through Telescopes on ground. Its presence is observed through the interaction of bodies with the blackholes.

HOW THE IMAGE WAS CAPTURED?

- The image emerged from two years of computer analysis of observations from a network of radio antennas called the **Event Horizon Telescope. In all, eight radio observatories on six mountains and four continents** observed the galaxy in Virgo on and off for 10 days in April 2017. So that an **entire Earth Sized Telescope was formed.**
- The telescope array also monitored a dim source of radio noise called Sagittarius A* (pronounced Sagittarius A-star), at the heart of our Milky Way galaxy. There, 26,000 light-years from Earth, and cloaked in interstellar dust and gas, lurks another black hole, with a mass of 4.1 million suns. The network is named after the edge of a black hole, the point of no return; beyond the event horizon, not even light can escape the black hole's gravitational pull.

NAME OF THE BLACKHOLE CAPTURED?

- The captured blackhole has been named as **'Powehi'.**

►SUPER EARTH

Astronomers have discovered a frozen planet with a mass over three times that of the Earth, orbiting the closest solitary star to the Sun. Its name is Barnard's Star b.

EXPLAINED

- The **potentially rocky planet, known as Barnard's star b, is a 'super-Earth'** and orbits around its host star once every 233 days.
- The planet **lies at a distant region from the star known as the 'snow line'**. This is well beyond the habitable zone in which liquid water, and possibly life, could exist.
- **Barnard's star is the next closest star to the Sun after** the Alpha Centauri triple system.
- It is a low-mass star called a red dwarf.
- Barnard's star b is the **second closest known exoplanet to our Sun**.
- **The closest planet is Proxima b** which revolves around the red dwarf Proxima.

SUPER EARTH

- It is an **extrasolar planet with a mass higher than earth** but substantially lower than Uranus and Neptune.

- **The term "super-Earth" refers only to the mass of the planet, and so does not imply anything about the surface conditions or habitability**.

►BEDIN I

IN NEWS

Scientists have discovered a dwarf galaxy and named it Bedin I. The discovery is made by the use of the Hubble telescope.

EXPLAINED

- **Bedin I** is a **dwarf spheroidal galaxy** located in the **constellation Pavo**.
- It is one of the **oldest galaxies known**, having formed around 10–13 billion years ago, and is one of the most isolated dwarf galaxies known to mankind.
- As such, **it has been deemed by astronomers as a "fossil" from the early universe**. It was **accidentally discovered by Italian astronomer Luigi Bedin**, whose team was studying white dwarfs using the Hubble Space Telescope.

►SPACE HARPOON (REMOVE DEBRIS SATELLITE)

IN NEWS

University of Surrey has tested SPACE HARPOON to remove debris from the space as this space debris may be dangerous for future satellites and space stations.

EXPLAINED

- **The RemoveDEBRIS satellite**, which was deployed from the International Space Station, is equipped with **different tech that's capable of ensnaring space junk**.
- Before this harpoon test, the spacecraft successfully **deployed a net for grabbing debris**.
- Thousands of old satellite and rocket parts, and other junk circle the Earth, a potential threat to working spacecraft, including the International Space Station.

►MOHAMMAD VI-B

- Morocco has launched its **second earth observation satellite named Mohammad VI-B**.
- It will be placed at the same orbit as its **twin satellite Mohammad VI-A** (The first Moroccan Satellite).
- The satellite will be used for **mapping, land surveying, agriculture monitoring, prevention and management of natural disasters** monitoring changes in the environment and desertification and border & coastal surveillance.

►OUMUAMUA

Oumuamua is the first and currently only interstellar object detected passing through the Solar System.

EXPLAINED

- It was discovered by **Robert Weryk using the Pan-STARRS telescope** at Haleakala Observatory, Hawaii, after it passed its closest point to the Sun.
- It has a **dark red color, similar to objects in the outer Solar System**.
- Oumuamua showed no signs of a comet coma (atmosphere) despite its close approach to the Sun, but **underwent non-gravitational acceleration.**
- The object has a rotation **rate similar to the average spin rate** seen in Solar System asteroids, but is more **elongated than all but a few other natural bodies**.

►SMALL SATELLITE LAUNCH VEHICLES (SSLV)

IN NEWS

SSLV is a launch vehicle being developed by the **Indian Space Research Organisation** (ISRO) with **payload capacity of 500 kg to Low Earth orbit or 300 kg to Sun synchronous orbit** for launching small satellites.

EXPLAINED

- SSLV was developed with the aim of **launching small satellites commercially at drastically reduced price** and higher launch rate as compared to PSLV.
- **The launch readiness period** of SSLV is expected to be **less than a week** instead of months.
- The launch vehicle **can be assembled both vertically** like the existing PSLV and GSLVs **and horizontally** like the decommissioned SLV and ASLV.
- **The first three stages** of the vehicle **use solid propellant**, with a **fourth stage** being a **velocity-trimming module**.

SECTION 2

IT, MOBILE TELEPHONY, ROBOTICS AND CYBER SECURITY

- A Cellular Network is a radio frequency network, where in the targeted land area is divided into Cells. Each Cell is serviced by at least one Base Station.
- Each cell uses a different set of frequencies from neighbouring cells. When these cells are joined together they provide coverage over a wide geographical area.

► GROWTH OF MOBILE TELEPHONY

1. **1 G**: Became popular in 1970s, was capable of transferring only analogue Voice via AM (Amplitude Modulation) and FM (Frequency Modulation). Used in Cordless Phones, Paging, Private Mobile Radio
2. **2 G**: Became popular in 1990s, Still in use. Started Digital Voice Encoding using GSM (Global System for Mobile communications) and CDMA (Code Division Multiple Access). Operates in 900 Mhz or 1800 Mhz Bands. It marked the beginning of SMS (Short messaging Service)
3. **2.5 G**: Marked the beginning of GPRS (General Packet Radio Service).
4. **2.75 G**: Ushered in the Enhanced GPRS or EDGE (Enhanced Data rate for GSM Evolution).
5. **3 G:** GPRS along with EDGE along with WCDMA (Wideband Code Division Multiple Access), allows transfer speeds up to 7.2 Mbps. Also known as Universal Mobile Telecommunication System(UMTS)
6. **3.5 G:** Uses high Speed Downlink Packet Access (HSDPA) and speed up to 14.4 Mbps
7. **4 G (LTE):** Mobile Broadband Technology and uses Enables 3D virtual Reality. Two 4G candidate systems are commercially deployed worldwide: Mobile WiMAX standard that was used first in South Korea in 2007 and **Long Term Evolution** (LTE) standard that was used in Norway and Sweden in 2009.

- VoLTE (Voice over LTE): It is a new protocol for transmitting voice data over the LTE network. While 2G and 3G networks are circuit-switch based, 4G or LTE networks utilise Packet Switching. When a call is made over a 2G or a 3G network, a certain amount of network bandwidth is assigned to that call which does not terminate till the call ends. While on a VoLTE network, voice calls are broken up into packets of information.
- LTE and VoLTE are not the same. While LTE is a wholly IP-based communications protocol and so is capable of only transmitting data, VoLTE converts a voice call into digital packets and transmits over the LTE network. VoLTE is dependent on the LTE technology.

8. **5G:** It is a wireless communication technology using radio waves or radio frequency (RF) energy to transmit and receive data. It is the next generation mobile networks technology after 4G LTE networks. 5G technologies will enter services gradually, beginning in 2019 and advance to a full range of services by 2024. The final standard for 5G will be set up by the International Telecommunications Union (ITU).

►BLUETOOTH

It is a low cost, low power radio interface. It has the advantage of being an open standard that allows other devices to communicate with each other intelligently. It can connect up to 8 devices simultaneously and has a range of 32 feet or 10 metres.

►LI-FI

- When a constant current is applied to an LED light bulb, a constant stream of photons is emitted from the bulb which is observed as visible light. If the current is varied slowly the output intensity of the light dims up and down. Because LED bulbs are semiconductor devices, the current, and hence the optical output, can be modulated at extremely high speeds which can be detected by a photodetector device and converted back to electrical current. The intensity modulation is imperceptible to the human eye, and thus communication is just as seamless as Wifi. Using this technique, high speed information can be transmitted from an LED light bulb.
- The visible light spectrum is plentiful, unlicensed and free to use. Li-Fi can achieve about 1000 times the data density of Wi-Fi because visible light. Further very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output
- It requires fewer components than radio technology and LED illumination is already efficient and the data transmission requires negligible additional power.
- The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments. It is difficult to eavesdrop on Li-Fi signals since the signal is confined to a closely defined illumination area and will not travel through walls.

►MILLIMETER WAVES

- Today's wireless networks have a problem.
- As more devices consume more data than ever before on the same bands of the radio-frequency spectrum that mobile providers have always used, lesser bandwidth becomes available for everyone, causing slower service and more dropped connections.
- To solve the above issue, signals can be transmitted on a completely new spectrum. Hence, Telecom providers are experimenting **Millimeter waves**.
- Millimeter waves are broadcasted at frequencies between 30 and 300 giga-hertz.
- They are called millimeter waves because they vary in **length from 1 to 10 mm,** compared to the radio waves that serve today's smartphones, which measure tens of centimeters in length.
- Until now, only satellites and radar systems used millimeter waves.
- **Drawback**: Millimeter waves **can't easily travel** through buildings or obstacles and they can be absorbed by tree-cover and rain

►SMALL CELLS

- Small cells are portable miniature **base stations** that **require minimal power to operate** and can be placed for every 250 metres.
- To prevent signals from being dropped, **carriers would install** thousands of these stations in a city to form a dense network, receiving signals from other base stations and sending data to users at any location.
- While traditional cell networks have also relied on an increased number of base stations, achieving 5G performance will require an even greater infrastructure.
- The antennas on small cells are much smaller than traditional antennas when they are transmitting tiny millimeter waves.

►MIMO

- MIMO stands for **multiple-input multiple-output**.
- MIMO describes wireless systems that use two or more transmitters and receivers to send and receive **more data at once**.
- MIMO is already found on 4G base stations. However, massive MIMO has only been tested in labs and a few field trials.
- It has set new records for spectrum efficiency, which is a measure of how many bits of data can be transmitted to a certain number of users per second.
- **Drawback**: Installing so many antennas to handle cellular traffic causes Interference of signals cross each other. (Interference is the unwanted signals or noise on the reception of a wanted signal). Hence 5G must incorporate **Beamforming**.

►BEAMFORMING

- Beamforming is a **traffic-signalling system** for cellular base stations that identifies the **most** efficient **and fast data-delivery** route to a user.
- It **reduces interference for nearby users** in the process.
- Millimeter waves are easily blocked by objects and tend to weaken over long distances.
- **Beamforming helps by focusing a signal in a concentrated beam** that points only in the direction of a user, rather than broadcasting in many directions at once.
- This increases the signal's chances of arriving intact and reduce interference.

►FULL DUPLEX

- **Transceivers** (a device that has the capability to both transmit and receive signals) that are used in mobile phones today, either transmit or receive information over the same frequency.
- If a mobile phone has to do both at the same time, transmission and reception is done on different frequencies. With 5G, a transceiver will be able to transmit and receive data at the same time, on the same frequency.
- This technology is known as full duplex.
- Full Duplex could double the capacity of wireless network.

►CLOUD COMPUTING

- Cloud computing is the delivery of computing services—servers, storage, databases, networking, software, analytics and more—over the Internet ("the cloud").
- Cloud Computing Services provide the new model of offering services (Platform as a Service (PaaS),

Infrastructure as a Service (IaaS), Software as a Services (SaaS) and Storage as a Service (STaaS)) to the users at fast pace which is also cost effective.

- In order to utilise and harness the benefits of Cloud Computing, the government of India has embarked upon an ambitious initiative - "GI Cloud" which has been named as 'MeghRaj'.
- This initiative is to implement various components including governance mechanism to ensure proliferation of Cloud in the government. The focus of this initiative is to accelerate delivery of e-services in the country while optimizing ICT spending of the Government.

►NET NEUTRALITY

- Net neutrality is the principle that internet service providers and governments regulating the internet should treat all data on the internet the same, and not discriminating or charging differentially on the basis of user, content, website, platform, application, type of attached equipment, or mode of communication.
- In 2016, TRAI took a revolutionary decision, prohibiting telecom service providers from levying discriminatory rates for data, thus ruling in favor of Net Neutrality in India. This move was welcomed by not just by millions of Indians but also by various political parties, businesspersons, and industry leaders.

►ELECTROMAGNETIC SPECTRUM

- Electromagnetic radiation is transmitted in waves or particles at different wavelengths and frequencies. This broad range of wavelengths is known as the electromagnetic (EM) spectrum.
- The spectrum is generally divided into seven regions in order of decreasing wavelength and increasing energy and frequency.
- The common designations are radio waves, microwaves, infrared (IR), visible light, ultraviolet (UV), X-rays and gamma-rays. Visible light lies toward the shorter end, with wavelengths from 400 to 700 nanometres.

►INTERNET OF THINGS (IOT)

- The concept is basically **connecting any device with an on and off switch to the Internet** and to each other. This includes everything from cellphones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of.
- This also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig. The IoT is a giant network of connected "things" (which also includes people). The relationship is between people-people, people-things, and things-things.
- The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. In India, it is being promoted by the Telecom Regulatory Authority of India.

►VIRTUAL REALITY V/S AUGMENTED REALITY

- Virtual reality (VR) is an artificial, computer-generated simulation or recreation of a reallife environment or situation.
- On the other hand, Augmented reality (AR) is a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it. AR is developed into apps and used on mobile devices to blend digital components into the real world in such a way that they enhance one another, but can also be told apart easily.
- Augmented reality and virtual reality are inverse reflections of one in another with what each technology seeks to accomplish and deliver for the user. Virtual reality offers a digital recreation of a real life setting, while augmented reality delivers virtual elements as an overlay to the real world.

►QUANTUM COMPUTING

- Quantum computing is the next technological revolution. In a normal computer, information is stored as bits (either zero or one). Instead a quantum computer has quantum bits.
- These are made from quantum particles that can be zero, one, or a state in between (having both values) at the same time. A quantum bit could be any fundamental particle (a photon or an electron or it could be a nucleus also). Simply put, it is a particle that can have two different properties at once.

- In a normal computer, a particular calculation goes through all the different possibilities of zeros and ones for a particular calculation. Because a quantum computer can be in all the states at the same time, it ca test a vast number of possibilities simultaneously.

►QUBITS

- Unlike classical computers, quantum computers work on **Qubits**.
- Qubits **work faster** because of the way such circuits are designed.
- As discussed above, a **Qubit or quantum bits** may be 0,1 or any value between them superimposed to appear 0 or 1. That is it can be both 0 and 1.

►PARALLELISM

- This **superposition** of qubits is what gives quantum computers their inherent parallelism.
- **Parallelism** allows a **quantum computer to work on a million computations.**

►BHARATNET

- It is an initiative to start a broadband revolution in rural areas.
- It has been planned as an "information super-highway" by the creation of a robust last-mile infrastructure for ensuring broadband connectivity to Gram Panchayats.
- **Target**: BharatNet will to connect all the 2,50,000 Gram panchayats in the country and provide 100 Mbps connectivity.
- To achieve this, the existing fibres of PSUs like BSNL, RailTel and Power Grid are being utilised and fibre is being laid to connect to Gram Panchayat.
- Non-discriminatory access to the BharatNet will be provided to all the service providers like Telecom Service Providers (TSPs), Internet Service Providers(ISPs), Cable TV operators and Content providers to launch various services in rural areas.
- **Funding**: The project is funded by the Universal Service Obligation Fund (USOF).
- This project is a Centre-State collaborative project, with the States contributing free Rights of Way (authority to build infrastructure) for establishing the Optical Fibre Network.

►M2M COMMUNICATIONS

- M2M communications refers to **automated applications** which involve machines or devices communicating through a network **without human intervention**.
- Sensors and communication modules are used in M2M devices, enabling **data to be transmitted** from one device to another device through wired and wireless communications networks.
- M2M is going to be the **next generation of Internet revolution** connecting more and more devices on Internet.
- TRAI has acknowledged the potential of M2M Communications under the National Telecom Policy, 2012 as it forms a key component of **Internet Of Things (IOT)**.
- It is expected to revolutionize the performance of various sectors, businesses and services, by providing automation and intelligence to the end devices, in a way that was never imagined before.
- **Potential Applications**: It may be applied to robots and conveyor belts on the factory floor; To tractors and irrigation on the farm, from heavy equipment to hand drills, from jet engines to bus fleets; From home appliances to health monitoring; From Smart Grid to Smart Water. It can bring substantial tangible social and economic benefits by giving more efficient and effective services to the citizens. All in all, it has huge potential for bringing smartness in cities, city management, villages, traffic management, agriculture etc.

►FIBRE OPTICS

- A fibre optic cable is a network cable that contains strands of glass fibres inside an insulated casing.
- They're designed for long distance, very high performance data networking and telecommunications.
- In comparison to wired cables, fibre optic cables provide higher bandwidth and can transmit data over longer distances.
- Fibre optic cables carry communication signals using pulses of light generated by small lasers or light-emitting diodes (LEDs).

- The cable consists of one or more strands of glass. The centre of each strand is called the core, which provides the pathway for light to travel.
- The cables use the phenomenon of Total Internal Reflection. The core is surrounded by a layer of glass called cladding that reflects light inward to avoid loss of signal and allow the light to pass through bends in the cable.
- Fibre optics have a high capacity. Fibre cables can provide speeds up to 100 Gbps.
- Reduced costs: Since light can travel much longer distances down a fibre cable without losing its strength, it reduces the need for any additional devices like signal enhancers. This reduces the cost.
- Fibre is less vulnerable to interference. On the other hand, a traditional network cable requires special shielding to protect it from electromagnetic interference.

►CYBER SECURITY

►MALWARE

- Malware, or malicious software, is any program or file that is harmful to a computer user.
- Malware includes computer viruses, worms, Trojan horses and spyware.
- Malwares can perform a variety of functions, including stealing, encrypting or deleting sensitive data, altering or hijacking core computing functions and monitoring users' computer activity without their permission.

►TYPES OF MALWARE

There are different types of malware that contain unique traits and characteristics.

Virus	A virus is the **most common type of malware**. It can **execute itself** and spread by infecting other programs or files.
Worm	A worm is a **type of malware that can self-replicate** without a host program. Worms typically **spread without any human interaction or directives** from the malware authors.
Trojan	A Trojan horse is a malicious program that is **designed to appear as a legitimate program.** Once activated following installation, Trojans can execute their malicious functions.
Spyware	Spyware is a kind of malware that is **designed to collect information and data on users and observe their activity** without users' knowledge.

► RANSOMWARE

- It is a malicious software that is injected into the computer to limit the access of the system to the user and encrypt the data.
- Cyber criminals demand money in lieu of encryption key (that would unlock all the data and restore the access to the system).
- Nowadays, ransom is demanded in terms of Bitcoins.
- Recently, systems were infected with **WannaCry ransomware** across the globe.
- In 2017, India faced the threat from **Locky ransomware.**

►XAFECOPY

- It is a **Trojan Malware**.
- It is **disguised as useful apps** and operates normally. The Trojan secretly loads malicious code onto the device.
- Once the app is activated, the Xafecopy malware clicks on web pages with Wireless Application Protocol (WAP) billing. WAP is a form of mobile payment that charges costs directly to the user's mobile phone bill.
- After this the malware silently subscribes the phone to several services. The process also does not require user to register a debit or credit card or set up a user-name and password.
- The malware uses technology to bypass 'captcha' systems designed to protect users by confirming the action is being performed by a human**.**

►WEB CRAWLER

- A web crawler is also known as a web spider.
- It is a program or automated script which browses the World Wide Web in a systematic manner. This process is called Crawling or spidering.

- Web crawlers are mainly used to create a copy of all the visited pages for later processing by a search engine (like google).
- Crawlers can also be used for automating maintenance tasks on a Web site, such as checking links or validating HTML code.

►BOT

Bot is a software that is capable of compromising the victims' machine and using it for further malicious activities. The activities could be directed by Bot's command and control server.

►NATIONAL CYBER SECURITY POLICY, 2013

It aimed at building a secure and resilient cyberspace for citizens, businesses and Government, by way of actions to protect information and information infrastructure in cyberspace, build capabilities to prevent and respond to cyber threats, reduce vulnerabilities and minimize damage from cyber incidents through a combination of institutional structures, people, processes, technology and cooperation.

►CYBER APPELLATE TRIBUNAL

In accordance with the provision contained under Section 48(1) of the IT Act 2000, the Cyber Regulations Appellate Tribunal (CRAT) was established in 2006. As per the IT Act, any person aggrieved by an order made by the Controller of Certifying Authorities or by an Adjudicating Officer under the Act can appeal before the Cyber Appellate Tribunal (CAT).

►CERT-IN

CERT-In is the national nodal agency for responding to computer security incidents as and when they occur. In the recent Information Technology Amendment Act 2008, CERT-In has been designated to serve as the national agency to perform the following functions in the area of cyber security:

1. Collection, analysis and dissemination of information on cyber incidents.
2. Forecast and alerts of cyber security incidents
3. Emergency measures for handling cyber security incidents
4. Coordination of cyber incident response activities.
5. Issue guidelines, advisories, vulnerability notes and whitepapers relating to information security practices, procedures, prevention, response and reporting of cyber incidents.
6. Such other functions relating to cyber security as may be prescribed

►ELECTRONIC SIGNATURE

- It is an electronic sound, symbol, or process, attached to or logically associated with a contract or other record and executed or adopted by a person with the intent to sign the record. Electronic signatures have been used for e-signing of offer letters, sales contracts, permission slips, rental/lease agreements, liability waivers, financial documents, etc. They are legally binding in most business and personal transactions in almost every country in the world.
- While Electronic signatures, (or E-Signatures) are a broad category of methods for signing a document, a Digital signature is a type of electronic signature that uses a specific technical implementation. A Digital Signature is an electronic form of a signature. Just as one authenticates a document with handwritten signature, a digital signature authenticates electronic documents.
- A Digital Signature Certificate (DSC) can be presented electronically to prove identity, to access services on the internet or to sign certain documents digitally. A DSC provides with a high level of security for online transactions by ensuring absolute privacy of information exchanged using a DSC.
- A licensed certifying authority (CA) issues the digital signature, which has been granted a license to issue a digital signature certificate under Section 24 of the Information Technology Act, 2000.
- DSCs can be used for e-filing of income tax returns, e-tendering on websites of government departments and ministries like Indian Railway Catering and Tourism Corporation, Director General of Foreign Trade, Ministry of Corporate Affairs and Registrar of Companies.

ORGANISATIONS

►C-DAC

- Centre for Development of Advanced Computing (C-DAC), established in 1988, has emerged as a premier R&D

organization in IT&E (Information Technologies and Electronics) working on strengthening national technological capabilities in the context of global developments in the field and responding to change in the market need in selected foundation areas.

- The setting up of C-DAC in 1988 itself was to build Supercomputers in context of denial of import of Supercomputers by USA. Since then C-DAC has been undertaking building of multiple generations of Supercomputer starting from PARAM with 1 GF in 1988.
- Almost at the same time, C-DAC started building Indian Language Computing Solutions with setting up of GIST group (Graphics and Intelligence based Script Technology); National Centre for Software Technology (NCST) set up in 1985 had also initiated work in Indian Language Computing around the same period.
- Electronic Research and Development Centre of India (ER&DCI) with various constituents starting as adjunct entities of various State Electronic Corporations, had been brought under the hold of Department of Electronics and Telecommunications (now MeitY) in around 1988. They were focusing on various aspects of applied electronics, technology and applications.

►SAMEER

Society for Applied Microwave Electronics Engineering and Research (SAMEER) was set up as an autonomous R&D laboratory with a broad mandate to undertake R & D work in the areas of Microwave Engineering and Electromagnetic Engineering Technology.

►ERNET (EDUCATION AND RESEARCH NETWORK)

- ERNET India is an Autonomous Scientific Society of Ministry of Electronics and Information Technology, Government of India. In addition to providing connectivity, it has been meeting the needs of academic and research institutions by providing IT consultancy, project management and training.
- ERNET has been providing Domain name services and connectivity services, both terrestrial & via very small aperture terminal (VSAT) from its inception. A VSAT is a two-way satellite ground station with a dish antenna that is smaller than 3 meters.

►UNIVERSAL SERVICE OBLIGATION FUND (USOF)

- It is a **statutory fund under the Indian Telegraph (Amendment) Act, 2003.**
- It aims to enable rural Indians to achieve their fullest potential and participate productively in the development of the nation by being effectively connected through a reliable and ubiquitous telecommunications network.
- It works towards:
  - Network extension & stimulate undertaking the ICT services;
  - Mainstreaming the underserved & un-served areas/ groups by bridging the Access;
  - Enabling citizens exercise their political rights in an informed way; and
  - Promote equitable distribution of telecom/digital revolution and fair allocation of national resource.

CURRENT affairs& relatedconcepts

►MAKING INDIA 5G READY

The Steering Committee constituted for identifying the 5G deployment roadmap for India recently submitted **report titled 'Making India 5G Ready'**.

TECHNICAL SPECIFICATION FOR 5G

- **High data rates** (1 Gbps for hotspots, 100 Mbps download and 50 Mbps upload for wide-area coverage)
- **Massive connectivity** (1 million connections per square kilometre)
- **Ultra-low latency** (1 millisecond)
- **High reliability** (99.999% for mission critical 'ultra-reliable' communications), and
- **Mobility at high speeds** (up to 500 km/h i.e. high-speed trains).

►NET NEUTRALITY IN INDIA

The **Telecom Commission**, the highest decision-making body in the Department of Telecom has recently **approved the principles of net neutrality** recommended by TRAI last year.

ABOUT NET NEUTRALITY

- **Basic principles** of net neutrality:
  - Nobody owns the internet
  - It is free and open to all
  - Internet Service Providers (ISPs) must treat all internet traffic equally without any regard to the type, origin or destination of the content or the means of its transmission.
- According to TRAI net neutrality principles, any form of discrimination or interference in the treatment of content, including practices like **blocking, degrading, slowing down** or **granting preferential speeds or treatment to any content is prohibited.**

►DIGITAL SKY PLATFORM

India had announced the release of its Civil Aviation Regulations (CAR) to enable safe flying of **RPAS (Remotely Piloted Aerial Systems)** in India.

RPAS

RPAS, popularly referred to as **drones**, are a technology platform with wide-ranging applications.

DIGITAL SKY PLATFORM

- Launched to start registration of drones, pilots, and operators Registration portal for online permission
- First of its kind that implements **'no permission, no take-off' (NPNT)** – a novel system of software-based self-enforcement to minimize deviations from the CAR.
- It is envisioned that in the future **Digital Sky Service Providers (DSPs)** will be extending the functionality of the platform through **Application Program Interfaces (APIs)**.

PERMISSIONS TO FLY IN DIFFERENT ZONES

- **Green zones** – Flying in the green zones, requires only intimation of the time and location via the portal or the app.
- **Yellow zones** – Permission will be required for flying in yellow zones.
- **Red zones** – Flights will not be allowed to fly.

►ROBINSECTS

Scientist have developed **robots for pollination**; called as Robinsects or Nova-Crafters, based on the concept of 'Biomimetics'.

ABOUT ROBOINSECTS

- Robinsects/Nova-Crafeters are **GPS and Artificial Intelligence enabled small robotics hovers/drones** which are programmed to carry out the pollination.
- Algorithms are being developed to help the robot locate flowers, and its robotic arm, topped with a set of soft

brush tips–designed to act like a bee's hairs–will gently reach out to each flower and pollinate it.

ABOUT BIOMETRICS

Biomimetics, also known as bionics, biognosis, or biomimicry, is the use and implementation of concepts and **principles from nature to creating new materials, devices and systems.**

►PRATYUSH AND MIHIR

Minister for Earth Sciences (MoES) unveiled

- **India's fastest supercomputer named Pratyush** and
- high performance computer system 'Mihir'.

ABOUT PRATYUSH AND MIHIR

- MoES has acquired a high performance computing (HPC) system which is an array of computers jointly hosted by **IITM, Pune and National Centre for Medium Range Weather Forecasting, Noida.**
- The HPC at Pune is named **Pratyush** with a capacity of **4 petaflops** (a measure of a computer's processing speed expressed as a quadrillion floating point operations per second).
- The HPC at Noida named **Mihir** with capacity of **2.8 petaflops** giving a total capacity of **6.8 petaflops**.

SIGNIFICANCE

- It is India's first **multi-petaflop supercomputer**
- It is the **fourth fastest super-computer in the world** which is dedicated to weather and climate research after Japan, U.S.A. and United Kingdom.
- It will also take India up from the present **365th position to top 30** in the **infrastructural ranking** of **Top 500 HPC facilities** in the world.
- **Sunway TaihuLight** is the World's fastest computer, belonging to China.

►PANEL FOR AI ROADMAP

The government has formed a high-level panel under the chairmanship of **Rajiv Kumar** to lay out a roadmap for **India's research and development on AI and its applications.**

ABOUT AI

- It is branch of computer science dealing with **simulation of intelligent behavior in computers** visa- vis visual perception, speech recognition, decision making and translation between languages.
- It enables computer system to carry out task on their own that otherwise requires human intelligence.

OTHER DEVELOPMENTS

- Recently, **Department of Defence Production constituted** a task force headed by **N Chandrasekaran,** to study use of artificial intelligence in military.
- Commerce and Industry Minister Sets up Task Force chaired **by V. Kamakoti on Artificial Intelligence for Economic Transformation.**

►GLOBAL CYBERSECURITY INDEX (GCI)

India is ranked a high 23rd out of 165 nations in **The Global Cybersecurity Index (GCI) 2017.**

ABOUT GCI

- It was the second Global Cybersecurity Index (GCI), released by the **International Telecommunication Union (ITU),**
- It said that only about half of all countries have a cybersecurity strategy or are in the process of developing one.
- The **top 3 most committed** countries to cybersecurity are **Singapore United States and Malaysia.**
- **India has been listed in the "maturing" category,** which refers to 77 countries that have developed complex commitments to cybersecurity and engage in cybersecurity programmes and initiatives.

ABOUT ITU

- ITU, based in Geneva, Switzerland, is the **leading UN agency** for ICT.
- As the global focal point for governments and the private sector, ITU's role in helping the world communicate spans 3 core sectors: **radio communication, standardization and development.**

►WORLD CONGRESS ON INFORMATION TECHNOLOGY (WCIT) 2018

Recently World Congress on Information Technology (WCIT) 2018 or the **'Olympics of IT'** was held in **Hyderabad** for the **first time** in India.

THEME

Future Enterprises

ABOUT WCIT

- WCIT is a **biennial event** and considered as the biggest event of its kind.
- It aims to **provide single platform** to IT experts, policy and decision makers and Government officials from all over the world together to discuss various challenges and possible solutions to them.
- It was **first held in 1978.**
- The 2014 WITC 2016 edition was held in Brasilia, Brazil.

►MOLECULAR ROBOTS

What	They are tiny robots which can be programmed to move and build molecular cargo using a robotic arm.
Size	Millionth of a millimetre. (10^{18} such robots piled over each other = single grain of salt)
Composition	The robot is made up of just 150 Carbon, hydrogen, oxygen and nitrogen atoms.
Capability	Each robot can manipulate a single molecule.
Working	The robots operate by carrying out chemical reactions in special solutions which can be controlled and programmed by scientists to perform basic tasks.
Complexity	Whilst building and operating such tiny machine is extremely complex, the techniques used by the team are based on simple chemical processes.

BENEFITS

1. Reduce demand for material

2. Accelerate and improve drug discover

3. Reduce power requirements Increase miniaturization

APPLICATIONS

Such robots can be used for **medical purposes**, advanced **manufacturing** and building **molecular factories** and assemble lines.

WAY AHEAD

Such robots represent the epitome of miniaturization of machinery. Molecular robots may soon build molecular and materials on assembly line in molecular factories.

►SHAKTI PROCESSOR PROGRAM

- It is an open source initiative by the **RISE Group** at **IIT Madras.**
- Under the program, 6 microprocessors have been built. They run on Linux Platform.
- The Projects also involves development of interconnects for server and supercomputers based
- The used BlueSpec Verilog language to capture the processor functionality.
- The microprocessors have been fabricated at INTEL's US based plants.
- The microprocessors have been named as **RISECREEK.**
- It can meet the demand of defence and strategic equipment.

PARASHAKTI

It is an advanced microprocessor for supercomputers.

►MINIMAL FAB

- CSIR in collaboration with AIST, Japan is setting up a unique low cost semiconductor device fabrication project.
- It will not require setting up of costly clean room and chip fabrication facility.
- This facility will be creating an avenue for Electronics System Design Manufacturing sector industries to fabricate semiconductor chips meeting the demand of IOT devices in India and abroad.

►NATIONAL SUPERCOMPUTING MISSION

- **Jointly steered by MEITY and Department of Science and Technology (DST).**
- Being implemented by CDAC and IISc.
- Aims to empower our national academic and R&D institutions spread over the country by installing a vast supercomputing grid comprising of 70 high performance computing facilities. These supercomputers will also be networked on the National Supercomputing grid over the National Knowledge Network.
- Cost of Rs 4500 crore over a 7 year period.

OBJECTIVES

- Creation of state of art High Performance Computing facilities and infrastructure to enhance the national capability to enable cutting edge research in various domains in solving grand challenge problems.
- Development of HPC Applications for major Science and Engineering domains.
- Promote R&D in HPC leading to next generation Exa-scale computing readiness.
- Human Resource Development for HPC activities
- **Build approach:** Aims to design and manufacture the sub-systems of HPC system locally in India. CDAC is entrusted with building systems locally in India.
  - **Phase I:** Assembly in India
  - **Phase II:** Manufacturing in India
  - **Phase III:** Design and Manufacturing in India
- **Buy Approach:** IISc is tasked to implement this.
- ATOS (French company) has won tender to supply energy efficient Direct Liquid Cooled **BullSequana** supercomputers in India.
- Under the National Supercomputing Mission, GOI has decided to buy.

APPLICATIONS

- Climate Modelling
- Weather Prediction
- Aerospace Engineering
- Computational Biology
- Molecular Dynamics
- Atomic Energy Simulations
- National Security/Defence Applications
- Seismic analysis
- Disaster simulations and management
- Computational Chemistry
- Computational Material Science and Nanomaterials
- Discoveries beyond Earth (Astrophysics)
- Big Data Analysis
- Finance
- Information repositories/ Government Information Systems

►PARAM SHAVAK

It is an affordable supercomputing solution in a box that aims to provide computational resource (capacity building) with advance technologies to perform high end computations for scientific, engineering and academic programs to address and catalyse the research using

TECHNICAL SPECIFICATIONS

- 2-5 Tera flops peak computing power with 8 TB of storage.
- 64 GB RAM
- Powered with 2 multicore CPUs each with minimum 12 cores.
- 2 numbers of accelerator - cards for deep learning.

FEATURES

- Only HPC solution available as a desktop model
- Equipped with indigenously developed software (ONAMA and CHReMe)
- Operates under normal environmental conditions thus saving a lot of customer investment and recurring expenditure costs (Less cooling costs)
- Equipped with same parallel programming development environment as available with large HPC clusters.
- Provision for access to CDAC National PARAM Supercomputing Facility for more computational needs based on usage policies.
- Low sound level and heat dissipation so as to make the system comfortable to be placed as table top model in working place.
- Affordable licensing policies (one time purchase) for academic use.

►TRINETRA

- It is the next generation indigenous HPC interconnect, being developed by CDAC.
- It will facilitate efficient inter-node communication between compute nodes under National Supercomputing Mission.
- It is being designed for performance, power efficiency and support for large scale systems.

►EXASCALE COMPUTING

- It refers to computing systems capable of at least one exascale FLOPS calculations per second.
- Exascale computing would be considered to be a significant achievement in computer engineering, for it is estimated to be the order of processing power of the human brain at neural level.

►SPINNAKER SUPERCOMPUTER

- It is the **world's largest neuromorphic supercomputer**.
- Designed and built to work in the same way a human brain
- It has been designed and built in the **University of Manchester, UK**.
- SpiNNaker is unique because, unlike traditional computers, it doesn't communicate by sending large amounts of information from point A to B via a standard network. Instead it mimics the massively parallel communication architecture of the brain, sending billions of small amounts of information simultaneously to thousands of different destinations.
- It is funded by Human Brain Project of the EU.

►ONE-NATION ONE CARD - NATIONAL COMMON MOBILITY CARD (NCMC)

- It is an inter-operable transport card that would allow the holders to pay for their bus travel, toll taxes, parking charges, retail shopping and even withdraw money.
- It has been implemented by **Rupay card mechanism.**
- It is supported by Automatic Fare Collection Gate 'Swagat' and an open Loop Automatic Fare Collection system 'Sweekar'.
- NCMC was envisaged as part of the National Urban Transport Policy, 2006 of the Ministry of Housing and Urban Affairs.
- These cards would be issued by all public and private banks the same way credit, debit and prepaid cards are issued.
- Pilot project for NCMC ecosystem was done in Delhi Metro.

►FASTAG

- It is a simple to use, reloadable tag which enables automatic deduction of toll charges and lets the vehicle pass through the toll plaza without stopping for cash transaction.
- FASTag is linked to a prepaid account from which the applicable toll amount is deducted.
- It employs RFID technology and is affixed on the vehicles windscreen after the tag account is active.
- All 4 wheel motors vehicles sold after 1 December 2017 will have FASTags fitted on them by manufacturer of the vehicle or its authorised dealer.

RFID TECHNOLOGY

RFID is an acronym for "radio-frequency identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves. RFID is similar to barcoding in that data from a tag or label are captured by a device that stores the data in a database. RFID, however, has several advantages over systems that use barcode asset tracking software. The most notable is that **RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner.**

►NEAR FIELD COMMUNICATION TECHNOLOGY

- Near-field communication (NFC) is a set of communication protocols that enable two electronic devices, one of which is usually a portable device such as a smartphone, to establish communication by bringing them within 4 cm (1.6 in) of each other
- NFC devices are used in contactless payment systems, similar to those used in credit cards and electronic ticket smartcards and allow mobile payment to replace or supplement these systems.

►PROXIMITY CARD TECHNOLOGY

- A proximity card is a contactless smart card which can be read without inserting it into a reader device, as required by earlier magnetic stripe cards such as credit cards and contact type smart cards.
- The proximity cards are part of the contactless card technologies. Held near an electronic reader for a moment they enable the identification of an encoded number. The

reader usually produces a beep or other sound to indicate the card has been read.

►CALL FOR CODE INITIATIVE

- It is a partnership initiative of US company IBM along with Indian IT companies for developing to build global solutions for disaster management.
- **Indian IT companies participating are:**
  - Persistent Systems, Invest India, Wipro, Capgemini and NASSCOM

►NAVLEKHA

- It is an **initiative of Google** which helps Indian Vernacular news publishers to get their content online. There are close to 1.35 lakh newspapers in India without a digital presence. The projects aims to bring these publishers online by making web hosting smooth and simple. It will allow local publishers who do not have websites to make their offline content fit for online publishing in less than a minute.
- It uses Artifical Intelligence to allow publishers to simply scan documents or PDFs and create instant web pages on the platform.
- Google will help these publishers to receive training and support and a branded page domain for the first three years.

►ASK DISHA (DIGITAL INTERACTION TO SEEK ANYTIME HELP)

It is a Artificial Intelligence powered chatbot launched by **IRCTC**. The chatbot is special computer program designed to simulate conversation with users, especially over the internet.

►BOLO APP BY GOOGLE

- It is app designed for primary grade children. It helps to improve their English & Hindi reading skills by encouraging them to read aloud - just as they would normally do - and giving them instant feedback -even when completely offline. It acts as personal tutor.
- Bolo comes with a fun and helpful reading tutor, 'Diya' which is powered by the same technology that is in Google Assistant.

It helps children by:

- Read all by themselves
- Choose from a large variety of engaging stories in both English & hindi
- Understand English better
- Enjoy as they learn
- Personalised for each child
- Read without distractions (and without data too)

►NATIONAL KNOWLEDGE NETWORK

- Aims to inter-connect all knowledge institutions across the country through high speed data connection network, to encourage sharing of resources and collaborative research.
- NKN with its multi-gigabit capability aims to connect all universities, research institutions, libraries, laboratories, healthcare and agricultural institutions across the country.
- It is being implemented by **National Informatics Centre.**
- NKN connectivity with National Research and Education Networks of Nepal, Bhutan, Sri Lanka and Bangladesh
- 14 links have been upgraded to 10G based on their usage ie TIFR, IIT Roorkee, IIT Delhi, IIT Kharagpur, IIT Guwahati, IIT Chennai, IIT Kanpur, Delhi University, BHU, JNU and Gujarat Data Centre.
- NKN connectivity has also been extended to 500 NIC district centres.
- Virtual Classrooms

►NATIONAL DIGITAL LIBRARY OF INDIA

- It is a project of **MHRD** under the aegis of National Mission on Education through Information and Communication Technology (NMEICT). It is being implemented by **IIT Kharagpur**.
- It is a single window platform that collects and collates metadata from premier learning institutions in India and abroad. It is a digital repository containing textbooks, articles, videos, audiobooks, lectures, simulations, fiction and other kinds of learning media.
- NDL is also available on Mobile App.
- NDLI has also become a member of RightsStatements.org and sits on its Steering Committee to promote proper

dissemination of copyrighted and non-copyrighted digital heritage items.

►NATIONAL VIRTUAL LIBRARY OF INDIA

- It is being implemented under the **National Mission on Libraries under the Ministry of Culture.**
- Being implemented by **IIT Bombay (In collaboration with CDAC and IGNOU)**
- Cost of the project is Rs 72 crore to be completed by 2019.
- Aims to facilitate creation of a comprehensive database on digital resources of India on information about India in open access environment.
- Putting information of the entire Indian cultural heritage in the digital web world.
- Create, collect, encode, and collect various digital artifacts related to Indian culture, in the form of a portal, and to allow relevant information access through web-based search.

SALIENT FEATURES OF NVLI ARE

- Federated searching through multilingual user interfaces
- Virtual learning environment
- E-Governance platform facilitating data analytics
- Multilingual searching and retrieval on ontology/thesaurus based.
- Ensuring preservation of digital content for the future generation.

►WIFI CHOUPAL SCHEME

It is **CSC SPV's ambitious initiative** to boost internet connectivity at the last mile by utilizing BharatNet infrastructure. Initiated in January 2016, it engages Village Level Entrepreneurs (VLEs) as Community Internet Service Providers.

OBJECTIVE

- Seamlessly enhance Internet connectivity for rural citizens by leveraging BharatNet infrastructure.
- Ensure citizens are connected with high speed internet, enabling access to information and online Government-to-Citizen services.
- Support opportunities for livelihood and enhance citizen's participation in governance.

APART FROM WI-FI SERVICES, THE FOLLOWING SERVICES ARE ALSO AVAILABLE THROUGH WI-FI CHOUPAL:

- GPON & OFC Installation and Maintenance
- **DIGI GAON:** CSC proposes to transform villages into Digital Villages. A Digital village will have access to education, healtcare, ICT, finance, clean water and sanitation, and improved livelihoods, including entrepreneurial endeavors and value-addition by villagers themselves.
- **Fiber to the Home (FTTH)**: Uninterrupted high speed internet service is provided after the Village level Entrepreneur installs overhead OFC and other infrastructure.
- **Internet at Home/Business:** Wifi-connectivity is extended to subscribers who want to enjoy connectivity at home/office, for example small enterprises and Government agencies. It is suited for subscribers with higher usage needs and whp are willing to pay more for the services. The services come with a one-time hardware installation cost to be borne by the subscriber. The service can be used to connect 5Ps of a village: Post Office, Police Station, Panchayat Office, Primary/Secondary School, Primary Health Centre.
- **WiFi Village**: a WiFi coverage zone is created to cover all inhabited areas of the village and low cost data plans are used to connect end user devices like smart phones and tablets.
- Optical Fiber Maintenance: VLE provide Optical fiber maintenance. They capture GIS coordinates, carry out restoration work where ever required.
- Through enabling access to affordable Internet connectivity, Wi-Fi Choupal helps bridge the digital divide, thereby spurring economic growth.

TARIFFS

Wi-Fi Choupal offers lowest tariff plans, best suited for subscribers in rural areas. Tariff plans are available in the range of Rs. 10 to Rs. 925. It also has wide ranging schemes and offers to suit the varying needs of wide consumer base in rural areas.

►CRYPTOCURRENCY

- **European Central Bank** defined virtual currency as "a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community.

- Examples of such currencies are Bitcoin, Ripple etc.
- All such currencies take help of Blockchain technology in their operation.

→BLOCK CHAIN TECHNOLOGY

- A blockchain is a database that is shared across a network of computers.
- Once a record has been added to the chain it is very difficult to change.
- To ensure all the copies of the database are the same, the network makes constant checks.
- Blockchains have been used to underpin cyber-currencies like bitcoin, but many other possible uses are also emerging such as in supply chain management, banking services, healthcare, voting etc.

►MALWARE

- **GravityRAT**, a malware allegedly designed by Pakistani hackers, has recently been updated further and equipped with anti-malware evasion capabilities.
- The RAT was first detected by Indian Computer Emergency Response Team, CERT-In, on various computers in 2017. It is designed to infiltrate computers and steal the data of users, and relay the stolen data to Command and Control centres in other countries.
- The 'RAT' in its name stands for Remote Access Trojan, which is a program capable of being controlled remotely and thus difficult to trace.
- GravityRAT is unlike most malware, which are designed to inflict short term damage. It lies hidden in the system that it takes over and keeps penetrating deeper.

►RANSOMWARE

- In 2018, India got attacked by SamSam ransomware, which is different from the traditional ransomware attacks.
- Unlike most ransomwares, SamSam is a thorough encryption tool, rendering not only work data files unusable but any programme that is not essential to the operation of a Windows computer, most of which are not routinely backed up.
- SamSam's attacking method unique as it is manual and as a result, attackers can employ countermeasures (if needed) to evade many security tool.

►CYPAD

- Union Home Minister inaugurated a national cyber forensic lab and Cyber Prevention, Awareness & Detection Centre (CyPAD).
- The National Cyber Forensic Lab (NCFL) is part of the Indian Cyber Crime Coordination Centre (I4C) initiative and CyPAD is the Delhi Police's cybercrime unit.

►I4C INITIATIVE

- To act as a nodal point in the fight against cybercrime.
- Identify the research problems/needs of LEAs and take up R&D activities in developing new technologies and forensic tools in collaboration with academia / research institutes within India and abroad.
- To prevent misuse of cyber space for furthering the cause of extremist and terrorist groups.
- Suggest amendments, if required, in cyber laws to keep pace with fast changing technologies and International cooperation.
- To coordinate all activities related to implementation of Mutual Legal Assistance Treaties (MLAT) with other countries related to cybercrimes in consultation with the concerned nodal authority in **Ministry of Home Affairs.**
- **Components Of The I4C Scheme:**
  - **National Cybercrime Threat Analytics Unit (TAU)**
    - This will be met through a National Cybercrime Threat Analytics Unit (TAU), which shall provide a platform for law enforcement personnel, persons from private sector, academia and research organizations to work collaboratively in order to analyse all pieces of puzzles of cybercrimes.
  - **National Cybercrime Reporting**
    - This unit will work in tandem with already established investigation units at state and central levels as well as experts from different spheres to create expert investigation teams and will have the capability to respond in real time to rapidly changing cybercrime threat.
  - **Platform for Joint Cybercrime Investigation Team**
    - Its objective is to drive intelligence-led, coordinated action against key cybercrime threats and targets.
  - **National Cybercrime Forensic Laboratory (NCFL) Ecosystem**

- Forensic analysis and investigation of cybercrime as a result of new digital technology and techniques.

- National Cybercrime Training Centre (NCTC)
  - National Cybercrime Training Centre (NCTC) will be setup to focus on standardization of course curriculum focused on cybercrimes, impact containment and investigations, imparting practical cybercrime detection, containment and reporting trainings on simulated cyber environments.
- **Cybercrime Ecosystem Management Unit**
  - Develop ecosystems that bring together academia, industry and government to operate, investigate a cybercrime basis established standard operating procedures, contain the impact of cybercrimes and respond to cybercrimes.
- **National Cyber Research and Innovation Centre**
  - Track emerging technological developments, proactively predict potential vulnerabilities, which can be exploited by cybercriminals.
  - To leverage the strength and expertise of all stakeholders, be it in academia, private sector or inter-governmental organizations.

►CYBER SURAKSHIT BHARAT PROGRAMME

- **Ministry of Electronics and Information Technology (MeitY)**, announced the Cyber Surakshit Bharat initiative in association with National e-Governance Division (NeGD) and industry partners.
- Conceptualized with the mission to spread awareness about cybercrime and building capacity for safety measures for Chief Information Security Officers (CISOs) and frontline IT staff across all government departments, Cyber Surakshit Bharat will be operated on the three principles of **Awareness, Education and Enablement.**
- Cyber Surakshit Bharat **is the first public-private partnership of its kind** and will leverage the expertise of the IT industry in cybersecurity.

SECTION 3

BIOTECHNOLOGY

►DNA

- Deoxyribonucleic acid (DNA) is the chemical compound that contains the instructions needed to develop and direct the activities of nearly all living organisms.
- Each DNA strand is made of four chemical units, called nucleotide bases: **adenine (A), thymine (T), guanine (G) and cytosine (C).** Bases on opposite strands pair specifically for e.g. an A always pairs with a T; a C always pairs with a G.
- These nucleotide bases get attached with sugar and phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix.
- DNA contains the information needed to build the entire human body. The order, or sequence, of these bases determines the information available for building and maintaining an organism.
- DNA can replicate itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.

►MITOCHONDRIA

- These are **double-membrane cellular organelle**, which are crucial for generating energy. Mitochondria, the powerhouse of the cell, have its own set of generic material called mitochondrial DNA or mtDNA.
- It is inherited maternally. But what really makes them unique is that they divide independently of the cell.
- The mitochondrial DNA controls its functions much like the rest of the DNA (what is known as the nuclear DNA after the fact that it is lodged in the nucleus of the cell) of any living form, and decides what the organism would look and act like.
- It makes up **less than 0.0005% of our entire DNA**, but since the child receives it only from the mother, any aberrations in her mitochondrial DNA that may cause diseases is passed on completely to the child.

►GENE

A gene refers to the unit of DNA that carries the instructions for making a specific protein. The Human Genome Project has estimated that humans have between 20,000 and 25,000 genes. Every person has two copies of each gene, one inherited from each parent.

►CHROMOSOMES

- Chromosomes are bundles of **tightly coiled DNA located within the nucleus of almost every cell** in our body. Humans have 23 pairs of chromosomes i.e. 46 chromosomes.
- In plant and animal cells, DNA is tightly packaged into thread-like structures called chromosomes. In contrast, in bacteria DNA floats freely around the cell. 1 set comes from the mother and one set comes from the father.
- Of these 23 pairs, one pair is of sex chromosomes which determines the sex of the offspring, X and Y chromosomes. The other 22 pairs are autosomes (non-sex chromosomes), are same for both males and females.
- Genes on X and Y chromosomes are not the same. X chromosome has more genes Y and is larger too.

►ABNORMAL INHERITANCE OF SEX CHROMOSOMES

GENOTYPE	GENDER	SYNDROME	PHYSICAL TRAIT
XX	FEMALE	NONE	Normal
XY	MALE	NONE	Normal
XXY	MALE	KLINEFELTER'S	sterility, small testicles, breast enlargement
XO	FEMALE	TURNER'S	Sex organs don't mature at adolescence, sterility, short stature
XXX	FEMALE	XXX	Learning disabilities, limited fertility, impacting stature.

►GENOME

A genome is an organism's complete set of DNA, including all of its genes. Each genome contains all of the information needed to build and maintain that organism. In humans, a copy of the entire genome—more than 3 billion DNA base pairs—is contained in all cells that have a nucleus. All living things have a unique genome.

►THE HUMAN GENOME PROJECT

- It is an international collaboration that successfully determined, stored, and rendered publicly available the sequences of almost all the genetic content of the human organism. It operated from 1990 to 2003 and provided researchers with basic information about the sequences of the three billion chemical base pairs ([A], [T], [G], and [C]) that make up human genomic DNA.
- It is intended to improve the technologies needed to interpret and analyze genomic sequences. It focused to address the ethical, legal, and social implications that might arise from defining the entire human genomic sequence.
- India did not participate in **HGP-read**. The original HGP was a "read" in that it used chemicals and instruments to decipher the genome for the first time.
- Since 2016 another project, called the **Human Genome Project–write** (HGP-write), is underway to synthesise a human genome from scratch.
- The potential benefits of HGP-write to India include providing new solutions to diseases like malaria, dengue and chikungunya. The tools, techniques and technologies that are going to be developed through HGP-write will be universally applicable to all organisms, especially at an earlier stage for organisms with smaller genomes (for example, viruses), towards building individual genes and genomes efficiently and in an inexpensive manner.

►PERSONAL GENOMICS

- An area of genomics that focusses on the sequencing of an individual's genome. It allows giving personalized genetic information. The genome can be compared with the standardized results and consequently disease and abnormalities can be predicted.
- The Personal Genome Project was launched in 2005. It provides open access by publishing all the data freely.

►SEQUENCING

- Sequencing is the process determining the exact order of the bases in a strand of DNA. Because bases exist as pairs, and the identity of one of the bases in the pair determines the other member of the pair, researchers do not have to report both bases of the pair.
- Sequencing is performed by synthesis. DNA polymerase (the enzyme in cells that synthesizes DNA) is used to generate a new strand of DNA from a strand of interest.
- In the process, each base is read not just once, but several times in overlapping segments to ensure accuracy. Researchers use DNA sequencing to search for genetic variations and/or mutations that may play a role in the development or progression of a disease. The disease-causing change may be as small as the substitution, deletion, or addition of a single base pair or as large as a deletion of thousands of bases.

► DIFFERENCE BETWEEN

DEOXYRIBONUCLEIC ACID (DNA)	RIBONUCLEIC ACID (RNA)
A nucleic acid that contains the genetic instructions used in the development and functioning of all modern living organisms.	The information found in DNA determines which traits are to be created while the various forms of RNA do the work.
The blueprint of biological guidelines that a living organism must follow to exist and remain functional.	Helps carry out DNA blueprint guidelines. Transfers genetic code needed for the creation of proteins from the nucleus to the ribosome.
Double-stranded	Single-stranded
Adenine links to thymine (A-T) and cytosine links to	Adenine links to uracil (A-U) and cytosine links to

guanine (C-G).	guanine (C-G).
Found in the nucleus of a cell and in mitochondria	This molecule is found in a cell's nucleus, its cytoplasm, and its ribosome.
DNA is self-replicating	RNA is synthesized from DNA when needed.

►BETA-CAROTENE

- Beta-carotene is **a pigment found in plants** that gives them their color. The name beta-carotene is derived carrot. Beta-carotene is considered an **antioxidant and is also a precursor to vitamin A**.
- This compound helps maintain healthy skin and also plays a vital role in eye health. Carotene can lower their risk for coronary artery disease, stroke, macular degeneration, and other age-related diseases. Beta-carotene is one of the carotenoid.

►CAROTENOIDS

- **Carotenoids are a class** of more than 750 **naturally occurring pigments** synthesized by plants, algae, and photosynthetic bacteria.
- They are naturally occurring fat-soluble pigments. These richly colored molecules are the sources of the yellow, orange, and red colors of many plants.
- Animals are unable to synthesize carotenoids, depending completely in plants. Carotenoids act as antioxidants in the human body. They have strong cancer-fighting properties.

►ANTIOXIDANTS

Antioxidants are molecules which can safely interact with free radicals (single oxygen atoms that can damage cells) and terminate the chain reaction before vital molecules are damaged. Vitamin antioxidants are **vitamin E, beta-carotene**, and **vitamin C**. The body cannot manufacture these micronutrients.

►CRISPR-CAS9

- **Crisp** - Clustered Regularly Interspaced Short Palindromic Repeats and Cas associated genes. CRISPR-Cas9 is a unique technology that enables geneticists and medical researchers to edit parts of the genome by removing, adding or altering sections of the DNA sequence. It is currently the simplest, most versatile and precise method of genetic manipulation.
- The **CRISPR-Cas9 system** consists of two key molecules that introduce a change (mutation) into the DNA. These are:

1. An enzyme called **Cas9.** This acts as a pair of 'molecular scissors' that can cut the two strands of DNA at a specific location in the genome so that bits of DNA can then be added or removed.
2. A piece of RNA called guide RNA (gRNA). This consists of a small piece of pre-designed RNA sequence. It binds to DNA and the pre-designed sequence 'guides' Cas9 to the right part of the genome. This makes sure that the Cas9 enzyme cuts at the right point in the genome.

►ASSISTED REPRODUCTIVE TECHNOLOGY (ART)

- The technology used to achieve pregnancy in procedures such as fertility medication, in vitro fertilization and surrogacy.
- It is reproductive technology used primarily for infertility treatments, and is also known as fertility treatment.
- It mainly belongs to the field of reproductive endocrinology and infertility, and may also include intracytoplasmic sperm injection (ICSI) and cryopreservation.
- **In Vitro Fertilization (IVF)** is an assisted reproductive technology (ART). IVF is the process of fertilization by extracting eggs, retrieving a sperm sample, and then manually combining an egg and sperm in a laboratory dish. The embryo(s) is then transferred to the uterus.

►STEM CELLS

- Stem cells are a class of undifferentiated cells that can differentiate into specialized cell types. Commonly, stem cells come from two main sources: Embryos formed

during the blastocyst phase of embryological development (embryonic stem cells) and Adult tissue (adult stem cells).

- Both types are generally characterized by their potency (potential to differentiate into different cell types such as skin, muscle, bone, etc.).

►EMBRYONIC STEM CELLS

- Embryonic stem cells are derived from a embryo that is in the earlier phases of development. Reproduction begins when a male's sperm fertilizes a female's ovum (egg) to form a single cell called a zygote.
- The single zygote cell then begins a series of divisions, forming 2, 4, 8, 16 cells, etc. After four to six days - before implantation in the uterus - this mass of cells is called a blastocyst.
- The blastocyst consists of an inner cell mass (embryoblast) and an outer cell mass (trophoblast).

►ADULT OR SOMATIC STEM CELLS

- Adult or somatic stem cells exist throughout the body after embryonic development and are found inside of different types of tissue. These stem cells have been found in tissues such as the brain, bone marrow, blood, blood vessels, skeletal muscles, skin, and the liver.
- They remain in a quiescent or non-dividing state for years until activated by disease or tissue injury.
- Adult stem cells can divide or self-renew indefinitely, enabling them to generate a range of cell types from the originating organ or even regenerate the entire original organ. Adult stem cells are limited in their ability to differentiate based on their tissue of origin.
- The outer cell mass becomes part of the placenta, and the inner cell mass is the group of cells that will differentiate to become all the structures of an adult organism.

►POTENCY OF STEM CELLS

Stem cells are categorized by their potential to differentiate into other types of cells. Embryonic stem cells are the most potent since they must become every type of cell in the body. The classification includes:

1. **Totipotent** - the ability to differentiate into all possible cell types. Examples are the zygote formed at egg fertilization and the first few cells that result from the division of the zygote.
2. **Pluripotent** - the ability to differentiate into almost all cell types. Examples include embryonic stem cells and cells that are derived from the mesoderm, endoderm, and ectoderm germ layers that are formed in the beginning stages of embryonic stem cell differentiation.
3. **Multipotent** - the ability to differentiate into a closely related family of cells. Examples include adult stem cells that can become red and white blood cells or platelets.
4. **Oligopotent** - the ability to differentiate into a few cells. Examples include (adult) lymphoid stem cells.
5. **Unipotent** - the ability to only produce cells of their own type, but have the property of self-renewal required to be labelled a stem cell. Examples include adult muscle stem cells.

Embryonic stem cells are considered pluripotent instead of totipotent because they do not have the ability to become part of the extra-embryonic membranes or the placenta.

►VITAMINS

Vitamins are chemical compounds that are needed by the human body to function properly. While Vitamin A, D, E and K are Fat-soluble, others are Water-soluble. Their intake is vital for the human body. Their Excess or deficiency may lead to diseases.

VITAMINS	SOURCES	ESSENTIAL FOR	DEFICIENCY DISEASES
A	Oil, fish, liver, milk, butter and carrot	Eye and lungs	Night blindness
D	Animal fat, milk ghee, butter	Bones and teeth formation	Rickets
E	Vegetables, milk, egg, yolk	Sex glands	Sterility
K	Liver, spinach, cauliflower	Blood clotting	Haemorrhage

B complex	Cereals, Milk, egg, meat	Nervous system, skin, blood and tongue	Beri-Beri, slow growth, Inflammation of tongue
C	Lemon , tomatoes, oranges , grapes	Gums and Wound	Scurvy

►BIO INTERNATIONAL CONVENTION

- The first BIO International Convention was held in 1993.
- It is hosted by Biotechnology Innovation Organization (BIO).
- BIO represents biotechnology companies, academic institutions, state biotechnology centres and related organizations across the United States and in more than 30 other nations.
- It is largest global event for the biotechnology industry offering key networking and partnering opportunities, and provides insights and inspiration on the major trends affecting the industry.
- It features keynotes and sessions from key policymakers, scientists, CEOs, and celebrities. It also features the BIO Business Forum (One-on-One Partnering), sessions covering biotech trends, policy issues and technological innovations, and the world's largest biotechnology exhibition - the BIO Exhibition.
- BIO works throughout the year to create a policy environment that enables the industry to continue to fulfill its vision of bettering the world through biotechnology innovation.
- BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products

► BIOTECHNOLOGY INDUSTRY RESEARCH ASSISTANCE COUNCIL (BIRAC)

- BIRAC is a not-for-profit Public Sector Enterprise, set up by Department of Biotechnology (DBT), Government of India as an Interface Agency to strengthen and empower the emerging Biotech enterprise to undertake strategic research and innovation, addressing nationally relevant product development needs.
- BIRAC implements its mandate through a wide range of impact initiatives, be it providing access to risk capital through targeted funding, technology transfer, IP management and handholding schemes that help bring innovation excellence to the biotech firms and make them globally competitive.
- BIRAC has initiated several schemes, networks and platforms that help to bridge the existing gaps in the industry-academia Innovation research and facilitate novel, high quality affordable products development through cutting edge technologies.
- BIRAC has initiated partnerships with several national and global partners to collaborate and deliver the salient features of its mandate.

►NATIONAL BIOTECHNOLOGY DEVELOPMENT STRATEGY (NBDS) 2015-2020

- The NBDS aims to attract significant amount of investment under the Make in India programme for making the new biotech products.
- The project will also focus on building a strong infrastructure for research, development and commercialization of the bio-tech products.
- The project will also help India's human resources progress scientifically and technologically.
- The primary objective of the NBDS is to build a skilled workforce and improve research facilities in basic, disciplinary and inter-disciplinary streams of scientific studies.
- Under the NBDS, India will start making its own supply of vaccines and antibiotics, which will benefit the country's economy significantly.
- The NBDS training includes dual degree programmes that cover both, the aspects of core scientific subjects and their economic applicability.
- The new project will also focus on attracting global and national alliances and exchange of ideas and knowledge among various international institutes.

CURRENT affairs& relatedconcepts

►mRNA

MIT researchers have designed **inhalable form of mRNA** that could be used to treat lung diseases. This, mRNA, can be administered **directly into the lungs through aerosols**.

ABOUT THE PROCESS

- RNA–in this role–is the **"DNA photocopy" of the cell**. When the cell needs to produce a certain protein, it activates the protein's gene–the portion of DNA that codes for that protein–and produces multiple copies of that piece of DNA in the form of messenger RNA, or mRNA.
- The multiple copies of mRNA are then used to translate the genetic code into protein through the action of the cell's protein manufacturing machinery, the ribosomes.
- Thus, RNA expands the quantity of a given protein that can be made at one time from one given gene, and it provides an important control point for regulating when and how much protein gets made.

►DNA FINGER PRINTING

In a first for India, every one of **Kerala's captive elephants** now has a **unique DNA-based genetic record**.

DNA FINGERPRINTING

- Unlike the microchip-based ID used, DNA fingerprinting provides a unique identity and is more fool-proof. **This could help solve wildlife crime cases involving poaching and illegal trade**.
- The method is a forensic technique that makes it possible to identify individuals people or animals based on unique DNA characteristics called micro-satellites (DNA portions that occur repeatedly), much like fingerprints.

HOW IT WORKS?

- The DNA is isolated from the available sample.
- Each type of sample has a specific protocol for isolation.
- The DNA fragments are then multiplied using a reaction called **Polymerase Chain Reaction (PCR).**
- This amplified DNA sample then undergoes a technique called **gel electrophoresis**, which splits it into different visible bands. The band pattern formed by an individual's DNA is unique.
- The bands of two or more DNA samples can then be compared using software.

►BISPHENOL A (BPA)

Researchers enhanced **micron-sized titanium dioxide** particles to trap and destroy bisphenol A (BPA).

DESTROYING BPA

- Newly created **tiny spheres of Titanium dioxide** provide plenty of surface area to anchor cyclodextrin — a benign sugar-based molecule which has a two-faced structure, with a **hydrophobic (water-avoiding) cavity and a hydrophilic (water-attracting) outer surface.**
- BPA being hydrophobic is attracted to the cavity where it is degraded into harmless chemicals.

ABOUT BPA

- Bisphenol A (BPA) is a chemical produced in large quantities for use primarily in the **production of polycarbonate plastics and epoxy resins.**
- It **can leach into food** from the protective internal epoxy resin coatings of canned foods and from consumer.
- It is an **endocrine system disruptor** and it can interfere with the production, and function of natural hormones.
- **It can also be found in breast milk**. Its Prolonged exposure is suspected of affecting the health of children.

►REPURPOSE USED COOKING OIL (RUCO)

FSSAI launched Repurpose Used Cooking Oil (RUCO) initiative.

BACKGROUND

- Earlier, food safety regulator notified standards for used cooking oil.
- **National Policy on Biofuels 2018** encourages setting up of supply chain mechanisms for **biodiesel production from Used Cooking Oil.**
- FSSAI is also looking at introducing regulations to ensure that companies that use large quantities of cooking oil maintain a **stock register** and hand it over to registered collecting agencies to convert it into biofuel.

ABOUT RUCO INITIATIVE

- It has been launched with an aim to enable collection and **conversion of used cooking oil to bio-diesel.**
- Under this around 64 companies at 101 locations have been identified to enable collection of used cooking oil.

ABOUT TOTAL POLAR COMPOUNDS:

- During frying, several properties of oil are altered, **Total Polar Compounds (TPC)** are formed on repeated frying. The toxicity of these compounds is associated with several diseases such as hypertension, atherosclerosis, Alzheimer's disease, liver diseases.
- Biodiesel Association of India is partner of FSSAI for this project

SIGNIFICANCE

- India has the potential to recover 220 crore litres of used cooking oil for the production of biodiesel by 2022 if co-ordinated actions are taken.
- It is **environment friendly** because as of now cooking oil is either not discarded or disposed in an environmentally hazardous manner, thereby, choking drains and sewerage systems.
- It would **promote public health** as the initiative would prevent diversion of UCO to smaller restaurants, dhaabas and street-vendors.

►BACTERIA WOLBACHIA

Recently experiments have demonstrated the **positive correlation** between **presence of Wolbachia bacteria** in mosquitoes and **reduced spread of diseases** such as Malaria and Dengue.

ABOUT BACTERIA

- Wolbachia is a tiny bacterium that is present in up to **60% of all species of insects, including several mosquito species.**
- But it is usually not **present in the Aedes aegypti mosquito**, the primary species responsible for transmitting dengue, chikungunya and Zika.
- When present in the mosquito, the **viruses cannot replicate** which help to reduce the spread of disease.
- The World Mosquito Program **introduces Wolbachia into Aedes aegypti mosquitoes.**
- Once Wolbachia carrying mosquitoes are released, they breed with wild mosquitoes and over time, the majority of mosquitoes carry Wolbachia.
- This new method provides **bio-control approach** to handle these diseases.

►COLOURED X-RAY ON HUMAN

Scientists have performed the **first-ever 3-D, colour X-ray on a human.**

ABOUT COLOURED X-RAY

- The device is **based on the traditional** black-and-white X-ray and **incorporates particle-tracking technology** developed for CERN's Large Hadron Collider.
- When X-rays travel through your body, they're absorbed by denser materials (bones) and pass right through softer ones (muscles and other tissues). The places where the X-rays couldn't pass through appear solid white.
- Instead of recording the X-rays as either passing right through the body or getting absorbed by the bone, this scanner is better as it **records the precise energy levels** of the X-rays as they hit each particle in your body.
- It then **translates those measurements into different colours** representing your bones, muscles, and other tissues.
- Thus, it clearly **shows the difference between bone, muscle and cartilage** and also the position and size of cancerous tumours as well.

►'P NULL' PHENOTYPE

A team of doctors from Kasturba Medical College (KMC) has identified a **rare blood group called "pp" or "P null" phenotype** for the first time in India.

SIGNIFICANCE

- ABO and Rh are the common types of blood group systems.
- However, there are more than 200 minor blood group antigens known besides A, B and Rh.

- A blood type is considered rare if fewer than one in 1,000 people have it.
- The 'P null' blood group has anti-PP1Pk antibody that has the potential to cause acute intravascular haemolytic reaction to incompatible blood transfusion.
- This antibody is also known to **cause recurrent abortions** in women.
- Finding compatible unit for such case is a near impossible task without a well-established rare donor panel, hence **Rare donor registry** should be maintained for managing such cases.

►DRY SORBENT INJECTION (DSI)

- CPCB has asked coal-fired thermal plants to comply with the environmental norms by December 31, 2019.
- NTPC's power plant in Dadri is the first in the India to opt for DSI System **for controlling sulphur dioxide (SO2) emissions.**

ABOUT DSI

- Dry Sorbent Injection (DSI) system is a pollution control system for the reduction of SOx (SO2, SO3), HCl and **heavy metals like mercury**.
- It is a dry process in which a sorbent (a material used to absorb or adsorb liquids or gases) is injected into the coal fired boiler where it interacts with various pollutants like SOx, HCl.
- The **resultant dry waste is removed via either an electrostatic precipitator** (ESP) or a fabric filter baghouse.

ADVANTAGE

It offers various advantages in comparison to traditional acid gas scrubber technology such as: **lower capital cost**, wide range of **favourable operation conditions,** and much lesser time for completing installation and commissioning

►ARTIFICIAL LEAF

Indian Institute of Sciences' researchers has developed an artificial leaf recently.

ABOUT ARTIFICIAL LEAF

- It will help in **reducing carbon footprint** as it absorbs carbon dioxide in the atmosphere to generate fuel and oxygen in the process, simulating the process of photosynthesis.
- While most plants **convert less than one per cent o**f the available solar energy into chemical energy, the leaf can **convert about 20 per cent of the incident solar energy into chemical energy.**
- **Also,** it is **100 times more efficient than a natural leaf** in absorbing carbon dioxide during the process.
- It is composed of **completely biocompatible, earth abundant, semiconductor nano crystals** called **Quantum dots** which act as catalyst to convert absorbed **CO2 into bicarbonate and then 'formate'** (derivative of formic acid) that can be used as **bio fuel.**

→QUANTUM DOT

- It is **a semiconductor nano crystal** which **is made of specific materials**.
- It has a discrete quantized energy spectrum.
- It contains a small finite number of **conduction band electrons, valence band holes, or excitons**.
- They are typically between **10 and 50 nm in size**
- They glow a particular color after being illuminated by light.
- The color they glow depends on the size of the nanoparticle. The smaller the nanoparticle, the higher the energy difference between valence band and conduction band, which results in a deeper blue color.
- For a larger nanoparticle, the energy difference is lower, which shifts the glow toward red.
- It has many **applications** in several areas such as **solar cells, transistors, LEDs, medical imaging and quantum computing.**

►BIO INK

Recently, a new printing material called **flink (functional living ink)**, has been developed by scientists using bacterias.

ABOUT BIO INK

- Bio ink consists of a **hydrogel biomaterial.**
- It temporarily **mimics the natural extracellular matrix environment** of mammalian cells, giving them time to produce their own milieu.
- Bio inks are ideal for 3D bioprinting, thus provide a **3D environment for culturing cells.**
- **Application**: It can be used for **printing complex tissues** using the patient's own stem cells for surgical bone or cartilage implants, which could be used in **knee and hip surgeries.**

SECTION 4

HEALTH

►MALARIA

- Malaria is caused by Plasmodium parasites. The parasites are spread to people through the bites of infected female Anopheles mosquitoes.
- There are 5 parasite species that cause malaria in humans, and 2 of these species P. falciparum and P. vivax pose the greatest threat.
- The mosquitoes **lay their eggs in water**, which hatch into larvae, eventually emerging as adult mosquitoes. The **female mosquitoes seek human blood to nurture their eggs.**
- **Vulnerable**: Population groups like → infants, children under 5 years of age, pregnant women and patients with HIV/AIDS, as well as non-immune migrants, mobile populations and travellers.
- Malaria elimination is **defined as the interruption of local transmission** of malaria **in a defined geographical area** because of deliberate efforts.
- Malaria eradication is defined as the **permanent reduction to zero of the worldwide incidence** of malaria infection caused by human malaria parasites because of deliberate activities.
- The **most common antimalarial drugs include**: Chloroquine (Aralen), Quinine sulfate (Qualaquin), Hydroxychloroquine (Plaquenil), Mefloquine, Combination of atovaquone and proguanil (Malarone).
- The government launched a **national strategic plan** for elimination of malaria and pledged to eradicate the vector-borne disease by 2027. The strategic plan gives year-wise elimination targets in various parts of the country depending upon the endemicity of malaria in the next five years.
- The plan has four components based on WHO recommendations:
  - Diagnosis and case management;
  - Surveillance and epidemic response;
  - Prevention using integrated vector management;
  - Cross-cutting interventions, which include advocacy, communication, research and development.

►DENGUE

- Dengue is endemic throughout the tropics and subtropics.
- Dengue virus is transmitted by female mosquitoes mainly of the species **Aedes aegypti** and, to a lesser extent, **Ae. albopictus.**
- This mosquito also transmits chikungunya, yellow fever and Zika infection.
- Symptoms typically begin three to fourteen days after infection and may include high fever, headache, vomiting, muscle and joint pains, and a characteristic skin rash.
- In a small proportion of cases, the disease develops into the life-threatening dengue hemorrhagic fever, resulting in bleeding, low levels of blood platelets and blood plasma leakage.

►ACUTE ENCEPHALITIS SYNDROME (AES)

- Rheumatic heart disease is a sequela of **Acute Rheumatic Fever (ARF)**, which is usually a **disease of poverty associated with overcrowding**, **poor sanitation** and other **social determinants of poor health**.
- Rheumatic heart disease (RHD) is **damage to one or more heart valves**.

CAUSES

- It is commonly caused by **recurrence of ARF**, where the heart **has become inflamed**. The heart valves **can remain stretched and/or scarred**, and normal blood flow through damaged valves is interrupted.
- **Impact on blood flow**: Consequently, blood may flow backward through **stretched valves that do not close properly**, or may be **blocked due to scarred valves not opening properly**. When the heart is damaged in this way, the heart valves are unable to function adequately, and heart surgery may be required.

EFFECTS

If untreated, RHD causes heart failure and those affected are at risk of stroke. These conditions cause progressive disability, reduce quality of life and can cause premature death in young adults.

- Most people with RHD **have a heart murmur** which can be heard through a stethoscope.
- Symptoms of moderate to severe RHD can **include chest pain, breathlessness** with physical activity or when lying down, weakness and tiredness, and swelling of the legs and face.

►ROTAVIRUS

- Rotavirus disease is more common in **infants** and young **children**. However, older children and adults also can get sick from rotavirus.
- Children who get infected may have severe watery diarrhea, often with vomiting, fever, and abdominal pain.
- The virus spreads by the **fecal-oral route**. This means the virus is shed by an infected person and then enters a susceptible person's mouth to cause infection.
- **Rotasil** is a vaccine developed against Rotavirus.
- The Rotasil has been developed and manufactured by the Serum Institute of India situated in Pune.

►TRACHOMA

- Trachoma is an **eye infection** caused by the bacterium **Chlamydia trachomatis.**
- It affects the **conjunctiva** under the eyelids.
- Repeated infections cause scarring leading to in-turning of the eyelashes and eyelids.
- This further causes damage to the cornea and leads to irreversible blindness.
- The infection **spreads through personal contact** and flies that have contact with the discharge from the eye.
- Symptoms begin with **mild itching** and **irritation** of the eyes and eyelids. They may progress to blurred vision and eye pain.
- Antibiotics treat early-stage trachoma. Surgery is required in later stages. Access to clean water and improved sanitation are key to prevention.

►LEPROSY

- Leprosy is an infection caused by slow-growing bacteria called Mycobacterium leprae.
- Leprosy is also known as **Hansen's disease**, after the scientist who discovered M. leprae in 1873.
- It can affect the nerves, skin, eyes, and lining of the nose (nasal mucosa).
- Leprosy primarily affects the skin and the nerves outside the brain and spinal cord, called the peripheral nerves. It may also strike the eyes and the thin tissue lining the inside of the nose.
- The main symptom of leprosy is disfiguring skin sores, lumps, or bumps that do not go away after several weeks or months. The skin sores are pale-colored.
- Leprosy is actually not that contagious.
- One can catch it only if one come into close and repeated contact with nose and mouth droplets from someone with untreated leprosy.
- Children are more likely to get leprosy than adults.
- Dapsone, which is bacteriostatic or weakly bactericidal against M. leprae, was the mainstay treatment for leprosy for many years until widespread resistant strains appeared.
- Combination therapy has become essential to slow or prevent the development of resistance. So Rifampicin is now combined with dapsone to treat paucibacillary leprosy.
- Rifampicin and clofazimine are now combined with dapsone to treat multibacillary leprosy.

►BIRD FLU (AVIAN INFLUENZA) TYPES H5N1 & H5N8

- Influenza viruses are grouped into **three types, A, B, and C**.
- Among these only **type A is known to infect animals** while **Type B & C infect humans causing mild disease.**
- Avian Influenza(AI), caused by Influenza virus type A, is a highly contagious **viral** disease that affects both domestic and wild birds.
- Influenza A viruses are further classified into subtypes based on two surface proteins. For instance, a virus that has **HA 5 protein and NA 8 protein is designated as subtype H5N8.**
- In birds, AI viruses are shed in the **faeces and respiratory secretions**.
- They can all be spread **through direct contact with secretions** from infected birds, especially through faeces or through contaminated feed and water.
- The **first line of defence** against avian influenza **is the early detection** of disease linked to a high level of awareness among animal owners.
- Avian influenza is a **notifiable** disease listed by the OIE, so all Member Countries report all highly pathogenic avian influenza viruses.

- As the virus is stable in the environment and highly transmissible in nature, **rigorous biosecurity measures and hygiene are needed** in protecting against the disease.
- Some of the measures include:
  - **Surveillance** and tracing of potentially infected or exposed poultry;
  - **Strict quarantine** and controls on movement of poultry and any potentially contaminated vehicles and personnel;
  - **Thorough cleaning and decontamination** of infected premises;

►H1N1

- H1N1 virus or swine flu is a **respiratory disorder**.
- According to WHO, the **virus is a strain of influenza**. It is commonly known as swine flu because it was detected in patients who were directly in contact with pig. It originated from **animal influenza viruses**.
- It was detected for the first time in **North America in 2009,** after which it rapidly spread all around the world.
- The H1N1 virus spreads just like other seasonal influenza viruses. It spreads from **exposure to an infected person**.
- When an infected person coughs or sneezes, he/she leaves behind infected droplets. Exposure to these infected droplets can contaminate hands and surfaces.
- The symptoms of H1N1 are **similar to a seasonal flu.**
- The symptoms include cough, fever, sore throat, runny nose, headache and body ache. In extreme cases, the patient also feels chills and fatigue.
- It can develop into serious problems **such as pneumonia, lung infection and other breathing problems.**
- High risk groups are given hereunder:
  - Children under 5 years old.
  - People 65 or older
  - Children and teens (under age 18) who are getting long-term aspirin therapy and who might be at risk for Reye's syndrome after being infected with swine flu. **Reye's syndrome** is a life-threatening illness linked to aspirin use in children.
  - Pregnant women
  - Adults and children with chronic lung, heart, liver, blood, nervous system, neuromuscular, or metabolic problems
  - Adults and children who have weakened immune systems (including those who take medications to suppress their immune systems or who have HIV)
  - People in nursing homes and other long-term care facilities.
- Flu vaccine which are used to protect against seasonal flu disorders also protects against H1N1 virus strain. **Oseltamivir (Tamiflu), Peramivir (Rapivab),** and **Zanamivir (Relenza)** are the common anti-viral drugs used in treating H1N1.
- Antibiotics won't do anything. That's because flu is caused by a virus, not bacteria.
- A sick patient should also take plenty of liquids intake and take lot of rest.

►DEMENTIA

- Dementia describes a set of symptoms that may **include memory loss** and **difficulties with thinking**, **problem-solving** or **language.**
- These changes **are often small to start with**, but for someone with dementia they have become severe enough to affect daily life.
- A person with dementia may also experience changes in their mood or behaviour.
- It is caused when the brain is damaged by diseases, such as Alzheimer's disease or a series of strokes.
- **Alzheimer's** is a type of dementia that causes problems with memory, thinking and behavior. Alzheimer's disease accounts for 60 to 80 percent of cases.
- **Factors that increase risk of Dementia are**: Mid-life hearing loss; Smoking; High Blood pressure; Physical inactivity; Obesity; Depression; Social Isolation; Type 2 Diabetes; Failing to complete secondary education.
- Basic remedy starts early in life with **better education during childhood**. If people stayed in school until the age of 15, the benefits of education and socialisation would help reduce the cases of dementia.
- Overall, life style changes incorporated in one's life reduces the occurrence of dementia. This can be done by eliminating and reducing the risk factors given above.
- Strengthening of Basic Education, Health nutrition programs can help in the development and increase of dementia in future.

- Hence comes, the importance of **Sarva Siksha Abhiyaan**, **Mid-Day Meal scheme**, **Anti-Tobacco campaign**, **Sports** etc.

►HIV

- It stands for Human Immunodeficiency Virus. HIV if left untreated, can lead to the disease AIDS (Acquired Immuno Deficiency Syndrome). Unlike some other viruses, the human body can't get rid of HIV completely. So once you have HIV, you have it for life.
- HIV attacks the body's immune system, specifically the CD4 cells (T cells), which help the immune system fight off infections. If left untreated, HIV reduces the number of CD4 cells (T cells) in the body, making the person more likely to get infections or infection-related cancers. Over time, HIV can destroy so many of these cells that the body can't fight off infections and disease. These opportunistic infections or cancers take advantage of a very weak immune system and signal that the person has AIDS, the last state of HIV infection.
- No effective cure for HIV currently exists, but with proper treatment and medical care, HIV can be controlled. The medicine used to treat HIV is called antiretroviral therapy or ART. If taken the right way, every day, this medicine can dramatically prolong the lives of many people with HIV, keep them healthy, and greatly lower their chance of transmitting the virus to others.
- Four high-prevalence states of Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu account for about 55% of the total cases in the country.

►NACO

- The National AIDS Control Organisation (NACO) was established in **1992** as a division of India's Ministry of Health and Family Welfare.
- It provides leadership to HIV/AIDS control programme in India.
- NACO spearheads HIV/AIDS control programme through Anti-retroviral therapy (ART).
- Anti-retroviral therapy (ART) effectively suppresses replication, if taken at the right time. Successful viral suppression restores the immune system and halts onset and progression of disease as well as reduces chances of getting opportunistic infections.

►NICED

- The vision of NICED, is to perform research and develop strategies for treatment, prevention and control of enteric infections (like typhoid, cholera) and HIV/AIDS threatening the Nation's health.
- Collaborate with other national and international scientists who are working for the same vision.
- NICED is affiliated to Indian Council of Medical Research (ICMR).
- It commenced 'dengue mapping' in West Bengal.

►YAWS

- Yaws is a **chronic bacterial disease** that affects skin, bone and cartilage. It is known to affect the most underserved population. It leads to disfiguring and debilitating in children.
- It is one of the first diseases targeted by WHO and The United Nations International Children's Emergency Fund (UNICEF) for eradication in the 1950s. Humans are believed to be the only reservoir, and transmission is from person to person.
- Yaws is cured by a single oral dose of an inexpensive **antibiotic azithromycin**. India has become the first country under the 2012 WHO's Neglected Tropical Diseases (NTD) roadmap to be officially acknowledged as being yaws-free. It has achieved this important milestone much before the WHO global target year of 2020.

►MATERNAL AND NEONATAL TETANUS

- Maternal and Neonatal Tetanus (MNT) is a common lethal consequence of unclean deliveries and umbilical cord care practices. The development of Tetanus leads to extremely high mortality rates.
- MNT deaths can be easily prevented by hygienic delivery and cord care practices, and/or by immunizing mothers with tetanus vaccine that is cheap and effective. Until a few decades ago India reported 1,50,000 to 2,00,000 neonatal tetanus cases annually. But now, the elimination of tetanus means that in India, the annual rate of maternal and neonatal tetanus is less than 1 per 1000 live births.

►NEGLECTED TROPICAL DISEASES (NTDS)

They are a diverse group of communicable diseases that prevail in tropical and subtropical countries. They mainly affect populations living in poverty, without adequate sanitation and in close contact with infectious vectors and domestic animals and livestock. WHO NTD Roadmap targets elimination of many of these diseases and the eradication of at least two by 2020.

►EBOLA VIRUS DISEASE (EVD)

- It was formerly known as Ebola haemorrhagic fever is a severe and often fatal illness in humans. The virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. Fruit bats of the Pteropodidae family are natural Ebola virus hosts.
- Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals such as chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rainforest.
- Ebola then spreads through human-to-human transmission via direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected people, and with surfaces and materials (e.g. bedding, clothing) contaminated with these fluids.
- It was first identified in 1976 in the Democratic Republic of Congo in a village near the Ebola River, from which it takes its name. Symptoms are the sudden onset of fever fatigue, muscle pain, headache and sore throat which is followed by vomiting, diarrhea, rash, symptoms of impaired kidney and liver function, and in some cases, both internal and external bleeding (e.g. oozing from the gums, blood in the stools). Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes.

► 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.

►DENGVAXIA

- Developed and manufactured by Sanofi-Pasteur, a unit of French pharmaceutical company Sanofi as a Vaccine for Dengue.
- It has been designed to protect people in the 9-45 age groups from all four subtypes of the virus. The vaccine has received approval in 14 countries.
- The World Health Organisation (WHO) observes that dengue has become the fastest-growing mosquito-borne disease as it infects as many as 400 million people and kills 22,000 people every year.
- Dengue fever is a vector-borne disease caused by a family of viruses that are transmitted by Aedes aegypti mosquitos. It is most prevalent in the tropical regions.

►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.

►FOOD IRRADIATION

- Food irradiation (the application of ionizing radiation to food) is a technology that improves the safety and extends the shelf life of foods by reducing or eliminating microorganisms and insects.
- Like pasteurizing milk and canning fruits and vegetables, irradiation can make food safer for the consumer. Irradiation does not make foods radioactive, compromise nutritional quality, or noticeably change the taste, texture or appearance of food.

ADVANTAGES OF IRRADIATION

1. Prevention of Foodborne Illness – to effectively eliminate organisms that cause foodborne illness, such as Salmonella and Escherichia coli (E. coli).
2. Preservation – to destroy or inactivate organisms that cause spoilage and decomposition and extend the shelf life of foods.
3. Control of Insects – to destroy insects in or on tropical fruits imported into the United States. Irradiation also decreases the need for other pest-control practices that may harm the fruit.
4. Delay of Sprouting and Ripening – to inhibit sprouting (e.g., potatoes) and delay ripening of fruit to increase longevity.
5. Sterilization – irradiation can be used to sterilize foods, which can then be stored for years without refrigeration. Sterilized foods are useful in hospitals for patients with severely impaired immune systems, such as patients with AIDS or undergoing chemotherapy. Foods that are sterilized by irradiation are exposed to substantially higher levels of treatment than those approved for general use.

SOURCES OF RADIATION FOR USE ON FOODS

1. Gamma rays are emitted from radioactive forms of the element cobalt (Cobalt-60) or of the element cesium (Cesium-137). Gamma radiation is used routinely to sterilize medical, dental, and household products and is also used for the radiation treatment of cancer.
2. X-rays are produced by reflecting a high-energy stream of electrons off a target substance (usually one of the heavy metals) into food. X-rays are also widely used in medicine and industry to produce images of internal structures.
3. Electron beam which is similar to X-rays and is a stream of high-energy electrons propelled from an electron accelerator into food.

►MEDICAL COUNCIL OF INDIA (MCI)

- The Medical Council of India (MCI) is a statutory body for establishing uniform and high standards of medical education in India.
- The Council grants recognition of medical qualifications, gives accreditation to medical schools, grants registration to medical practitioners, and monitors medical practice in India.
- It was first established in 1934 under the Indian Medical Council Act, 1933. The Council was later reconstituted under the Indian Medical Council Act, 1956 that replaced the earlier Act.
- NITI Aayog has recommended the replacement of Medical Council of India (MCI) with National Medical Commission (NMC).
- National Medical Commission (NMC) Bill 2017 that seeks to overhaul the medical education system in India and replace MCI with National Medical Commission (NMC) is yet to be passed by Parliament.

►INDIAN MEDICAL ASSOCIATION (IMA)

- Indian Medical Association is the only representative voluntary organization of Doctors of Modern Scientific System of Medicine, which looks after the interest of

doctors as well as the well-being of the community at large.

- The Association was started in 1928 on the occasion of the 5th all India Medical Conference at Calcutta.
- It is headquartered in New Delhi.

►WORLD MEDICAL ASSOCIATION (WMA)

- The World Medical Association (WMA) is an international and independent confederation of free professional medical associations, representing physicians worldwide.
- It was established in 1947 and headquartered in Paris, France.
- The purpose of the WMA is to serve humanity by endeavouring to achieve the highest international standards in Medical Education, Medical Science, Medical Art and Medical Ethics, and Health Care for all people in the world.

CURRENT affairs& relatedconcepts

►HUMAN MICROBIOME

Indian Human Microbiome Initiative, led by The National Centre for Microbial Resource (NCMR) - National Centre for Cell Science (NCCS) has been put up for approval.

ABOUT MICROBIOME

- The **collective genome of all micro-organisms** contained within the human body, residing inside tissues & bio-fluids is called **Human Microbiome**.
- It includes bacteria, archaea, fungi, protists and viruses.
- Most of them have either *commensal* (co-exist without harming humans) or *mutualistic* (each benefit from the other).

HUMAN MICROBIOME RESEARCH IN INDIA

- **India doesn't have a dedicated national human microbiome project**. But, the proposed Indian Human Microbiome Initiative holds a lot of potential.
- The project will include **collection of saliva, stool and skin swabs** of 20,000 Indians across various ethnic groups from different geographical regions.
- India provides for a wide range of research with more than 4,500 ethnic groups and presence of two global biodiversity hotspots (Himalayan range and Western Ghats).

►INTEGRATED HEALTH INFORMATION PLATFORM (IHIP)

Integrated Health Information Platform (IHIP) under **Integrated Disease Surveillance Programme (IDSP)** was launched in 7 states.

ABOUT IHIP

- It is **real time, village wise**, **case based** electronic health information system with **GIS tagging.**
- It will help in prompt prevention and control of epidemic prone diseases.
- It will provide near-real-time data to policy makers for detecting outbreaks, reducing the morbidity and mortality and lessening disease burden.

OBJECTIVES

- To enable creation of interoperable **Electronic Health Records (EHRs)** which can be made available and accessible throughout the country.
- Information from other branches like tuberculosis control programme, maternal and child health programme and non-communicable disease programme also will be included in this platform.

ABOUT IDSP

- It is the disease surveillance scheme under **National Health Mission**, assisted by the **World Bank**.
- The IDSP portal is a one stop portal which has facilities for data entry, view reports, outbreak reporting, data analysis, training modules and resources related to disease surveillance.

►ZIKA VIRUS

Few cases of Zika virus disease have been reported in Bihar.

ABOUT ZIKA

- **First identified in Uganda** in 1947 in monkeys, Zika was detected in humans five years later.
- In 2015, a major outbreak in Brazil led to the revelation that Zika can be associated with **microcephaly**, a condition in which **babies are born with small and underdeveloped brains.**
- Generally, the virus is not considered dangerous to anyone other than pregnant women.

INDIA'S RESPONSE

- **National Guidelines and Action Plan on Zika virus** disease have been prepared and shared with the States.

- **Integrated Disease Surveillance Programme** (IDSP) is tracking for clustering of acute febrile illness in the community.
- **The Rashtriya Bal Swasthya Karyakram** (RBSK) is monitoring **microcephaly** from 55 sentinel sites.

►TB REPORT BY WHO

Recently, World Health Organisation (WHO) released **World TB Report 2018**, with collaboration of **UN's first high-level meeting** (HLM) on TB.

REPORT FINDINGS

- TB is the **10th leading cause** of death worldwide.
- Since 2011, it has been the leading cause of death from a single infectious agent, ranking above HIV/AIDS.
- Overall, TB deaths have **decreased** over the past year.
- However, underreporting and under-diagnosis of TB cases remains a major challenge.

OBSERVATIONS FOR INDIA

- India accounted for **27% of the total new infections** of TB in 2017, which is the highest among the top 30 high TB burden countries in the world.
- India also led in cases of **Multi-Drug Resistant TB** (MDR-TB).
- Nearly a quarter of the world's MDR-TB cases are in India (24 per cent).

►NEW INFLUENZA RESEARCH PROGRAMME

Recently, Indian and European Union (EU) collaborated for new influenza research programme **to develop Next Generation Influenza Vaccine.**

ABOUT PROGRAMME

- The programme will **get fund of EUR 15 million** under EU funding programme for research and innovation called **'Horizon 2020'.**
- It aims at further advancing the next generation influenza vaccine with improved efficacy and safety, duration of immunity, and reactivity against an increased breadth of influenza strains.

ABOUT HORIZON 2020

- It is the **biggest EU Research and Innovation programme** with nearly €80 billion of funding available over 7 years (2014 to 2020).
- It is helping to achieve research and innovation on excellent science, industrial leadership and tackling societal challenges.

►FIRST INDIA DESIGNED VACCINE PASSING WHO TEST

India made **ROTAVAC vaccine** and **Typbar Typhoid Conjugate Vaccine** received WHO pre-qualification.

ROTAVAC VACCINE

- It is a **low cost vaccine.**
- Developed by **Bharat Biotech Limited** under an **innovative PPP model** involving Ministry of Science and Technology, institutions of the US Government and various NGOs.
- It has been included in India's **Universal Immunization Program** in 2016.

TYPBAR TYPHOID CONJUGATE VACCINE

- It is the **world's first typhoid vaccine developed by Bharat Biotech limited.**
- It can be given to infants older than six months.
- It confers long-term protection against typhoid fever.

SIGNIFICANCE

- Accelerate **availability of the vaccine** to the developing countries with highest burden of diseases
- Increases the scope for **credible industrial, scientific and regulatory processes** to develop more vaccines in the country.
- Necessary for United Nation agencies like UNICEF, the Pan American Health Organization (PAHO) and GAVI (a vaccine alliance) to purchase the vaccine in partnership with developing countries.

►ACTIVE PHARMACEUTICAL INGREDIENTS (APIs)

Department of Pharmaceuticals (DoP) has sought support from other government departments **to reduce India's import dependence** on **Active Pharmaceutical Ingredients** (APIs).

INDIA AND APIs

- **Bulk drugs or APIs** are the active raw materials used in a drug that give it the therapeutic effect.

- **V.M. Katoch committee** was formed to formulate a long-term policy and strategy for **promoting domestic manufacture** of APIs/bulk drugs in India.
- Recently, Heavy Water Board has signed an agreement with an Indian firm for supply of Heavy Water for development of deuterium labeled compounds, NMR Solvents, d-labeled Active Pharma Ingredients (APIs).

►DIGITAL THERAPEUTICS

America's Food and Drug Administration (FDA) has given its approval to some digital therapeutics.

ABOUT DIGITAL THERAPEUTICS

- It can broadly be defined as a treatment or therapy that utilizes digital and often **Internet-based health technologies** to spur changes in patient behavior to treat a medical or psychological condition.
- It uses methods rooted in **cognitive behavioral therapy** to spur patients to make lifestyle changes.

APPLICATION

- It is often used as a **preventive measure** for patients who are at risk of developing more serious conditions.
- For instance, a patient with prediabetes may be prescribed digital therapeutics as a method to change their diet and behavior.
- It can also be used to treat patients with **psychological and neurological disorders.**

►E-CIGARETTES

The government recently quoted a WHO report to state that there is **sufficient evidence** to warn children, adolescents, pregnant women, and women of reproductive age against use of e-cigarettes.

ABOUT E-CIGARETTES

- E-cigarettes are a type of **Electronic Nicotine Delivery Systems (ENDS)** which **claims to emit nicotine without other harmful chemicals that are present** in normal cigarettes.
- They aim to provide a **similar sensation to inhaling tobacco smoke**, without the smoke and are **sold as aids to reduce or quit smoking**.
- They produce an **aerosol by heating a fluid** that usually **contains nicotine, flavorings, and other chemicals** which is then **inhaled by users of e-cigarettes**.
- Smoking e-cigarettes is also called **vaping.**

►PROJECT DHOOP

Project Dhoop has been launched by **Food Safety and Standards Authority (FSSAI).**

ABOUT PROJECT DHOOP

- It is a **nationwide campaign** launched by FSSAI along with NCERT, New Delhi Municipal Council and **North MCD Schools**.
- Purpose: To **spread awareness about consumption of Vitamin D through natural sun light** and **consuming fortified food** among school going children.
- The project urges the schools to **shift their morning assembly timing to noon** time so that children are able to absorb optimum levels of Vitamin D through natural sunlight.
- It will ensure that the children are exposed to sun light that will give them the **required 90% of Vitamin through sun light**.

►GRAPHENE

- Scientists have found a new application of Graphene, for detecting Amyotrophic Lateral Sclerosis (ALS).
- Recently, Scientists have developed a new graphene-based battery material with **charging speed five times faster** than lithium-ion batteries.

ABOUT 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**.

PROPERTIES

- 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.

►MONKEY FEVER

A case of Kyasanur Forest Disease (KFD), a viral disease which is transmitted to humans through ticks has been reported in Wayanad district.

WHAT IS MONKEY FEVER?

- It is a tick borne (a tick which is found on monkeys) viral haemorrhagic fever and it is endemic to South Asia. The disease (monkey fever) is caused by virus which belongs to the family Flaviviridae.
- The same family also causes yellow fever and dengue fever.
- Why it is also called as Kyasanur Forest Disease or Monkey Fever? The disease was first reported from the Kyasanur Forest of Karnataka in India in 1957. The disease was first identified as an epizootic outbreak amongst monkeys and hence, it is locally known as the monkey disease or monkey fever.

►ZEARALENONE

Recently, Zearalenone has been detected in the wheat, rice, corn and oats from the market of Uttar Pradesh. Food Safety and Standard Authority (FSSAI) does not impose maximum limits for this fungus but European Union does..

WHAT IS IT?

- It is a **fungal toxin** which infests cereals like wheat, maize and barley.
- It normally affects the crops during the growth stage and when the cereals are stored without drying them properly.
- Zearalenone behaves like oestrogen, the female sex hormone, and could cause endocrine disturbances in humans.
- Effects of Zearalenone are documented on animals and it has been observed that it causes infertility.
- At the same time, effect of zearalenone is not clear. However, it is believed that consumption of this fungus is dangerous to humans.

►MITOCHONDRIAL REPLACEMENT THERAPY

UK has become the first country in the world to legalize Mitochondrial Replacement Therapy (MRT) also known as 3 Parent's Babies.

WHAT ARE MITOCHONDRIA?

- Rod like structures inside the cell
- Powerhouse of the cell
- Generate all the energy for the body activities
- They have mitochondrial-DNA which is different from DNA and genetic material present in the nucleus
- Mitochondrial DNA forms 0.1% of the genetic material of the cell
- Mitochondrial DNA doesn't significantly impact the features and appearance.

ABOUT MRT

This therapy to replace the defected mitochondrial DNA of the mother with the mitochondrial DNA of the donor lady

POSITIVE ASPECTS

It helps to reduce the genetic defects in the child due to defected mitochondrial DNA

NEGATIVE ASPECTS

How does mitochondrial DNA impact the features is not yet fully discovered. Before legalizing, this aspect should be dealt with in detail.

►BRUCELLA FREE VILLAGES

- Brucella Free Villages campaign has been launched by the Government of India to reduce the incidence of Brucella bacteria.
- The nodal Ministry is Department of Biotechnology, Ministry of Science and Technology

BRUCELLOSIS

- It is a bacterial disease caused in animals mainly cow, goat, sheep and buffalos.
- It can impact humans as well.

HOW DOES IT IMPACT HUMANS?

- Consumption of unpasteurized milk, undercook meat, cheese and dairy products made from the milk of infected animal.
- In rare cases it can spread through air as well.
- It can spread through the secretions of animals.

►IRON FORTIFICATION IN RICE AND WHEAT

Government of India is fortifying wheat flour and rice to arrest growing anaemia among children.

WHAT IS IRON FORTIFICATION?

Increasing the content of iron in food grains to address iron deficiency and iron deficiency anaemia.

WHEAT FLOUR FORTIFICATION

Wheat flour is fortified with a compound known as: Sodium Iron Ethylenediaminetetraacetic Acid (Na Fe EDTA)

RICE FORTIFICATION

It is being fortified with iron by the process known as '***Extrusion'***.

WHAT IS EXTRUSION?

- Dough is made from rice flour.
- Iron is added to this dough.
- This dough is made to pass through a machine called extruder that would cut the dough into rice like fine grains.

►NATIONAL DEWORMING INITIATIVE

It is an initiative of the Ministry of Health and Family Welfare to carry out the deworming exercise in all the children of the age group of 1-19 years of age

FACTS FOR PRELIMS

- National Deworming Day – 10th February and 10th August every year
- All states and union territories participate.
- Schools and Anganwadis give **Albendazole** tablet for deworming
- The infection caused by these parasitic intestinal worms is known as Soil Transmitted Helminth Infection `

WHY THE INFECTION IS CALLED 'SOIL TRANSMITTED HELMINTH INFECTION'?

- This infection spreads through soil that contains faeces of the infected person
- Faecal matter of the infected person contains eggs of the parasitic worms that contaminate the soil

►NATIONAL HEALTH POLICY, 2017

The Union Cabinet has approved the National Health Policy, 2017 (NHP, 2017). The Policy seeks to reach everyone in a comprehensive integrated way to move towards wellness. It aims at achieving universal health coverage and delivering quality health care services to all at affordable cost.

SALIENT FEATURES

1. Increase in public health expenditure to up to 2.5% of the GDP by 2025.
2. 2/3rd or more expenditure on Primary Healthcare Centers.
3. Health and wellness centers would be built to promote primary healthcare.
4. Preventive and Promotive healthcare
5. **Make-in-India:** Promoting the manufacturing of medical devices in India based upon the local needs.
6. Digital Healthcare
7. Making available 2 beds/1000 population
8. It envisages the creation of an empowered Medical Tribunal that would look into the speedy resolution of disputes related to service quality, unfair practices, cost of services etc.

►NATIONAL NUTRITION MISSION

National Nutrition Mission was launched by the Government of India.

NODAL MINISTRY

Ministry of Women and Child Development

COLLABORATING MINISTRIES

1. Ministry of Health and Family Welfare
2. Ministry of Drinking Water and Sanitation

COMPONENTS

1. Monitoring of schemes related to nutrition using ICT tools
2. Promotion of digital tools among Anganwadi Workers. Motivating the Anganwadi workers to end the practice of using registers
3. Reducing under-nutrition, wasting and stunting among children.
4. Setting up height measuring facilities at Anganwadi centers.

5. Setting up of Nutrition Resource Centers

►INDIA HYPERTENSION MANAGEMENT INITIATIVE (IHMI)

This initiative was launched to reduce mortality due to cardiovascular diseases in India.

AGENCIES INVOLVED

- Central Government (Ministry of Health and Family Welfare)
- State Governments
- WHO
- Indian Council for Medical Research

LINE OF ACTION

- Reduce high blood pressure
- Reduce salt consumption
- Reduce artificial trans-fat consumption

►LaQShya

WHAT IS LaQShya?

Labour Room Quality Improvement Initiative **LaQShya** is an initiative launched by the Ministry of Health and Family Welfare to improve the services provided to the pregnant ladies in Labour room and Maternity Operation Theatres.

OBJECTIVE

Reduce Maternal and Neo-Natal Mortality Rate.

►ANTHOCEPHALUS CADAMBA

Scientists from IIT developed a technology to use the extract of Anthocephalus Cadamba to kill the skin cancer cells.

WHAT IS ANTHOCEPHALUS CADAMBA?

It is a medicinal plant whose extract is used to fight skin cancer

TECHNOLOGY

The extract of the plant is mixed with a heated dye. This mixture is found to be toxic to skin cancer cells.

►LEPTOMONAS SEYMOURI

Leptomonas Seymouri is a new parasite that is known to cause Kala-Azar.

WHAT IS KALA-AZAR?

- Parasitic Disease cause by Leishmania Donovani
- It leads to enlargement of Liver, Spleen.
- It impacts bone marrow as well.
- It is also known as Dumdum Fever or Black fever

SYMPTOMS

- Ulcers
- Fever
- Low Red Blood Cell count
- Enlargement of Liver and Spleen
- Anemia

►CARB-X

- The Combating Antibiotic Resistant Bacteria(CARB-X) Biopharmaceutical Accelerator is a public-private international partnership. It is being created by U.S. Department of Health and Human Services (HHS).
- It was set up in 2016 to focus on innovations that improve diagnosis and treatment of drug-resistant infections.

PURPOSE

It provides a new, collaborative approach to speed research, development and delivery of new antibiotics, vaccines, diagnostics, and other innovative products to address the urgent global problem of drug-resistant bacterial infections.

HEADQUARTERS

CARB-X is headquartered at Boston University School of Law (BU Law), USA.

FOCUS

All CARB-X funding so far is focused on projects to address the most resistant Gram-negative bacteria.

►ANTIBIOTIC RESISTANCE

Antibiotic resistance has become a **global crisis** threatening the management of infections.

REASONS

- **Indiscriminate use of antibiotics** especially in India where antibiotics are easily available over the counter.
- In hospital critical care units, more than 50% organisms are now resistant even to these drugs.

PROLONGED USAGE

Prolonged use of antibiotics in patients admitted to hospitals and their abuse in animal husbandry as growth promoters.

CHEAP

Cheaper antibiotics such as penicillin can no longer cure an infection, and high-end ones like third- and fourth-generation drugs are **unaffordable**.

ANTIMICROBIAL v/s ANTIBIOTIC RESISTANCE

- Antibiotic resistance is a **subset of antimicrobial resistance** (AMR), a wider category covering resistance in all microorganisms (bacteria, parasites, viruses and fungi) to drugs.
- Antibiotics (drugs against bacteria) are the commonest in uses.

→ SUPERBUGS

1. Staphylococcus epidermidis
2. MRSA
3. Candida Auris (Fungus): Has been found in Australia, Canada, Venezuela, Japan and USA
4. New Delhi metallo-beta-lactamase 1

FACTORS LEADING TO ANTI-MICROBIAL RESISTANCE ARE

- Self medication
- Over use of antibiotics in animals meant for human consumption
- Access to anti-biotics without prescription
- Improper disposal of anti-biotics
- Mass bathing

STEPS TO REGULATE AMR ARE

- ICMR has set up **National Anti-Microbial Resistance Research and Surveillance Network (AMRRSN)** to enable compilation of National Data of AMR at different levels of Health Care.
- Chennai Declaration on antibiotics
- National Action Plan on Antimicrobial Resistance 2017
- WHO 'Global Action Plan on antimicrobial resistance'

►DISEASE X

- It is code name for an unknown pathogen which may cause disease and potentially an epidemic in future.
- R&D Blueprint is a global strategy and preparedness plan that allows the rapid activation of R&D activities during epidemics. It aims to fast-track the availability of effective tests, vaccines and medicines that can be used to save lives and avert large scale crisis. WHO is the convener.

►IMPORTANT DISEASES IN NEWS

→ LEPTOSPIROSIS	• **Bacterial disease** that affects both humans and animals. Humans become infected through direct contact with urine of infected animals or with urine-contaminated environment. Bacteria enter body through cuts or abrasions on the skin, or through mucous membranes of mouth, nose and eyes. Person to person transmission is rare. **SYMPTOMS:** • High fever, severe headache, muscle pain, chills, redness of the eyes, abdominal pain, jaundice, haemorrhages in the skin and mucous membranes, vomiting, diarrhoea and rash.
→ WEST NILE VIRUS	• It can cause fatal neurological disease in humans. WNV is commonly found in Africa, Europe, Middle East, North America and West Asia. • Human infection is most often the result of bites from infected mosquitoes. Mosquitos become infected when they feed in infected birds, which circulate the virus in their blood for a few days. Human to Human transmission have occurred through organ transplant, blood transfusions and breast milk. To date, no human to human transmission of West Nile Virus has been reported through casual contact.
→ NIPAH	• It is a zoonotic virus, can be also transmitted through contaminated food or directly between

	people. It causes asymptomatic infection to acute respiratory illness and fatal encephalitis. The virus can also cause severe disease in animals such as pigs, resulting in economics losses to farmers. • First recognised outbreak was among pig farmers in Malaysia. Fruit Bats belonging to the genus Pteropus genus are the natural hosts for Nipah virus.
→ ZIKA	• It is a mosquito transmitted infection • During pregnancy, the virus can cause birth defects in nowborn called **microcephaly** - a condition defined by small heads and brain damage, along with other defects like blindness, deafness, seizures and other congenital defects. • It can also lead to **Guillain-Barré syndrome,** a form of temporary paralysis in adults, that has links to other neurological complications. **SYMPTOMS:** • **Transmission:** Bite of an infected female mosquito, primarily Aedes aegypti. This mosquito also spreads yellow fever, dengue and chikungunya. Aedes mosquitos usually bite during the early morning and late afternoon/evening. o Can also be sexually transmitted. o No treatment of vaccine is available for Zika.
→ CONGO FEVER	• Transmitted to humans from ticks and livestock animals. Tick borne virus belongs to the Bunyaviridae Family. • People at risk to exposure are livestock workers, animal herders and those employed in slaughterhouses. • Endemic to Middle East, Balkans, Africa and Asia. • No vaccine exists either for humans or animals.
→ YELLOW FEVER	It is an acute viral haemorrhagic disease transmitted by infected mosquitoes. The 'yellow' in the name refers to the jaundice that affects some patients. • A small proportion of patients who contract the virus develop severe symptoms and approximately half of those die within 7 to 10 days. • The virus is endemic in tropical areas of Africa and Central and South America. • Large epidemics of yellow fever occur when infected people introduce the virus into heavily populated areas with high mosquito density and where most people have little or no immunity, due to lack of vaccination. In these conditions, infected mosquitoes of the Aedes aegypti specie transmit the virus from person to person. • The yellow fever virus is an arbovirus of the flavivirus genus and is transmitted by mosquitoes, belonging to the Aedes and *Haemogogus* species. In tropical rainforests, monkeys are the primary reservoir of yellow fever.

►RARE DISEASES

According to WHO, these are diseases which have a very low prevalence rate and are often life threatening lifelong diseases. Most of the rare diseases are genetic in origin.

- They are also called orphan diseases because drug companies are not interested in developing treatment for these conditions due to low profitability.

- Ex of Rare disease are: Sickle Cell Anaemia, Thalassemia, Auto-immune disorders, Haemophilia etc.
- Karnataka is the first state to release a Rare disease and Orphan Drugs Policy.

►VACCINE HESITANCY

- It refers to delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context specific varying across time, place and vaccines. It includes factors such as complacency, convenience and confidence
- Delhi High Court stalled Delhi Government's plan for a measles rubella vaccination campaign in schools across the capital. The HC asked Delhi Government to take the consent of parents of children before vaccinating them.

REASONS

- Vaccine derived diseases: such as Vaccine derived Polio
- Cultural and religious practices.

►INDIAN PHARMACOPOEIA COMMISSION (IPC)

- It is an **autonomous institution of the Ministry of Health and Family Welfare**.
- It is created **to set standards of drugs** in the country.
- It **publishes official documents** for improving Quality of Medicines by way of adding new and updating existing articles in the form of Indian Pharmacopoeia (IP).
- It also **promotes rational use** of generic medicines by publishing National Formulary of India.
- It has approved modern animal free tests for drug manufacturers.

INDIAN PHARMACOPOEIA (IP)

- It **contains a collection** of authoritative procedures of analysis and specifications for Drugs.
- It has **got legal status** under the Second Schedule of the Drugs & Cosmetics Act, 1940.

►FIXED DOSE COMBINATIONS

- Ministry of Health and Family Welfare in exercise of powers conferred by the Drugs and Cosmetics Act, 1940 has prohibited the manufacture for sale, sale or distribution of human use of 328 FDCs and restricted the manufacture, sale and distribution of 6 FDCs.

FIXED DOSE COMBINATIONS:

- Two or more drugs contained in a single dosage form, such as a capsule or tablet.
- It reduces the number of pills a person must take each day, fixed-dose combination drugs can help improve adherence to treatment regimen. They are also cheaper.
- For ex. FDC have been introduced in TB and AIDS etc.
- However, on the recommendation of **Nilima Shirsagar committee** FDCs were banned because:

1) FDCs were formulated without due diligence, with dosing mismatches that could result in toxicity.
2) Over the years, India has become a "**dumping ground" for irrational FDCs** that are not approved in other countries for consumption

►DRUG TECHNICAL ADVISORY BOARD (DTAB)

- It is a statutory body constituted under the Drug and Cosmetics Act, 1940.
- It advises the Central and State Governments on technical matters on matters related to drugs and medical devices.
- Director General of Health Services, is the ex-officio, Chairman of the body.
- It does not oversee Ayurveda, Siddha, or Unani medicines.

►DRUG CONSULTATIVE COMMITTEE (DCC)

- It is a statutory committee formed by the Central Government under the Drugs and Cosmetics act.
- It would advise the Central Government, State Government and DTAB on any other matter tending to secure uniformity throughout India.

►NATIONAL MEDICAL DEVICES PROMOTION COUNCIL

AIMS

- To give a fillip to the domestic manufacturing in the medical device sector

- It will function under the DPIIT, Ministry of Commerce and Industry.
- It will be headed by Secretary, DPIIT. Andhra Pradesh Medtech Zone, Vishakhapatnam will provide technical support to the council.

FUNCTIONS OF THE COUNCIL ARE:

- Act as a facilitating and promotion & developmental body for the Indian MDI.
- Understand best global practices, networking activities and deliberate on various parameters for inclusion in industrial and trade policies in medical devices.
- Support dissemination and documentation of international norms and standards for medical devices
- Drive a robust and dynamic Preferential Market Access (PMA) policy.
- Make recommendations to government on industry feedback and global practices.

►NATIONAL HEALTH PROFILE

- It is prepared by the Central Bureau of Health Intelligence
- It covers demographic, socio-economic, health status and health finance indicators, along with comprehensive information on health infrastructure and human resources in health.

►NATIONAL HEALTH RESOURCE REPOSITORY (NHRR)

- It is India's first ever national healthcare facility registry of authentic, standardised and upgraded geo-spatial data of all public and private healthcare establishments.
- NHRR Project is to strengthen evidence based decision making and develop a platform for citizen and provider centric services by creating a robust, standardised and secured IT enabled repository of India's healthcare resources.
- NHRR will be the ultimate platform for comprehensive information of both, Private and Public healthcare establishments including Railways, ESIC, Defence and Petroleum healthcare establishments.
- Under the Collection of Statistics Act, 2008, over 20 lakh healthcare establishments like hospitals, doctors, clinics, diagnostic labs, pharmacies and nursing homes would be enumerated under this census capturing data on over 1400 variables.
- ISRO is the project technology partner. It will be implemented by Central Bureau of Health Intelligence.

Benefits of NHRR are:

- Create a reliable, unified registry of India's healthcare resources showing distribution pattern of health facilities and services between cities and rural areas.
- Generate real world intelligence to identify gaps in health and service rations, and ensure judicious health resource allocation and management.
- Identify key areas of improvement by upgrading existing health facilities or establishing new health facilities keeping in view the population density, geographic nature, health condition, distance etc.

►CENTRAL BUREAU OF HEALTH INTELLIGENCE

It is a **statutory body** established in 1961.

- It is the health intelligence wing under Directorate General of Health Services.
- It aims to create a strong health management information system in India.

►QUADRIVALENT INFLUENCE VACCINE

- **WHO** has recommended the use of Quadrivalent injectible influenza vaccine developed by Sanofi Pastuer.
- The vaccine will contain 4 influenza virus strains (Two A subtypes and two B subtypes - HINI and H3N2 and Victoria and Yamagata respectively). Earlier Trivalent vaccine was used which only contained two subtype A but only one of the B subtype virus.
- Quadrilateral vaccine was approved for active immunisation of adults of age 18 to 64 years in 2017 by Drug Controller General of India.

ABOUT INFLUENZA

- It is an acute respiratory infection caused by caused by influenza virus.
- There are 4 types of Influenza viruses A, B, C and D. Influenza A and B viruses circulate and cause seasonal epidemics

- Influenza A Virus: It is classified according to the combinations of proteins found on the surface of the virus. Currently circulating in humans are subtype H1N1 and H3N2 influenza virus. Only influence type A viruses are known to have caused pandemics.
- Influenza B Virus: They are broken down to lineages. It is of two types Yamagata and Victoria.
- Influenza C Virus: Detected less frequently and usually causes mild infections, thus does not present public health importance.
- Influenza D virus: primary affect cattle and are not known to infect or cause illness in people.

►HIV CURE

- First claims of patient treated of HIV Aids: Berlin Patient.
- 2019 Second Claim of a patient being treated of HIV: Anonymous London Patient
- Both instances of HIV cure resulted from bone-marrow transplants given to infected patients. But the transplants were intended to treat cancer in the patients, not HIV.
- Stem cell transplant involving **CCR5-delta 32 homozygous donor cells**. About 1% of people of Northern European Descent, mainly Swedes, are born with a mutation of CCR5 Delta 32.
- HIV uses the CCR5 protein to enter immune cells, but it can't enter cells which have CCR5-Delta 32 mutation.

►REPLACE INITIATIVE OF WHO

- It is an action package by WHO to eliminate industrially produced transfat from the global food supply by 2023.
- REPLACE provides a six-step action package for the global elimination of trans fat. This package supports governments to ensure the prompt, complete, and sustained elimination of industrially-produced trans fat from the food supply. The practical, step-by step action package is supported by an overarching technical document that provides a rationale and framework for this integrated approach to trans fat elimination.

The six areas of action include:

- Review dietary sources of industrially-produced trans fat and the landscape for required policy change.
- Promote the replacement of industrially-produced trans fat with healthier fats and oils.
- Legislate or enact regulatory actions to eliminate industrially-produced trans fat.
- Assess and monitor trans fat content in the food supply and changes in trans fat consumption in the population.
- Create awareness of the negative health impact of trans fat among policy-makers, producers, suppliers, and the public.
- Enforce compliance with policies and regulations.

►ANEMIA MUKT BHARAT INITIATIVE

TARGETS

- Anemia Mukt Bharat strategy has been designed to reduce prevalence of anemia by 3 percentage points per year among children, adolescents and women in the reproductive age group (15–49 years), between the year 2018 and 2022. It plans to reach out to 450 million beneficiaries with specific anemia prevalence targets for year 2022 to be achieved.
- It will be implemented in all villages, blocks and districts of all the States/UTs of India through existing delivery platforms as envisaged in the National Iron Plus Initiative (NIPI) and Weekly Iron Folic Acid Supplementation (WIFS) program.

COMPONENTS

1) **Intensified National Iron Plus Initiative (I-NIPI)**

   Prophylactic Iron Folic Acid supplementation given to children, adolescents, women of reproductive age and pregnant women irrespective of anemia

2) **Deworming: National Deworming Day**

3) **Intensified year round Behavior Change Communication Campaign (Solid Body, Smart Mind) including ensuring delayed cord clamping**
   - Compliance to Iron Folic Acid supplements and deworming
   - Appropriate Infant and Young Child Feeding (IYCF) with emphasis on adequate and age-appropriate complementary foods for children 6 months and above
   - Increase intake of iron-rich, protein-rich and vitamin C-rich foods through dietary diversification/quantity/ frequency and food fortification.
   - Promoting practice of delayed cord clamping (by at least 3 minutes or until cord pulsations cease) in all health facility deliveries followed by early initiation of breastfeeding with 1 hour of birth

4) **Testing of anemia using digital methods and point of care treatment**
   - Use of digital haemoglobinometers for haemoglobin level estimations in two beneficiaries group namely:
     - Adolescent girls and boys 10-19 years, in government and government aided schools
     - Pregnant women registered for antenatal check-ups. This may be extended to all age groups later. In-school adolescents will be screened by the Rashtriya Bal Swasthya Karyakram (RBSK) mobile teams using digital haemoglobinometers.

5) **Mandatory provision of Iron Folic Acid fortified foods in public health programs**
   - GOI has mandated use of fortified salt, wheat flour and oil in foods served under ICDS and Mid Day Meal Scheme to address micronutrient deficiencies. All health facility based programs where food is being provided are mandated to provide fortified wheat, rice (with iron, folic acid and

6) **Addressing non-nutritional causes of anemia in endemic pockets, with special focus on malaria, haemoglobinopathies and fluorosis.**

INSTITUTIONAL MECHANISM

- Rashtriya Kishor Swasthya Karyakram (RKSK) National Steering Committee will be expanded to include National Anemia Mukt Bharat Steering Committee, headed by Secretary, Ministry of Health and Family Welfare.
- National Anemia Mukt Bharat Unit will be established to support and monitor states for strategy implementation.
- National Centre of Excellence and Advanced Research of Anemia Control will be established at AIIMS, New Delhi to provide technical inputs and address research needs.
- www.anemiamuktbharat.info portal will be developed.

FUNDING

- Budget under Anemia Mukt Bharat strategy is allocated for procurement of supplies (Iron Folic Acid and Albendazole), costs of therapeutic management (test and treat) of in-school adolescents and pregnant woman, capacity building activities, IEC activities, ASHA incentives and program monitoring.
- Average per district cost of implementing the strategy is approximately Rs 109 lakhs, where the tentative cost of Rs 70 lakh funds. Funds from various schemes such as NHM, Janani Shishu Suraksha Karyakram will be utilised for the scheme.

SECTION 5

INTELLECTUAL PROPERTY

►INTELLECTUAL PROPERTY

- Creations of the mind like inventions; literary and artistic works; and symbols, names and images used in commerce.
- It is generally divided into **two categories**:
- Industrial Property includes patents for inventions, trademarks, industrial designs and geographical indications.
- Copyright covers literary works (such as novels, poems and plays), films, music, artistic works (e.g., drawings, paintings, photographs and sculptures) and architectural design. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and broadcasters in their radio and television programs.

►INTELLECTUAL PROPERTY RIGHTS

- Like any other property right, they allow creators (or owners) of patents, trademarks or copyrighted works to benefit from their own work or investment in a creation. They are outlined in Article 27 of the Universal Declaration of Human Rights.
- The importance of intellectual property has been recognized in the Paris Convention for the Protection of Industrial Property (1883) and the Berne Convention for the Protection of Literary and Artistic Works (1886).
- The legal protection of new creations encourages the commitment of additional resources for further innovation.
- The promotion and protection of intellectual property lead to economic growth, creates new jobs and industries, and enhances the quality and enjoyment of life.
- An efficient and equitable intellectual property system can help all countries to realize intellectual property's potential as a catalyst for economic development and social and cultural well-being.

IPRS	ADMINISTRATIVE MINISTRY
Patents, Copyrights, Designs, Trade Marks and Geographical Indicatons	Ministry of Commerce and Industry
Protection of Plant Varieties and Farmers' Rights Act, 2001	Ministry of Agriculture
Semiconductor Integrated Circuits Layout-Design Act, 2000	Ministry of Electronics and Information technology

NOTE: Copyrights were earlier administered by the Ministry of Human Resource Development. In 2016, it was transferred to Department for Promotion of Industry and Internal Trade under Ministry of Commerce and Industry

►PATENT

- A patent is an exclusive right granted for an invention – a product or process that provides a new way of doing something. A patent provides patent owners with protection for their inventions. Protection is granted for a limited period, generally 20 years.
- Patents provide incentives to individuals offering the possibility of material reward for their marketable inventions. These incentives further encourage innovation, which in turn enhances the quality of human life. Once a patent is granted, an invention cannot be commercially made, used, distributed or sold without the patent owner's consent.
- A patent owner has the right to decide who may use the patented invention for the period during which it is protected. In return for patent protection, all patent owners have to publicly disclose information on their inventions in order to enrich the total body of technical knowledge in the world. This ever increasing body of public knowledge promotes further creativity and innovation.
- To be granted a Patent, an invention must be of practical use, must show an element of "novelty" (some new characteristic that is not part of the body of existing knowledge in its particular technical field) must show an "inventive step" that could not be deduced by a person with average knowledge of the technical field.

►PATENTING IN INDIA

- In India, under the provisions of **section 159 of the Indian Patents & Designs Act,1970,** the Central Government is empowered to make rules for implementing the Act and regulating patent administration. Accordingly, the Patents

Rules, 1972 were notified and amended by the Patents (Amendment) Rules, 2006.

- The government has recently amended the rules and introduced measures to expedite examination of patent applications by start-ups as well as entities choosing India for the first filing of patent. India suffers with lakhs of patent applications pending in the country.

►TRADEMARK

- Trademark is a distinctive sign that identifies certain goods or services produced or provided by an individual or a company. Its origin dates back to ancient times when craftsmen reproduced their signatures, or "marks", on their artistic works or products of a functional or practical nature.
- Trademark protection ensures that the owners of marks have the exclusive right to use them to identify goods or services, or to authorize others to use them in return for payment. The period of protection varies, but a trademark can be renewed indefinitely upon payment of the corresponding fees.
- Trademark protection is legally enforced by courts. Trademark protection helps curb the efforts of unfair competitors, such as counterfeiters, to use similar distinctive signs to market inferior or different products or services.
- The Trademark system is governed by The Madrid Protocol. In India, The Trade Marks Registry which was established in 1940 administers the Trade Marks Act, 1999 and the rules made there under.
- The Registry acts as a resource and information Centre and is a facilitator in matters relating to trademarks in the country. Trade Marks Registry also functions as an office of origin under the Madrid Protocol. The Head Office of the Trade Marks Registry is at Mumbai.
- The Controller General of Patents, Designs and Trademarks heads the Registry offices and functions as the Registrar of TRADEMARKS

►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 has come into force with effect from 15th September 2003. It is used to identify agricultural, natural or manufactured goods. It can be renewed from time to time for further period of 10 years each.
- 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

CURRENT affairs& relatedconcepts

►WIPO TREATIES

The Union Cabinet has approved the proposal submitted by DIPP (Department of Industrial Policy & Promotion) regarding **accession to the WIPO Copyright Treaty and WIPO Performers and Phonograms Treaty.**

ABOUT WIPO COPYRIGHT TREATY

- It is a special agreement under the **Berne Convention** (for protection of literary and artistic works) that deals with the protection of works and the rights of their authors in the **digital environment.**
- Any Contracting Party must comply with the substantive provisions the Protection of Literary and Artistic Works.
- The term of protection must be **at least 50 years** for any kind of work.

ABOUT WIPO PERFORMANCES AND PHONOGRAMS TREATY

- It deals with the rights of two kinds of beneficiaries, particularly in the **digital environment**:
  - performers (actors, singers, musicians, etc.); and
  - producers of phonograms (persons or legal entities that take the initiative and have the responsibility for the fixation of sounds)
- It grants them these **economic rights**: the right of reproduction; the right of distribution; the right of rental; and the right of making available.
- The term of protection must be **at least 50 years.**

ABOUT WIPO

- It is one of the 15 **specialized agencies of the United Nations** with headquarters at Geneva, Switzerland.
- It aims to promote worldwide protection of both **industrial property** (inventions, trademarks, and designs) and **copyrighted materials** (literary, musical, photographic, and other artistic works).

►INTERNATIONAL INTELLECTUAL PROPERTY INDEX (IIPI)

Recently, **Global Innovation Policy Centre (GIPC) of US Chambers of Commerce** had released the International Intellectual Property Index (IIPI) 2018.

ABOUT IIPI 2018

- It is an **annual Index** which **examines a country's Intellectual Property (IP) framework** across **eight categories of indicators** – patents, copyrights, trademarks, trade secrets and market access, enforcement, commercialisation of IP assets, systemic efficiencies and ratification of international treaties.
- USA topped the list followed by UK and Sweden.
- **India** has been **ranked 44 out of 50 countries** up from 43 out of 45 in 5th edition.

►KANDHAMAL HALDI

Odisha's Kandhamal Haldi (turmeric), famous for its healing properties, is all set to receive GI tag.

ABOUT KANDHAMAL HALDI

- The golden yellow spice, named after the district where it is produced, has been cultivated since time immemorial and is known for its **medicinal value.**
- Turmeric is the main **cash crop** of tribal people in Kandhamal.

►iPrism

It is an Intellectual Property based competition for school and college students

WHO IS ORGANIZING THE COMPETITION?

- Cell for IPR Protection and Management (CIPAM)
- Ericsson India
- ASSOCHAM

Students would be required to submit movies and gaming apps based upon Intellectual Property

WHAT IS CIPAM?

- Cell for IPR Protection and Management
- It implements the National IPR Policy, 2016
- It also creates awareness about Intellectual Property and facilitates registration of patents

SECTION 6

NUCLEAR SCIENCE

►BASICS

- An atom is made up of a Nucleus (with Protons and Neutrons) and electrons revolving around the nucleus.
- The mass of the atom is concentrated in the nucleus. The number of protons(Z) in an atom determine the atomic number of an element. While the term atomic deals with 10-10m, the term nuclear deals with 10-15m.
- The volume of an atom is about 15 orders of magnitude larger than the volume of a nucleus. It is the electrons that are responsible for the chemical behavior of atoms, and which identify the various chemical elements.
- The total number of Protons and Neutrons, called Nucleons is called the Atomic Mass Number(A)
- Atoms such as 1H, 2H whose nuclei contain the same number of protons but different number of neutrons (different A) are known as isotopes. Uranium, for instance, has three isotopes occurring in nature – 238U, 235U and 234U.Hydrogen has 3 types of isotopes, Protium, Deuterium and Tritium.

►DISCOVERY OF NEW ELEMENTS

- Four new elements—with atomic numbers 113, 115, 117, and 118—earned their spots on the periodic table.
- The International Union of Pure and Applied Chemistry revealed that the elements were named after locations of scientists' institutions: Tennessine (Tennessee), Nihonium (Japan) and Moscovium (Moscow).
- Yuri Oganessian, a nuclear physics professor at the Joint Institute for Nuclear Research, inspired the fourth, Oganesson.
- The four elements, synthetically created in labs, round out the seventh row of the table.

►NUCLEAR FUEL

- A good Nuclear fuel is essential to sustainability of a nuclear power plant. A Nuclear fuel generally sustains a chain reaction, has a very high chance of fission when bombarded with neutrons, releases 2 or more neutrons under collision, enabling it to compensate for unsuccessful fissions, has a reasonable half-life and is available in sustainable quantities.
- The **Uranium U-235** is a suitable candidate for a nuclear fuel, however it is not available in abundant quantities across the world.

► TYPES OF FUEL

- Fissionable Fuel consists of isotopes that are capable of undergoing nuclear fission. Typical fissionable materials: 232Th, 233U, 235U, 238U, 239Pu, 240Pu, 241Pu.
- Fertile material are isotopes that are non-fissionable by neutrons, but can be converted into fissile isotopes (after neutron absorption and subsequent nuclear decay). Th-232(Thorium) is a fertile isotope, Th-232 cannot be fissioned by a fast moving neutron. Th-232 is not capable of sustaining a nuclear fission chain reaction, because neutrons produced by fission of 238U have lower energies than original neutron. Upon capturing a neutron, Th-232 converts to U-233 which is fissionable. Typical fissile materials: 235U, 233U, 239Pu, 241Pu.
- Fissile material are fissionable isotopes that are capable of undergoing nuclear fission. Typical fertile materials: 238U, 232Th.

►NUCLEAR ENRICHMENT

- To ensure that the Nuclear Reaction is sustainable, a Nuclear Reactor uses such a fuel that has a high probability of fission when bombarded by a fast moving Neutron. To ensure this, a process called Enrichment is carried out.
- The process of increasing the concentration of one isotope relative to another is called "enrichment."
- Naturally-occurring uranium contains 0.72% of the U-235 isotope. The remaining 99.28% is the u-238 isotope which is a fertile isotope, but is not a fissile isotope. The level of enrichment required depends on specific reactor design (e.g. PWRs and BWRs require 3% – 5% of 235U) and specific requirements of the nuclear power plant operator. Without required enrichment these reactors are not able to initiate and sustain a nuclear chain reaction.
- Enrichment accounts for almost half of the cost of nuclear fuel and about 5% of the total cost of the electricity generated. Enrichment processes require uranium to be in a gaseous form at relatively low temperature, hence uranium oxide from the mine is converted to uranium hexafluoride in a preliminary process, at a separate conversion plant.
- The radioactive half-life for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. After two half-lives, there will be one

fourth the original sample, after three half-lives one eighth the original sample, and so forth.

►NUCLEAR FISSION VS FUSION

PARAMETER	NUCLEAR FISSION	NUCLEAR FUSION
Definition	Fission is the splitting of a large atom into two or more smaller ones.	Fusion is the fusing of two or more lighter atoms into a larger one.
Natural occurrence of the process	Fission reaction does not normally occur in nature.	Fusion occurs in stars, such as the sun.
Byproducts of the reaction	Fission produces many highly radioactive particles.	Few radioactive particles are produced by fusion reaction.
Conditions	High-speed neutrons are required.	High density & high temperature environment.
Energy Requirement	Takes little energy to split two atoms in a fission reaction.	Extremely high energy is required to bring two or more protons close enough that nuclear forces overcome their electrostatic repulsion.
Energy Released	The energy released by fission is a million times greater than that released in chemical reactions, but lower than the energy released by nuclear fusion.	The energy released by fusion is three to four times greater than the energy released by fission.
Nuclear weapon	One class of nuclear weapon is a fission bomb, also known as an atomic bomb or atom bomb.	One class of nuclear weapon is the hydrogen bomb, which uses a fission reaction to "trigger" a fusion reaction.
Energy production	Fission is used in nuclear power plants.	Fusion is an experimental technology for producing power.
Fuel	Uranium is the primary fuel used in power plants.	Hydrogen isotopes (Deuterium and Tritium) are the primary fuel used in fusion power plants.

NUCLEAR POWER REACTORS

►MODERATOR

- Moderator is used to moderate, that is, to slow down, neutrons generated from fission reaction. The probability that fission will occur depends on incident neutron's energy. Nuclei with low mass numbers are most effective for this purpose, so the moderator is always a low-mass-number material.
- Commonly used moderators include:- regular (light) water (roughly 75% of the world's reactors), solid graphite (20% of reactors) and heavy water (5% of reactors). Beryllium and beryllium oxide (BeO) have been used occasionally, but they are very costly.

►COOLANT

- The heat released by fission in nuclear reactors must be captured and transferred for use in electricity generation. Reactors use coolants which remove heat from the core where the fuel is processed and carry it to electrical generators. Coolants also serve to maintain pressures within the core.
- Generally used Coolants are: - Light Water, Heavy water and liquid Sodium.
- **Note:** Based on the type of moderator and coolant, nuclear power plants are classified into Light Water, Heavy Water and Fast Breeder Reactors.

►LIGHT WATER REACTOR

- They use H20 as both moderator and coolant. They require the use of enriched fuel. Depending on the type of technology employed they are further divided into Boiling Water Reactor(BWR) and Pressurized Water Reactor(PWR)
- BWR uses boiling water to generate electricity. Fukushima Daichi was the first such BWR. Tarapur Nuclear Power station in India hosts a BWR.
- PWR uses specially built reactor where in the pressure inside the reactor core is greater than atmospheric pressure. This prevents the water from boiling and allows the water to attain greater temperatures. The hot water that leaves the pressure vessel is looped through a steam generator, which in turn heats a secondary loop of water to steam that can run turbines and generator. (BWRs don't have any steam generator). INS Arihant and Kudankulam Plant in Tamil Nadu use a PWR.
- All liquids, at any temperature, exert a certain vapour pressure. The vapor pressure increases with temperature, because at higher temperature the molecules are moving faster and are more able to overcome the attractive intermolecular forces that tend to bind them together. Boiling occurs when the vapor pressure reaches or exceeds the surrounding pressure from the atmosphere.
- At standard atmospheric pressure, water boils at approximately 100 degrees Celsius. That is simply another way of saying that the vapor pressure of water at that temperature is 1 atmosphere. At higher pressures (such as the in a pressure cooker), the temperature must be higher before the vapor pressure reaches the surrounding pressure, so water under pressure boils at a higher temperature. This is what happens in a PWR.
- A similar condition also occurs in areas of higher altitudes, atmospheric pressure decreases. The vapor pressure reaches that pressure at a lower temperature. This leads to early boiling of water when cooking, however the food may not cook properly!

►HEAVY WATER REACTOR

- It is also referred to as **CANDU reactor**. Use of heavy water (D2O) as both moderator and coolant. Can be used with unenriched uranium fuel. Also known as Pressurized Heavy Water Reactor(PHWR).
- The use of Deuterium instead of Hydrogen gives a neutron to better perform the moderation and also increases the probability of a chain reaction.

►FAST BREEDER REACTORS

- In contrast to most normal nuclear reactors, however, a fast reactor uses a coolant that is not an efficient moderator, such as liquid sodium, so the neutrons remain high-energy.
- Although these fast neutrons are not as good at causing fission, they are readily captured by U-238, which then becomes plutonium Pu-239.
- These reactors are designed to maximize plutonium production and produce more fuel than they consume(Breed). Pu-239 is formed in every reactor and also fissions as the reactor operates.

►INDIA'S 3 STAGE NUCLEAR PROGRAMME

►STAGE 1: PRESSURISED HEAVY WATER REACTOR

- It uses Natural UO2 (Uranium Dioxide) as fuel matrix, Heavy water as moderator & coolant and Natural U (unenriched).
- The by-product Pu-239 is to be used in the next stage 2. High purity heavy water is used in PHWRs for serving as the moderator and the primary coolant. The first heavy water plant was set up in India at Nangal in 1962. Other

Heavy water plants are at Baroda, Tuticorin, Kota, Thal, Hazira Thalchar and Manuguru.

►STAGE 2: FAST BREEDER REACTOR

- India's second stage of nuclear power generation envisages the use of Pu-239 obtained from the first stage reactor operation, as the fuel core in fast breeder reactors (FBR). Pu-239 serves as the main fissile element in the FBR. A blanket of U-238 surrounding the fuel core will undergo nuclear transmutation to produce fresh Pu-239 as more and more Pu-239 is consumed during the operation.
- Besides a blanket of Th-232 around the FBR core also undergoes neutron capture reactions leading to the formation of U-233. U-233 is the nuclear reactor fuel for the third stage of India's Nuclear Power Programme. Setting up Pu-239 fuelled fast Breeder Reactor of 500 MWe power generation is in advanced stage of completion.
- Concurrently, it is proposed to use thorium-based fuel, along with a small feed of plutonium-based fuel in Advanced Heavy Water Reactors (AHWRs). The AHWRs are expected to shorten the period of reaching the stage of large-scale thorium utilization.

►STAGE 3: BREEDER REACTOR OR ADVANCED HEAVY WATER REACTOR

- They are proposed Breeder reactors using U-233 fuel. India's vast thorium deposits permit design and operation of U-233 fuelled breeder reactors.
- U-233 is obtained from the nuclear transmutation of Th-232 used as a blanket in the second phase Pu-239 fuelled FBR.
- The U-233 fuelled breeder reactors will have a Th-232 blanket around the U-233 reactor core which will generate more U-233 as the reactor goes operational thus resulting in the production of more and more U-233 fuel from the Th-232 blanket as more of the U-233 in the fuel core is consumed helping to sustain the long term power generation fuel requirement. These U-233/Th-232 based breeder reactors are under development and would serve as the mainstay of the final thorium utilization stage of the Indian nuclear programme.

►NUCLEAR POWER CORPORATION OF INDIA LIMITED (NPCIL)

- It A Public Sector Enterprise under the administrative control of the Department of Atomic Energy (DAE), Government of India. The Company was registered as a Public Limited Company under the Companies Act, 1956 in September 1987 with the objectives of operating atomic power plants and implementing atomic power projects for generation of electricity in pursuance of the schemes and programmes of the Government of India under the Atomic Energy Act, 1962.
- NPCIL also has equity participation in BHAVINI, another PSU of Department of Atomic Energy (DAE) which implements Fast Breeder Reactors programme in the country. NPCIL is responsible for design, construction, commissioning and operation of nuclear power reactors. NPCIL is a MoU signing, profit making and dividend paying company with the highest level of credit rating. It is headquartered at Mumbai.

►KUDANKULAM NUCLEAR POWER PLANT (KKNPP)

- Kudankulam Nuclear Power Plant is a nuclear power station situated in Kudankulam in the Tirunelveli district of Tamil Nadu. KKNPP was the outcome of an inter-governmental agreement between the erstwhile Soviet Union and India in 1988. The unit is India's 22nd nuclear power reactor and among the largest in the country. Construction of the nuclear power plant project, which is an Indo-Russian joint venture, started in 2002 but was delayed because of sustained opposition from the local communities who argued that it was unsafe.
- Beyond power generation, the project is also seen as a symbol of maintaining cordial relations between India and Russia.
- The second unit of the Kudankulam Nuclear Power Project (KNPP) in Tamil Nadu has attained its generation capacity of 1,000 MWe.

►ATOMIC ENERGY COMMISSION

- The Indian Atomic Energy Commission was first set up in August 1948 in the Department of Scientific Research, which was created a few months earlier in June 1948. The Department of Atomic Energy (DAE) was setup in 1954

under the direct charge of the Prime Minister through a Presidential Order.

- Subsequently, in accordance with a Government Resolution dated March 1, 1958, the Atomic Energy Commission (AEC) was established in the Department of Atomic Energy. It is headquartered in Mumbai. Dr. Homi Bhabha was the first chairman of AEC. The functions of the Atomic Energy Commission are:

1. to organise research in atomic science in the country;
2. to train, atomic scientists in the country;
3. to promote nuclear research in commission's own laboratories as well as in India; to undertake prospecting of atomic minerals in India

►INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

- It is also known as the world's "Atoms for Peace". The organization works within the United Nations.
- The IAEA is the international centre for cooperation in the nuclear field.
- The Agency works with its Member States and multiple partners worldwide to promote the safe, secure and peaceful use of nuclear technologies.
- The IAEA has its headquartered in Vienna.

►NUCLEAR SUPPLIER GROUP (NSG)

- It was formed in 1974 in response to India's nuclear test, Smiling Buddha also known as Pokharan 1. The primary objective of NSG is to strengthen the NPT. The present strength of NSG is 48 members. As the preliminary meetings were held in London, it is also known as the London Group, the decisions of NSG are consensus based.
- It is engaged in Nuclear Supplies in the form of fuel, equipment and technology. Before 1992, the Reactor Specific Clause of NSG guidelines allowed India to enter Nuclear trade with members and set up nuclear power stations at Tarapur by keeping only the particular power plant under inspection of IAEA.
- In 1992, the guidelines were revised and a full-scope clause was introduced under which a non NPT signatory like India would have to place all its nuclear reactors under IAEA inspection. In 2008, the isolation of India ended when NSG granted a clean waiver to India from the full-scope safeguards.
- In 2011, the NSG guidelines were again modified to prohibit trade in enrichment of Uranium and reprocessing of spent fuel with any country that has not signed NPT.

► ASPEN MEET OF NSG

The Aspen meet of 2011 has laid out the criterion of membership:

1. Ability to supply Nuclear items
2. Adherence to NSG guidelines
3. Enforcement of Domestic Export Control Regimes
4. Compliance to one or more NPT
5. Support to International efforts towards non-proliferation of WMD

India has refused to sign NPT not because of its lack of commitment for non-proliferation but because it considers NPT a flawed treaty which creates a world with 'nuclear haves' and 'have-nots'. India has placed all its civil nuclear establishments under the inspection of IAEA.

►NUCLEAR FREE ZONES

1. Antarctica by Antarctic treaty
2. Space by Outer Space Treaty
3. Seabed by Seabed arms control treaty
4. Tlatelolco treaty for Latin America and Caribbean
5. Bangkok Treaty for South East Asia
6. Pelindaba Treaty for Africa

►ITER (INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR)

- India has assumed chairmanship of ITER council since January 1st 2018 for a period of two years.
- ITER's First Plasma is scheduled for December 2025.
- It is located in Cadarche, Southern France.
- ITER is the world's largest tokamak.
- First fusion device to produce net positive energy.
- First fusion device to maintain fusion for long periods of time.
- First fusion device to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity.

- It is a magnetic fusion device designed to prove the feasibility of fusion as a large scale and carbon free source of energy based on the same principle the powers our Sun and stars.

THE ITER TOKAMAK HAS BEEN DESIGNED TO

- Produce 500 MW of fusion power from 50 MW of input heating power. It will be the first fusion experiment in history to produce net energy gain - generate more energy than it consumes.
- Demonstrate the integrated operation of technologies for a fusion power plant
- Achieve a deuterium-tritium plasma in which the reaction is sustained through heating
- Test tritium breeding
- Demonstrate the safety characteristics of a fusion device

TOKAMAK

- It is an experimental machine designed to harness the energy of fusion. Inside a tokamak, energy produced through fusion of atoms is absorbed as heat in the walls of the vessel. Just like a convention power plant, a fusion power plant will use this heat to produce steam and then electricity by way of turbines and generators.
- It has a doughnut shaped vacuum chamber. In this, due to extreme heat and pressure, gaseous hydrogen fuel becomes plasma - in this state hydrogen atoms can be brought to fuse and produce energy. The charged particles of plasma can be shaped and controlled by massive magnetic coils placed around the vessel. Physicists use this important property to confine the hot plasma away from the vessel walls.

PARTICIPATING COUNTRIES: 35 COUNTRIES

- China, EU, India, Japan, South Koran, Russia and US. The seven members will share the cost of project construction, operation and decommissioning. They will also share the experimental results and IPR generated by operation phase.
- EU is responsible for largest portion of construction costs (45.6%), the remainder is shared equally by China, India, US, Japan, Korea and Russia (9.1% each).

►HYDROGEN BOMB

- A Hydrogen bomb is a powerful atomic weapon. The energy released in a Hydrogen bomb is several magnitudes higher than an Atom bomb. Hydrogen bombs can devastate whole cities in one explosion. A Hydrogen bomb derives its energy through the fusion of atoms. An Atom bomb derives its energy from fission.
- A fusion bomb is more sophisticated and difficult to make, since it requires a much higher temperature (in the order of millions of degrees centigrade). So a fission is carried out first to produce more energy, which is then used to initiate fusion. In a fusion bomb, a fission device has to be triggered first.
- It is easier to make Hydrogen bombs in small size, so it is easier to place them in missiles. Hiroshima and Nagasaki both were atomic bombs and till date Hydrogen bombs have never been used in war. Recently, North Korea has claimed to have mastered over the technique of developing such bombs.

CURRENT affairs& relatedconcepts

►APSARA – U

A swimming pool type research reactor "**Apsara-upgraded"** has become operational at Bhabha Atomic Research Centre (BARC), Trombay.

ABOUT RESEARCH REACTORS

- Research reactors are nuclear reactors used for research, radioisotope production, education, training etc.
- Research reactors are simpler than power reactors and operate at lower temperatures.
- Currently Apsara-u, Dhruva and kamini are the research reactors operational in India.

ABOUT APSARA-U

- It is the **upgraded version of "Apsara",** the first research reactor in Asia which had become operational in 1956 and was shut down in 2009.
- It uses plate type dispersion fuel elements made of **Low Enriched Uranium (LEU).**
- Owing to higher neutron flux, this reactor will **increase indigenous production of radio-isotopes** for medical application by about 50%.

►ROOPPUR NUCLEAR POWER PROJECT

- India and Bangladesh have signed a Civil Nuclear Cooperation Agreement.
- Rooppur Nuclear Power Project is a collaboration between the India, Russia and Bangladesh.
- This will be the first time Indian companies will be able to participate in a nuclear power project abroad.

►MEDICAL CYCLOTRON FACILITY CYCLONE-30

Cyclone-30, the biggest cyclotron in India for medical application became operational in September 2018.

- Cyclone-30 facility at Variable Energy Cyclotron Centre (VECC) , Kolkata is a unit of **Department of Atomic Energy (DAE) .**
- This facility will provide for affordable radio isotopes and related radiopharmaceuticals for the entire country
- It will be used to produce **^{18}F (Fluorine-18 isotope)** for the preparation of **[^{18}FlFluorodeoxyglucose (FDG),** a radio-pharmaceutical .
- After the commissioning of liquid target (for FDG production) and solid targets (production of **Germanium-68, Palladium-103** and other isotopes), work on studies related to installation of **Iodine isotope [1-123]** production target, material study target and Accelerator Driven System target will also be taken up.
- It will also have export potential for Germanium-68/Gallium-68 generator for in-situ production of Gallium-68 and Palladium-103 isotopes, used for breast cancer diagnosis and prostate cancer treatment

ABOUT CYCLOTRON

- A cyclotron is a type of particle accelerator.
- A cyclotron accelerates charged particles outwards from the center along a spiral path.
- The particles are held to a spiral trajectory by a static magnetic field and accelerated by a rapidly varying (radio frequency) electric field.
- Cyclotrons were the best source of high-energy beams for nuclear physics experiments.
- Cyclotrons can be used in particle therapy to treat cancer.
- Ion beams from cyclotrons can be used, as in proton therapy, to penetrate the body and kill tumours by radiation damage, while minimizing damage to healthy tissue along their path.

►CAESIUM - 137

- It is the heavier, radioactive isotope of Caesium whose most stable form is Cs-133. Silvery white, soft and

malleable, Cs-137 is one of the very few metals that exist in liquid form at room temperature.

- It is produced as a byproduct in fission reactions of uranium and plutonium in nuclear plants or nuclear explosions. It is, this, part of the spent fuel.
- Cs-137 has a half-life of about 30 years.
- Cs-137 decays by Gamma and Beta decays. Exposure to small amounts of Cs-137 is not very harmful. Very high exposure can result in increased risk of cancer.

USES

In measuring instruments in the construction and other industries; well logging devices in the drilling industry for characterisation of rocks.

►INDIGENOUS KAIGA NUCLEAR POWER PLANT SETS A WORLD RECORD

- Reflecting India's strength of indigenous capability to design, construct and operate nuclear powers plants and indicates ability to master high-end technology, a world record was set when Unit-1 of Kaiga Generating Station (KGS) continuously operated nuclear power reactors by clocking 941 days of non-stop run.
- KGS stands second in the world among the Pressurised Heavy Water Reactors (PHWRs) and in terms of operating continuously, it stands at the fourth position among all nuclear power reactors.

►KALPAKKAM FAST BREEDER REACTOR EXPECTED TO ACHIEVE CRITICALITY

- Country's first indigenously developed 500-megawatt (mw) prototype fast breeder reactor at Kalpakkam in Tamil Nadu is expected to achieve criticality in 2019.
- Achieving criticality means that the reactor is fully operational and safe.
- The design of the country's first fast breeder reactor, called Prototype Fast Breeder Reactor (PFBR), was done by the Indira Gandhi Centre for Atomic Research (IGCAR).
- **Bharatiya Nabhikiya Vidyut Nigam (Bhavini)**, a public sector company under DAE, has been given the responsibility to build the fast breeder reactors in the country.

►LOCATION OF PROPOSED AND EXISTING NUCLEAR POWER PLANTS IN INDIA

LOCATION & STATE	NATURE	CAPACITY
Kakrapar, Gujarat		2X700 MW
Rawatbhata, Rajasthan		
Gorakhpur		2X700 MW
Kudankulam, Tamill Nadu		2X1000
Kalpakkam, Tamil Nadu (Being Implemented by BHAVINI)	Prototype Fast Breeder Reactors (PFBR)	500
Chutka, Madhya Pradesh		2X700
Kaiga, Karnataka		2X700
Mahi Banswara, Rajasthan		2X700
Jaitapur, Maharashtra (France AREVA)		6X1650 MW
Kovvada, Andhra Pradesh (USA)		5X1208
Chhaya Mithi Virdi, Gujarat (USA)		6X1000
Haripur, West Bengal (Russia)		6X1000 MW
Bhimpur, Madhya Pradesh		4X700 MW
Tarapur, Maharashtra		
Narora, Uttar Pradesh	Pressurised Heavy Water Reactors (PHWR)	

►GLOBAL CENTRE FOR NUCLEAR ENERGY PARTNERSHIP (GCNEP)

- Government of India has approved the establishment of Global Centre for Nuclear Energy Partnership (GCNEP) at village Jasaur Kheri & Kheri Jasaur, near Bahadurgarh, District Jhajjar, Haryana
- GCNEP will help in capacity building, in association with the interested countries and the IAEA, involving technology, human resource development, education & training and giving a momentum to R&D in enlisted areas.

SECTION 7

DEFENCE TECHNOLOGY

►ARIHANT CLASS SUBMARINE

- It is a class of nuclear-powered ballistic missile submarines being built for the Indian Navy.
- The Arihant-class submarines are nuclear powered ballistic missile submarines built under the Advanced Technology Vessel (ATV) project
- They will be **the first nuclear submarines designed and built by India** and are **similar to the Akula-class submarine of Russia.**
- The submarines are powered by a pressurised water reactor with highly enriched uranium fuel and the miniaturized version of the reactor was designed and built by the Bhabha Atomic Research Centre (BARC) at the Indira Gandhi Centre for Atomic Research (IGCAR) in Kalpakkam.
- As of now, one Arihant class submarines, i.e. INS Arihant has been commissioned and other INS Arighat has been launched, of which commissioning is expected by the year 2020.
- Arihant is the first ballistic missile submarine to have been built by a country other than one of the five permanent members of the United Nations Security Council USA, UK, China, Russia and France.

INS ARIHANT

- INS Arihnat, meaning Slayer of Enemies, is the lead ship of India's Arihant class of nuclear-powered ballistic missile submarines.
- Arihant is the first ballistic missile submarine to have been built by a country other than one of the five permanent members of the United Nations Security Council, i.e., USA, UK, China, Russia and France.
- Recently, it successfully completed its first deterrence patrol. With the completion of the patrol, India have finally achieved the longstanding ambition to have a **nuclear triad**.
    - A nuclear triad refers to the three components of atomic weapons delivery: strategic bombers, intercontinental ballistic missiles (ICBMs) and submarine launched ballistic missiles (SLBMs).
- Vessel was built under the Advanced Technology Vessel (ATV) project at the Ship Building Centre in the port city of Visakhapatnam.
- Arihant is capable of carrying nuclear tipped ballistic missiles, the class referred to as Ship Submersible Ballistic Nuclear (SSBN). SSBNs are designed to prowl the deep ocean waters carrying nuclear weapons and provide a nation with an assured second-strike capability — the capability to strike back after being hit by nuclear weapons first.
- It will be armed with the K-15 Sagarika missiles with a range of 750 km and eventually with the much longer range (3500km) K-4 missiles.
- There is also provision to launch non- nuclear tipped BrahMos supersonic cruise missile as well as the 1,000-km sub-sonic cruise missile Nirbhay.

INS ARIGHAT

- INS Arighat is the second Arihant-class, nuclear-powered ballistic missile submarine being built by India.
- Arighat will have twice as many missile hatches as its predecessor INS Arihant, so it will be able to carry more missiles. It will also have a more powerful reactor than Arihant.
- The submarine was originally assumed to be named INS Aridhaman, but when launched it was named INS Arighat.
- It is being built under the Advanced Technology Vessel (ATV) project to build nuclear submarines at the Ship Building Centre in Visakhapatnam.

►NATIONAL AUTHORITY FOR CHEMICAL WEAPONS CONVENTION (NACWC)

The National Authority for Chemical Weapons Convention (NACWC) has been awarded **ISO 9001:2008, Certificate**.

SIGNIFICANCE

- The ISO 9001 Certificate makes the **NACWC** the first among all 188 members nations of **OPCW** to attain this distinction.
- It is also the first Government of India department to have qualified for ISO 9001:2008 certification.
- It is a recognition of **successful performance of the authority** with enhanced administrative efficiency and accountability.

ABOUT NACWC

- NACWC was set up as an office of Cabinet Secretariat to fulfil obligations under Chemical Weapons Convention (CWC).
- **It was established** under **Chemical Weapons Convention Act, 2000**.

- It acts as national focal point for effective bond with Organization for Prohibition of Chemical Weapons (OPCW) and other State Parties.

ABOUT CWC

- It is an **arms control treaty** that outlaws the production, stockpiling, and use of chemical weapons and their precursors.
- The Convention opened for signature in Paris on **13 January 1993.**
- It is administered by the **Organisation for the Prohibition of Chemical Weapons (OPCW)**, an intergovernmental organization based in The Hague, Netherlands.

►ADVANCED TOWED ARTILLERY GUN SYSTEM (ATAGS)

Recently, **Advanced Towed Artillery Gun System (ATAGS),** has set a new world record in range by **hitting targets at a distance of 48 km.**

ABOUT ATAGS

- It is being jointly developed by the **DRDO** and the private sector.
- ATAGS is a 155mm, 52 calibre towed artillery gun being developed in mission mode by DRDO as a part of the **Army's artillery modernisation programme.**

►VERY SHORT-RANGE AIR DEFENCE SYSTEM (VSHORAD)

Army has begun contract negotiations for the **very short-range air defence system** or VSHORAD.

ABOUT VSHORAD

- VSHORAD system should have a **maximum range of 6 km,** an **altitude of 3 km** and **all weather capability.**
- It will replace IGLA (Russian made), currently deployed by army.

ABOUT ILGA

- IGLA is a **man-portable air defence** missile system.
- IGLA is a new-generation system featuring considerably extended firing range and **enhanced kill probability** against aerial targets.
- It possess a new quality for this class of systems - **high engagement effectiveness** against small-size targets like cruise missiles and UAVs.

►DEFENCE PLANNING COMMITTEE (DPC)

Government has established a Defence Planning Committee (DPC) under the **chairmanship of the National Security Adviser** (NSA).

ABOUT DPC

- **Nature:** DPC is a will be a **permanent inter-ministerial body**.
- **Composition:** DPC will consist of the Chairman of the Chiefs of the Staff Committee (COSC), other service chiefs, Defence Secretary, **Foreign Secretary** and **Secretary (expenditure)** in the Finance Ministry.
- NSA is also empowered to co-opt other members as and when required.
- Chief of Integrated Staff in the Defence Ministry will be the member secretary of the DPC, and his headquarters will be the secretariat.
- DPC will **submit all its reports** to the **defence minister.**

►AKASH MISSILE

- Surface-to-air missile
- Capable of destroying aerial targets such as fighter jets, ballistic missiles, cruise missiles
- Range – 25 KM (Short range missile)
- **Supersonic missile** (Speed more than speed of sound in air)
- Capable of carrying the nuclear warhead
- Capable of destroying multiple targets coming from different directions simultaneously

ENGINE

RAM Engine – Air propulsion system

DRDO

Developed indigenously

►NIRBHAY MISSILE

- Sub-sonic cruise missile
- Indigenously developed by DRDO
- Top Speed – 0.7 Mach

- It can be launched from air, sea and water
- Long range missile
- Range of about 1,000 KM

WHAT IS A SUB-SONIC MISSILE?

A missile whose speed is less than the speed of sound in air

►BRAHMOS MISSILE

- Brahmos is jointly developed by India and Russia
- The current range of the missile is 450 KM
- Medium range ramjet Super-Sonic cruise missile – speed of 2.8 Mach
- It can be launched from air, water and sea
- Fastest cruise missile in the world
- The name BrahMos is a portmanteau formed from the names of two rivers, the Brahmaputra of India and the Moskva of Russia.

►INS KALVARI

- It is an Kalvari class Indian submarine that has been commissioned into the Indian Navy.
- It was built at Mazagaon Docks Limited, Mumbai.
- French Naval Company DCNS has assisted India in building the same.
- A project under the Make-In-India programme.

PRELIMS FOCUSED FACTS

- India plans to acquire 6 such Scorpene-class submarines.
- INS Kalvari is the first out of the 6 Kalvari Class submarines. (INS Khanderi and INS Karanj are the next in-line submarines)
  - Other three submarines are: INS Vela, INS Vagir, INS Vagsheer
- It is a diesel-electric attack submarine.
- It is not nuclear capable.
- It is fitted with dual propulsion system.
- Diesel propulsion system
- Air Independent Propulsion System – It would enable the submarine to stay under water for long.
- Torpedoes and Exocets
- Exocets – French made anti-ship missiles

This submarine has been named after '*Tiger Shark*', a deep-sea predator in the Indian Ocean.

►INS KARANJ

- 3rd Scorpene class Submarine
- Technology transfer from France
- Built in India by Mazagaon Docks Limited
- It is being built under Project 75 of the Indian Navy

OTHER SCORPENE CLASS SUBMARINES

- 1st – INS Kalvari
- 2nd – INS Khandari
- INS Kalvari has been commissioned for Indian Navy
- INS Khandari and INS Karanj has been launched and are expected to be commissioned very sooni

►RUSTOM-II

It is an unmanned aerial vehicle or drone developed indigenously by DRDO.

RUSTOM SERIES

4 RUSTOM series drones have been developed by DRDO including RUSTOM-I, RUSTOM-II, RUSTOM-H, RUSTOM-C

FACTS FOR PRELIMS

- RUSTOM-II is a MALE (Medium Altitude and Long Endurance) Drone
- Altitude – 22,000 feet
- Endurance – flight of 20-24 hours
- Can be flown manually and automatically
- Speed – 280 km/hr
- Payloads – Synthetic aperture radar, Medium Range Electro Optic, Long Range Electro Optic

UTILITY

It would be used by all the three armed forces and intelligence agencies for surveillance purposes

►SARAS PT1N

- Saras is the **indigenous multi-role aircraft** developed by National Aeronautics Laboratories (NAL).
- It can perform both civilian and military operations.
- This aircraft programme is named after Indian crane **Saras.**

PT1N

- SARAS PT1N is an upgraded 14-seater aircraft.

- The aircraft has been designed to travel at 425 km/h and it has a maximum continuous flight time of around five hours.
- The aircraft will be **certified for** both civil and military use.
- The plane is **capable of** executing both day and night missions.
- It can be **used for** transporting civilians, freight, and in remote sensing exercises.
- It **can take off** and land from semi-prepared airfields and even on grass runways.
- The aircraft has been designed to operate and manoeuvre at high altitudes and under extreme temperatures.

TECHNICAL UPGRADATION

To make it more effective, the revised version (PT1N) is equipped with a more modern avionics system, improved radar, linear wing flap actuator, environment control, engine flap actuators, better flight control system, a larger metallic rudder for enhanced control, redesigned landing-gear actuators, a brand-new brake system, and a fire-resistant design.

►AGNI V

- Agni-V, with a **range of over 5,000 km**, is India's longest-range intercontinental ballistic missile.
- Agni V is part of the Agni series of missiles, one of the missile systems under the original **Integrated Guided Missile Development Program**.
- It is the **mainstay of India's nuclear triad** (Land, sea and air) to deliver nuclear weapons.

NEW TECHNOLOGIES INCORPORATED

- **Navigation systems**:
  - **Ring Laser Gyro based Inertial Navigation System (RINS):** A ring laser gyroscope (RLG) consists of a ring laser having two independent counter-propagating resonant modes over the same path; thus the difference in the frequencies is used to detect rotation.
  - **Micro Navigation System (MINS):** Most modern and accurate for micro navigation.
- Both these ensured that the missile reached the target point within few metres of accuracy.
- **High speed on-board computer** and **fault-tolerant software** are other technological features.

USAGE OF GRAVITATIONAL PULL

- The missile is **programmed in such a manner** that after reaching the peak of its trajectory, it will turn towards the Earth to continue its journey towards the intended target with an increased speed due to the attraction of the Earth's gravitational pull.

►AGNI-VI (UNDERDEVELOPMENT)

- Agni-VI is an **intercontinental ballistic missile** being developed by the DRDO for the use of the Indian Armed Forces Strategic Forces Command.
- Agni-VI will be a four-stage intercontinental ballistic missile, which is in the hardware development phase, after its design phase was completed.
- Agni-VI is expected to have Multiple independently targetable reentry vehicle as well as Maneuverable reentry vehicle (MaRV).
- It is supposed to have operational range from 8,000-12,000 kms.

OTHER AGNI MISSILES

- Agni-I (Range: 700 km): Short-range ballistic missile
- Agni-II (Range: 2000 km): Medium-range ballistic missile
- Agni-III (Range: 3000 km): Intermediate range ballistic missile
- Agni-IV ((Range: 74000 km): Intermediate range ballistic missile

►MAN PORTABLE ANTI-TANK GUIDED MISSILE (MPATGM)

- MPATGM is third-generation anti-tank guided missile (ATGM) indigenously developed by DRDO.
- It has strike range of 2.5 km. It weighs around 14.5 kg to maintain man portability. It is capable of being fired from shoulder and can be used during day and night. It has minimum lateral centre and gravity offset.
- It works on fire and forget principle and is known for its top attack capabilities. It is effective against both stationary and moving targets. It will be deployed in infantry and parachute battalions of Indian Army.

►NAVIKA SAGAR PARIKRAMA - INSV TARINI

- INSV Tarini is a 56 foot sailing vessel built in India by M/s Aquarius Shipyard Pvt Ltd, Goa. It was inducted into the Indian Navy recently in February 2017. It has Raymarine navigation suite and an array of satellite communication systems for perfect navigation anywhere in the world. It showcases the 'Make in India' initiative on the International forum.
- Navika Sagar Parikrama is the name of expedition for circumnavigation of the globe on INSV Tarini by Indian Navy's Women Naval Officers. The six-member all-woman team circumnavigated and managed the whole operation in their first ever global journey. The voyage finished on 21 May 2018.
- During the course of her voyage, the vessel has met all criteria of circumnavigation, viz. crossing the Equator twice, crossing all Longitudes, as also the three great capes (Cape Leeuwin, Cape Horn and Cape of Good Hope).

►PINAKA

- The indigenous Pinaka rocket system of the DRDO is being evolved into a precision-guided missile, with enhanced range and accuracy to hit its targets.
- Developed by DRDO, the weapon system is equipped with state-of-the-art guidance kit comprising of an advanced navigation and control system.
- It is used to neutralize the enemy's positions that are strategically important for the enemy. The advanced versions of this system can also be used to conduct surgical strikes even without entering into the enemy area.
- Pinaka is capable of working in different modes – autonomous mode, stand-alone mode, remote mode and manual mode.
- The second variant of Pinaka, known as Mark-II, has a maximum range of 75 km.
- DRDO is working with Israel's IMI to develop Pinaka Mark-III which will use IMI's Trajectory Correction System (TCS) that will enhance the accuracy of the attack.

►QUICK REACTION SURFACE-TO-AIR MISSILE (QRSAM)

- The QR-SAM weapon system has been jointly developed by the DRDO and Bharat Electronics Ltd.
- It is a quick reaction, all-weather, network-centric missile system capable of search-on-the-move.
- The missile system can also engage multiple targets within a range of around 30 km with two vehicle configuration for area air defence.5.
- It is a truck-mounted missile with a 360° rotatable, electro-mechanically operated, turret-based launch unit.

►LONG RANGE SURFACE-TO-AIR MISSILE (LRSAM)

- Long Range Surface to Air Missile (LR-SAM) has been jointly developed by DRDO and IAI, Israel to be launched from ship.
- It possesses high degree of maneuverability at target interception range. LR-SAM has been developed to counter a wide variety of airborne threats, like anti-ship missiles, aircraft, helicopters, UAVs drones and supersonic missiles.
- Successful trials of Missile have been carried out recently and the weapon systems proven end to end.

►MISSILE DEFENCE SYSTEM (S-400)

- India has recently completed negotiations to buy **S-400 Triumph air defence systems from Russia**. India wants the missile system to tighten its air defence mechanism against both China and Pakistan.
- Missile defence is a system, weapon or technology involved in detection, tracking, interception and tracking of attacking missiles. The United States, Russia, China, India, Israel and France have all developed such air defence systems.
- Surface-to-air missile is a missile designed to destroy aircraft or other missiles. Attempts to develop them started during World War II and first operational systems were introduced in 1950s.
- **Examples:** Nike Ajax and Patriot (United States), S-75 (Soviet Union), S-300 (Soviet Union and later Russia), etc.
- A list of surface-to-air missiles by countries:

COUNTRY	SURFACE-TO-AIR MISSILE
China	TY, HQ series, Sky Dragon, QW series, etc
France	Masurca, AS-20, Roland, etc
Germany	Roland, IDAS and LFKNC

India	Akash, QRSAM, Barak 8, Trishul, Pradyumna, Ashwin and PDV Ballistic Missile Interceptor
Israel	Arrow, Barak and SPYDER
Pakistan	Anza
United States	FIM, MIM, CIM, RIM, series and Terminal High Altitude Area Defence (THAAD)
USSR/Russian Federation	2K series, 9K series, S-200, S-300, S-400 and S-500
North Korea	KN6

►TACTICAL MISSILE 'PRAHAR'

- It is **solid-fueled surface-to-surface short-range tactical ballistic missile.** It has been indigenously developed by DRDO. It has operational range of 150 km and flight altitude of 35 km.
- It is quick-reaction, all-weather, all-terrain, highly accurate battlefield support tactical missile with advance manoeuvring capability. It is capable of carrying multiple types of warheads weighing around 200 kg and neutralizing wide variety of targets.
- It is fitted with inertial navigation system. It is also equipped with state-of-the-art navigation, guidance and electromechanical actuation systems with advanced on-board computer. It can be launched from road mobile system, which can carry six missiles at time. It can also be fired in salvo mode in all directions from launcher.

SIGNIFICANCE

- Prahaar missile fills vital gap between Multi Barrel Rocket systems such as 'Pinaka' and medium range ballistic missiles such as Prithvi. It also fills short-range tactical battlefield missile role as required by Indian Army to take out strategic and tactical targets. It is comparable to MGM-140 Army Tactical Missile System of United States.

►ASTRA BVR-AAM

- Astra is **air to air beyond visual range** missile indigenously developed by Defence Research and Development Organisation (DRDO).
- More than 50 private and public sector industries are involved in development and production of different sub-systems of the missile.
- It is one of the smallest weapon system developed by DRDO, having length of 3.8-metre and weighing 154kg It is single stage solid fuelled missile and has payload capacity of 15 kg conventional explosives.
- It is radar homing supersonic missile having maximum speed of Mach 4 (four times speed of sound). It possesses high Single Shot Kill Probability (SSKP) making it highly reliable.
- It is all-weather missile with active radar terminal guidance, excellent electronic counter-counter measure (ECCM) features, smokeless propulsion and process improved effectiveness in multi-target scenario.It has advance on-board electronic counter-measures that jam radar signals from enemy radar, making tracking of the missile difficult.
- It is fitted with terminal active radar-seeker and an updated mid-course internal guidance system that helps missile to locate and track targets. The missile can be integrated with all fighter aircraft of IAF including Sukhoi-30 MKI, Mirage-2000, MiG-29, Jaguar and the Tejas Light Combat Aircraft (LCA)

►BALLISTIC MISSILE INTERCEPTOR ADVANCED AIR DEFENCE (AAD) SYSTEM

- DRDO conducted successful tested supersonic endo-atmospheric interceptor missile developed under Ballistic Missile Interceptor Advanced Air Defence (AAD) System from Abdul Kalam Island (earlier known as Wheeler Island) Odisha.
- The Indian Ballistic Missile Defence Programme is an initiative to develop and deploy a multi-layered ballistic missile defence system to protect India from ballistic missile attacks.
- Introduced in light of the ballistic missile threat from mainly Pakistan, as well as from China, it is a double-tiered system consisting of two land and sea-based interceptor missiles, namely the Prithvi Air Defence (PAD) missile for high altitude interception, and the Advanced Air Defence (AAD) Missile for lower altitude interception.
- The two-tiered shield should be able to intercept any incoming missile launched from 5,000 kilometres away.The system also includes an overlapping network of early warning and tracking radars, as well as command and control posts

►LCA TEJAS

- Tejas is a single-seat, single-jet engine, multirole light fighter.
- It is the smallest and lightest multi-role supersonic fighter aircraft in the Indian Air Force.
- It came from the Light Combat Aircraft (LCA) programme, which began in the 1980s to replace India's ageing MiG-21 fighters. In 2003, the LCA was officially named "Tejas"
- It has been designed and developed by Aeronautical Development Agency (ADA) and Hindustan Aeronautics Limited (HAL).

►CHINOOK HELICOPTERS

- Boeing-made Chinook helicopters, are expected to bolster the heavy-lift capabilities of the air force and strengthen India's defence ties with the United States.
- The CH-47F (I) Chinook is a heavy lift, tandem rotor helicopter that serves armed forces of 19 countries. It will greatly enhance IAF's HADR (humanitarian assistance and disaster relief) capability.
- The Chinook is an advanced multi-mission helicopter that will provide support to the Indian armed forces during disaster relief, medical evacuation, search and rescue missions, aircraft recovery and parachute drops.
- Each Chinook can carry goods and cargo weighing up to 9.6 tonnes. The cargo can include men and machines such as artillery guns and light armoured vehicles. Chinook is suited for operations in the Himalayas and has the capability to ferry heavy cargo like road construction equipment over difficult terrain.
- The Chinook contains a fully integrated, Digital Cockpit Management System, Common Aviation Architecture Cockpit and advanced cargo-handling capabilities.
- In July 2018, the first CH-47F (I) Chinook helicopter made for the Indian Air Force completed its first flight. The Indian Air Force received its first Chinook heavy-lift helicopter on February 10 at the Mundra port in Gujarat.

►MISSION SHAKTI (A-SAT)

- Called ASAT in short, it is the technological capability to hit and destroy satellites in space through missiles launched from the ground.
- The test was done in the lower atmosphere to ensure that there is no space debris as the satellite was orbiting at 300 km from Earth's surface.
- In order to carry out this test, India issued a **Notice to Airmen (NOTAM)** to airline authorities across the world informing them about an impending missile test.
    - This notice does not have to specify the kind of missile being tested, only the flight path and the region affected, so that airborne systems are able to avoid it.

OBJECTIVE OF THIS MISSION

- The technology is aimed at destroying, if necessary, satellites owned by enemy countries.
- Strengthening critical infrastructures such as navigation systems, communication networks, broadcasting, banking systems, stock markets, weather forecasting, disaster management, land and ocean mapping and monitoring tools, and military applications.
- To execute this mission, DRDO's Ballistic Missile Defence interceptor was used, which is part of the ongoing ballistic missile defence programme.
- With this mission India joins an exclusive group of space faring nations consisting of USA, Russia and China.
    - It requires very advanced capabilities in both space and missile technologies that not many countries possess.
- There are international treaties governing the use of space, that mandate that outer space, and celestial bodies like the Moon, must only be exploited for peaceful purposes.
    - Outer Space Treaty 1967
- But there is a more compelling, practical and selfish reason for countries not wanting to destroy each other's satellites — the problem of space debris.

IMPORTANT FACTS

- The first anti-satellite test (ASAT) was carried out by the US military way back in 1959. The then Soviet Union followed the test a year later.
- After that Chinese undertook this test in the year 2007.

IMPORTANT FACTS ASSOCIATED WITH THE TEST

Kessler Syndrome:

- It is a scenario in which the density of objects in low Earth orbit (LEO) is high enough that collisions between objects could cause a cascade where each collision generates space debris that increases the likelihood of further collisions.

- The Kessler syndrome (also called the Kessler effect, collisional cascading or ablation cascade), proposed by the NASA scientist Donald J. Kessler in 1978.
- One implication is that the distribution of debris in orbit could render space activities and the use of satellites in specific orbital ranges impractical for many generations.

OTHER WAYS OF MAKING SATELLITES DYSFUNCTIONAL:

- Technologies have been developed to jam the communication from the satellites by interfering with its radio signals.
- Sending satellites that could just approach a target close enough to deviate it from its selected orbit, without destroying it.
- Use of ground-based lasers to 'dazzle' the sensors of the satellites and make them at least "partially blind"

►PRITHVI

- Prithvi is a tactical **surface-to-surface short-range ballistic missile (SRBM)** jointly developed by DRDO of India under the Integrated Guided Missile Development Program (IGMDP).
- The Prithvi missile project encompassed developing three variants for use by the Indian Army, Indian Air Force and the Indian Navy.
  - Prithvi I – Army version (150 km range with a payload of 1,000 kg)
  - Prithvi II – Air Force version (350 km range with a payload of 500 kg)
  - Prithvi III – Naval version, also called as Dhanush (350 km range with a payload of 1,000 kg)

►NAG

- The Nag missile is an Indian third generation **"fire-and-forget" anti-tank guided missile.**
- It is an all-weather, top attack missile with a range of 3 to 7 km.
- It is being developed by India's DRDO under the Integrated Guided Missile Development Program and is manufactured by Bharat Dynamics Limited.
- **Helicopter-launched NAG (HELINA)**, can be fired from Dhruv advanced light helicopter (ALH) and HAL Rudra attack helicopter
- **Land based version (NAMICA)** has maximum range of 4 km while air-based version has a maximum range of 7 km.

►TRISHUL MISSILE

- It is a quick reaction short-range surface-to-air missile developed in India.
- It was developed by DRDO as a part of the Integrated Guided Missile Development Program.
- It can be used as an anti-sea skimmer from a ship against low flying attacking missiles.

►BARAK-8 MISSILE

- Barak 8 also known as **LR-SAM or as MR-SAM is an Indian-Israeli surface-to-air missile (SAM)**, designed to defend against any type of airborne threat including aircraft, helicopters, anti-ship missiles, and UAVs as well as ballistic missiles.
- The missile has maximum speed of Mach 2 with a maximum operational range of 70 km, which was later increased to 100 km.

►MILAN-2T ANTI-TANK MISSILE

- It is an anti-tank missile is aimed at destroying the vehicles that are heavily armoured. The features of the Milan-2T Anti-Tank Missile are:
  - Milan is a portable medium-range, anti-tank missile produced by Euromissile, based in Fontenay-aux-Roses in France.
  - The Milan munitions consist of the missile in a waterproof launch tube.
  - While MILAN 2 has a single shaped charge warhead for use against very thick and composite armour, MILAN 2T is armed with a tandem charge for use against reactive armour.

►DHANUSH ARTILLERY GUN

- **Dhanush is upgraded version of Swedish 155-mm Bofors howitzers**, which India procured in the mid-1980s, based on its original designs.
- It is also dubbed as desi bofors.
- It is the first long-range artillery gun to be produced in India.

- It has been developed by Ordnance Factory Board (OFB), Kolkata based on requirements of Indian Army and manufactured by Jabalpur-based Gun Carriage Factory.

►SMART FENCING OF BORDERS

- **BOLD-QIT** (Border Electronically Dominated QRT Interception Technique) under Comprehensive Integrated Border Management System (CIBMS) was introduced on Indo- Bangladesh border in Dhubri, Assam.
- CIBMS was introduced by Ministry of Home Affairs after the Pathankot terrorist attack.
  - It aims to integrate a grreater usage of technology by the border controlling forces in their Command & Control structure.
  - BOLD-QIT is therefore a technical system within CIBMS to strengthen the border security at India – Pakistan and India – Bangladesh border.

►SPACE FORCE

US is planning to create a Space Force, a new branch of the US Military, by 2020.

SPACE FORCE WILL COMPRISE THREE UNITS:

- **Space Command** will be led by a four star general to oversee warfighting operations.
- **Space Development Agency:** To identify and develop new technologies.
- **Space Operations Force:** Made up of leaders and fighters for their expertise
- At present, US Air Force Space Command looks after space power and air force cyberwarfare. This division will come under Space Force. Space Force will use satellites to aid other arms of the military by strengthening communications, navigation and providing intelligence to counter adversaries which could use missiles or cyber warfare to target its satellites.

►HYPERSONIC WEAPONS

- China has developed its first hypersonic aircraft which could carry nuclear warheads and penetrate any current generation anti-missile defence systems.
- It has been named as **Xingkong-2** or **Starry Sky-2**.
- It travels at least 4 times faster than the speed of sound.
- Hypersonic vehicles have a special type of jet engine called a Supersonic Combustion Ramjet or Scramjet to fly through the atmosphere.
- Russia has developed **Avangard missiles** which is Hypersonic Ren

WHAT ARE HYPERSONIC WEAPONS?

- Can travel more than 5 times the speed of sound (5 mach)
- The low altitude path of Hypersonic weapons combined with the curvature of the Earth helps them hide from radar.
- Challenge to missile defence systems
- Very high speeds gives low time to respond to adversaries

►AK 203 RIFLES

- India will be manufacturing AK 203 rifles at Amethi, Uttar Pradesh after agreement with Russia.
- **It is the most advanced version of AK-47 rifles.**
- It's magazine can hold 30 bullets and has an effective range of 400 m.
- It is lighter and shorter than INSAS rifle.
- These rifles will progressively replace Army's in-service INSAS and AK-47 rifles.
- Will be manufactured in **Korwa area of Amethi**.

SECTION 8

MISCELLANEOUS

►MACH NUMBER

- As an aircraft moves through the air, the air molecules near the aircraft are disturbed and move around the aircraft.
- At higher speeds, energy of the aircraft goes into compressing the air and locally changing the density of the air. This compressibility becomes more important as speed increases.
- Near and beyond the speed of sound, about 330 m/s, small disturbances are transmitted. A sharp disturbance generates a shock wave that affects both the lift and drag of an aircraft.
- The ratio of the speed of the aircraft to the speed of sound determines the compressibility effects. Because of the importance of this speed ratio, aerodynamicists have designated it with a special parameter called the Mach number

►MACH NUMBER (VARIATIONS)

The Mach number M allows to define flight regimes in which compressibility effects vary:

1. **Subsonic**: Occurs for Mach numbers less than one, M < 1.
2. **Transonic:** As the speed of the object approaches the speed of sound, the flight Mach number is nearly equal to one, M = 1, and the flow is said to be transonic.
3. **Supersonic** conditions occur for Mach numbers greater than one,1 < M < 5. Compressibility effects are important for supersonic aircraft, and shock waves are generated by the surface of the object.
4. For speed, greater than five times the speed of sound, **M > 5, the flow is said to be hypersonic**. At these speeds, some of the energy of the object now goes into exciting the chemical bonds which hold together the nitrogen and oxygen molecules of the air.

   Role of Mach Number in Space Research: The speed of sound varies from planet to planet. A Space Shuttle re-enters the atmosphere at high hypersonic speeds, M ~ 25. Under these conditions, the heated air becomes an ionized plasma of gas and the spacecraft must be insulated from the high temperatures.

►MAGLEV TRAINS

- Maglev technology is a high-speed train technology which tries to address these challenges with relatively less maintenance.
- Maglev stands for magnetic levitation which is the technique used in maglev trains. It is a new version of bullet trains or high-speed trains. They are very different from conventional trains as well as high-speed wheeled trains.
- They are levitated, propelled and guided by using magnets. The friction, energy consumption, and the noise production are almost zero as they run on elevated guideways. Maglevs have already led to a highly energy efficient and comfortable version of high-speed trains. Unlike wheeled systems, maglevs do not need maintenance frequently because wheels and the rails do not wear out.

►LIDAR

- The railway is going to use LiDAR technology aerial survey using a chopper to speed up work on India's first high-speed train corridor between Mumbai and Ahmedabad as this technology gives accurate data on contours of the land even below vegetation.
- The use of LiDAR (Light Detection and Ranging) will allow survey of the 508-km corridor to be completed in 9-10 weeks against the normal 6-8 months.
- The advantage of LiDAR is that it penetrates through vegetation to identify the accurate level and contour of land. Therefore, cross-section of land can be seen without any foliage which will help plan for bridges and other infrastructural peripherals.

CURRENT affairs& relatedconcepts

►NATIONAL CHILDREN'S SCIENCE CONGRESS (NCSC)

26th National Children's Science Congress (NCSC) is being held in Odisha.

THEME

Science, Technology and Innovation for a Clean, Green and Healthy Nation

ABOUT NCSC

- A nationwide Science Communication program
- Started in the year 1993.
- It is a forum for children of the **age-group of 10-17 years**, both from formal school system as well as from out of school,

PURPOSE

To exhibit creativity and innovativeness and more particularly ability to solve societal problems experienced locally using method of science.

►INDIAN SCIENCE CONGRESS (ISC)-2019

World's largest science meet **'Indian Science Congress (ISC)-2019'** was held in January 2019, in **Jalandhar, Punjab.**

THEME

Future India: Science and Technology

ABOUT ISC

- **Purpose:** To deliver the benefits of Science & Technology to the last man in the society and scientists being a pivot should put their heart and soul into finding new solutions to the problems facing the nation and improve the quality of life of common man.
- It is the only second time for a University of Punjab to organize their herculean science spectacle.

BACKGROUND

- The Indian Science Congress Association (ISCA) owes its origin to the foresight and initiative of **two British Chemists**, namely, Professor J.L. Simonsen and Professor P.S. MacMohan.
- The first meeting of the Congress was held in January 1914 at the premises of the Asiatic Society, Calcutta.

►HAVING TWO TIME ZONES IN INDIA

Council of Scientific & Industrial Research's National Physical Laboratory (CSIR-NPL), which maintains Indian Standard Time (IST), has published a **research article** describing the necessity of two time zones.

NEED FOR TWO TIME ZONES

- At present, the country observes a single time zone based on the longitude passing through 82°30'E.
- India extends from 68°7'E to 97°25'E, with the **spread of 29°** representing **almost two hours** from the geographic perspective.
- Early sunrise in the easternmost parts- (as early as 4AM in June) in the Northeast - causes the loss of many daylight hours by the time offices or educational institutions open, and that early sunset (4PM in winters), for its part, leads to higher consumption of electricity.
- The researchers estimated **energy savings at 20 million kWh** if we follow two time zones.

PROPOSAL FOR NEW TIME ZONE

- The research paper proposes to call the two time zones IST-I (UTC + 5.30 h) and IST-II (UTC + 6.30 h).
- The proposed **line of demarcation is at 89°52'E**, the narrow border between Assam and West Bengal.
- States west of the line would continue to follow IST (to be called IST-I).
- States east of the line — Assam, Meghalaya, Nagaland, Arunachal Pradesh, Manipur, Mizoram, Tripura, Andaman & Nicobar Islands —would follow IST-II.

►NOBLE PRIZE 2018: PHYSIOLOGY

It has been jointly awarded to **James P. Allison** and **Tasuku Honjo** for their **discovery of 'immune checkpoint therapy,'** a cancer treatment.

IMMUNE CHECKPOINT THERAPY

Concept: Stimulating the inherent ability of our immune system to attack tumor cells by releasing the brakes on immune cells.

DETAILS

- **James P. Allison studied a known protein** that functions as a **brake on the immune system**.
- He realized the potential of releasing the brake and thereby unleashing our immune cells to attack tumors.
- **Tasuku Honjo discovered a protein** on immune cells and, after careful exploration of its function, eventually revealed that it **also operates as a brake**, but with a different mechanism of action.
- Therapies based on his discovery proved to be strikingly effective in the fight against cancer.

►NOBLE PRIZE 2018: PHYSICS

- Nobel Prize in Physics 2018 was awarded for groundbreaking **inventions in the field of laser physics.**
- One half to **Arthur Ashkin** for the **optical tweezers** and their application to biological systems.
- The other half jointly to **Gérard Mourou and Donna Strickland** for their method **of generating high-intensity, ultra-short optical pulses.**
- Donna Strickland is **third women** to win Physics Noble.

APPLICATION

- **Optical Tweezers** are widely used to investigate the machinery of life.
- **Chirped Pulse Amplification (CPA)** are used for subsequent high-intensity lasers. Its uses include the millions of corrective eye surgeries that are conducted every year using the sharpest of laser beams.

►NOBLE PRIZE 2018: CHEMISTRY

- The Nobel Prize in Chemistry 2018 was divided.
- One half awarded to **Frances H. Arnold for the directed evolution of enzymes.**
- The other half jointly to **George P. Smith and Sir Gregory P. Winter** for the **Phage Display** of peptides and antibodies.
- Ms. Arnold, only the **fifth woman** to win a chemistry Nobel.

FIRST DIRECTED EVOLUTION OF ENZYMES

- These are **proteins** that catalyse chemical reactions.
- Has been used in manufacturing of chemical substances, such as pharmaceuticals, and the production of renewable fuels for a greener transport sector.

PHAGE DISPLAY

- Here, a **bacteriophage** – a virus that infects bacteria – can be used to evolve new proteins.
- It has produced anti-bodies that can neutralise toxins, counteract autoimmune diseases and cure metastatic cancer.
- **Adalimumab, a first protein evolved through phage display,** is used for rheumatoid arthritis, psoriasis and inflammatory bowel diseases.

►ABEL PRIZE

- Highest Prize in mathematics awarded annually by the King of Norway to one or more outstanding mathematicians. It is directly modeled after Nobel Prizes.
- It is named after Neils Henrik Abel.
- The 2019 Abel Prize was Awarded to **Karen Uhlenbeck (First time awarded to women mathematician)** for her work in geometric partial differential equations, guage theory and integrable systems.

►FIELDS MEDAL

- It is a prize awarded to two, three or four mathematicians under 40 years of age at the International Congress of International Mathematical Union. This award has been awarded every four years.
- In 2018 the Fields Medal was awarded to 4 people.
- Akshay Venkatesh, who is a Australian citizen of Indian descent was awarded the fields medal in 2018 for his work of analytic number theory, topology and representation theory. He works in Stanford University.

►HYDROGEN-CNG

Delhi is all set to be **India's first city** to launch hydrogen-enriched CNG (HCNG) buses in 2019.

ABOUT HCNG

- HCNG is a vehicle fuel which is a **blend of compressed natural gas and hydrogen**, typically 8-50% hydrogen by volume.
- **Existing natural gas engines can be used** with HCNG, although higher hydrogen blends require re-tuning of the engines for optimal performance.
- Studies indicate that HCNG mixtures with 20- 30% hydrogen by volume are optimal for vehicle performance and **emissions reduction**.
- It improves the **engine efficiency**, lowers fuel consumption upto 5 per cent as compared to a CNG bus.
- Improves combustion, reduces emissions of Carbon Monoxide.

►WORLD'S FIRST HYDROGEN FUEL CELL TRAIN

Germany has rolled out world's first hydrogen fuel cell powered trains called **Coradia iLint.**

ABOUT THE TRAIN

- Coradia iLint is world's **first noise free, zero emissions** trains running at 140km/hr It covers 1000 km on a full tank of hydrogen with seating capacity of 150 passengers.
- Its running cost is **cheaper** than the diesel trains.
- It was manufactured by **Alstom, Europe's largest railway manufacturers**.

ABOUT HYDROGEN FUEL CELL

- It is a fuel cell that combines hydrogen and oxygen to produce electricity with **water and steam as the only by-products**.
- The excess energy can be stored on board in ion lithium batteries.
- It is a climate friendly fuel as it **does not emit carbon dioxide** or particulate matter as the case with conventional fuels like diesel, coal etc.

►POLARIMETRY DOPPLER WEATHER RADAR

ISRO recently launched the **Polarimetry Doppler Weather Radar** at Satish Dhawan Space Centre, Sriharikota.

ABOUT RADAR

- The radar has been indigenously developed by **Bharat Electronics Ltd (BEL),** Bengaluru.
- It is the seventh radar of such type manufactured in the country under "Make in India".

SIGNIFICANCE

- Radar provides advanced information, **enhances the lead-time** essential for saving lives and property in the event of a natural disaster associated with severe weather.
- While conventional radars are able to track and predict cyclones, the Doppler Weather Radar provides **detailed information on a storm's internal wind flow** and structure.
- The polarimetric capability of the radar will **significantly improve the accuracy of rainfall estimation** leading to accurate and timely flash flood warnings, according to ISRO's earlier release.

►PRIME MINISTER'S SCIENCE TECHNOLOGY AND INNOVATION COUNCIL (PM-STIAC)

Union Government constituted new **21-member advisory panel** on science, technology and innovation called Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC).

ABOUT COUNCIL

- It will be chaired by the government's **Principal Scientific Advisor, Dr K. Vijay Raghavan.**
- The new panel will advise the PM on all matters related to science, technology and innovation, and would also monitor the implementation of the PM's vision.
- It will also advise government on developing '**Clusters of Excellence**' in science including city-based R&D clusters.
- It will work to bring together all science and technology partners from academia and institutes to industries near such centres or cities.

►IMPRINT – II

- **Impacting Research, Innovation and Technology** or **IMPRINT** is a national initiative of Ministry of Human Resource Development (MHRD).
- It aims to address engineering challenges in **10 technology domains** relevant to India through an inclusive and sustainable mode.
- The 10 domains include**:** (i) Health care (ii) Information and Communication Technology (iii) Energy (iv) Sustainable Habitat (v) Nano-technology Hardware (vi) Water Resources and River systems (vii) Advanced Materials (viii) Manufacturing (ix) Security and Defense (x) Environmental Science and Climate Change
- **IMPRINT was launched in 2015** as a joint initiative of IIT and IISc under which 142 project are being implemented presently.
- The **round two of IMPRINT – IMPRINT II**, will be jointly funded and steered by MHRD and Department of Science and Technology.

►START UP INDIA'S ACADEMIA ALLIANCE PROGRAM

Start-up India launched Startup Academia Alliance Program.

ABOUT PROGRAM

- It is a **unique mentorship opportunity** between academic scholars and start-ups to promote **the spirit of entrepreneurship** in the country.
- It aims to **reduce the gap** between **scientific research and its industrial application** in order to increase the efficacy of technology and widen its impact.
- It has been partnered by Regional Centre for Biotechnology, The Energy and Resources Institute (TERI), Council on Energy, Environment and Water, and TERI School of Advanced Studies to provide mentorship and guidance to relevant start-ups in the field of **renewable energy, biotechnology, healthcare** etc.

►THERMAL BATTERY

World's first-ever thermal battery plant was inaugurated in Andhra Pradesh.

ABOUT THERMAL BATTERY

- **Conventional battery technology** is based on the system of charging/discharging cycles that are driven by electricity.
- **Thermal batteries**, on the other hand, use thermal energy to operate, i.e., the **energy created by temperature differences**.
- A thermal battery consists of **two parts: a cool zone known as sink, and a hot source called source.**
- Both these sides consist of compounds known as **phase-changing materials (PCMs)**, which can change their state of matter on the basis of a physical/chemical reaction.
- When the sink of a thermal battery receives heat, it **transforms physically or chemically,** thereby storing energy, while the source cools down.
- During operation, the sink is cooled down, so it releases the stored energy, while the source heats up.
- Depending on the nature of the battery, the system can derive heat from any source, which makes a thermal battery **very versatile.**

►INDIA'S FIRST LITHIUM ION (LI-ION) BATTERY PROJECT

Central Electro Chemical Research Institute (CECRI), under **Council of Scientific & Industrial Research** (CSIR) and RAASI Solar Power Pvt Ltd have signed a Memorandum of Agreement for **transfer of technology** for India's first Lithium Ion (Li-ion) Battery project.

ABOUT LITHIUM ION BATTERY

- These are **rechargeable batteries** having **high energy density**
- Rechargeable lithium-ion batteries cycle 5000 times or more compared to just 400-500 cycles in lead acid.
- Commonly used in **consumer electronics.**

APPLICATION

- They have applications in **Energy Storage System** – from hearing aid to container sized batteries to power a cluster of villages, **Electric Vehicles** (2-wheeler, 3-wheeler, 4-wheeler and Bus), Powering Robots in Processing Industry, etc.
- Lithium-ion batteries **can power any electrical application without the need of physical wires-means wireless.**

- They have a potential to enable cost reduction, coupled with appropriate supply chain and manufacturing technology for mass production.
- Technology related to Lithium ion battery can assist in National Electric Mobility Mission, make in India and increasing the share of Clean Energy in the energy basket by generating.

LI ION BATTERY AND INDIA

- Currently, Indian manufacturers **source Lithium Ion Battery from China, Japan and South Korea** among some other countries.
- India is **one of the largest importers** and in 2017, it imported nearly 150 Million US Dollar worth Li-Ion batteries.

►AUGMENTING WRITING SKILLS FOR ARTICULATING RESEARCH (AWSAR)

AWSAR was launched **to reward PhD scholars** and post-doctoral fellows.

ABOUT AWSAR

- The scheme has been initiated by **National Council of Science and Technology Communication** (NCSTC), Department of Science & Technology (DST)
- **Purpose**: To encourage, empower and endow **popular science writing** through newspapers, magazines, blogs, social media etc. by young PhD scholars and post-doctoral fellows during the course of their higher studies.
- Under the scheme best articles which would be selected would be provided **monetary incentives.**

►GRAPHENE BASED BATTERY

Recently, Scientists have developed a new graphene-based battery material with **charging speed five times faster** than lithium-ion batteries.

ABOUT GRAPHENE

- Graphene form of carbon consists of **planar sheets (2D structure)** which are one atom thick, with the atoms arranged in a **hexagonal lattice** (honeycomb-shaped lattice).
- Very **good conductor of electricity and heat**
- About 200 times **stronger** than steel and nearly transparent.
- Impermeable to gases

APPLICATION OF GRAPHENE

It can be used as/in

- Paints and coatings,
- lubricants, oils and functional fluids,
- capacitors and batteries,
- thermal management applications,
- display materials and packaging,
- solar cells, inks and 3Dprinters' materials and films etc.

►PRIME MINISTER'S FELLOWSHIP SCHEME

Cabinet decided to implement "Prime Minister's Fellowship Scheme".

ABOUT THE SCHEME

- It is a public-private partnership (PPP) between
  - **Science & Engineering Research Board (SERB)**, which is an autonomous body under the Department of Science and Technology (DST),
  - Government of India, and
  - Confederation of Indian Industry (CII).
- **Purpose:** to improve the quality of research by **attracting the best talents across the country** and **reduce brain drain**.
- **Eligibility:** Under the scheme **around 1000 students** who have completed B.Tech or integrated M.Tech or M.sc in Science and technology streams will be **offered direct admission in PhD programme in the IITs/IISc** with a fixed amount of fellowship.
- Apart from this, a **research grant of Rs.2 lakhs** will be provided to each of the Fellows for a period of 5 years to enable them to participate in international research conferences and present research papers.

►EXCITONIUM

Researchers have proven the existence of the **new form of matter 'excitonium'**.

ABOUT EXCITONIUM

- It **exhibits microscopic quantum phenomenon** like a super conductor.

- It is formed of excitons.

ABOUT EXCITONS

- When an electron which is seated at the edge of the crowded electron valence band gets excited and jumps over the energy gap into an empty conduction band, its leaves behind a hole in the valence band.
- The **hole in the valence band** acts as a positively charged particle and **attracts the escaped electron.**
- When the escaped electron with negative charge pairs with the hole, a **composite bosonic particle** – exciton is formed.

►JIGYASA INITIATIVE

"JIGYASA" (means curiosity) is one of the major initiatives taken up by CSIR at national level, during its **Platinum Jubilee Celebration** Year.

ABOUT JIGYASA

- It is a **student- scientist connect programme** which will be **implemented by Council of Scientific and Industrial Research (CSIR) in collaboration with Kendriya Vidyalaya Sangathan (KVS).**
- CSIR is widening and deepening its **Scientific Social Responsibility (SSR)** further with the programme.

►BRAYTON TEST LOOP FACILITY

Indian scientists at IISC, Bengaluru, have indigenously developed the Super Critical Carbon Di Oxide Brayton Test Loop facility

WHAT IS BRAYTON TEST LOOP FACILITY?

It is a technology that uses **Supercritical Carbon Di Oxide** for generation of power and solar thermal power plants.

WHAT IS SUPERCRITICAL CARBON DI OXIDE?

- Carbon Dioxide that is maintained above it's critical point
- Temperature > 31 Degrees Celsius
- Pressure > 73 Atmospheres
- Carbon Di Oxide above the critical point is twice as dense as steam.

FEATURES OF BRAYTON TEST LOOP FACILITY

- Supercritical Carbon Di Oxide would replace steam as the working fluid in power plants
- Power plants based on supercritical carbon di oxide have 50% more energy conversion efficiency than normal thermal power plants

BENEFITS

- More energy conversion efficiency would mean more amount energy from same thermal inputs
- This would reduce the carbon foot print and greenhouse gas emission
- Cost effective
- Waterless facilities (Unlike thermal power plants, they don't use water)
- Brayton test loop facility can be linked to solar thermal sources of heat thus, enhancing the amount of green & renewable energy
- The turbine size in Brayton Facility is smaller thus, reducing the initial capital requirements

UMBRELLA PROGRAMME

The supercritical carbon di oxide Brayton Test Loop Facility has been indigenously developed by Indian Scientists under the Solar Energy Research Institute for India and Unites States (SERIIUS)

►EUROPEAN SYNCHROTRON RADIATION FACILITY (ESRF)

India has joined the European Synchrotron Radiation Facility (ESRF) as an **associate member,** thus becoming the **twenty-second country to join it.**

LOCATION AND CONTROL

It is maintained by the European Union is established at **Grenoble, France**

IMPORTANCE

- **Produces high quality X rays**: The ESRF is the most intense source of synchrotron-generated light, producing X-rays that are 100 billion times brighter than the X-rays generally used in hospitals.
- These X-rays, endowed with exceptional properties, are produced by the high-energy electrons that race around the storage ring.

FUNCTIONS AS SUPER MICROSCOPE

It is because of the brilliance and quality of its X-rays, the ESRF functions like a "super-microscope" which "films" the position and motion of atoms in condensed and living matter, and reveals the structure of matter.

OPPORTUNITIES

It provides opportunities for scientists in the exploration of materials and living matter in many fields: chemistry, material physics, archaeology and cultural heritage, structural biology and medical applications, environmental sciences, information science and nanotechnologies.

UPGRADE

ESRF has embarked upon an Upgrade Programme the ESRF-EBS (Extremely Brilliant Source) (2015-2022) programme to develop a new generation of synchrotron storage rings, that will produce more intense, coherent and stable X-ray beams.

►INTERNATIONAL ENERGY AGENCY

- It is a **Paris** based autonomous intergovernmental organisation established in the framework of OECD in 1974 in the wake of 1973 oil crisis.
- It was initially dedicated to responding to physical disruptions in the supply of oil as well as serving as an information source about the international oil market and other energy sources.
- It acts as policy adviser to its member states but also with non-member states such as China, India and Russia.
- The agency's mandate has been broadened to focus on 3E's of Energy Security, Energy Development and Environmental Protection.
- It has broad role in promoting alternate energy sources, rational energy policies, and multinational energy technology co-operation.
- **Membership:** Only OECD member states can become members of the IEA. Except for Chile, Iceland, Israel and Slovenia all OECD member states are members of IEA.
- India is not a full member of the body but **associate member**. Other associate members are China, Indonesia, Morocco, Singapore and Thailand.

►IEA'S TCP ON BIOENERGY (IEA'S TECHNOLOGY COLLABORATION PROGRAM ON BIOENERGY)

- **Ministry of Petroleum and Natural Gas** (GOI) has joined IEA's Bioenergy TCP as its 25th member.
- It is an international platform for co-operation among countries with aim of improving cooperation and information exchange between countries that have national programs in bioenergy research, development and deployment.
- It aims to facilitate the market introduction of advanced biofuels with an aim to bring down emissions and reduce crude imports.
- Provides a platform for international collaboration and information exchange in bioenergy research, technology development, demonstration, and policy analysis with a focus on overcoming environmental, institutional, technological, social and market barriers to near and long term deployment of bioenergy technologies.
- R&D work under the IEA Bioenergy TCP is carried out within well-defined 3-year program called 'Tasks'. Each year the progress of the Tasks is evaluated and scrutinized and each 3 years the content of the Tasks is reformulated and new Tasks initiated.
- India can participate in other related Tasks focussing on Biogas, Solid Waste Management, Biorefining etc.

►ADVANCED MOTORS FUELS - TECHNOLOGY COLLABORATION PROGRAM (AMF-TCP)

- Joining of AMF-TCP by **Ministry of Petroleum and Natural Gas** (MOPNG) is to facilitate the market introduction of Advanced motor fuels with an aim to bring down emissions and achieve higher fuel efficiency in transport sector. India will be 16th member of AMF-TCP.
- Also provides an opportunity for fuel analysis, identifying new/alternate fuels for deployment in transport sector and allied R&D activities for reduction in emissions in fuel intensive sectors.
- Over the years, a number of fuels have been covered in previous Annexes such as
  - Reformulated fuels (gasoline & diesel)
  - Biofuels (ethanol, biodiesel)
  - Synthetic fuels (Methanol, Fisher-Tropsch, DME etc)
  - Gaseous Fuels
- Association with AMF-TCP will help MOPNG in furthering its efforts in identification and deployment of suitable for deployment in transport sector in near future.

►INTERNATIONAL ENERGY AGENCY – OCEAN ENERGY SYSTEMS (IEA-OES)

- India is also member of IEA-OES.
- Nodal agency for membership would be **National Institute of Ocean Technology.**
- India will have access to advanced R&D teams and technologies across the world. India will have access to technology collaboration in ocean energy devices (including wave, currents and tidal). India being a tropical country has high sea surface temperatures and hence Ocean Thermal Energy Conversion (OTEC) is a good option for India.
- IEA-OES initiative is to advance research, development and demonstration of technologies to harness energy from all forms of ocean renewable resources, as well as for other uses, such as desalination etc. through international cooperation and information exchange.

►EARTH BIOGENOME PROJECT

Aims to sequence, catalog and characterise the genomes of **all of the Earth's eukaryotic biodiversity over in 10 years.**

IT IS AN INTERNATIONAL COLLABORATION

- US Department of Agrculture:
- Vertebrate Genomes Project - Aims to sequence the genetic code of all 66,000 extant vertebrates. (Rockfeller University, USA)
- BGI - China: Leading the effort to sequence 10,000 plant genomes
- Global Ant Genomes Alliance: Aims to sequence around 200 ant genomes.
- Many others

GOALS

- Benefitting Human Welfare
  - Create new biological synthetic fuels
  - Generate new bio materials
  - Generate new approaches to feeding the world
  - Identify drugs to slow or reverse ageing
  - Develop new treatments for infectious and inherited diseases
- Protecting Biodiversity
- Understanding Ecosystems

►BIOFUTURE PLATFORM

It is an action-oriented, country-led, multistakeholder mechanism for policy dialogue and collaboration among leading countries, organisations, academia and the private sector.

LAUNCHED IN 2016

- **Proposed by Brazil.** The initiative aims to bring relatively limited but strong group of like-minded countries which are either already leaders in the new advanced **bio-economy or interested in its development.**
- 20 countries are founding and current Member States: Argentina, Brazil, Canada, China, Denmark, Egypt, Finland, France, India, Indonesia, Italy, Morocco, Mozambique, Netherlands, Paraguay, Philippines, Sweden, UK, USA, Uruguay.
- Biofuture Platform's core groups consists of Brazil, India, UK, Canada and Netherlands.
- Initially Government of Brazil acted as the secretariat/facilitator of the Biofuture Platform. However, **from February, 2019 International Energy Agency (IEA)** took over as the Facilitator of the body.

►MISSION INNOVATION

- It is a global initiative of 23 countries and the European Commission (on behalf of EU). These 24 members have committed to seek to:
  - Double public investment in clean energy R&D in 5 years
  - Engaging with the private sector, fostering international collaboration
  - These countries collectively accounts for more than 80 percent of the world's total public financing of clean energy R&D.
- Mission Innovation Champions Programme to felicitate clean energy innovators

INNOVATION CHALLENGES

1) Smart Grids Innovation Challenge
2) Off-Grid Access to Electricity Innovation Challenge
3) Carbon Capture Innovation Challenge
4) Sustainable Biofuels Innovation Challenge
5) Converting Sunlight Innovation Challenge
6) Clean Energy Materials Innovation Challenge

7) Affordable Heating and Cooling of Buildings Innovation Challenge
8) Renewable and Clean Hydrogen

- International Energy Incubator is located in India.
- India has established a separate Mission Innovation secretariat.
- Ministry of Science and Technology is the nodal ministry of Mission Innovation in India
- **India Co-leads the:**
  - Smart Grids Innovation Challenge
  - Off-Grid Access to Electricity Innovation Challenge
  - Sustainable Biofuels Innovation Challenge
- **Participates in the:**
  - Carbon Capture Innovation Challenge
  - Converting Sunlight Innovation Challenge
  - Clean Energy Materials Innovation Challenge
  - Affordable Heating and Cooling of Buildings Innovation Challenge
  - Renewable and Clean Hydrogen Innovation Challenge

►NEW SPECIES OF MAN FOUND - HOMO LUZONENSIS

- Found in Callao Cave, Luzon Island, Philippines
- Homo Luzonensis is the 2nd new human species to be identified in southeast Asia in recent years. In 2004, Homo Floresiensis , also known as Hobbit, a species that would have stood over just a metre in height, was discovered on Flores Island of Indonesia.

FEATURES OF HOMO LUZONENSIS

- Extremely small molars compared with other ancient human relatives
- Cusps on the molars, like those in Homo Sapiens, are not as pronounced as they were in earlier hominins. Shape of internal molar enamel looks similar to that of both Homo sapiens and Homo erectus.

►SHIFT IN MAGNETIC NORTH POLE

Earth has:

- **Geographic poles** which are defined by the axis around which the planet rotates, and are fixed.
- **Magnetic Poles:**
  - Earth acts as a bar magnet with a magnetic North Pole and mangetic South Pole. The magnetic North Pole which was located in Northern Canada is moving towards Russia.
- The pace of movement of magnetic north pole used to be about 14-15 km per year till the 1990s. It has increased to 55 km per year in last few years.
- Earth's magnetism is due to movement of iron and nickel in earth's core.
- **World Magnetic Model (WMM)** tracks the movement of magnetic poles. Every five years, a new and updated version of the WMM is released. It was last updated in 2015 and the next was scheduled to be released in end 2019. However, due to extraordinarily large and erratic movements of the north magnetic pole, an out of cycle update as released in February 2019. It is produced by US National Geophysical Data Centre in collaboration with British Geological Survey.

IMPACT OF ACCELERATED SHIFT IN MAGNETIC POLES

- Transportation sector such as aviation and shipping depends on correctly knowing the position of magnetic north to chart out their navigation paths.
- Strategic reasons: Magnetic north helps in firing missiles

►EARTHQUAKE SWARM

- It is a series of many (sometimes thousands) low intensity earthquakes without a discernible main shock than can occur over weeks in active geothermal areas.
- An Earthquake Swarm was experienced in Palghar, Maharashtra.
- Such swarms have been experienced previously in Saurashtra, Gujarat and Koyna, Maharashtra also.

►DAY LIGHT SAVING TIME

It is a practice in which clocks are moved forward in the summer. This practise is more popular in countries in European and American countries.

REASONS FOR DAY LIGHT SAVINGS

- Reduced spending on lighting needs

- Increased length of day time

NEGATIVE IMPACTS

- Changing times leads to interference with circadian rhythms
- Inconvenient for businesses
- Countries near the Equator do not experience high variations in daytime hours between seasons. India also does not follow day light savings time.
- **EU has voted to end the practice of Day light saving from 2021.**

►GROSS DOMESTIC KNOWLEDGE PRODUCT

- Propounded by **Umberto Sulpasso**, Senior Fellow, Centre for Digital Future, University of Southern California.
- As an economy develops, the key driver of growth changes over time. However, one engine which has always dominated the modern times and has acted in different ways, is Knowledge.

4 BASIC PILLARS OF GDKP ARE:

- Knowledge Items:
- Country's knowledge producing matrix
- Country's knowledge user matrix
- Cost of Learning

India was the first country for which GKDP was calculated.

►DST-INTEL COLLABORATIVE RESEARCH PROJECTS

STREAMING ANALYTICS OVER TEMPORAL VARIABLES FROM AIR QUALITY MONITORING (SATVAM)

- High resolution air quality monitoring and air pollutant data analytics
- These projects will lead to the design and development of low-cost, multi-parameter, water quality platforms with auto-sampling capabilities integrated with energy harvesting system. The projects will also result in development of sensors for water quality and water flow integrated with communication system to develop an early warning mechanism.

WATER QUALITY MONITORING PROJECTS ARE:

1. Aquatic Autonomous Observatory (*Niracara Svayamsasita VedhShala - NSVS*)
2. Integrated low-cost water sensors for real- time river water monitoring and decision- making (SensorWarn)

These projects will lead to the design and development of low-cost, multi-parameter, water quality platforms with auto-sampling capabilities integrated with energy harvesting system. The projects will also result in development of sensors for water quality and water flow integrated with communication system to develop an early warning mechanism.

►FORWARD SEARCH EXPIREMENT (FASER)

- It aims to find light, extremely light and weakly interacting particles that have so far not been discovered, even at the Large Hadron Collider, which the world's largest particle accelerator in the world.
- **Four main LHC detectors** - are not suited for such particles that might be produced parallel to the beam line.
  - It will be a new experiment at CERN.
  - It will be operational in 2021.

►WORLD'S STANDARD DEFINITION OF KILOGRAM, SECOND & METRE REDEFINED

- At 26th meeting of the General Conference on Weights and Measures (CGPM) held at Palais des Congrés, Versailles, France has decided to redefine World's standard definition of kilogram, Second & Metre.
- The definition of the **seven base units** namely, **second, metre, kilogram, ampere, Kelvin, mole and candela** has been changed from being linked to artefacts to being based on the fundamental constants on nature.
- For example - definition of metre has been changed to link it to the speed of light.

BENEFITS

- The change in the definition will result in uniform and worldwide accessible SI system for international trade, high- technology manufacturing, human health and safety, protection of environment, global climate studies and the basic science under-pinning these.
- The units are expected to be stable in the long term, internally self-consistent and practically realisable being

based on the present theoretical description of nature at the highest level.

ABOUT GENERAL CONFERENCE ON WEIGHTS AND MEASURES (CGPM)

- CGPM is the **highest international body** of the world for accurate and precise measurements.
- India became a signatory in 1957
- Comprises of 60 countries including India and 42 Associate Members.
- The **International Bureau of Weights and Measures (BIPM)**, the main executive body of CGPM has the responsibility of defining the International System of Units (SI)
- The dissemination of SI units for the welfare of society and industries in India is the responsibility of **Legal Metrology, Department of Consumer Affairs, Government of India.**

ABOUT KILOGRAM

- The International prototype of kilogram (IPK) is kept at the BIPM, Paris and serves as the international standard of kilogram.
- It is made of 90% platinum and 10% iridium and is a cylinder of 39 mm diameter and 39 mm height.
- Replicas of the IPK are made of the same material and used at BIPM as reference or working standards and national prototype of kilogram (NPK), kept at different National Metrology Institutes (NMIs).
- NPK-57, kept at **CSIR- National Physical Laboratory**, is sent periodically to BIPM for calibration.

→ KIBBLE BALANCE

- Kibble balance is a self-calibrating electromechanical balance and provides the measurements of mass, traceable in terms of electrical parameters and provides linkage of macroscopic mass to the Planck constant(h)
- **NPL-India**, in association with Department of Consumer Affairs, Government of India is looking forward for the development of 1 kg Kibble balance.
- The advantages of Kibble balance would be that the NPK need not to be sent to BIPM for calibrations and the accuracy and stability of Kibble balance is very high which is very important where low weights with high accuracies are essential, for example in pharmaceuticals and biotechnologies.

►2019 AS THE YEAR OF PERIODIC TABLE

- **UN General Assembly** has proclaimed 2019 as the International Year of the Periodic Table of Chemical Elements (IYPT).
- 1869 is considered as the year of discovery of the Periodic Table by the Russian scientist, **Dmitri - Mendeleev.**
- **2019 will be the 150th year of establishment of the Periodic Table.**
- Periodic Table of Chemical Elements is one of the most significant achievements in science, capturing the essence not only of chemistry, but also of physics and biology.
- It is a unique tool, enabling scientist to predict the appearance and properties of matter on the Earth and in the rest of the Universe.
- The Periodic Table of Chemical Elements is one of the most significant achievements in science, capturing the essence not only of chemistry, but also of physics and biology.
- It is a unique tool, enabling scientist to predict the appearance and properties of matter on the Earth and in the rest of the Universe.
- The 2019 International Year of the Periodic Table is **an IUPAC initiative** and widely supported. The management committee consisting of representatives of the initiating organizations, **UNESCO** and a number of later added international organizations

→ INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY (IUPAC)

- It is the world authority on
  - chemical nomenclature and terminology
  - naming of new elements in the periodic table
  - standardized methods for measurement
  - atomic weights
- It was established in 1919 by academic and industrial chemists.
- 2019 is the 100th year of the establishment of the body.

►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 horizontal cross-section of the eventual 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.

APPLICATIONS OF 3D PRINTING

- **Education:** 3D printing enables students to materialise their ideas in a fast and affordable way.
- **Rapid Prototyping:** Manufacturers have long used 3D printers in their design process to create prototypes.
- **Rapid Manufacturing:** Rapid manufacturing is a new method of manufacturing where companies are using 3D printers for short run / small batch custom manufacturing
- **Automotive:** Companies are using it to produce not just parts, but tools, jigs and fixtures
- **Aviation:** Aerospace component
- **Data processing :** Multi material voxel-printing method enables the physical visualisation of data sets commonly associated with scientific imaging.
- **Construction:** Can you print buildings? – you sure can. There are not many of them, but companies like Apis Cor are producing fascinating results. The company claims it can print a house within 24 hours.
- **Architecture:** When architects need to present their work as a physical scale model, 3D printing will always be a quick and efficient way to do it
- **Consumer Products:** Furniture, Lighting, Jewellery
- **Medical & Dental:** Patients around the world are experiencing improved quality of care through 3D printed implants and prosthetics never before seen
- **Food:** 3D Printing is allowing for odd kinds of food to come about. Shape-changing or transparent pasta's could be available at a store near you any time soon. Even NASA are getting in on the act with pizza printed in space.

SECTION 2

MCQs

ANSWER KEY

Q1. The applications of Navic include:
1. Terrestrial, Aerial and Marine Navigation
2. Disaster Management
3. Mapping and Geodetic data capture
4. Visual and voice navigation for drivers

Select the correct answer using the code given below.
(a) 1 and 2 only (b) 1, 2 and 3 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Q2. NASA's ICESat-2 mission aims to
(a) Explore the presence of ice on mars
(b) Map melting ice sheets in Greenland and Antarctica
(c) Understand the sea level rise across the globe
(d) Both b and c

Q3. Consider the following statements about Graphene:
1. Graphene is an allotrope of carbon.
2. It conducts heat and electricity efficiently, and is non-transparent.
3. Graphene supercapacitors can charge faster and has longer life span than traditional electrolytic batteries.

Which of the above statements is/are correct?
(a) 1 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Q4. Consider the following statements about Gaganyaan
1. ISRO and NASA have agreed to work together for first manned space mission Gaganyaan.
2. India is planning to send three humans (Gaganyatris) into space i.e. in low earth orbit (LEO) by 2022.
3. This mission will make India third nation in the world after USA and China to launch human spaceflight mission.

Which of the statements given above is/are correct?
(a) 3 only (b) 2 only
(c) 1, 2 and 3 (d) 1 and 2 only

Q5. Consider the following statements with reference to Chang'e-4 mission:
1. The mission has been launched by China
2. It is China's first manned mission to Moon

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q6. Which of the following are the global satellite navigation systems?
1. GPS 2. GLONASS
3. Galileo 4. BeiDou
5. QZSS 6. NavIC

Select the correct answer using the code given below:
(a) 1, 2, 3, 4 (b) 1, 3, 5, 6
(c) 1, 2, 3, 5, 6 (d) 1, 2, 3, 4, 5, 6

Q7. Consider the following statements:
1. The GSLV MkII is a two-stage heavy lift launch vehicle developed by ISRO.
2. The GSLV MkIII has four solid strap-ons, a core liquid booster and a cryogenic upper stage.
3. The GSLV MkIII launched GSAT-29, a communication satellite for high-quality internet services.

Which of the statements given above is/are correct?
(a) 1 and 2 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

Q8. Consider the following statements with reference to 'Hyper-spectral Imaging':
1. It can be used to analyse soil health without requiring physical collection of soil samples.
2. Recently, ISRO launched India's first Hyperspectral Imaging Satellite (HysIS).

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q9. The Remove Debris project is most closely related to
(a) Great Pacific Garbage Patch
(b) Global Warming
(c) Solar storms
(d) Kessler's syndrome

Q10. According to the International Astronomical Union (IAU), a "dwarf planet" in the solar system is a celestial body that
(a) Is a satellite.
(b) Has a nearly round shape.
(c) Is not in orbit around the sun.
(d) Has cleared the neighbourhood around its orbit.

Q11. Which of the following demonstrations/technologies associated with the proposed Gaganyaan programme have been successfully tested?

1. Space Capsule Recovery Experiment
2. Crew module Atmospheric Reentry Experiment
3. Pad Abort Test
4. GSLV MkIII

Select the correct answer using the code given below:

(a) 1, 2 and 3 only (b) 2 and 3 only
(c) 1 and 4 only (d) 1, 2, 3 and 4

Q12. Consider the following statements about Agni-V:

1. It has a range which enables it to reach most parts of China.
2. Along with the Prithvi, the Agni series of missiles are part of India's nuclear weapons delivery systems.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q13. Consider the following statements about the James Webb Space Telescope:

1. It is a successor to the Thirty MetreSpace Telescope
2. Its mirrors are made from beryllium and coated with gold

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q14. Which of the following reasons best explains why metal utensils do not work in microwave ovens?

(a) They deflect microwaves from the food.
(b) They produce sparks on coming in contact with microwaves.
(c) They are bad conductors of heat.
(d) They absorb all microwaves not allowing heat to reach the food.

Q15. How do detergents clean greasy dirt from fabrics?

(a) By increasing the volume of the liquid used to wash the fabric.
(b) By decreasing the viscosity of the water.
(c) By increasing the temperature of the water.
(d) By decreasing the surface tension between water and oil/grease.

Q16. With reference to neutrinos, consider the following statements:

1. It is a subatomic particle with no electrical charge and a very small mass.
2. It travels close to the speed of light.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q17. With reference to blood pressure in a healthy human body, consider the following statements:

1. It is the force that blood exerts against the wall of a blood vessel.
2. It is greater in arteries than in veins.
3. It is measured by sphygmomanometer.

Which of the statement given above is/are correct?

(a) 1 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Q18. With reference to the Department of Atomic Energy's 3-stage Nuclear Power Programme, consider the following statements:

1. The first stage envisages setting up of Fast Breeder Reactors (FBRs).
2. Plutonium is produced in the second stage by irradiation of uranium-238.
3. The third stage is based on the Plutonium-Uranium cycle.

Which of the statements given above is/are correct?

(a) 1 and 3 only (b) 2 and 3 only
(c) 2 only (d) 1, 2 and 3

Q19. Consider the following statements regarding the ExseedSAT 1, India's first private satellite:

1. It is the mini communication satellite weighing just a kg.
2. It was recently launched in space by ISRO.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q20. With reference to dark matter, consider the following statements:

1. It does not interact with the electromagnetic force.
2. The existence of dark matter can be inferred from its gravitational effect.
3. The majority of the universe is made of the dark matter.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q21. Technical specifications for 5G technology includes:

1. Massive connectivity
2. Ultra-low latency
3. High reliability
4. High data rates

Select the correct answer using the code given below.

(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Q22. Which among the following is NOT the basic principle of the net neutrality?

(a) Nobody owns the internet.
(b) It is free and open to all.
(c) Internet Service Providers (ISPs) must treat all internet traffic equally.
(d) None of the above

Q23. Consider the following statements regarding the GROWTH-India.

1. It is India's first robotic telescope.
2. It has been funded by the Science and Engineering Board (SERB).

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q24. The government has formed a high-level panel under the chairmanship of **Rajiv Kumar** to lay out a roadmap to

(a) Facilitate India's research and development on AI and its applications.
(b) Study use of artificial intelligence in military.
(c) Revive economic growth.
(d) None of the above

Q25. Which of the following statements is/are correct?

1. Global Cybersecurity Index (GCI), released by the International Telecommunication Union (ITU),
2. India has been listed in the top 3 most committed countries to cybersecurity.

Select the correct answer using the code given below:

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q26. Which of the following statements regarding recently unveiled supercomputers PRATYUSH and MIHIR is NOT correct?

(a) India's fastest supercomputer is named PRATYUSH.
(b) MIHIR is a high performance computer system.
(c) These are India's first multi-petaflop supercomputers.
(d) It is the fastest super-computer in the world.

Q27. Which of the following statements is NOT correct about the World Congress on Information Technology (WCIT) 2018?

(a) It was held in Hyderabad for the first time in India.
(b) It is a biennial event and considered as the biggest event of its kind
(c) It was first held in 2008.
(d) Its theme was "Future Enterprises".

Q28. What is/are the significance of recently launched Repurpose Used Cooking Oil (RUCO) Initiative ?

1. Used cooking oil can be converted to bio-diesel.
2. Public health will be promoted.
3. There will be less environmental hazards.

Select the correct answer using the code given below.

(a) 1 only (b) 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Q29. Which of the following statements is NOT correct with regard to the Coloured X-Ray on Human ?

(a) Scientists have performed the first-ever 3-D, colour X-ray on a human.
(b) It records the precise energy levels of the X-rays as they hit each particle in your body.

(c) It is unable to show the clear difference between bone, muscle and cartilage.
(d) It incorporates particle-tracking technology developed for CERN's Large Hadron Collider.

Q30. Which of the following statements regarding the Artificial Leaf is/are correct ?
1. It will help in reducing carbon footprint.
2. It is 100 times more efficient than a natural leaf in absorbing carbon dioxide.
3. It can convert about 100 per cent of the incident solar energy into chemical energy.

Select the correct answer using the code given below:
(a) 2 only (b) 1 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

Q31. The fuse wire in an electric circuit is based upon which among the following properties of electric current?
(a) Heating effect of current
(b) Ionising effect of current
(c) Magnetic effect of current
(d) Chemical effect of current

Q32. Arrange the following electromagnetic radiations in decreasing order of energy:
1. Gamma rays 2. Ultraviolet rays
3. X-rays

Select the correct answer using the codes given below.
(a) 1-3-2 (b) 2-1-3
(c) 1-2-3 (d) 3-1-2

Q33. Consider the following statements about the ROTAVAC vaccine:
1. It is developed by Bharat Biotech Limited.
2. It has recently received WHO pre-qualification.
3. It is yet to be included in India's Universal Immunization Program.

Which of the statements given above is/are correct?
(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q34. Consider the following statements regarding the Active Pharmaceutical Ingredients (APIs):
1. APIs are the active raw materials used in a drug that give it the therapeutic effect.
2. V.M. Katoch committee was formed to formulate a long-term policy and strategy for promoting domestic manufacture of APIs/bulk drugs in India.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q35. Consider the following statements regarding the E-cigarettes:
1. E-cigarettes are a type of Electronic Nicotine Delivery Systems (ENDS) which claims to emit nicotine without other harmful chemicals that are present in normal cigarettes.
2. They aim to provide a similar sensation to inhaling tobacco smoke, without the smoke and are sold as aids to reduce or quit smoking.
3. They produce an aerosol by heating a fluid that usually contains nicotine, flavorings, and other chemicals which is then inhaled by users of e-cigarettes.

Which of the statements given above is/are correct?
(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q36. World TB Report 2018 was released by
(a) WHO (b) WMA
(c) UNDP (d) Lancet

Q37. Consider the following statements about the Integrated Health Information Platform (IHIP):
1. It is launched in all States and UTs under Integrated Disease Surveillance Programme (IDSP).
2. It is real time, village wise, case based electronic health information system with GIS tagging.
3. It will help in prompt prevention and control of epidemic prone diseases.

Which of the statements given above is/are correct?
(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q38. Consider the following statements about the World Intellectual Property Organization (WIPO):

1. WIPO It is one of the 15 specialized agencies of the United Nations
2. It is headquartered at Geneva, Switzerland.
3. It aims to promote worldwide protection of both industrial property and copyrighted materials.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q39. Kandhamal Haldi (turmeric), famous for its healing properties, is all set to receive GI tag. To which state does it belong?

(a) Odisha (b) Rajasthan
(c) Madhya Pradesh (d) Tamilnadu

Q40. Chips manufacturers usually flush bags of chips with nitrogen gas to

(a) make the bag lighter.
(b) prevent oxidation of the chips.
(c) make chips crispier.
(d) prevent growth of microorganisms.

Q41. Consider the following statements about International Intellectual Property Index (IIPI):

1. Global Innovation Policy Centre (GIPC) of US Chambers of Commerce had released the International Intellectual Property Index (IIPI) 2018.
2. It is an annual Index which examines a country's Intellectual Property (IP) framework across eight categories of indicators.
3. India has been ranked among top 10% nations in this index.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q42. Consider the following statements about National Authority for Chemical Weapons Convention (NACWC)

1. NACWC was set up as an office of Cabinet Secretariat to fulfil obligations under Chemical Weapons Convention (CWC).
2. It was established under Chemical Weapons Convention Act, 2000.
3. It acts as national focal point for effective bond with Organisation for Prohibition of Chemical Weapons (OPCW) and other State Parties.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q43. Which of the following correctly explains 'Quasar'?

(a) A highly magnetized, rotating neutron star that emits a beam of electromagnetic radiation.
(b) Bright distant objects that derive energy from black hole at the cores of galaxies.
(c) Objects which are too large to be called planets and too small to be stars.
(d) Interstellar clouds that contain a very high concentration of dust.

Q44. Consider the following statements about INS Aridhaman"

1. It is the first Arihant-class submarine, slated to be launched and inducted into services.
2. It is nuclear-power ballistic missile submarine.
3. It is powered by a pressurized water reactor.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q45. Consider the following statements about the Project Dhoop:

1. It is a nationwide campaign launched by FSSAI along with NCERT, New Delhi Municipal Council and North MCD Schools.
2. It aims to spread awareness about consumption of Vitamin D through natural sun light and consuming fortified food among school going children.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q46. Consider the following statements regarding the new definition of 'Kilogram':

1. The 26th General Conference on Weights & Measures (CGPM) in a historic decision unanimously redefined World's standard definition of kilogram.

2. It will result in uniform and worldwide accessible SI system for high- technology manufacturing, basic science, etc.
3. It will change measurements in our day to day life like in kitchen, trade & transport etc.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q47. Consider the following statements about Indian Science Congress (ISC)-2019:

1. It was held in January 2019, in Jalandhar, Punjab.
2. Its theme was 'Future India: Science and Technology'

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q48. Consider the following statements about Higgs Boson:

1. It is popularly known as the God particle and is responsible for giving mass to fundamental subatomic particles.
2. Recently, Scientist at CERN observed the Higgs boson decaying to fundamental particles known as bottom quarks.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q49. 2018 Noble Prize in Physiology was awarded for

(a) the discoveries of molecular mechanisms controlling the circadian rhythm.
(b) the discoveries of mechanisms for autophagy.
(c) the discoveries of cells that constitute a positioning system in the brain.
(d) the discovery of cancer therapy by inhibition of negative immune regulation.

Q50. Consider the following statements about recently established Defence Planning Committee:

1. It will be chaired by Prime Minister.
2. It will be a permanent inter-ministerial body.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q51. Which among the following are present in the blood group AB?

1. Antibody A 2. Antigen A
3. Antibody B 4. Antigen B

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 4 only (d) All are present.

Q52. Consider the following statements about Hydrogen-enriched CNG (HCNG):

1. HCNG is a vehicle fuel which is a blend of compressed natural gas and hydrogen.
2. It improves the engine efficiency, lowers fuel consumption upto 5 per cent as compared to a CNG bus.
3. Delhi is all set to be India's first city to launch hydrogen-enriched CNG (HCNG) buses in 2019.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q53. Consider the following statements about "Augmenting Writing Skills for Articulating Research (AWSAR)"

1. Recently, AWSAR was launched to reward PhD scholars and post-doctoral fellows.
2. Under the scheme best articles which would be selected would be provided monetary incentives.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q54. Consider the following statements about Prime Minister's Fellowship Scheme:

1. Its purpose is to improve the quality of research by attracting the best talents across the country.
2. It will help reduce brain drain.
3. Under the scheme around 1000 students who have completed B.Tech or integrated M.Tech or M.sc in Science and technology streams will be offered direct admission in PhD programme in the IITs/IISc with a fixed amount of fellowship.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only

(c) 2 and 3 only (d) 1, 2 and 3

Q55. Consider the following statements about the Excitonium:

1. It is the new form of matter whose existence is proved recently.
2. It exhibits microscopic quantum phenomenon like a super conductor.

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q56. 2018 Noble Prize in Chemistry was awarded for

(a) the phage displays of peptides and antibodies.
(b) the directed evolution of enzymes.
(c) the design and synthesis of molecular machines.
(d) the mechanistic studies of DNA repair.

Q57. Which of the following statements is/are correct about Mars?

1. It has no natural satellite.
2. It has the presence of volcanoes.
3. It is the brightest planet in the night sky.

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q58. Which of the following events can cause gravitational waves?

1. Explosion of star.
2. Two big stars moving at very high speed.
3. Two black holes orbit each other and merge.

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q59. 2018 Noble Prize in Physics was awarded for

(a) the optical tweezers and their application to biological systems.
(b) the method of generating high-intensity, ultra-short optical pulses.
(c) the discovery of gravitational waves.
(d) both a and b

Q60. Which among the following are the functions of the liver?

1. Production of insulin for the regulation of the glucose levels in the blood.
2. Production of bile.
3. Production of cholesterol to help carry fats through the body.

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q61. Which of the following are the constituents of a cell nucleus?

1. DNA 2. RNA
3. Protein

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q62. A man is pushing hard against a rigid brick wall. In this context, which among the following is correct?

(a) The internal energy used by the man is zero.
(b) The work done by the man is zero.
(c) The force applied by the man is zero.
(d) None of the above

Q63. A solution containing 'X' reacts with crushed egg-shells to produce 'Y' gas that turns limewater milky. The 'X' and 'Y' are

(a) Hydrochloric acid and Hydrogen Sulphide respectively.
(b) Hydrochloric acid and Carbon Dioxide respectively.
(c) Nitric acid and Nitrogen Dioxide respectively.
(d) Nitric acid and Carbon Monoxide respectively

Q64. Which of the following is known as functional units of heredity?

(a) Genes (b) Chromosomes
(c) Nucleus (d) Ribosomes

Q65. "This effect is used in the military to detect enemy aircrafts, by astrophysicists to measure velocities of stars and by doctors to study heart beats and blood

flow. It is also used by the police to check over-speeding of vehicles."

Which effect is the above paragraph referring to?

(a) Raman Effect
(b) Doppler Effect
(c) Photoelectric Effect
(d) Joule Thompson Effect

Q66. Consider the following statements:

1. Photovoltaic cell converts the light energy into electrical energy.
2. Recently China has become the first country to construct a photovoltaic highway.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q67. The human voices are more clearly heard at dusk rather than during day time because of the phenomenon of

(a) Refraction of sound
(b) Diffraction of sound
(c) Scattering of sound
(d) Dispersion of sound

Q68. A person X met with an accident and was in urgent need of blood transfusion.

Unfortunately his blood type could not be determined. In this case, which may be the safest blood group that can be transfused to X?

(a) A+ve (b) O-ve
(c) O+ve (d) AB+ve

Q69. Consider the following statements:

1. Darwin's theory of evolution describes the evolution of life from simple to more complex forms.
2. Mendel's theory describes the mechanism for the inheritance of traits from one generation to the next.
3. Both Darwin and Mendel's theories successfully explain the beginning of life on Earth.

Which of the statements given above are correct?

(a) 1, 2 and 3 (b) 1 and 3 only
(c) 2 and 3 only (d) 1 and 2 only

Q70. As compared with solids and liquids:

1. the force of attraction between the particles is maximum in gases.
2. the kinetic energy of the particles is minimum in gases.

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q71. Which of the following compounds is added to Liquefied Petroleum Gas (LPG) to make its odour detectable?

(a) Isobutane (b) Ethyl Mercaptan
(c) Ethanol (d) Methanol

Q72. Skating on ice becomes possible due to which of the following reasons?

(a) The boiling point of water increases due to pressure of the skates
(b) The melting point of ice decreases due to pressure of the skates
(c) The boiling point of water decreases due to pressure of the skates
(d) The melting point of ice increases due to pressure of the skates

Q73. Which of the following enzymes of digestive system breaks down starch into sugar?

(a) Pepsin (b) Protease
(c) Salivary amylase (d) Lipase

Q74. Which among the following organs help in removal of excretory wastes?

1. Kidney 2. Skin
3. Lungs

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q75. Which among the following phenomena explains the fact that we see lightning much before we hear its thunder?

(a) Light waves can travel in vacuum whereas sound waves cannot.
(b) Light waves travels faster than sound waves.

(c) Intensity of light waves is more than sound waves.
(d) Light waves are scattered more than sound waves

Q76. Pusa Vivek QPM 9 Improved, a hybrid maize, is considered a rich source of which of the following?
1. Tryptophan
2. Vitamin A

Select the correct answer using the code given below:
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q77. Consider the following statements:
1. The boundary between the solar wind and the interstellar wind is the heliopause, where the pressures of the two winds are in balance.
2. Voyager-2 has become the first manmade object to cross the heliopause and enter into the interstellar space.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q78. With regards to the S-400 System, consider the following statements:
1. It is a mobile system consisting of surface-to-air missile system.
2. It integrates anti-aircraft missile system jointly developed by India and Russia – BrahMos.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q79. Consider the following statements about the MASCOT (Mobile Asteroid Surface Scout):
1. The MASCOT probe has been sent on the surface of Mercury.
2. It has been jointly developed by Germany and France.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q80. Which of the following countries has granted citizenship to the humanoid robot 'Sophia'?
(a) The United States (b) Israel
(c) Saudi Arabia (d) Singapore

Q81. Consider the following statements regarding Oumuamua:
1. Oumuamua is the first interstellar object known to enter our solar system.
2. It was discovered by astronomers using the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS).

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q82. Consider the following pairs:
1. Parker Solar Probe: The National Aeronautics and Space Administration
2. Helios 2 Spacecraft: The Japan Aerospace Exploration Agency (JAXA)

Which of the pairs given above is/are correctly matched?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q83. Consider the following statements:
1. AstroSat is the first dedicated astronomy satellite of India.
2. India's Chandra X-Ray Observatory has found a black hole in a binary star system.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q84. Consider the following statements about NASA's Dawn spacecraft:
1. Dawn Spacecraft Mission had explored the two largest bodies in the main asteroid belt, Vesta and Ceres.
2. The spacecraft finally ran out of hydrazine, the fuel which keeps the spacecraft oriented and in communication with Earth.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q85. Consider the following statements about HY-1C Satellite:

1. It was launched by India.
2. It will help improve understanding of maritime waters and climate change.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q86. Recently, India successfully put into orbit two earth observation satellites, NovaSAR and S1-4 aboard PSLV-CA rocket. These satellites are related to which of the following countries?

(a) France (b) Russia
(c) The United Kingdom (d) Indonesia

Q87. Which of the following satellites will be the first to directly measure wind speeds and directions all over the globe, allowing scientists to improve worldwide weather forecasts?

(a) The Aeolus Satellite (b) Astrosat
(c) ANUSAT (d) GSAT-8

Q88. Consider the following statements about the Global Precipitation Measurement (GPM) Mission:

1. It provides next-generation global observations of rain and snow to advance our understanding of Earth's water and energy cycle, improve forecasting of extreme events, and provide accurate and timely information to directly benefit the society.
2. GPM is a joint mission between NASA and the ISRO.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q89. Consider the following statements about Artificial Neural Network (ANN):

1. An Artificial Neural Network (ANN) is an information processing paradigm, that is inspired by the way biological nervous systems, such as the brain, process information.
2. ANNs, like human beings, learn by example.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q90. Consider the following statements:

1. Exoplanet is a planet which are outside our solar system and is not bound by the gravitational force of a star.
2. Kepler space telescope discovered many exoplanets by using the "transit method" of studying dip in brightness of the planet.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q91. Consider the following statements about DEET:

1. It is the most common active ingredient in insect repellents, and can be applied to skin and clothing.
2. It was developed by the Indian Agricultural Research Institute (IARI).

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q92. Consider the following statements, with reference to the 'neutrino particles':

1. These are the smallest particles that form the Universe.
2. Neutrinos carry electric charge.
3. According to the Standard Model of Particle Physics, they are mass-less.

Which of the statements given above is/are correct?

(a) 1 only (b) 1 and 2 only
(c) 1 and 3 only (d) 1, 2 and 3

Q93. Consider the following statements :

1. A kilogram will be defined by a tiny, but immutable fundamental value, called the 'Planck Constant.'
2. The headquarter of the International Bureau of Weights and Measures (BIPM) is situated in London.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q94. Which of the following pairs is/are **incorrectly** matched?

1. Satish Dhawan Space Centre: Sriharikota
2. Semi-Conductor Laboratory: Chandigarh

3. Vikram Sarabhai Space Centre: Thiruvananthapuram

Select the correct answer using the code given below:

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 only (d) None of the above

Q95. The 'Growth-India Telescope', which recently studied supernova, is located in which of the following centres?

(a) Harshil (Uttarakhand)
(b) Tawang Valley (Arunachal Pradesh)
(c) Gangtok (Sikkim)
(d) Hanle (Jammu and Kashmir)

Q96. With reference to GSLV F11/ GSAT 7A mission, consider the following statements:

1. GSLV-F11 is the 14th flight of India's Geosynchronous Satellite Launch Vehicle (GSLV) and its 8th flight with indigenous Cryogenic Upper Stage (CUS).
2. GSLV – F11 is ISRO's 4th generation launch vehicle with 3 stages.
3. GSAT-7A with a lift-off mass of 2250 kg, is a geostationary satellite.

Which of the statement(s) given above is/are correct?

(a) 2 only (b) 1 and 2
(c) 2 and 3 (d) 1, 2 and 3

Q97. With reference to Voyager space probe, consider the following statements:

1. It has been launched to study outer planets like Jupiter, Saturn etc.
2. It has been launched by European space Agency.

Which of the statement(s) given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q98. BeiDou, sometimes in the news recently, is related to which of the following?

(a) It is a search engine, similar to Google, used by the Chinese government.
(b) It is a navigation system similar to GPS and Glonass.
(c) It is a type of software to filter objectionable content.
(d) It is the fastest supercomputer of the world made by China.

Q99. Consider the following statements about the "far side of the moon":

1. The Far side of the moon is always away from the Sun and it never gets sunlight.
2. No part of the far side of the Moon is visible from the Earth.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q100. Consider the following statements with respect to Aditya L1:

1. Aditya - L1 is the first Indian mission to study the Sun system.
2. It is meant to observe only the solar corona layer of the Sun.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

ANSWER KEY

1.	d	**23.**	c	**45.**	c	**67.**	a	**89.**	c
2.	d	**24.**	a	**46.**	b	**68.**	b	**90.**	b
3.	b	**25.**	a	**47.**	c	**69.**	d	**91.**	a
4.	b	**26.**	d	**48.**	c	**70.**	d	**92.**	c
5.	a	**27.**	c	**49.**	d	**71.**	b	**93.**	a
6.	a	**28.**	d	**50.**	b	**72.**	b	**94.**	d
7.	c	**29.**	c	**51.**	c	**73.**	c	**95.**	d
8.	c	**30.**	c	**52.**	d	**74.**	d	**96.**	c
9.	d	**31.**	a	**53.**	c	**75.**	b	**97.**	a
10.	b	**32.**	a	**54.**	d	**76.**	c	**98.**	b
11.	d	**33.**	b	**55.**	c	**77.**	a	**99.**	d
12.	c	**34.**	c	**56.**	a	**78.**	a	**100.**	a
13.	a	**35.**	d	**57.**	b	**79.**	b		
14.	a	**36.**	a	**58.**	d	**80.**	c		
15.	d	**37.**	c	**59.**	d	**81.**	c		
16.	c	**38.**	d	**60.**	b	**82.**	a		
17.	d	**39.**	a	**61.**	d	**83.**	a		
18.	b	**40.**	b	**62.**	b	**84.**	c		
19.	a	**41.**	b	**63.**	b	**85.**	b		
20.	b	**42.**	d	**64.**	a	**86.**	c		
21.	d	**43.**	b	**65.**	b	**87.**	a		
22.	d	**44.**	c	**66.**	c	**88.**	a		

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