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TARGET 2021

SCIENCE & TECHNOLOGY

INDEX

TARGET 2021

SCIENCE & TECHNOLOGY

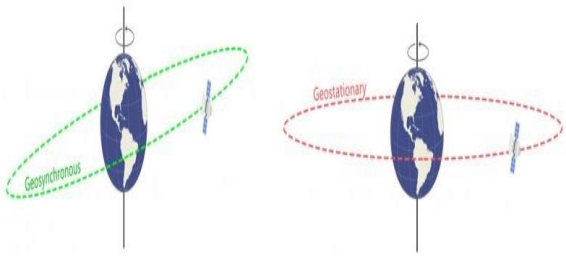
(JUNE 2020 TO MAY 2021)

1. SPACE TECHNOLOGY

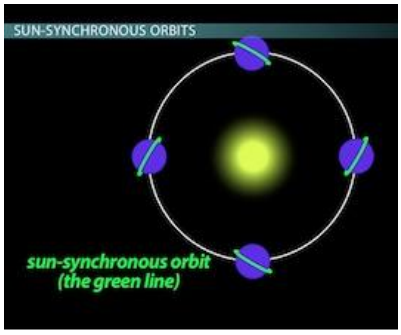
INTRODUCTION

1.1 Types of Orbits

- There are many different satellite orbits that can be used depending upon satellite's functions and area it is to serve.
- The lower the satellites orbit the Earth, the stronger the gravitational pull, and this means that the satellite must travel faster to counteract this pull. Further away the gravitational field is less and the satellite velocities are correspondingly less.
- A satelliteorbits the Earth in one of two basic types of orbits such as **Circular and Elliptical satellite orbit**.
- For a circular orbit, the distance from the Earth remains the same at all times whereas the elliptical orbit changes the distance to the Earth.
- Circular orbits are classified into Low Earth Orbit (LEO), Medium Earth Orbit, Geosynchronous orbit etc.
- Most satellites, the International Space Station, the Space Shuttle, and the Hubble Space Telescope are all in Low Earth Orbit.
- LEO (180 – 2000 Km) is convenient for installing new instruments, fixing things that are broken, and inspecting damage.
- A **geosynchronous orbit**, located at 35,790 km has the same orbital period as the sidereal rotation period of the Earth.
- It allows satellites to synchronize with the rotation of the Earth (only in time and not in direction).
- This makes geosynchronous satellites particularly useful for **telecommunications** and other **remote sensing** applications.



- One particular form of geosynchronous orbit is known as a **geostationary orbit**, in which the satellite rotates in the same direction as the rotation of the Earth and has an approximate 24 hour period.
- The satellite placed in geostationary orbit remains in the same position relative to the Earth.
- It is used by many applications including **direct broadcast** as well as **communications** or relay systems.
- While geosynchronous satellites can have any inclination, geostationary orbit lie on the same plane as the equator.
- **Polar Orbit** –Satellites placed in polar orbits have an inclination of about 90 degrees to the equator and travels north-south over the poles at lower altitudes.



- A satellite in the polar orbit approx. takes 90 minutes for a full rotation. As a result, a satellite can observe the entire surface in the time span of 24 hours.
- They are often used for applications such as **monitoring crops, forests and even global security**.

- **Sun Synchronous Orbit** –It is a special case of Polar Orbit moving from pole to pole allowing satellite to pass over any given point of the planet's surface at roughly the same local time each day.
- Since there are 365 days in a year and 360 degrees in a circle, it means that the satellite has to shift its orbit by approximately one degree per day.
- These orbits are used for satellites that need a constant amount of sunlight and are useful for imaging, spy, and weather satellites.

1.2 Types of Satellites

- **Communication Satellites**provide services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations.
- The Indian National Satellite (INSAT) series of satellites in **Geostationary Orbit** (INSAT-3A, 3C, 4A, 4B, 4CR) are used for communication purposes.
- GSAT series also joins the constellation of INSAT system in providing communication services.
- **Earth Observation Satellites**are used for several applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management.
- Indian Remote Sensing (IRS) series of satellites in Sun-synchronous polar orbit are Earth observation satellites.
- Satellites in - **Sun-synchronous orbit** – RESOURCESAT-1, 2, 2A CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1
- Satellites in **Geostationary orbit** - INSAT-3D, Kalpana & INSAT 3A, INSAT -3DR
- **Navigation Satellites**are used to meet the emerging demand of positioning, navigation and timing and also civil aviation requirements. GAGAN and IRNSS (NAVIC) are navigation satellite system in use.
- **GPS Aided GEO Augmented Navigation (GAGAN),** is implemented jointly by ISRO and Airport Authority of India (AAI).
- The main objectives of GAGAN are to provide Satellite-based Navigation services with accuracy and integrity required for civil aviation applications and to provide better Air Traffic Management over Indian Airspace.
- The GAGAN Signal-In-Space (SIS) is available through GSAT-8 and GSAT-10.
- **Indian Regional Navigation Satellite System (IRNSS), NavIC** is an independent regional navigation satellite system to provide accurate position information service.
- **Space Science and Exploration Satellites** encompasses research in areas like astronomy, astrophysics, planetary and earth sciences, atmospheric sciences and theoretical physics.
- **E.g** – Mars Orbiter Mission, AstroSat**,** Chandrayaan -1,2.

1.3 Launch Vehicles

- Launch Vehicles are used to carry spacecraft to space.
- Following are the various launch vehicles used by ISRO
- **Historic launchers** - Satellite Launch Vehicle - 3 (SLV-3) and Augmented Satellite Launch Vehicle (ASLV).
- SLV was India's first experimental satellite launch vehicle with solid engines in all 4 stages. ASLV has 3 times augmented capacity of SLV-3.
- **Operational launchers** - Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) and Sounding Rockets.
- **Future launchers** – GSLV MK-III, Reusable Launch Vehicle (RLV-TD), Scramjet Engine – TD.

1.4 PSLV

- It is the**3rd generation launch vehicle** and first Indian launch vehicle to be equipped with liquid stages.

- PSLV emerged as the reliable and versatile workhorse launch vehicle of India with consecutively successful missions.
- It successfully launched two spacecraft such as Chandrayaan-1 in 2008 and Mars Orbiter Spacecraft in 2013.
- 3 variations in PSLV - PSLV-G (General), PSLV-XL variants and PSLV-CA (Core Alone).
- It has 4 stages in its operation to provide thrust in launching spacecraft to different orbits.
- **Stage I**: It uses **solid rocket motor** that is augmented by 6 solid strap-on boosters. Strap on boosters are used only in G and XL variation.
- **Stage II**: It uses an Earth storable **liquid rocket engine**, known as the Vikas engine.
- **Stage III**: It uses **solid rocket motor** that provides high thrust after the atmospheric phase of the launch.
- **Stage IV**: It comprises two Earth storable **liquid engines**.
- **Capacity** - 1,750 kg of payload to Sun-Synchronous Polar Orbits of 600 km altitude and to 1,425 kg of payload to Geosynchronous and Geostationary orbits, like satellites from the IRNSS constellation.
- **PSLV launches**–PSLV-C48/RISAT-2BR1, PSLV-C47 / Cartosat-3, PSLV-C46/RISAT-2B, PSLV-C45/EMISAT MISSION, PSLV - C44/Microsat, Kalamsat etc

1.5 GSLV

- It is the **4th generation** launch vehicle, a three-stage vehicle with four liquid strap-on boosters.
- GSLV Mk II is the largest launch vehicle developed by India, which is currently in operation.
  1. **Stage I**: It uses **solid rocket** motor with 4 liquid strap-ons.
  2. **Stage II**: It uses **liquid rocket** engine (similar to vikas engine of PSLV stage II).
  3. **Stage III**: It uses India's **first cryogenic engine** (CE-7.5) in the upper stage. It enabled the launching of 2000 kg of communication satellites.
- **Capacity -** It can take up to 5000 kg of pay load to Low Earth Orbits, 2500 kg of payload to Geosynchronous Transfer Orbit (GTO) which are primarily INSAT class of communication satellites.
- **GSLV Launches –** GSLV – F11/GSAT-7A and GSLV – F08/GSAT – 6A mission.
- The next variant of GSLV is GSLV Mk III, with indigenous high thrust cryogenic engine.

1.6 GSLV MK III

- GSLV Mk III is a three-stage heavy lift launch vehicle which has two solid strap-ons, a core liquid booster and a cryogenic upper stage.
- The cryogenic upper stage C25 is powered by CE-20 which is India's largest cryogenic engine.
- It is designed to carry 4000 kg classes of satellites into Geosynchronous Transfer Orbit (GTO) or about 8000 kg classes to Low Earth Orbit (LEO), which is about twice the capability of GSLV Mk II.
- **Recent Launches** – GSLV-Mk III - M1 / Chandrayaan-2 Mission, GSLV Mk III-D2 / GSAT-29, GSLV MK III D1/GSAT – 19 and LVM-3 /CARE (Crew module Atmospheric Re-entry Experiment) mission.
- It is the designated launch vehicle for India's upcoming second moon mission and the first human space flight scheduled for 2022.

1.7 RLV-TD

- Reusable Launch Vehicle – Technology Demonstrator (RLV-TD) is a fully reusable launch vehicle to enable low cost access to space.
- The configuration of RLV-TD is similar to that of an aircraft and combines the complexity of both launch vehicles and aircraft.
- The winged RLV-TD has been configured to act as a flying test bed to evaluate various technologies, namely, hypersonic flight, autonomous landing and powered cruise flight.

- In future, this vehicle will be scaled up to become the first stage of India's reusable two stage orbital launch vehicle.
- **Objectives of RLV-TD -** Hypersonic aero thermodynamic characterisation of wing body, Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes, Integrated flight management and Thermal Protection System Evaluation
- It was successfully flight tested in 2016 from Sriharikota.

1.8 Small Satellite Launch Vehicle

- ISRO has completed the design of SSLV which can place a 500 kg payload at a height of 500 km in the Low Earth Orbit (LEO).
- It has three solid motor stages with a lift off mass of 120 tonnes.
- It is shorter in length than the PSLV and GSLV.
- It can accommodate multiple satellites like the PSLV and GSLV, albeit smaller ones.
- Unlike the PSLV and GSLV, the SSLV can be assembled both vertically and horizontally.

1.9 Sounding Rockets

- Indian Space Research Organisation (ISRO) has launched RH-560, a sounding rocket to study attitudinal variations in the neutral winds and plasma dynamics.
- Sounding rockets are one or two stage solid propellant rockets used for probing the upper atmospheric regions and for space research.
- They serve as platforms to test or prove prototypes of new components or subsystems intended for use in launch vehicles and satellites.

Operational sounding Rockets

Currently, three versions are offered as operational sounding rockets , which cover a payload range of 8-100 Kg and an apogee range of 80-475 km.

Vehicle	RH-200	RH-300-Mk-II	RH-560-MK-II
Payload (in kg)	10	60	100
Altitude (in km)	80	160	470
Purpose	Meterology	Aeronomy	Aeronomy
Launch Pad	Thumba Balasore	SDSC-SHAR	SDSC-SHAR

- It is possible to conduct coordinated campaigns by simultaneously launching sounding rockets from different locations in a single day.
- ISRO started launching indigenously made sounding rockets from 1965.
- In 1975, ISRO consolidated all its sounding rocket activities under the Rohini Sounding Rocket (RSR) Programme.
- RH-75 was the first truly Indian sounding rocket from the Thumba Equatorial Rocket Launching Station (TERLS) [Numbers in the name indicates the diameter of the rocket in mm]

1.10 Vikas Engine

- Vikas is a family of liquid fuelled rocket engines that powers India's launch vehicles PSLV and GSLV.
- It is aimed at improving the payload capability of PSLV, GSLV and GSLV Mk-III launch vehicles.
- It is used in second stage of PSLV which consists of four stages in its operation (Solid-Liquid-Solid-Liquid) and in second stage and four strap-on stages of GSLV.
- GSLV is a three-stage vehicle (Solid-Liquid-Cryogenic Engine) with four liquid strap-on boosters.
- ISRO has recently improved the thrust of the Vikas engine which is expected to boost the rocket engine.
- The main beneficiary of the high-thrust Vikas engine is GSLV-Mark III launcher, which is expected to lift 4,000-kg satellites to space.
- GSLV-Mark III uses twin engine core liquid stage (L110).

- GSLV – Mark III with upgraded Vikas engine would be the third Mk-III and the first working one to be designated MkIII Mission-1 or M1.

1.11 Cryogenic Engine

- Cryogenics is the science that addresses the production and effects of very low temperatures.
- A cryogenic rocket engine uses a cryogenic fuel or oxidizer, which are gases liquefied and stored at very low temperatures.
- Notably, these engines were one of the main factors of NASA's success in reaching the Moon.
- Amongst all rocket fuels, hydrogen is known to provide the maximum thrust.
- But hydrogen, in its natural gaseous form, is difficult to handle, and, therefore, not used in normal engines in rockets like PSLV. However, hydrogen can be used in liquid form.
- The problem is hydrogen liquefies at very low temperature, nearly 250 degrees Celsius below zero.
- To burn this fuel, oxygen also needs to be in liquid form, and that happens at about 90 degrees Celsius below zero.
- Creating such a low-temperature atmosphere in the rocket is a difficult proposition, because it creates problems for other material used in the rocket.

1.12 Scramjet Engine - TD

- Usually, launch vehicles carry oxidiser along with the fuel for combustion to produce thrust to launch satellites into orbit.
- Nearly, 70% of the propellant (fuel – oxidiser) by weight consists of oxidiser which makes it to carry only 2-4% of their lift-off mass to orbit.
- Therefore, air-breathing propulsion system which can utilise the atmospheric oxygen during their flight and reduce the total propellant required to place a satellite in orbit is being developed by various space agencies.
- Ramjet, Scramjet and Dual Mode Ramjet (DMRJ) are the three concepts of air-breathing engines.
- A **ramjet** is a form of air-breathing jet engine that uses the vehicle's forward motion to compress incoming air for combustion without a rotating compressor.
- Fuel is injected in the combustion chamber where it mixes with the hot compressed air and ignites.
- It works most efficiently at supersonic speeds around Mach 3 (three times the speed of sound) and can operate up to speeds of Mach 6.
- However, the ramjet efficiency starts to drop when the vehicle reaches hypersonic speeds.
- A **scramjet** engine is an improvement over the ramjet engine as it efficiently operates at hypersonic speeds and allows supersonic combustion. Thus, it is known as Supersonic Combustion Ramjet, or Scramjet.
- A **dual mode ramjet** (DMRJ) is a type of jet engine where a ramjet transforms into scramjet over Mach 4-8 range, which means it can efficiently operate both in subsonic and supersonic combustor modes.
- ISRO's Advanced Technology Vehicle (ATV), which is an advanced sounding rocket, was the solid rocket booster used for test of Scramjet engines at supersonic conditions.
- ATV is a two- stage solid launch vehicle capable of carrying Scramjet engines weighed 3277 kg at lift-off.
- India is the fourth country (after USA, Russia and European Space Agency) to demonstrate the flight testing of a Scramjet Engine.

1.13 Green Propellants

- ISRO is developing green propellants to eliminate the emission of chlorinated exhaust products from rocket.
- The propellants are based on Glycidyl Azide Polymer (GAP) as fuel and Ammonium Di-Nitramide (ADN) as oxidizer.

- ISRO is also carrying out various technology demonstration projects involving green propellant combinations such as Hydrogen Peroxide (H2O2), Kerosene, Liquid Oxygen (LOX), Liquid Methane etc.
- It has successfully developed **ISROSENE**, which is a rocket grade version of kerosene as an alternative to conventional hydrazine rocket fuel.
- It has already used Liquid oxygen and liquid hydrogen combination in cryogenic upper stage of GSLV MK-III.

1.14 The International Space Station (ISS)

- It is a modular space station (habitable artificial satellite) in low Earth orbit.
- The ISS programme is a multi-national collaborative project between five participating space agencies:
    1. NASA (United States),
    2. Roscosmos (Russia),
    3. JAXA (Japan),
    4. ESA (Europe),
    5. CSA (Canada).
- The ownership and use of the space station are established by intergovernmental treaties and agreements.
- It is suited for testing the spacecraft systems and equipment required for possible future long-duration missions to the Moon and Mars.
- It is the only active modular space station (habitable artificial satellite) in the Low-Earth Orbit (LEO).
- It is the largest artificial object in space and the largest satellite in low Earth orbit, regularly visible to the naked eye from Earth's surface.
- It circles the Earth in roughly 93 minutes, completing 15.5 orbits per day.
- It is like a large laboratory in space that has been there since 1998. It allows astronauts to come aboard and stay for weeks or months to carry out experiments in microgravity.
- **Recent Developments -** Russia announced that it would be withdrawing from the International Space Station in 2025, and build and manage its own floating laboratory that will be launched into orbit by 2030.

INDIAN MISSIONS IN NEWS

1.15 Earth Observation Satellite EOS-01

- EOS-01 is an earth observation satellite in Low Earth Orbit.
- It was launched by PSLV-C49, which is 2nd flight of PSLV in 'DL' configuration (with 2 Solid Strap-on motors).
- It is intended for applications in agriculture, forestry and disaster management support.
- Along with this, it also lifted nine international customer satellitesfrom Lithuania (1), Luxembourg (4) and USA (4).
- They were launched under a commercial arrangement with NewSpace India Limited (NSIL).

1.16 GISAT-1

- Geo Imaging Satellite-1 or GISAT-1 is India's first earth observation satellite in a geostationary orbit.
- ISROplans to launch it using GSLV-F10 rocket.
- The rocket will first place GISAT-1 in geosynchronous orbit, and subsequently in geostationary orbit, using its onboard propulsion system.
- It will facilitate near real-time observation of the Indian sub-continent, under cloud-free condition, at frequent intervals.

- With onboard high-resolution cameras, the satellite will allow India to monitor the Indian land mass and the oceans, particularly its borders.
- It would help in quick monitoring of natural disasters, episodic and any short-term events.
- It will obtain spectral signatures of agriculture, forestry, mineralogy, disaster warning, cloud properties, snow and glacier and oceanography.

1.17 PSLV-C51/Amazonia-1 Mission

- ISRO has launched Brazil's Amazonia-1 satellite along with 18 co-passenger satellites onboard the Polar Satellite Launch Vehicle (PSLV-C51).
- PSLV-C51 is the 53rd flight of PSLV and 3rd flight of PSLV in 'DL' configuration (with 2 solid strap-on boosters).
- Orbit - Sun synchronous polar orbit.
- The 18 co-passenger satellites onboard PSLV-C51 includes 4 from IN-SPACe and 14 from NewSpace India Ltd (NSIL).
- NSIL had collaborated with USA for this mission.
- These satellites are intended for providing Radio relay services.

Amazonia-1

- It is the first dedicated commercial mission of NSIL, a Government of India Company under Department of Space.
- Amazonia-1 is the optical earth observation satellite of the **Brazil's** National Institute for Space Research (INPE).
- It would provide remote sensing data to users for monitoring deforestation in Amazon region and analysis of diversified agriculture across the Brazilian territory.

1.18 Project NETRA

- Project NETRA - Network for space object Tracking and Analysis is an early warning system launched in 2019.
- It aims for early waring in space to detect debris and other hazards to Indian satellites.
- Under the project, the ISRO plans to put up many observational facilities such as Connected radars, Telescopes, Data processing units, Control center.
- The project will give India its own capability in Space Situational Awareness (SSA) like the other space powers which is used to 'predict' threats from debris to Indian satellites.
- NETRA's eventual goal is to capture the GEO, or geostationary orbit, scene at 36,000 km where communication satellites operate.
- The effort would make India a part of international efforts towards tracking, warning about and mitigating space debris.

1.19 NISAR

- In 201, ISRO and NASA signed a partnership to collaborate on and launch NISAR (NASA-ISRO SAR) by 2022.
    1. NASA is providing L-band SAR, a high-rate communication subsystem for science data, etc.,
    2. ISRO is providing the S-band radar, and launch services.
- NISAR is a Synthetic Aperture Radar (SAR) that can produce extremely high-resolution images for a joint earth observation satellite mission.
- It will be the first satellite mission to use two radar frequencies (L-band and S-band) to measure changes in Earth's surface less than a centimetre across.
- NISAR will observe Earth's land and ice-covered surfaces with 12-day regularity on ascending and descending passes, sampling Earth on average every 6 days for a baseline 3-year mission.
- Radar penetrates clouds and darkness, enabling NISAR to collect data day and night in any weather.
- It would provide a means of disentangling highly spatial and temporally complex processes like ecosystem disturbances, natural hazards, etc.

1.20 IRNSS

Indian Regional Navigation Satellite System (IRNSS) was recognised by the International Maritime Organisation (IMO).

- IRNSS is an independent regional navigation satellite system being developed by India.
- After the US, Russia and China that have their own navigation systems, India became the fourth country to have its system recognised by IMO.
- It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area.
- An Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30° South to 50°North, Longitude 30°East to 130°East.
- It will provide two types of services, namely, Standard Positioning Service (SPS) which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorised users.
- The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.
- The space segment consists of the IRNSS constellation of eight satellites, NavIC launched by PSLV.
- Three satellites are located in suitable orbital slots in the geostationary orbit and the remaining four are located in geosynchronous orbits.
- **Use of IRNSS** - While the system will be open to all including security agencies, all merchant vessels including small fishing vessels are authorised to use the system.
- Vessels that have transponders will be tracked by satellite navigation showing accurate position in the Indian Ocean region.
- At any given time, there are at least 2,500 merchant vessels in Indian waters that can all use the IRNSS.
- **Recent Developments -** The Maritime Safety Committee (MSC) of the IMO recognised the IRNSS as a component of the World-wide Radio Navigation System (WWRNS).
- With the recognition, the IRNSS is similarly placed as GPS, most commonly used by marine shipping vessels across the world.
- Unlike GPS, IRNSS is a regional and not a global navigation system.
- This is also a significant achievement towards the 'Atmanirbhar Bharat' initiative.

1.21 Space Ties with Quad

- India is deepening its space ties with the members of the Quadrilateral Security Dialogue or Quad grouping (An informal strategic dialogue between the US, Japan, Australia and India).
- **USA** - NISAR (NASA-ISRO SAR) is a joint collaboration between ISRO and NASA for dual frequency Synthetic Aperture Radar (SAR) for earth observation.
- An ISRO built Airborne SAR (ASAR) was flown over the US aboard NASAs aircraft during 2019 and data acquisitions were made in 92 sites.
- ASAR repeat flight campaigns are being planned for the year of 2021.
- Both agencies are working for an implementing arrangement to carry NASAs Laser Reflectometer Array (LRA) in Chandrayaan-3.
- ISRO-NASA Joint Working Group on Human Spaceflight Programme (HSP) is exploring collaboration opportunities.
- **Japan** - LUPEX (Lunar Polar Exploration) is a joint mission between ISRO and Japan Aerospace Exploration Agency (JAXA) to explore the Moon's South Pole in 2023.
- ISRO and JAXA are working on sharing earth observation data and establishing ISRO's NavIC reference station in Japan.
- **Australia** - ISRO and Australian Space Agency (ASA) inked an Amendment of the '2012 India Australia Inter-Governmental MoU for cooperation in Civil Space Science, Technology and Education'.

- This Amendment makes India's Department of Space and ASA as the Executive Organisations and provides scope for other related entities to conclude implementing arrangements for specific cooperation activities.
- The two agencies reviewed the status of ongoing cooperation activities in earth observation, satellite navigation, and establishing a transportable terminal in Australia to support Indias 'Gaganyaan' programme.

1.22 Indo-French Space Collaborations

- ISRO and French space agency Centre National dEtudes Spatiales (CNES) are working on their third joint satellite mission.
- **TRISHNA** - ISRO and CNES have completed the feasibility study to realise the earth observation satellite mission with TRISHNA, thermal infrared imager.
- Thermal infraRed Imaging Satellite for High resolution Natural resource Assessment (TRISHNA) will monitor the water cycle to help in properly utilizing it.
- **ARGOS** of CNES will be integrated into ISRO's OCEANSAT-3 satellite.
- ARGOS is the global satellite-based data collection and location system of its kind dedicated to studying and preserving the environment.
- ISRO-CNES Human Space Programme (HSP) Working Group had discussed about medical aspects of human spaceflight and is finalising an arrangement to formalise cooperation in the field of space medicine.

Previous Joint Satellite Missions

- **MEGHA-TROPIQUES** (2011) - This Indo-French joint satellite mission that was launched to study the tropical atmosphere and climate related to aspects such as monsoons, cyclones, etc.
- **Satellite for ALTIKA and ARGOS (SARAL)** (2013) - This mission was launched to study the ocean from space using altimetry.

- There are discussions on establishing 'NavIC' (an independent regional navigation satellite system developed by India) reference station in France and CNES 'Scintillation' receivers in India.

1.23 Lunar Polar Exploration (LPE)

- Japan is planning for a joint lunar mission with India, named Lunar Polar Exploration (LPE).
- LPE hopes to put a lander and rover on Moon's surface.
- The mission will be launched after 2023.
- Japanese would be building the overall landing module and the rover, while ***ISRO would develop the lander system***.
- The mission will be ***launched from Japan***, and the designated launch vehicle is the ***H3 rocket, manufactured by Mitsubishi Heavy Industries***.
- ***Objectives -*** The mission's aim is to obtain actual data regarding the quantity of water from in-situ observations of areas where water is anticipated to exist, based on the available past observational data.
- It also seeks to understand the distribution, conditions, form and other parameters of the lunar water resources in the Polar Regions.
- The mission also seeks to improve the technology needed to explore the surface of low-gravity celestial bodies in order to support future lunar activities.
- These advancements include technology for mobility, lunar night survival and mining excavation.

1.24 Bhuvan Geospatial Portal

- ISRO has joined with MapmyIndia to offer fully indigenous mapping solutions.

Terms

- **VEDAS** is Visualisation of Earth observation Data and Archival System.
- It is an online geo-processing platform using optical, microwave, thermal and hyperspectral data covering applications particularly meant for academia, research and problem solving.
- **MOSDAC** (Meteorological and Oceanographic Satellite Data Archival Centre) is a data repository for all the meteorological missions of ISRO.
- It deals with weather-related information, oceanography and tropical water cycles.

- As part of the deal, ISRO and MapmyIndia would develop solutions by leveraging their geoportals and work on enhancing geospatial expertise.
- The partnership brings together MapmyIndia's digital maps and ISRO's catalogue of satellite imagery and earth observation data.
- Their partnership would help in further development of the indigenious geospatial portal **'Bhuvan'** of the ISRO.
- Holistic geospatial solutions will be built jointly utilising the earth observation datasets, "NavIC", "Bhuvan", "VEDAS" and "MOSDAC" geoportals, Web Services and APIs of MapmyIndia.
- **Bhuvan** is the national geoportal developed and hosted by ISRO in 2009 comprising geospatial data, services and tools for analysis.
- Itprovides visualisation services and Earth observation data to users in public domain.
- It also services several users for their remote sensing application needs.

1.25 RESPOND Programme

- ISRO will support eight joint research projects mooted by the Space Technology Cell (STC), Indian Institute of Technology, Delhi under its RESPOND programme.
- RESPOND (Research Sponsored) Programme aims to establish strong links with premiere academic institutions in India to carry out R&D projects in advanced areas of relevance to space.
- It aims to enhance academic base, generate human resources and infrastructure at the academic institutes to support the Indian Space program.
- Research proposals received from academia for consideration under RESPOND are accepted for taking up research along with appropriate technical and financial support, only after review of proposals.

Space Technology Cell

- It was set up at IIT, Delhi under a MoU signed between the ISRO and IIT-D in 2019 to strengthen the research collaboration between the two organisations.
- It was set up to carry out focused research projects in the space technology domain with specific deliverables.
- Since an MoU was signed between the ISRO and IIT-D in 2019, eight collaborative research projects have been announced.

- ISRO helps these institutions to provide fellowships to researchers to work on cutting edge research topics.

Other Notable Missions

1.26 Gaganyaan

- Gaganyaan is the India's first Human Space Flight Programme.
- ISRO is targeting December, 2021 to launch the unmanned test mission of Gaganyaan project.
- The programme will make India the fourth nation in the world to launch a Human Spaceflight Mission, only after the USA, Russia and China.
- It is being operating under a newly formed Centre, Human Space Flight Centre (HSFC).
- It aims to send a three-member crew to space for a period of five to seven days.
- ISRO has developed some critical technologies through demonstrations like Space Capsule Recovery Experiment (SRE-2007), Crew module Atmospheric Reentry Experiment (CARE-2014) and Pad Abort Test (2018).
- The spacecraft will be placed in a low earth orbit of 300-400km.

Objectives of Gaganyaan Mission

1. Enhance of science and technology levels in the country,
2. Serve as national project involving several institutes,
3. Inspire youth,
4. Develop technology for social benefits and
5. Improve International Collaboration
6. Improve Industrial Growth

- GSLV Mk-III launch vehicle will be used to for the mission. It has the payload capacity of 4000 kg satellites in Geosynchronous Transfer Orbit (GTO) and 8000 kg payload to Low Earth Orbit.
- The crew will be selected by Indian Air Force (IAF) and ISRO jointly after which they will undergo training for two-three years.
- **Re-entry & Recovery tech** - ISRO has already tested the GSLV Mk-III with experimental crew module.
- It came back to Earth after being taken to an altitude of 126 km into space. This this known as Crew module Atmospheric Re-entry Experiment (CARE).
- **Crew Escape System** – It is an emergency escape measure to quickly pull the astronaut crew out to a safe distance from launch vehicle during a launch abort.

Critical Technologies for Human Space Flight (HSF)-

1. Orbital Module
2. Crew Escape System
3. Integration facility
4. Crew Module
5. Deep Space Network
6. Re-entry and Recovery system

- Pad Abort test was conducted earlier to demonstrate this to ascertain the efficiency of crew escape system.
- **Life support** -The Environmental Control & Life Support System (ECLSS) is meant for humans inside to live comfortably.
- It ensures that conditions inside the crew module are suitable for living.
- The ECLSS -
  - i. Maintains a steady cabin pressure and air composition
  - ii. Removes carbon dioxide and other harmful gases
  - iii. Controls temperature and humidity
  - iv. Manages parameters like fire detection and suppression, emergency support
  - v. Takes care of food and water management
- ***Human Space Flight Centre*** **-** India's world-class facility for training GAGANYAAN astronauts will be established in three years at Challakere, Chitradurga district of Karnataka.
- Challakere, is called the Science City, it houses facilities of the ISRO, the DRDO's Advanced Aeronautical Test Range, the Bhabha Atomic Research Centre and the Indian Institute of Science.
- It will be the single-stop consolidating infrastructure and activities related to space travellers.
- It will also host work related to crew and service modules of the spacecraft that carries the astronauts and up to mission control.

1.27 GSLV-Mk III - M1 / Chandrayaan-2 Mission

- GSLV MkIII-M1, successfully launched Chandrayaan-2 spacecraft into its planned orbit but failed to soft-land the lander on the moon.
- **Chandrayaan-1** was designed to just orbit the Moon and make observations, while **Chandrayaan-2** is created to land on the Moon.
- It has three important components — the Orbiter, the Lander 'Vikram', and Rover 'Pragyan'
- The mission aims to explore the unexplored South Pole of the Moon.
- According to ISRO, there is a possibility of the presence of water in permanently shadowed areas around it.South Pole region also has craters that are cold traps and contain a fossil record of the early Solar System.
- GSLV MK – III also called as **'Baahubali'**, the country's heaviest and most powerful rocket to date.
- ISRO provides four reasons for what made the Chandrayaan-2 mission "special".
- Chandryaan-2 would be -
  1. the first space mission to conduct a soft landing on the moon's south pole
  2. the first Indian expedition to attempt a landing on lunar surface using home-grown technology

3. the first Indian mission to explore lunar terrain with home-grown technology
4. the mission that would make India only the 4th country to soft land on the moon

- **Orbiter -** The Orbiter will 100 km away from the moon, which will observe lunar surface and relay communication between Earth and the Lander.
- The orbiter is equipped with different kinds of camera to take create high-resolution three-dimensional maps of the surface, would remain in orbit for a year.
- **Vikram Lander -** Lander module Vikram was named after Vikram Sarabhai.
- It is the first time that ISRO is attempting to soft-land a module in extra-terrestrial space to mainly study the moon's atmosphere and look out for seismic activity.However, it failed in its attempt.
- **Pragyaan Rover -** Rover module Pragyaan means wisdom.
- The 6-wheeled, AI Solar powered rover was designed, developed and build indigenously by ISRO.The rover will be landed closer to the Moon's equator to receive more sun light.
- Its primary objective will be to study the composition of the surface near the lunar landing site, and determine its abundance of various elements.
- Both the Lander and Rover are designed to work for only 14 days (1 lunar day).
- This mission will help us to better understand the origin and evolution of the moon. Studies of lunar topography, mineralogy, elemental abundance, and signatures of water ice are the prime objectives.
- The orbiter has 8 instruments fitted into it and 7 of them are India's.
- NASA has one payload onboard called the Laser Retroreflector Array (LRA).
- The **'Terrain Mapping Camera-2'(TMC-2)** will map the lunar surface and help to prepare 3D maps of it.
- The **'Miniature Synthetic Aperture Radar'(Mini SAR)** will also map the surface of water-ice in the South Pole and thickness of the lunar dust on the surface.
- The **'Dual Frequency Radio Science'(DFRS)** will study the density of the electrons in the moon's ionosphere.
- The orbiter has a high-resolution camera (**OHRC**) that ensures that the lander makes a safe touchdown on the lunar surface by taking 3D images of the landing site.
- The '**Solar X-ray Monitor'(XSM)** measures the intensity of the solar rays and the outer most part of the atmosphere or its corona.
- **CLASS** (Chandrayaan 2 Large Area Soft X-ray Spectrometer) measures the light absorbed by the Moon and will check for different metals that are present in its spectrum.
- Thermo-physical property of the lunar surface and seismic activities will also be measured.
- **China's mission** - China landed a lander and rover on the Moon's far side (not facing the Earth). This was the first time any landing had taken place on that side.
- The Chinese mission, Chang'e 4, was designed to function for three lunar days but has already entered its fifth lunar night.

Chandrayaan-3

- Chandrayaan-3 is likely to be launched in 2022 (earlier scheduled to be launched in late 2020), which is India's third mission to Moon.
- It aims to make a soft-landing in the Lunar South Pole's Aitken basin.
- It will consist of only a lander and rover, as the orbiter of Chandrayaan-2 is still functioning and providing data.

1.28 Aditya-L1 Mission

- It is the first Indian mission to study the Sun.
- It is expected to be launched in 2019 by the launch vehicle PSLV-XL with six payloads from Sriharikota.

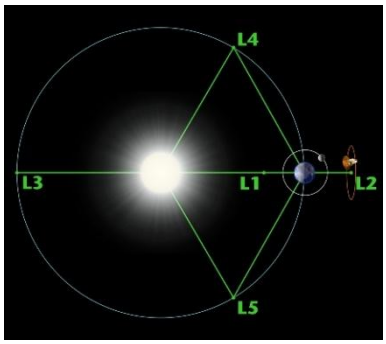
- The main aim of the solar mission is to do coronal and near UV studies.
- It was meant to observe only the solar corona but with additional experiments, it can provide observations of Sun's Photosphere (soft and hard X-ray), Chromosphere (UV) and corona (Visible and NIR).
- The outer layers of the 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.
- It will be launched into the halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system.
- This orbit has the advantage of allowing continuous monitoring of the sun.

Coronal Mass Ejections

Coronal Mass Ejections (CMEs) that comes from the Sun are huge bubbles of gas threaded with magnetic field lines. They cause various disturbances to the space environment, geomagnetic storms, satellite failures, and power outages.

- **Recent Developments -** Coronal Mass Ejections (CMEs) Identification in Inner Solar Corona (CIISCO) algorithm will be used in India's first solar mission, Aditya-L1.
- CIISCO was developed by the Aryabhatta Research Institute of observational sciences (ARIES) and Royal Observatory of Belgium.
- This new algorithm will be used to detect and track the accelerating Coronal Mass Ejections (CMEs) in the lower corona of the Sun.
- Previously, Computer Aided CME Tracking Software (CACTus) based on a **computer vision algorithm** was used to detect and characterise such eruptions.
- This vision algorithm detects the CMEs automatically in the outer corona where these eruptions cease to show accelerations and propagate with a nearly constant speed.
- However, this algorithm could not be applied to the inner corona observations due to the vast acceleration experienced by these eruptions.
- Aditya-L1 Support Cell (AL1SC), a community service centre, has been set up to **bring all science data on boardAditya-L1** to a single web-based interface. This will maximize utilization of data from Aditya-L1.
- AL1SC is a joint effort of Indian Space Research Organisation (ISRO) and Aryabhatta Research Institute of Observational Sciences (ARIES), an autonomous institute of the Department of Science & Technology.
- It is set up at the transit campus of ARIES at Haldwani, Uttarakhand.

Lagrange Points



- A Lagrange point is a location in space where the combined gravitational forces of two large bodies, such as Earth and the sun or Earth and the moon, equal the centrifugal force felt by a much smaller third body.
- The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" to make observations.
- The first point, L1, lies between Earth and the sun and gets an uninterrupted view of the sun and free from the occurrence of eclipses.
- L2 with the Earth, moon and sun behind it, a spacecraft can get a clear view of deep space and it has a protection for radiation field from sun.
- The James Webb Space Telescope will move into L2 point in 2018.
- The third Lagrange point, L3, lies behind the sun, opposite Earth's orbit. For now, science has not found a use for this spot.
- Points L4 and L5 are stable and lie along Earth's orbit at 60 degrees ahead of and behind Earth and dust and asteroids tend to accumulate in these regions due to its stability.
- Asteroids that surround the L4 and L5points are called Trojans and Earth's only known Trojan asteroid, 2010 TK7 is found in the region.

1.29 AstroSat

- It is a space observatory launched by ISRO in 2015.
- It was launched with a lift-off mass of about 1500 kg by PSLV-C30.
- It is India's first dedicated multi wavelength space observatory.
- Most other scientific satellites can observe only a narrow range of wavelength band.
- But AstroSat enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.
- It observes universe in the optical, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum.
- **Scientific objectives**-To understand high energy processes in binary star systems containing neutron stars and black holes, estimate magnetic fields of neutron stars, Study star birth regions and high energy processes in star systems lying beyond our galaxy, Detect new briefly bright X-ray sources in the sky and Perform a limited deep field survey of the Universe in the Ultraviolet region.
- The minimum useful life of the AstroSat mission is expected to be 5 years.

1.30 Mars Orbiter Mission

- It is ISRO's first interplanetary mission to planet Mars with an orbiter craft designed to orbit Mars in an elliptical orbit of 372 km by 80,000 km.
- It has been configured to carry out observation of physical features of mars and carry out limited study of Martian atmosphere with following five payloads - Mars Colour Camera (MCC), Thermal Infrared Imaging Spectrometer (TIS), Methane Sensor for Mars (MSM), Mars Exospheric Neutral Composition Analyser (MENCA) and Lyman Alpha Photometer (LAP)
- It was launched by **PSLV – C25** with lift off mass of 1337 Kg in Martian Orbit.

1.31 GEMINI system

- GEMINI (GAGAN Enabled Mariner's Instrument for Navigation and Information) is a new marine information dissemination system.
- It is to provide disaster warnings to fishermen by utilizing GAGAN (GPS Aided Geo Augmented Navigation) satellite systems of the AAI and ISRO.
- It is a portable device which receives data from the GAGAN satellites and sends it to the user's cellphone App, which decode the alerts.
- It is developed by INCOIS under Ministry of Earth Sciences and Airport Authority of India.
- The data coverage of GEMINI covers the entire India Ocean full-time, which will help in information transmission to the fishermen far away from coastal areas.

1.32 Mission Venus

- ISRO has opened for its "Mission Venus" seeking experiment ideas from space agencies, universities and researchers.
- It is planned to be launched in Mid-2023.
- It plans to study the planet from an elliptical orbit that is closest to Venus at 500 km and 60,000 km at the farthest end.
- It is currently being handled by the Space Science Programme Office.
- If the project is approved would be ISRO's third interplanetary mission after Chandrayaan – 1 and Mars Orbiter Mission.

GLOBAL MISSIONS

NASA

1.33 Heliophysics Missions

- NASA has approved two heliophysics missions to explore the Sun and the system that drives space weather near Earth.
- Understanding the physics that drive the solar wind and solar explosions could help in predicting these events.
- Together, NASA's contribution to the following will help in understanding the Sun and Earth as an interconnected system,
    1. Extreme Ultraviolet High-Throughput Spectroscopic Telescope Epsilon Mission (EUVST) and
    2. Electrojet Zeeman Imaging Explorer (EZIE)
- Funding comes from the Heliophysics Explorers Program, managed by the Explorers Program Office at NASA's Goddard Space Flight Center.

1.34 EUVST Epsilon Mission

- The Japan Aerospace Exploration Agency (JAXA) leads the EUVST Epsilon Mission (Solar-C EUVST Mission), along with other partners.
- Targeted for launch in 2026, EUVST is a solar telescope.
- It will study how the solar atmosphere releases solar wind and drives eruptions of solar material.
- These phenomena propagate out from the Sun and influence the space radiation environment throughout the solar system.
- EUVST will take comprehensive UV spectroscopy measurements of the solar atmosphere at the highest level of detail to date.
- This will allow scientists to tease out how different magnetic and plasma processes drive coronal heating and energy release.

1.35 EZIE Mission

- To be launched in 2024, EZIE will study electric currents in Earth's atmosphere linking aurora to Earth's magnetosphere that responds to solar activity and other factors.
- EZIE is an investigation comprising a trio of CubeSats that will study the source of and changes in the auroral electrojet (AE).
- [AE is an electric current circling through Earth's atmosphere around 60-90 miles above the surface and extending into the magnetosphere.
- They are generated by changes in the structure of the magnetotail.]
- The interaction of the magnetosphere and the solar wind compresses the Sun-facing side of the magnetosphere.
- This drags out the night-time side of the magnetosphere into what is called a magnetotail.
- The same space weather phenomena that power the aurora can cause interference with radio and communication signals and utility grids on Earth's surface, and damage to spacecraft in orbit.

1.36 Stardust 1.0

- The United States of America's Stardust 1.0 became the first commercial space launch powered by biofuel.
- Stardust 1.0 is a launch vehicle suited for student and budget payloads.
- It has a mass of 250 kg and can carry a maximum payload mass of 8 kg.
- It is manufactured by bluShift, an aerospace company that is developing rockets that are powered by bio-derived fuels.
- These rockets will help to launch small satellites called cubesats into space in a way.
- These rockets are relatively cheaper than using traditional rocket fuel and are less toxic for the environment.

Biofuel

- Biofuels are obtained from biomass, which can be converted directly into liquid fuels that can be used as transportation fuels.
- The two most common biofuels in use are,
  1. Ethanol is renewable and made from many kinds of plants.
  2. Biodiesel is produced by combining alcohol with new and used vegetable oils, animal fats or recycled cooking grease.
- They both represent the first generation of biofuel technology.

1.37 Perseverance

- Perseverance Rover is NASA's 4th generation Mars Rover.
- [NASA's previous Mars Rovers were Sojourner (Mars Pathfinder Mission in 1997), Spirit and Opportunity (Mars Exploration Rover Mission in 2004), and Curiosity (Mars Science Laboratory in 2012).]
- Perseverance is en route to Mars, and is set to land at Jezero Crater, which was likely filled with water in the past.
- In the dried up lake bed at Jezero Crater, it will look for fossils or some biosignatures.
- Also, it will produce oxygen on the Martian surface for the first time, using atmospheric CO2 from the Martian atmosphere.
- It will cache rock samples that will be returned to Earth by a subsequent European Space Agency/NASA mission.

1.38 Ingenuity

- Ingenuity, which was carried by NASA's Perseverance rover to Mars, will attempt up to four flights within a 31-Earth-day window.
- NASA announced that the ultra-light mini-helicopter Ingenuity had performed its first flight on Mars.
- It had been feeding off the Perseverance's power system.
- But now it will have to use its own solar-powered battery.
- To take high-resolution photographs, Ingenuity will attempt to fly in an atmosphere that is 1% the Earth's density, which makes achieving lift harder, but will be assisted by gravity that is one-third of Earth's.

Technology Demonstrations

Other technology demonstrations of the same kind as that of Ingenuity are,

- Mars Pathfinder rover Sojourner (1996) and
- Mars Cube One CubeSats that flew by Mars in 2018.

- It flies using counter-rotating blades that spin at 2,400 rpm. It has a wireless communication system. It is equipped with computers, navigation sensors, and two cameras.
- The helicopter's mission is experimental in nature and completely independent of the rover's science mission. Its main task is to carry out a technology demonstration to test the first powered flight on Mars.
- It will help collect samples from the surface from locations where the rover cannot reach.

1.39 Mars Oxygen In-Situ Resource Utilization Experiment

- NASA has announced that the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE) aboard the Perseverance rover was able to produce oxygen from the thin Martian atmosphere for the first time.
- MOXIE produced 5 grams of oxygen from carbon dioxide, enough for an astronaut to breathe for 10 minutes in Mars. It is designed to generate up to 10 grams of oxygen per hour.
- [In Mars' atmosphere, carbon dioxide makes up ~96% of the gas. But, oxygen is only 0.13%, compared to 21% in Earth's atmosphere.]
- To produce oxygen, MOXIE separates oxygen atoms from carbon dioxide molecules by using heat at a temperature of around 800 degrees Celsius.
- In the process, it also produces carbon monoxide as a waste product, which it releases in the Martian atmosphere.
- **Importance** - A substantial amount of oxygen supply on Mars is essential for crewed missions to Mars - Astronauts could breathe it.
- The oxygen produced could be used as liquid oxygen propellant and the rockets could use it as fuel while coming back to Earth.

1.40 OSIRIS-REx

- Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) spacecraft will depart asteroid Bennu, and start its two-year long journey back to Earth.
- OSIRIS-REx is NASA's first mission to visit a near-Earth asteroid, survey its surface and collect a sample from it.
- The seven-year-long mission was launched in 2016, reached its target in 2018. In October 2020, the spacecraft touched asteroid Bennu.
- When the spacecraft finally returns in September 2023, it will bring back the largest sample of dust and pebbles collected by a NASA mission since the Apollo astronauts collected samples of Moon rock.
- Bennu is considered to be an ancient asteroid that has not gone through a lot of composition-altering change through billions of years.
- This means that below its surface lie chemicals and rocks from the birth of the solar system. Studying Bennu might give clues about the origins of the solar system, the sun, the Earth and the other planets.

Asteroid Bennu

- Named after an Egyptian deity, Bennu is located about 200 million miles away from the Earth. It was discovered by a NASA-funded Lincoln Near-Earth Asteroid Research team in 1999.
- It is a **B-type asteroid**, implying that it contains significant amounts of carbon and various other minerals.
- Because of its high carbon content, Bennu reflects about 4% of the light that hits it, which is very low. (Earth reflects 30% of the light that hits it.)

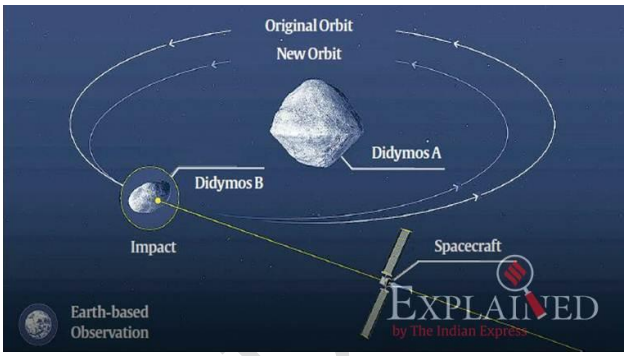
1.41 NASA New Missions

- NASA announced has selected four Discovery Program investigations to develop concept studies for possible new missions, which are as follows
- **DAVINCI+** - Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging Plus.
- This will analyse Venus's atmosphere to understand how it was formed and evolved, and if it ever had an ocean.
- This will advance understanding of the formation of terrestrial planets.
- **IVO** - Io Volcano Observer is a proposal to explore Jupiter's moon Io, which is extremely volcanically active.
- This will try to find out how tidal forces shape planetary bodies.
- The findings could further knowledge about the formation and evolution of rocky, terrestrial bodies and icy ocean worlds in the Solar System.
- **TRIDENT -** This aims to explore Neptune's icy moon, Triton, so that scientists can understand the development of habitable worlds in the Solar System.

- **VERITAS -** Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy will aim to map Venus's surface to find out why Venus developed so differently from Earth.

1.42 Asteroid Impact Deflection Assessment (AIDA) Mission

- AIDA is a dual-mission concept, involving two independent spacecraft NASA's Double Asteroid Redirection Test (DART), and European Space Agency's Asteroid Impact Mission (AIM).
- It involves Double Asteroid Redirection Test (DART) to avoid potential hit by the asteroids.
- DART is a planetary defence technique developed by NASA.
- Its objective is to save the planet from Asteroid collision by changing its motion in space.The spacecraft will cause deliberately crashing itself into the asteroid at a speed of approximately 6 km/s.
- It will be the first demonstration of the kinetic impactor technique to change the motion of an asteroid in space.



- It is going to be launched SpaceX Falcon 9 rocket that will hit Asteroid Didymos in September 2022.
- Flying along with DART will be an Italian-made miniature CubeSat, called **LICIACube**, to record the moment of impact.
- ESA's contribution is a mission called 'Hera', which will perform a close-up survey of the post-impact asteroid.

1.43 Artemis Mission

- Artemis is NASA's next mission to the Moon.
- ARTEMIS stands for Acceleration, Reconnection, Turbulence and Electrodynamics of Moon's Interaction with the Sun.
- It aims to send astronauts to the Moon by 2024 with the ultimate goal to land humans on Mars.
- The mission consists of spacecraft to measure what happens when the Sun's radiation hits our rocky moon, where there is no magnetic field to protect it.
- The ARTEMIS mission uses two of the five in-orbit spacecraft from another NASA Heliophysics constellation of satellites (THEMIS) that were launched in 2007 and successfully completed their mission earlier in 2010.
- The astronauts will be first sent to the Orion spacecraft using the new Space Launch System (SLS) rocket.
- The spacecraft will take the crew to the lunar orbit and will return them to Earth as well.
- The Orion spacecraft will be docked at the Gateway, from where the astronauts will take expeditions to the surface of the Moon in the human landing system.

1.44 New Frontiers program

- The New Frontiers program is a series of space exploration missions being conducted by NASA with the purpose of researching several of the Solar System bodies, including the dwarf planet Pluto.
- There are currently three New Frontiers missions in progress.
- **New Horizons**, which was launched in 2006 and reached Pluto in 2015. It is the first mission to the Pluto system and Kuiper Belt and fastest spacecraft ever launched.
- **Juno** was launched in 2011 and entered Jupiter orbit in 2016. It is to measure Jupiter's composition, gravity field, magnetic field and polar magnetosphere.
- **OSIRIS-REx**, launched in September 2016 towards near-Earth asteroid Bennu for detailed studies from 2018 to 2021 and a sample return to Earth in 2023.

Other Space Agencies

1.45 Micius Satellite

- Micius is the world's first quantum communications satellite, launched by China in 2016.
- The satellite serves as the source of pairs of entangled photons.
- Recently, it has sent light particles to the Earth to establish the world's most secure communication link.
- It has successfully brought entanglement-based quantum cryptography to its original ground stations 1,200 km apart by sending simultaneous streams of entangled photons to the ground stations to establish a direct link between the two of them.
- The satellite provided entangled photons as a convenient resource for the quantum cryptography and the two ground stations then used them according to their agreed protocol.
- Until now, this had never been done via satellite or at such great distances.
- It has not been specified how the messages were transmitted in this instance but in theory it could be done by optical fibre, another communications satellite, radio or any other agreed method.
- Scientists have started using quantum encryption for securing long-range communication and Micius has been at the forefront of quantum encryption for several years.

1.46 Mars Missions

- Three Mars missions - UAE's Hope, NASA's Perseverance and China's Tianwen-1 - are set to land on Mars in the year 2021.
- Earth and Mars are at their closest distance relative to each other every 26 months and this is when Earthlings try to send missions to Mars.
- Currently, there are 10 spacecraft from five different space agencies, either orbiting or on the ground on Mars.
    1. NASA has a lander (Mars Insight), a rover (Curiosity), and three orbiters (Mars Reconnaissance Orbiter, Mars Odyssey, MAVEN);
    2. India has an orbiter (Mangalyaan-1)
    3. European Union has 2 orbiters (Mars Express and ExoMars Trace Gas Orbiter)
    4. UAE has an orbiter (Hope)
    5. China has an orbiter (Tianwen-1)

1.47 Tianwen 1

- China National Space Administration (CNSA) has recently launched its first Mars probe named Tianwen 1 or Quest for Heavenly Truth 1.
- It aims to complete orbiting, landing and roving in a single mission.
- It used China's largest and most powerful launch vehicle Long March-5 rocket for the mission.
- **Tianwen-1's Goals** - To analyse and map the Martian surface and geology, look for water ice, study the climate and surface environment.
- The three scientific objectives -
    1. Orbiting the red planet for comprehensive observation,
    2. Landing on Martian soil
    3. Sending a rover to roam the landing site.
- It will conduct scientific investigations into the planet's soil, geological structure, environment, atmosphere and water, media reports said.
- It should arrive in orbit around the red planet in February 2021.

- Unlike NASA rovers, it will orbit Mars for few months before attempting to land in May, 2021 at Utopia Planitia.
- Utopia Planitia was selected for landing, as it would possibly have ancient groundwater deposits. It is where the U.S. lander Viking 2 touched down in 1976.
- China would become the third country after the former Soviet Union and the United States to put a robot rover on Mars.
- The first Mars rover will be named Zhurong after a traditional fire god. This name fits with the Chinese name for Mars - "Huo Xing" or fire star.
- China's previous attempt to send an exploratory probe to Mars called Yinghuo-1, in a Russian spacecraft in 2011 was failed.

1.48 Chang'e-5 Mission

- China has launched an unmanned spacecraft to bring back lunar rocks, the first attempt by any nation to retrieve samples from the Moon in four decades.
- Recently, China has launched the Long March-5 Y5 rocket, carrying the Chang'e-5 spacecraft from Wenchang Space Launch Center (China).
- It is named after the ancient Chinese goddess of the moon, will seek to collect lunar material to help scientists understand more about the moon's origins and formation.
- The spacecraft landed in Siziwang Banner, China's Inner Mongolia Autonomous Region.
- It returned with 2Kg of the fresh rock samples from the moon, which would help us know more about moon's origins and formation.
- These lunar samples were retrieved from a previously unvisited area of the moon known as the OceanusProcellarum, or Ocean of Storms.
- Ocean of Storms is a site near the Mons Rumker, which was believed to have been volcanic in ancient times.
- Mons Rumker, never sampled before, is geologically younger than the sampling areas of the U.S. and the Soviet missions.
- These young samples could help widen the spectrum of their analysis to understand the moon's volcanic activity and evolution.
- The sample collected would help scientists learn about the following
  1. Moon's origins,
  2. Volcanic activity on its surface and its interior, and
  3. When its magnetic field, key to protecting any form of life from the sun's radiation dissipated.
- The cargo capsule's departure from the lunar surface was also the first lift-off of a Chinese craft from an extra-terrestrial body.
- It made China only the third country to have retrieved lunar samples, joining the United States and the Soviet Union.
- **Docking** refers to connecting of two flying objects in space, either to transfer men or material from one to the other, or to join two structures to make a bigger one.
- As part of its manoeuvre in this mission, it has done its first docking in lunar orbit.

Other missions that had collected lunar samples

- The other two missions that had brought back the lunar samples from the moon surface were the following
  1. **USA's Apollo programme** (which first put men on the moon) – brought 382 kg of rocks and soil.
  2. **USSR's Luna** had deployed three successful robotic sample return missions in the 1970s, samples were collected from Mare Crisium, or "Sea of Crises" - a lunar basin.

1.49 BeiDou

- China's administration has officially commissioned BeiDou Navigation Satellite System constellation.
- It was initiated in 1994.
- It aims to integrate its application in different sectors, including fishery, agriculture, special care, mass-market applications, forestry and public security.
- It now offers services including accurate positioning, navigation and timing as well as short message communication.
- BeiDou uses a network of satellites and can provide positional accuracies of under 10 meters, whereas GPS provides positioning accuracies of under 2.2 meters.
- Chinese military has employed Beidou-guided conventional strike weapons to counter a US intervention in a potential contingency, if access to GPS is denied.
- Navigation Systems of other countries are as follows
    1. NAVIC – India
    2. GPS - USA
    3. GLONASS - Russia
    4. GALILEO – EU

1.50 Solar Orbiter Mission

- Solar Orbiter is a joint ESA & NASA mission to study the Sun.
- It was launched in February 2020
- Solar Orbiter will address big questions in Solar System science like how our star creates and controls the giant bubble of plasma that surrounds the whole Solar System and influences the planets within it.
- Recently scientists from NASA and ESA (European Space Agency) released first data captured solar orbiter.
- In mid-June, Solar Orbiter made its first close pass of the Sun, it has captured the closest images ever taken of the Sun.

1.51 Mission Hope

- United Arab Emirates's (UAE) first mission to Mars "Hope" was recently launched successfully from Japan Tanegashima Space Center.
- The mission was announced in 2015 with the aim of creating mankind's first integrated model of the Red planet's atmosphere.
- It will seek to address the question of how and why Mars lost its atmosphere which resulted in the loss of surface water and possibly the environment hospitable to life.
- It is the Arab world's first mission to Mars and also first interplanetary mission.
- The Al Amal probe, as it is called in Arabic, is expected to reach Mars by February 2021.
- The probe will stay in orbit for a Martian year, equivalent to 687 days on Earth, to gather data about Mars' atmosphere.
- It will carry the following scientific instruments mounted on one side of the spacecraft -
    1. High-resolution camera called Emirates eXploration Imager (EXI),
    2. Far-UV imaging spectrograph called Emirates Mars Ultraviolet Spectrometer (EMUS), and
    3. Emirates Mars InfraRed Spectrometer (EMIRS) and FTIR scanning spectrometer.
- The UAE became the fifth national space agency (after the US, EU, Russia, and India) to reach Mars.

1.52 Progress MS-16 Cargo Ship

- Progress MS-16 or Progress 77 cargo ship has delivered water, propellant and other supplies to the International Space Station (ISS).
- Progress MS-16 is an **unmanned** Russian cargo ship launched by Russian Space Agency, **Roscosmos**.
- **International Space Station** is the only active modular space station (habitable artificial satellite) in the Earth's Orbit.
- It is the largest artificial object in space and the largest satellite in low Earth orbit, visible to the naked eye from Earth's surface.
- It is a joint project between five participating space agencies - NASA (USA), Roscosmos, Japan Aerospace Exploration Agency (JAXA), European Space Agency, and Canadian Space Agency.

1.53 International Lunar Research Station

- **China** National Space Administration and **Russian** space agency Roscosmos would build an International Lunar Research Station (ILRS) on the lunar surface and/or on the lunar orbit.
- Russia and China will adhere to the principle of co-consultation, joint construction, and shared benefits, and facilitate extensive cooperation in the ILRS.
- Scientific research activities such as the lunar exploration and utilization, lunar-based observation, basic scientific experiment and technical verification will be carried out in ILRS.
- ILRS will be open to all interested countries and international partners, strengthen scientific research exchanges, and promote humanity's exploration and use of outer space for peaceful purpose.

1.54 Russia's Satellites Launch

- Russian space agency Roscosmos' Soyuz-2.1a carrier rocket with the Fregat upper stage launched the 38 foreign satellites from 18 countries into orbit from Baikonur cosmodrome, Kazakhstan.
- Among them was the Challenge-1, the first satellite made completely in Tunisia, which was created by the Telnet telecommunications group.
- In 2018, a Soyuz rocket carrying a Russian cosmonaut and a NASA astronaut failed mid-flight, forcing the crew to carry out an emergency landing.

1.55 Arktika-M Satellite

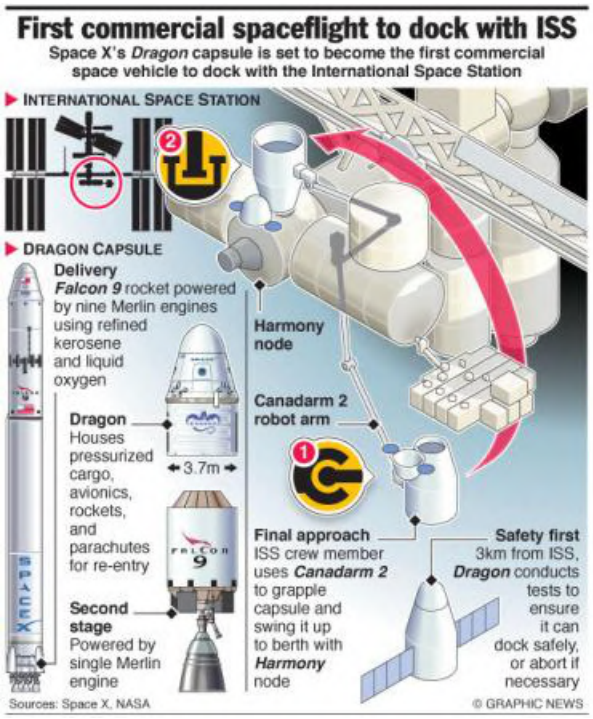
- Russia launched its space satellite Arktika-M from Kazakhstan by a Soyuz-2.1b carrier rocket with the Fregat booster.
- This is a remote-sensing and emergency communications satellite.
- It was launched to monitor the climate and environment in the Arctic.
- It will have a highly elliptical orbit that passes over northern latitudes allowing it to monitor northern regions for long periods before it loops back down under Earth.
- It will retransmit distress signals from ships, aircraft or people in remote areas as part of its Cospas-Sarsat satellite-based search and rescue programme.
- Russia plans to send a second satellite in 2023. These two will offer round-the-clock, all-weather monitoring of the Arctic Ocean and Earth's surface.

Private Sector in Space

1.56 SpaceX-NASA Dragon Demo-2 launch

- SpaceX's Falcon 9 rocket and Crew Dragon spacecraft, carrying two NASA astronauts, successfully blasted off from the Kennedy Space Center in Florida.
- Elon Musk's SpaceX has thus become the first private company to launch human beings into orbit.

- SpaceX is a company founded by billionaire entrepreneur Elon Musk, who also heads Tesla Motors that produces new-age automobiles.
- The rocket, named Falcon 9, which carried the spaceship into the orbit, was built by SpaceX.
- Crew Dragon Capsule is the spaceship that carries the astronauts. It returned back to earth after its short test flight making it the first splashdown by U.S. astronauts in 5 years.
- The astronauts have named the commercial spacecraft after one of the retired winged orbiters '*Endeavour*'.
- The Florida launch facility used for the flight still belonged to NASA.
- **Mission -** Veteran NASA astronauts Robert Behnken and Douglas Hurley flew onboard the spaceship named Crew Dragon.
- They have embarked on a 19-hour voyage to the orbiting International Space Station (ISS).
- Crew Dragon Capsule will dock automatically into the docking port Harmony, with the help of sensors and cameras.
- They will perform tests on the Crew Dragon and conduct research.
- At ISS, they will spend 4 months before returning home.
- On atmospheric re-entry, the Crew Dragon capsule will splashdown in the Atlantic Ocean and will be recovered by the Go Navigator Recovery Vessel.
- The mission was called Demo-2, in keeping with the fact that it was still only a 'test flight.'



- If successful, this would lead to more missions in the coming years.
- **Importance -** For NASA, it was the first flight of its astronauts on an American spaceship, launched on American soil, since the STS-135 mission in 2011.
- Following the 2011 mission, all astronauts were flown to the ISS in Russia's Soyuz Capsule.
- With the launch of SpaceX's Crew Dragon space craft, NASA is heralding a new chapter in space exploration.
- It sets the precedence for private participation in space operations.

1.57 Starship Enterprise

- Starship Enterprise, a preparation for revolutionising Mars exploration, is being developed by the SpaceX in **Boca Chica**.
- Starship represents the best shot at landing humans on Mars, which is not underwritten financially by government money.
- It promises to reduce mission costs by 95% to 99% by using innovations like refuelling the spacecraft in orbit, and manufacture of rocket fuel on Mars using materials that are found on Mars.

1.58 IN-SPACe

- Recently, the Government of India has created the Indian National Space Promotion and Authorization Center (IN-SPACe), an independent nodal agency under the Department of Space.
- IN-SPACe will be an autonomous nodal agency under the Department of Space.
- It is supposed to be a facilitator and a regulator. It will act as an interface between ISRO and private parties.
- It will provide the necessary support for the private space industry to conduct its activities.

- It will assess the needs and demands of private players including educational and research institutions.
- It will explore ways to accommodate these requirements in consultation with ISRO.
- Currently, there are more than 500 private companies which partner with the Indian Space Research Organization (ISRO) in carrying out various space activities.
- They provide materials used in manufacturing, mechanical fabrication, electronic fabrication, system development, integration, etc.
- Under the new system
  1. The government will allow utilizing those infrastructures of ISRO which are otherwise not available elsewhere in India.
  2. Permit establishment of facilities, within ISRO premises, based on safety norms and feasibility assessment.
  3. The decision of IN-SPACe shall be final and binding on all stakeholders including ISRO and private players will not be required to seek separate permission from ISRO.
- Existing ISRO infrastructure, scientific and technical resources and even data are planned to be made accessible to interested parties. [The infrastructure includes both ground- and space-based.]

1.59 Blockchain in Space

- JP Morgan has successfully tested a space-based payment infrastructure utilising blockchain technology, using GomSpace's satellites.
- It is the world's first bank-led tokenised value transfer in space.
- It was executed via smart contracts on a blockchain network that was established between two GOMX-4 satellites orbiting the earth in the low Earth orbit (LEO).
- This has validated the approach towards a decentralised network where communication with the earth is not necessary.
- It may lead to a potential peer-to-peer satellite marketplace in the long term, allowing data transfers between satellites against payment.

2. PLANETARY SYSTEMS

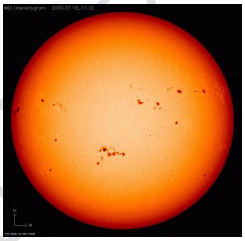
Introduction

2.1 Definition of a Planet

- International Astronomical Union (IAU), a group of experts, is the authorized body to define the criteria for any object to be designated as a planet.
- In 2006, IAU defines three criteria to classify any object as a planet
  i. It needs to be in orbit around any fully-fledged star.
  ii. It needs to have enough gravity to pull itself into a spherical shape.
  iii. It has cleared the neighborhood around its orbit
- This last criterion is the point at which planets and dwarf planets differ. Dwarf planets have other objects inits orbit around its star.
- In accordance with this, IAU decided to demote Pluto as a dwarf planet.
- IAU recognizes five named dwarf planets - Ceres, Pluto, Eris, Haumea, and Makemake.
- Except Ceres, other dwarf planets are also known as Plutoids.

2.2 Sun's Atmosphere

- The sun‟s atmosphere corona is much hotter than its visible surface Photosphere.
- Normally, the layer closest to a source of heat, the Sun‟s surface, in this case, would have a higher temperature
- than the more distant atmosphere.
- But the reason for the high temperature is the constant eruption of tiny solar flares in the solar atmosphere.
- The solar flares produce hard X-rays, whose wavelengths are much shorter than the light humans can see and it is a signature of extremely hot solar material.



2.3 Solar Cycles and Sun spots

- The amount of magnetic flux that rises up to the Sun's surface varies with time in a cycle called the solar cycle, which lasts 11 years on average.
- This cycle is sometimes referred to as the sunspot cycle.
- Sunspots are regions where the solar magnetic field is very strong.
- In visible light, sunspots appear darker than their surroundings because they are a few thousand degrees cooler than their surroundings.
- They are usually concentrated in two bands, about 15 - 20 degrees wide in latitude, that go around the Sun on either side of the solar equator.

2.4 Asteroid & Comet

- An asteroid is a small, naturally occurring, solar system body that orbits the sun. Asteroids are typically composed of rock-forming minerals, most commonly olivine and pyroxene.
- However, they often contain metal (iron and nickel), sulfides (chemical mixtures of metals and sulfur), clays, and organic compounds. The structure and composition of asteroids vary from object to object.
- Most asteroids in our solar system reside in the region between Mars and Jupiter known as the Asteroid Belt.
- A **comet** is a small body composed mostly of dusty material embedded with icy volatiles, such as water and carbon dioxide that formed in the **cold outer solar system**.

Naming of an Asteroid

- International Astronomical Union (IAU) serves as the internationally recognized authority for assigning designations to celestial bodies and surface features on them.
- According to IAU's guidelines, the privilege of naming a planet is first given to discoverers, who have 10 years to propose a name.
- The discoverer or team is expected to write a short citation, explaining the reasons for assigning the name.
- All names proposed are judged by the 15-member Working Group for Small Body Nomenclature (CSBN) of the IAU.
- It has recently named an asteroid after **Indian classical singer Pandit Jasraj.**
- It is located between Mars and Jupiter, and was discovered on November 11, 2006 by the Arizona based telescope.

2.5 Heliosphere, Heliopause and Interstellar Space

- The sun creates heliosphere by sending a constant flow of particles and a magnetic field out into space at over 670,000 miles per hour. This stream is called the 'solar wind.'
- Heliopause marks the end of a region created by our sun that is called the heliosphere.
- It is the boundary between our Solar System and the interstellar medium.
- It is the place where the sun's constant flow of material and magnetic field stop affecting its surroundings.
- Interstellar Space is the part of space that exists between stars with cold particles around it.

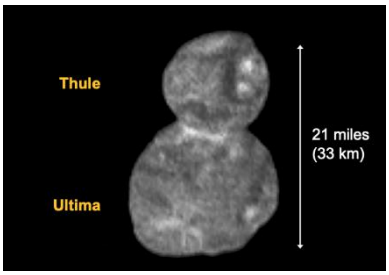
- Inside the heliosphere, the solar particles are hot but less concentrated. Outside of the bubble, they are very much colder but more concentrated.
- Once an object arrives in interstellar space, there would be an increase of "cold" particles around it.

2.6 Three Categories of Black Holes

- Black holes form when massive stars die and their cores collapse. They are electromagnetically dark, and so they are difficult to find.
- Their effects on the companion star are what indicate their presence.
- **Stellar mass black holes** - They are the smallest black holes formed by the gravitational collapse of a single star.
- **Gargantuan supermassive black holes** - They are black holes at our galaxy's center, 26,000 light years from Earth, which is four million times the sun's mass.
- **Intermediate-mass black holes** - They have masses somewhere in between the above two.

2.7 Arrokoth

- Ultima Thule, the farthest cosmic body ever visited by a spacecraft, has been renamed Arrokoth, or "sky" in the Native American language.
- Arrokoth is icy rock, which orbits in the dark and frigid Kuiper Belt about a billion miles beyond Pluto.
- Arrokoth is an example of a "cold classical object" which has remained undisturbed since the solar system formed some 4.5 billion years ago.
- It was surveyed by the NASA spaceship New Horizons in January 2019, with images showing it consisted of two spheres stuck together in the shape of a snowman.
- The new official name, which was chosen by the New Horizons team and ratified by the International Astronomical Union.



2.8 TRAPPIST-1

- It is a system of seven Earth-size planets orbiting an ultra-cool dwarf star about 40 light-years away.
- This is by far the largest collection of Earth-like planets in the habitable '**Goldilocks' zone** of a star.
- **Goldilocks** represents a zone which is neither too close nor too far from a star, which raises the possibility of liquid water being present on the surface.
- Unlike earlier discoveries of exoplanets, all seven planets could possibly have liquid water.
- Three of the planets have the greatest chance.
- Since the initial discovery of three planets was made using the Chile-based Transiting Planets and Planetesimals Small Telescope, the exoplanet system is called TRAPPIST-1.
- The TRAPPIST-1 planets have lower densities than Earth.
- In a new study, researchers found that the TRAPPIST-1 star is quite old: between 5.4 and 9.8 billion years.
- Recent evidence from NASA's Hubble space telescope revealed that earth sized exoplanets in the Trappist-1 system may contain water.

2.9 Saraswati - Supercluster of Galaxies

- A team of Indian scientists has reported the discovery of a 'supercluster' of galaxies and named it Saraswati.
- It is located four billion light years away from the earth.
- Galaxies are themselves made of billions of stars and planets, and a cluster typically contains several hundreds of these galaxies.

- Superclusters, a group of clusters of galaxies, are the largest structures of stars, planets and other heavenly bodies in the Universe.
- The Milky Way galaxy, of which the Earth is a very small member, is part of the Laniakea supercluster, which was identified only in 2014.

Recent Developments

2.10 Entangled Photons

- Entangled photons are twinned light particles whose properties remain intertwined no matter how far apart they are.
- If one of the photons is manipulated, the other will be similarly affected at the very same moment.
- It is this property that lies in the heart of the most secure forms of quantum cryptography (the study of concepts like encryption and decryption).
- If one of the entangled particles is used to create a key for encoding messages, only the person with the other particle can decode them.

2.11 South Pole Wall

- Spectacular 3D maps of the universe have revealed inconceivable wall known as South Pole Wall.
- It stretches 1.4 billion light-years across that contains hundreds of thousands of galaxies.
- One light-year is roughly 6 trillion miles, or 9 trillion kilometers, so this "biggest cosmic structure" is mind-bendingly humongous.
- It has been hiding in plain sight, remaining undetected until now because large parts of it sit half a billion light-years away behind the bright Milky Way galaxy and Zone of Avoidance.
- Zone of Avoidance is the disc of our home galaxy, a region thick and bright with dust and gas and stars.
- The South Pole Wall rivals in size the Sloan Great Wall, the sixth largest cosmic structure discovered.
- Other, larger such walls is the Hercules-Corona Borealis Great Wall, which spans 9.7 billion light-years.

2.12 Phobos

- Phobos is the innermost and larger of the two natural satellites of Mars, the other being Deimos.
- Both moons were discovered in 1877 by American astronomer Asaph Hall.
- Phobos is a small, irregularly shaped object with a mean radius of 11 km (7 mi) and is seven times as massive as the outer moon, Deimos.
- It is largely believed to be made up of carbonaceous chondrites.
- It is so close that it orbits Mars much faster than Mars rotates, and completes an orbit in just 7 hours and 39 minutes.
- Recently, The Mars Colour Camera (MCC) onboard ISRO's Mars Orbiter Mission has captured the image of Phobos, the closest and biggest moon of Mars.

- According to ISRO, the violent phase that Phobos has encountered is seen in the large section gouged out from a past collision (Stickney crater) and bouncing ejecta.
- Shklovsky,Roche, and Grildrig are other craters.

2.13 Asteroid 2020 ND

- NASA has issued a warning that a huge Asteroid 2020 ND is expected to move past the Earth.

- It will be as close as .034 astronomical units (5,086,328 kilometers) to our planet travelling at a speed of 48,000 kilometers per hour.
- Its distance from Earth has placed it in the potentially dangerous category.
- Potentially Hazardous Asteroids (PHAs) are those with a minimum orbit intersection distance (MOID) of 0.05 au or less.
- NASA classifies these objects as near-Earth objects (NEOs).However, it is not necessary that asteroids classified as PHAs will impact the Earth.

2.14 Venus Coronae

- Researchers have recently studied the formation of Venus' ring-shaped volcanic structures called "Coronae".
- They are formed by plumes of molten rock rising from the mantle up through the crust.
- This process is similar to how Earth's volcanos function.
- Venus was earlier determined to be an inactive planet. However, now it is being said that the interior is still churning and can feed many active volcanoes.

2.15 Inter-planetary Contamination in Mars

- Recently, astrobiologists have expressed concerns about possible 'interplanetary contamination' on Mars.
- Interplanetary contamination refers to biological contamination of a planetary body by a space probe or spacecraft, either deliberate or unintentional.
- In the past, space missions have established physical contact with astronomical bodies such as comets and asteroids, and crewed missions have landed on the Moon.
- However, since these bodies are known to be hostile to life, the possibility of their contamination has not been a pressing issue.
- **Type of Contaminations**
  a) Forward Contamination- It means the transport of Earth-based microbes to other celestial bodies.
  b) Back Contamination - It is the transfer of extraterrestrial organisms (if they exist) into the Earth's biosphere.
- 'Planetary protection policy' aims to limit the number of microbes sent to other planets, as well as ensuring that alien life does not cause havoc on Earth.
- The policy was laid down by Committee on Space Research (COSPAR) established by International Council for Science (ICSU).

2.16 Brown Dwarfs

- Recently, Citizen Scientists and NOIR Lab facilities discovered almost 100 nearby cool Brown Dwarfs.
- Brown dwarf are an astronomical object that is intermediate between a planet and a star.
- They usually have a mass less than 0.075 that of the Sun, or roughly 75 times that of Jupiter.
- They are outside the solar system. They give off little light and energy and they are challenging to locate.
- Brown dwarfs are also called failed stars, because their masses are heavier than planets but lighter than stars.
- Due to their small masses, they are unable to sustain fusion of their hydrogen to produce energy.
- It is believed that some of the more massive brown dwarfs fuse deuterium or lithium and glow faintly.

2.17 Sarabhai Crater

- A crater is a bowl-shaped depression produced by the impact of a meteorite, volcanic activity, or an explosion.
- The Sarabhai Crater is around 250 to 300 kilometres east of the crater where the Apollo 17 and Luna 21 Missions had landed.

- It is eight kilometres in diameter and located in the Mare Serenitatis in the Northeast quadrant of the Moon.
- The Crater has a depth of around 1.7 Kms taken from its raised rim.
- Chandrayaan 2 orbiter's Terrain Mapping Camera–2 (TMC-2) instrument has captured a photograph of the Sarabhai Crater on the Moon.
- The crater's outer region is dominated by numerous smaller craters of various sizes and is distributed over the flat Mare plains,
- It has defining features like a raised rim, gradient inner walls and the small hummocky floor.

2.18 Mare Serenitatis

- It is one of the lunar mare regions on the Moon which were formed between 3.9 and 3.8 thousand million years ago with vast lava plains creating a flat surface
- It was during this period when the Moon was heavily bombarded by asteroids and the major impact basins on the Moon were formed.
- The Sarabhai crater is an 'excellent example' to study the impact process of the Mare Serenitatis.
- It will help the Space Scientists to understand further the process on the lunar region filled with lava.

2.19 Helium Enhanced Cool Stars

- Indian Institute of Astrophysics (IIA) an autonomous institute of DST, have discover He-enhanced cool bright stars among the metal-rich parts of Omega Centauri globular cluster.
- This is the first time He-abundance has been found in Omega Centauri.
- Globular clusters are the stellar systems with millions of stars formed from the same gaseous cloud.
- Omega Centauri is the brightest and the largest globular cluster in our Milky Way Galaxy.
- Usually, the stars formed will be homogeneous in their chemical composition of elemental abundances.
- But, there are clusters which deviate from this norm.
- The different stars of Omega Centauri do not show the same metal content, a parameter that indicates its age, but a large range in it.
- The study provides a very important clue for the origin of the He-enhanced population establishing that these are the second generation of stars formed from the metal-rich and He-enhanced material from the first generation of stars.

2.20 AR2770 Sunspots

- A massive Sunspot group, AR2770, was observed using images of the Sun's surface from NASA's Solar Dynamics Observatory (SDO).
- This massive sunspot on the Sun will be turning towards earth which could result in major strong flares.
- Sunspots may release a huge amount of energy which in turn will lead to solar flares.

2.21 Dwarf Planet Ceres

- Ceres is a dwarf planet and it is the largest celestial object in the asteroid belt between Mars and Jupiter.
- It has a diameter of about 950 km, which is more than one-fourth of Earth's moon.
- It has 92 km wide crater named Occator located in Ceres' northern hemisphere.
- Scientist have recently found that it is said to have salty water underground, by observing the cracks created to form a crater.
- This crater is said to have formed by an impact approximately 22 million years ago.
- The scientists have given Ceres the status of an "ocean world" as it has a big reservoir of salty water underneath its frigid surface.

- This has led to an increased interest of scientists that the dwarf planet maybe habitable or has the potential to be.

2.22 Perseids Meteor Shower

- The Perseids are one of the brighter meteor showers of the year it was active from august 17-26.
- They occur every year between July and August and tend to peak around mid-August.
- Perseids are made of tiny space debris from the comet Swift-Tuttle.
- The Perseids are widely sought after by astronomers and stargazers because most years at its peak, one can see 60 to 100 meteors in an hour from a dark place.
- They are visible in the Northern Hemisphere and can be viewed in skies all across.

2.23 Discovery of Exoplanet using Radio waves

- An exoplanet is a planet that orbits a star outside the solar system.
- These exoplanets are hard to detect because they are hidden by the bright glare of the stars they orbit around.
- One of the key features of the exoplanet is that its orbit is wobbly because the star's gravitation is not at its center which makes the phenomenon possible.
- Recently, scientists have been able to discover an exoplanet and a wobbly star using just radio waves.
- In this method, scientists detect an exoplanet via auroras formed on it by the interaction of the star and a strong magnetic field around a planetary body.

2.24 Coronal Magnetic Field

- International team of solar has measured the global magnetic field of the Sun's corona, or outer atmosphere, for the very first time.
- The team used a technique known as coronal seismology or magneto seismology to measure the coronal magnetic field which has been known for a few decades.
- This method requires the measurement of the properties of magneto hydrodynamic (MHD) waves and the density of the corona simultaneously.
- The team used the improved measurements of the Coronal Multi-channel Polarimeter (CoMP) and advanced data analysis to measure the coronal magnetic field.
- There are two main puzzles about the Sun which this advancement will help address.
- **Coronal Heating Problem** - Though the core of the Sun is at a temperature of about 15 million degrees, its outer layer, the photosphere is a mere 5700 degrees hot.
- However, its corona or outer atmosphere, which stretches up to several million kilometres beyond its surface, is much, much hotter than the surface.
- It is at a temperature of one million degrees or more, attempts to explain this puzzle invoke the magnetic field of the corona.
- **Mechanisms of Eruptions of the Sun -** Solar flares and coronal mass ejections are driven by magnetic reconnections happening in the Sun's corona.
- Magnetic reconnection is a process where oppositely polarity magnetic field lines connect and some of the magnetic energy is converted to heat energy and also kinetic energy which leads to the generation of heating, solar flares, solar jets, etc.
- **India's Contribution -** India's first solar mission, Aditya-L1 satellite will aim to measure the solar coronal magnetic fields regularly.

Coronal Multi-channel Polarimeter

- CoMP is an instrument operated by High Altitude Observatory, of the U.S.
- It is located at Mauna Loa Solar Observatory, near the summit of that volcano on the big island of Hawaii.
- It is very important to measure the corneal magnetic fields regularly since the solar corona is highly dynamic and varies within seconds to a minute time scale.
- While photospheric magnetic fields are measured regularly from space.

- This will help understand the spectacular solar eruptions and predictions of space weather and many more things.

2.25 AUDFs01

- A team of Scientists from the Inter University Centre for Astronomy and Astrophysics (IUCAA) has discovered one of the earliest galaxies called AUDFs01 using AstroSat.
- The galaxy is located in the Hubble Extreme Deep field, 9.3 billion light-years away from Earth.
- Hubble eXtreme Deep Field (XDF) is a portion of space that contains approximately 5,500 galaxies, the oldest of which are seen as they were 13.2 billion years ago
- XDF is recorded by the Hubble Space Telescope for over 10 years.The galaxy was discovered using UltraViolet Imaging Telescope (UVIT) on Astrosat.

2.26 Solar Cycle 25

- Sun's surface is a very active space, electrically charged gases on its surface generate areas of powerful magnetic forces, which are called magnetic fields.
- Gases on the Sun's surface are constantly moving, these magnetic fields can get stretched, twisted and tangled creating motion on the surface, which is referred to as solar activity.
- Solar activity varied with the stages of the solar cycle, which lasts on average for a period of 11 years.
- Solar cycles have implications for life and technology on Earth as well as astronauts in space.
- Recently Scientists from NASA and the National Oceanic and Atmospheric Administration (NOAA) announced their predictions about the new solar cycle.
- It is named as Solar Cycle 25, which has begun already

2.27 Super Habitable Planets

- Recently researchers have found out that there are at least 24 super habitable planets which may support life better than the Earth.
- For this finding, researchers have rummaged for the planets which are older, slightly warmer and wetter than the Earth.
- Moreover, all these planets are 100 light-years away from the Earth located outside the Solar System.Favorable factors in planets for hosting life includes the following.
- **Age and Star the planet Orbits -** The scope of life on any planet significantly depends upon the star it orbits.
- **Types of Stars -** Scientists further classified these stars into G-stars which have lifespan less than that of 10 billion years and K-stars that are comparatively cooler, dwarf stars with lifespan of 20 to 70 billion years.
- **Mass of the Planet –** It is one of the promising factors to determine evidence regarding life-formation.
- The research concluded that the planet which is 10 percent larger than the Earth will be having greater area of habitable land with larger mass and would be able to easily retain its interior heating through radioactive decay.
- **Surface temperature of planets –**This play a crucial role in indicating any life-supporting evidences as it would decide the formation of water, moisture and clouds.

2.28 Great Conjunction

- Jupiter and Saturn will be close in the night sky after nearly 400 years.
- This astronomical event is called 'Great Conjunction' or 'Christmas Star'.
- On December 21, this event coincided with the winter solstice in the Northern Hemisphere and summer solstice in the Southern Hemisphere.

- A conjunction is not unique to Saturn and Jupiter however, it is the name given to any event where planets or asteroids appear to be very close together in the sky when viewed from the Earth.
- Astronomers use the word "great" for the conjunction of Jupiter and Saturn because of the planets' sizes.

2.29 Winchcombe Meteorite

- A piece of the Winchcombe meteorite that touched down in the Winchcombe town in Gloucestershire in the UK in February 2021 will be displayed at the National History Museum.
- Winchcombe Meteorite is a 103 gram fragment of black rock resembling coal. It is "astonishingly rare" as it is a carbonaceous meteorite.
    - Out of about 65,000 known meteorite types, only about 1,000 are of carbonaceous type.
- Winchcombe Meteorite dates back to the birth of the solar system nearly 4.5 billion years ago and therefore examining it may offer clues about the beginning of the solar system and maybe even the Earth.

Meteoroids - They are objects in space that range in size from dust grains to small asteroids. They are "space rocks".

Meteors - When meteoroids enter the Earth's atmosphere they are called meteors.

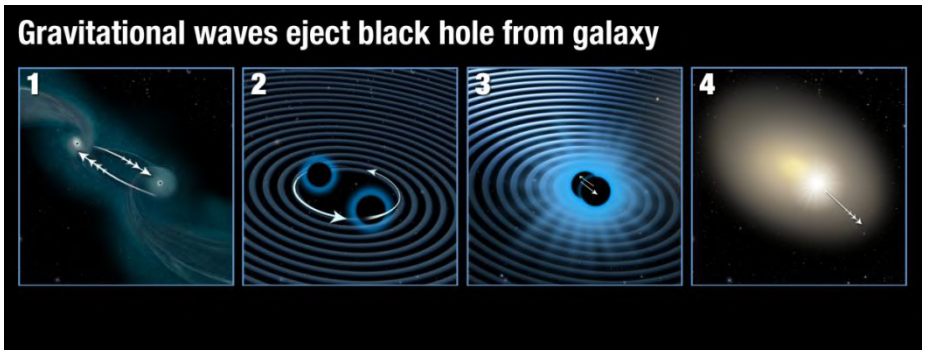
Meteorites - If a meteoroid enters the Earth's atmosphere and hits the ground, it is called a meteorite.

- Space agencies have launched specific missions to asteroids to be able to study them - OSIRIS-REx, Hayabusa2.

2.30 Missing Supermassive Black Hole

A supermassive black hole, which is estimated to weigh up to 100 billion times the mass of the Sun, is seemingly missing.

- Scientists have been looking for the black hole using NASA's Chandra X-ray Observatory and Hubble Space Telescope.
- They have so far found no evidence that it is anywhere to be found.
- The black hole is supposed to be located in Abell 2261.
- Abell 2261 is an enormous galaxy cluster that is about 2.7 billion light-years away from the earth.
- A reason for this could be that Abell's black hole has been ejected from the centre of the galaxy.This is based on 2018 data from NASA's Chandra Observatory.
- This may have happened because of the merging of two smaller galaxies to form Abell.
- In the process, both of their black holes merged to form an even bigger black hole.
- **'Recoiling' black holes**- When two black holes merge, they release what are known as gravitational waves.
- These are invisible ripples travelling at the speed of light, which squeeze and stretch anything in their path.
- During the merger, when the amount of waves generated in one direction is stronger than another, the new big black hole can be sent away from the centre of the galaxy into the opposite direction.
- This is known as a "recoiling" black hole.



2.31 NGC 2808

- Indian Institute of Astrophysics (IIA) has spotted rare hot UV-bright stars in the massive globular cluster NGC 2808 of our Milky Way Galaxy.
- [IIA is an autonomous institute of the Department of Science & Technology, Government of India]
- NGC 2808 is said to have at least five generations of stars, which exist in the late stages of evolution of a Sun-like star.
- Old globular clusters, referred to as dinosaurs of the Universe, help to understand how stars evolve through various phases between their birth and death.
- UV-bright stars have been distinguished from the relatively cooler main-sequence stars using images from Ultraviolet Imaging Telescope (UVIT) onboard satellite AstroSat.

2.32 Saturn's Obliquity

- Obliquity of a planet is the angle between its equatorial plane and the orbital plane, i.e the tilt of a planet.
- During Saturn's formation, its obliquity was 26.7°. But recent observations have shown that it has increased to 27°.
- This tilt may have been caused due to its satellites, which are moving away much faster than what was estimated before.

2.33 WASP-62b

- This is an exo-planet, which was first found in **2012**.
- It is 575 light years away and orbits its star in just four-and-half days.
- For the first time, astronomers have come across a huge planet with about half the mass of Jupiter which is cloudless and unblocked by haze.

2.34 Large Hadron Collider

- Physicists at the Large Hadron Collider (LHC) in Switzerland might have discovered a brand-new force of nature.
- LHC is the world's largest and most powerful particle accelerator. It is present in the European Council for Nuclear Research's (CERN's) accelerator complex and was first started up on 10 September 2008.
- It has a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.
- It is designed to produce proton-proton collision, to be followed by collisions between lead nuclei.
- Inside the accelerator, two high-energy particle beams travel at close to the speed of light before they are made to collide. The beams travel in opposite directions in two separate beam pipes kept at ultrahigh vacuum.
- They are guided around the accelerator ring by a strong magnetic field maintained by superconducting electromagnets.
- Much of the accelerator is connected to a distribution system of **liquid helium**, which cools the magnets, as well as to other supply services.

2.35 Muon g-2 Experiment

- The American particle accelerator Fermilab that carries the 'Muon g-2' experiment found that the Muons are not wobbling the way they should when exposed to magnetic fields.
- The 'g-factor' measures the strength of a muon's internal magnet, which determines the measure by which it wobbles when exposed to a magnetic field.

Muon

- Muon or fat electron is an elementary subatomic particle similar to the electron but 207 times heavier. It has two forms - the negatively charged muon and its positively charged antiparticle.
- Muon acts like a tiny magnet and therefore gets influenced by magnetic fields. When placed in an external magnetic field, the muon wobbles.

- The experiment measured the extent of the anomaly and announced that 'g' deviated from the amount predicted by the 'Standard Model' of particle physics.
- In the Muon g-2 experiment, the muons are exposed to a magnet and a flurry of other sub-atomic particles known as the 'quantum foam'.
- A new force of nature or a new fundamental sub-atomic particle is perhaps influencing the muons.

2.36 Coincidence of Supermoon and Total Lunar Eclipse

- On May 26, 2021, the "supermoon" of 2021 will coincide with this year's only total lunar eclipse after nearly six years.
- **Supermoon** - A supermoon happens when the full moon coincides with the moon's closest approach to Earth in its orbit (perigee). The Moon appears to be brighter but it is also larger than a regular full moon.
- The term supermoon was coined by astrologer Richard Nolle in 1979.
- In a typical year, there may be two to four full supermoons and two to four new supermoons in a row.
- **Total Lunar Eclipse** - It is a celestial event during which the Moon and Sun are on opposite sides of the Earth. A lunar eclipse only takes place when there is a full Moon.
- Because of the total lunar eclipse, the moon will also appear to be red.
- This is because the Earth will block some light from the Sun from reaching the moon and as the Earth's atmosphere filters the light, it will soften the edge of Earth's shadow giving the Moon a deep, rosy glow.
- Blood moon during a total lunar eclipse happens when the Earth passes in between the Sun and the Moon.
- There is another celestial event called "Super Blood Wolf Moon", which is a combination of Full Moon, Perigee, Lunar Eclipse in January month.

2.37 Asteriod 16 Psyche

- Asteroid 16 Psyche is located 370 million kilometres away from earth between Mars and Jupiter and has a diameter of 140 miles.
- It was discovered in the year 1853 by the Italian astronomer Annibale de Gaspard and was named after the ancient Greek goddess of the soul, Psyche.
- Unlike most asteroids that are made up of rocks or ice, scientists believe that Psyche is a dense and largely metallic object thought to be the core of an earlier planet that failed formation.
- Psyche's shape is like a potato which takes about five earth years to complete one orbit of the sun but only a bit over 4 hours to rotate once on its axis.
- Recently NASA has found out that asteroid 16 Psyche could be made entirely of metal.
- The primary target of the Psyche mission to be launched in 2022 by NASA is to study this asteroid completely and confirm the assumptions being made by the scientists.
- Psyche mission will be the first mission to investigate this metallic asteroid. It will land in early 2026.
- As the composition of Psyche is very similar to earth's own core, its study will also give an insight to earth's violent history of collisions and accretion that created it.

2.38 M Dwarf Stars

- M dwarfs, also known as Red Dwarfs, are the tiniest of the stars that have masses ranging from about 8 percent to about 50 percent of the Sun's mass.
- The planets circling an M dwarf must be in a close orbit to the star to be warm enough for life, like campers huddling around a small fire.
- The term "red dwarf" does not refer to a single kind of star.
- It is frequently applied to the coolest objects including K and M dwarfs which are true stars and brown dwarfs, often referred to as "failed stars" because they do not sustain hydrogen fusion in their cores.

- Characteristic features of M Dwarf Stars are
  1. The red dwarf stars have relatively low pressures, a low fusion rate, and a low temperature.
  2. The low temperature of red dwarfs implies that they are far dimmer than stars like the sun.
  3. The low temperature also means that they burn through their supply of hydrogen less rapidly.
  4. The red dwarf stars live for so long that not one of them has reached an advanced stage of evolution since the universe was created.
- Recently total of 53 M dwarfs were studied using the TIFR Near-Infrared (NIR) Spectrometer and Imager (TIRSPEC) instrument on the 2-m Himalayan Chandra Telescope (HCT) at Hanle, India.
- Using effective temperature (Teff), radius, and luminosity of nearby bright calibrator stars, the team has created new empirical relationships among those fundamental parameters and spectral indices of M dwarfs that could identify them as potentially habitable.

2.39 Origin of Carbon

- A study on 'white dwarfs' has provided new insights on the origins of the carbon in the Milky Way galaxy.
- White dwarfs are the dense remnants of a star after its death, whose nuclear energy supplies have been used up.
- They consist of degenerate matter with a very high density due to gravitational effects.
- Carbon is essential for life. It is the simple building block of all the complex organic molecules that organisms need.
- It is known that all the carbon in the Milky Way came from dying stars that ejected the element into their surroundings.
- However, there is a debate on what kind of stars made the major contribution. Most stars, except the most massive ones, turn into white dwarfs.
- When the massive ones die, they go with a spectacular bang known as the supernova.
- Both low mass and massive stars eject their ashes into the surroundings before they end their lives. These ashes contain different chemical elements, including carbon.
- In both the type of stars, carbon is synthesised in its deep and hot interiors through the triple-alpha reaction.
- [Triple-alpha reaction = Fusion of three helium nuclei]
- **In low-mass stars,** the newly synthesised carbon is transported to the surface from the interiors via gigantic bubbles of gas.
- From the surface, the carbon is injected into the cosmos through stellar winds.
- **Massive stars** enrich the interstellar medium with carbon before the supernova explosion, when they also experience powerful stellar winds.
- Researchers found that the more **massive the star** at birth, the more **massive the white dwarf** left at its death.

2.40 Lithium

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

2.41 Fast Radio Bursts

- According to recent observations Intense pulses of radio waves known as fast radio bursts (FRB) that have been frequently detected in other galaxies, have now been found in the Milky Way.
- The latest studies reported that two radio telescopes, one in the United States and the other in Canada detected a FRB, and it was named FRB 200428.
- FRBs were first discovered in 2007 and there are still many gaps in information regarding them.
- Many theories have also suggested that FRBs are caused by neutron stars, that are the corpses of stars which died in explosions called supernovas.
- Recent study identifies FRBs are in fact generated by a rare type of neutron star known as a 'magnetars'.
- The source of the FRB was traced to a magnetars known as SGR 1935+2154, located about 30,000 light-years from the earth.
- It lies in the centre of the Milky Way, in the constellation Vulpecula.
- The FRB generated by this magnetar was so powerful that it emitted as much energy in one millisecond as the sun does in 30 seconds, according to the scientists.
- The scientists also concluded that most FRBs in other galaxies also were generated by magnetars.

Magnetars

- Magnetars are the most powerful magnets in the cosmos.
- Their magnetic fields are 5,000 trillion times more powerful

2.42 Diamond-studded Meteorite

- A US study has analysed the diamond-studded meteorite that exploded over Sudan in 2008.
- The meteorite was part of a giant asteroid in our solar system, which was the same size as the dwarf planet Ceres.
- It had a unique mineral makeup, including 'amphibole' which requires prolonged exposure to water in order to develop.
- This mineral appeared only once on Allende meteorite that fell in Mexico.
- The meteorite belongs to the category of 4.6% of meteorites that have been found on Earth, which are known as Almahata Sitta (AhS).
- These black rocks are made of a material called carbonaceous chondrite.They contain organic compounds and a variety of minerals, and water.

2.43 Supernovas

- All stars burn nuclear fuel in their cores to produce heat energy, which generates internal pressure that pushes outwards.This pressure prevents the star from collapsing inward due to the action of gravity on its own mass.
- But when a star ages and runs out of fuel to burn, it starts to cool inside, which causes a lowering of its internal pressure and therefore due to gravity the star starts to collapse inwards.
- This builds up shock waves because it happens very suddenly, and the shock wave sends the outer material of the star flying. This is supernova.
- In stars that are **more than eight times** as massive as the Sun, the supernova is accompanied by a collapsing of the inner material of the dying star - this is known as Type II or core collapse supernova.
- The collapsing core may form a black hole or a neutron star, according to its mass.

Neutrinos

- Neutrinos come in three 'flavours' or 'types', and each flavour is associated with a light elementary particle - Electron-neutrino associated with the electron; muon-neutrino with muon and tau-neutrino with tau particle.
- As they spew out of the raging supernova, the neutrinos can change from one flavour to another in a process known as **neutrino oscillations**.

- Due to the high density and energy of the supernova, several interesting features emerge as this is a nonlinear phenomenon.
- This phenomenon may generate neutrino oscillations happening simultaneously over different energies (unlike normal neutrino oscillation), termed collective neutrino oscillation.
- The oscillation result may dramatically change when one allows the evolution with the angular asymmetry, the oscillations can happen at a nanosecond time scale, termed **fast oscillation**.

2.44 Asteroid 2001 FO32

- Asteroid 2001 FO32 is the largest asteroid passed by Earth in 2021.
- It was discovered 20 years ago by Lincoln Near-Earth Asteroid Research (LINEAR) program in Socorro, New Mexico in 2001.
- When it is at its closest to Earth, it is at a distance of 2 million km (Equal to 5¼ times the distance from Earth to the Moon). So, it has been designated as a "potentially hazardous asteroid".
- There is no threat of a collision with Earth now or for centuries to come.
- The reason for the asteroid's unusually speedy close approach is its highly eccentric orbit around the Sun, an orbit that is tilted 39° to Earth's orbital plane.
- This orbit takes the asteroid closer to the Sun than Mercury, and twice as far from the Sun as Mars.

2.45 Most Distant Quasar

- The most distant 'radio-loud' quasar was discovered with the help of European Southern Observatory's Very Large Telescope (ESO's VLT).
- VLT, which is the world's most advanced optical telescope, is located at Paranal Observatory in the Atacama Desert.
- Named P172+18, the quasar took 13 billion years for the quasar's light to reach earth. It emitted wavelengths with a gravitational redshift of 6.8.
- Only 3 other 'radio-loud' sources with redshift greater than 6 have been discovered so far and the most distant one had a redshift of 6.18.
- [Redshift of the radio wavelength occurs when light particles (photons) climb out of a gravitational well like a black hole and the light's wavelength gets drawn out.
- Higher the redshift, the farther away is the source.]
- P172+18 quasar appears to the scientists as it was when the universe was just around 780 million years old.
- The glowing disc around a blackhole 300 million times more massive than our Sun, thus, holds clues about the ancient star systems and astronomical bodies.

Quasars

- Quasars (quasi-stellar radio source) are very luminous objects in faraway galaxies that emit jets at radio frequencies.
- They are found **only in galaxies that have super massive blackholes** which power these bright discs.
- Most active galaxies have a supermassive black hole at the centre which sucks in surrounding objects.
- Quasars are formed by the energy emitted by materials spiralling around a blackhole right before being sucked into it. They are of two types,
  1. **Radio-loud quasars** (10% of quasar population) - Have powerful jets that are strong sources of radio-wavelength emission
  2. **Radio-quiet quasars** (about 90% of quasar population) - Lack powerful jets, and have relatively weaker radio emission than the radio-loud population.

2.46 Apophis Asteroid

- First detected in 2004, Apophis is now officially off National Aeronautics and Space Administration's (NASA's) asteroid "risk list".
- This has ruled out any chance of Apophis smacking Earth in 2068, and don't show any impact risk for at least the next 100 years.

- **Asteroids** or planetoids or minor planets are made up of metals and rocks. They revolve around the sun and are too small to be called planets.
- Asteroid belt is located roughly between the orbits of the planets Jupiter and Mars. The mass of all the asteroids is less than that of Earth's moon.

Sentry

- It is NASA's highly automated collision monitoring system that continually scans the most current asteroid catalog for possibilities of future impact with Earth over the next 100 years.
- Whenever a potential impact is detected, it will be analyzed and the results will be immediately published in the 'asteroid risk list', except in unusual cases where independent confirmation is sought.

2.47 Phosphine Gas in Venus

- International team of astronomers has discovered phosphine gas in the atmosphere of Venus.
- According to findings Venus has traces of phosphine in a concentration of approximately 20 parts per billion, thousands to millions of times more than what could otherwise be expected.
- Apart from being produced in industrial processes, phosphine, a colorless but smelly gas, is known to be made only by some species of bacteria that survive in the absence of oxygen.
- This discovery has triggered global excitement about the possibility of the presence of lifeforms on the neighbouring planet.
- Indian Space Research Organization (ISRO) is also planning a mission to Venus, tentatively called Shukrayaan, in the near future.

3. TELESCOPES & OBSERVATORIES

3.1 Chandra X-ray Project

- The Chandra X-ray Observatory is a space based telescope launched by Space Shuttle Columbia in 1999.
- The Chandra X-ray Observatory is part of NASA's fleet of "Great Observatories" along with the Hubble Space Telescope, the Spitzer Space Telescope.
- It is an Earth satellite in a 64-hour orbit at 139,000 km in space.
- It is designed to detect X-ray emissions from very hot regions of the universe such as exploded stars, cluster of galaxies and matter around black holes.
- The "X-ray universe" refers to the universe as observed with telescopes designed to detect X-rays. X-rays are produced in the cosmos when matter is heated to millions of degrees. Such temperatures occur where high magnetic fields, or extreme gravity, or explosive forces exist in space.
- The telescope is named after the Nobel Prize-winning Indian astrophysicist Subrahmanyan Chandrasekhar.
- Subrahmanyan Chandrasekhar 's work implied that stars more massive than the so-called Chandrasekhar limit would eventually collapse to become objects so dense that not even light could escape it.
- Chandrasekhar limit is the theoretical maximum mass a white dwarf star can have and still remain a white dwarf.
- Although this finding was received with some skepticism at the time, it went on to form the foundation of the theory of black holes, eventually earning him a Nobel Prize in physics for 1983.
- ***First X-rays from Uranus -*** Astronomers have found that Uranus is emitting X-rays (like other ringed planets Jupiter and Saturn) for the first time, using NASA's Chandra X-ray Observatory.
- Uranus is a cold planet that is made up of hydrogen and helium. It is also known as the 'sideways planet' because it rotates on its side, unlike any other planet in our solar system.
- While the rotation and magnetic field axes of other planets in our solar system are almost perpendicular to the plane of their orbit, the rotation axis of Uranus is nearly parallel to its path around the Sun.

3.2 Data Sonification

- NASA Chandra X-Ray Center (CXC) has unveiled a new 'sonification' project that transforms data from astronomical images into audio.
- It refers to the use of sound values to represent real data. It is the auditory version of data visualisation.
- In NASA's Chandra (sonification) project, for instance, data is represented using a number of musical notes.
- The birth of a star, a cloud of dust or even a black hole can be 'heard' as a high- or low-pitched sound.
- The Chandra project has created a celestial concert by translating the same data into sound.
- The data has been collected by NASA's Chandra X-Ray Observatory, Hubble Space Telescope and Spitzer Space Telescope.

3.3 Telescopes used for finding earth like planets

- **James Web Telescope –** It is sometimes called JWST or Web, it is an orbiting infrared observatory that will complement and extend the discoveries of the Hubble Space Telescope, with longer wavelength coverage and greatly improved sensitivity.
- The longer wavelengths enable Webb to look much closer to the beginning of time and to hunt for the unobserved formation of the first galaxies, as well as to look inside dust clouds where stars and planetary systems are forming today.
- It will be the largest, most powerful and complex space telescope ever built and launched into space.
- **Large Ultraviolet Optical Infrared Surveyor, commonly known as LUVOIR** – It is a multi-wavelength space telescope concept being developed by NASA under the leadership of a Science and Technology Definition Team.
- It has the key science goal of characterizing a wide range of exoplanets, including those that might be habitable.
- LUVOIR can observe ultraviolet, visible, and near-infrared wavelengths of light.
- **PLAnetary Transits and Oscillations of stars (PLATO)** is a space telescope under development by the European Space Agency for launch in 2026.
- The mission goals are
  1. To search for planetary transits across up to one million stars,
  2. To discover and characterize rocky extrasolar planets around yellow dwarf stars (like our sun), subgiant stars, and red dwarf stars.
- The emphasis of the mission is on earth-like planets in the habitable zone around sun-like stars where water can exist in liquid state.

3.4 Giant Metrewave Radio Telescope (GMRT)

- GMRT has been awarded with the Institute of Electrical and Electronics Engineers (IEEE) status for its novel engineering, advanced technology and scientific contributions made in the field of radio astronomy.
- Pune-based GMRT is an array of 30 antennas positioned in a 'Y' fashion of 45m diameter.
- It serves as a unique facility for radio astronomical research using the metrewavelengths range of the radio spectrum.
- The metre wavelength part of the radio spectrum has been particularly chosen for study with GMRT because man-made radio interference is considerably lower in this part of the spectrum in India.
- Operated by the TIFR – National Centre for Radio Astrophysics (NCRA), it was the brainchild of late Govind Swarup.

IEEE

- IEEE is the world's largest technical body publishing research from the fields of engineering and computing.
- Also, its awards standards to institutions and organisations involved in these fields.
- It considers an institution for the milestone on the basis of engineering, science, and computational facilities it offers for not less than 25 years.

- Extensively used for studying the universe in low frequency since 2000.
- Recently, the facility underwent its first upgrade that allows researchers to see much deeper into the universe.
- Demonstration of generation and reception of radio waves by J C Bose (1895) and the discovery of the Raman Effect by C V Raman (1928) have been the only IEEE milestone winners from India, till date.

3.5 Arecibo Telescope

- Puerto Rico's Arecibo telescope, the world's second-largest single-dish radio telescope built in 1963, has collapsed.
- The US National Science Foundation owned the telescope.
- Being the most powerful radar, scientists employed Arecibo to observe planets, asteroids and the ionosphere.
- It was helpful in making discoveries like finding prebiotic molecules in distant galaxies, the first exoplanets, and the first millisecond pulsar.
- In 1993, it was used to provide a strict test of Einstein's Theory of General Relativity and the first evidence for the existence of gravitational waves.

3.6 Aries-Devasthal Faint Object Spectrograph

- Aries-Devasthal Faint Object Spectrograph & Camera (ADFOSC) is an optical spectrograph, which is indigenously designed and developed by Aryabhatta Research Institute of observational sciences (ARIES).
- This low-cost spectroscope, India's largest astronomical spectrograph, has been commissioned on the Devasthal Optical Telescope (DOT).
- It can **locate extremely faint lightsources** from distant quasars and galaxies in a very young universe, regions around supermassive black-holes around the galaxies, and cosmic explosions.
- It uses a complex arrangement of lenses made of glasses, polished to better than 5-nm smoothness to produce sharp images of the sky.

3.7 Baikal-GVD

- Russian scientists launched Baikal-GVD (Gigaton Volume Detector), an underwater neutrino telescope in the waters of Lake Baikail, the world's deepest lake situated in Siberia.
- It is one of the world's three largest neutrino detectors along with the IceCube (South Pole) and ANTARES (Mediterranean Sea).
- It will study in detail the elusive fundamental particles called neutrinos and to possibly determine their sources.
- Studying them will help us understand the origins of the universe since some neutrinos were formed during the Big Bang; others continue to be formed due to supernova explosions or nuclear reactions in the Sun.
- One way of detecting neutrinos is in water or ice, where neutrinos leave a flash of light or a line of bubbles when they interact.
- An underwater telescope such as the GVD is designed to detect high-energy neutrinos that may have come from the Earth's core, or could have been produced during nuclear reactions in the Sun.

3.8 Square Kilometre Array

- SKA project is an international effort to build the world's largest radio telescope, with eventually over a square kilometre (one million square metres) of collecting area.
- It will use 1000s of dishes and up to a million low-frequency antennas that will enable astronomers to monitor the sky in unprecedented detail and survey the entire sky much faster than any system currently in existence.
- South Africa's Karoo region and Western Australia's Murchison Shire were chosen as co-hosting locations for this project.

- Karoo will host the core of the high and mid frequency dishes and Murchison will host the low-frequency antennas.
- **Recent Developments - MeerLITCH** is the world's first optical telescope linked to a radio telescope launched in South Africa**.**
- The device forms part of the SKA project and will be linked to MeerKAT, a radio telescope located 200km away.
- Scientists at Cambridge have finished designing the data processor of SKA's telescopes.

3.9 Gravitational Wave Observatory

- A gravitational wave (GW) is a concept, predicted by Einstein through his theory of general relativity which states that mass distorts both space and time.
- When an object accelerates, it creates ripples in space-time, just like a boat causes ripples in a pond. These space-time ripples are gravitational waves.
- GWs are caused by cataclysmic events that result in high-energy explosions, such as collision of black holes or neutron stars.
- GWs are extremely weak and so are very difficult to detect.
- Strength of the wave depends on the mass of the object and requires extremely sensitive detectors to sense them.
- Missions like **LIGO (Laser Interferometer Gravitational–wave Observatory) in U.S** helps to spot gravitation waves, detecting small changes in the distances between objects at set distances.
- **LIGO:** It is a large-scale physics experiment and observatory with the mission to **directly observe gravitational waves of cosmic origin.**
- A fourth gravitational wave has been detected with help from **Italy-based equipment Virgo detector**.
- The Virgo detector is an underground L-shaped instrument that tracks gravitational waves using the physics of laser light and space.
- The underground stations are known as interferometers, do not rely on light in the sky, but instead sense vibrations in space created by a gravitational wave.
- The Japanese **KAGRA detector** is set to go online in 2019 and LIGO India set to join by 2024.
- Previously, gravitational waves have been found using two U.S.-based detectors known as the Laser Interferometer Gravitational-Wave Observatory (LIGO).
- **LIGO-India,** or INDIGO, is a planned collaborative project between the LIGO Laboratory and the **Indian Initiative in Gravitational-wave Observations (IndIGO)** to create a world-class gravitational-wave detector in India.
- A site in the Hingoli district (Maharashtra) has been selected.
- **Noble Prize for Physics -** Rainer Weiss, Barry C. Barish's and Kip Thorne's were jointly awarded the Nobel Prize for physics for their contribution to the LIGO-VIRGO project and its detection of gravitational waves.

3.10 Kepler Telescope

- It is a space observatory dedicated to finding planets outside our solar system.It was originally launched in 2009 as part of NASA's Discovery Program.
- It recently ran out of fuel and was retired nearly after 9-year mission.
- It targets particularly alien planets that are around the same size as Earth in the "habitable" regions of their parent star.
- Since 2009, it has discovered extra-solar planets in the range between the size of Earth and Neptune.
- It was the first telescope to find a planet (Kepler-69c) approximately the size of Earth in the habitable region of a star.

- It examined the TRAPPIST-1 system which likely has multiple Earth-sized planets in it between December 2016 and March 2017.

3.11 Hubble Space Telescope

- It is the world's first large, space-based optical telescope, named in honor of astronomer Edwin Hubble.
- The Hubble is a joint project between NASA and the European Space Agency.
- Sun is the energy source of this space-based telescope.
- It has tracked the Neptune's Mysterious Shrinking Storm.Some of the interesting Hubble Discoveries are
    1. Creating a 3-D map of mysterious dark matter.
    2. Discovering Nix and Hydra, two moons of Pluto.
    3. Helping determine the rate of the universe's expansion.
    4. Discovering that nearly every major galaxy is anchored by a black hole.
    5. Helping refine the age of the universe.
- It has captured Comet 2I/Borisov, the second interstellar comet to enter the solar systemand the closest comet to the Sun.
- Borisov is only the second interstellar object ever seen entering the solar system. The first was **Oumuamua** in 2017.

3.12 James Webb Telescope

- NASA's James Webb Telescope is the world's **premier infrared space observatory** of the next decade.
- It is developed in coordination among NASA, the European Space Agency, and the Canadian Space Agency.
- It is the most sophisticated and expensive space observatory ever designed.
- It is scheduled for launch in 2021 aboard a European Ariane 5 rocket from French Guiana and to orbit at Earth's second Lagrange point (L2).
- It will study every phase in the history of our universe, ranging from the first luminous glows after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own Solar System.
- It was formerly known as the "Next Generation Space Telescope".
- It is funded by NASA in conjunction with the European Space Agency (ESA) and the Canadian Space Agency (CSA).
- After launch, it will head near the Earth-Sun '**L2**' Lagrange point almost a million miles away (1.5 million kilometers).

3.13 Ngari observatory

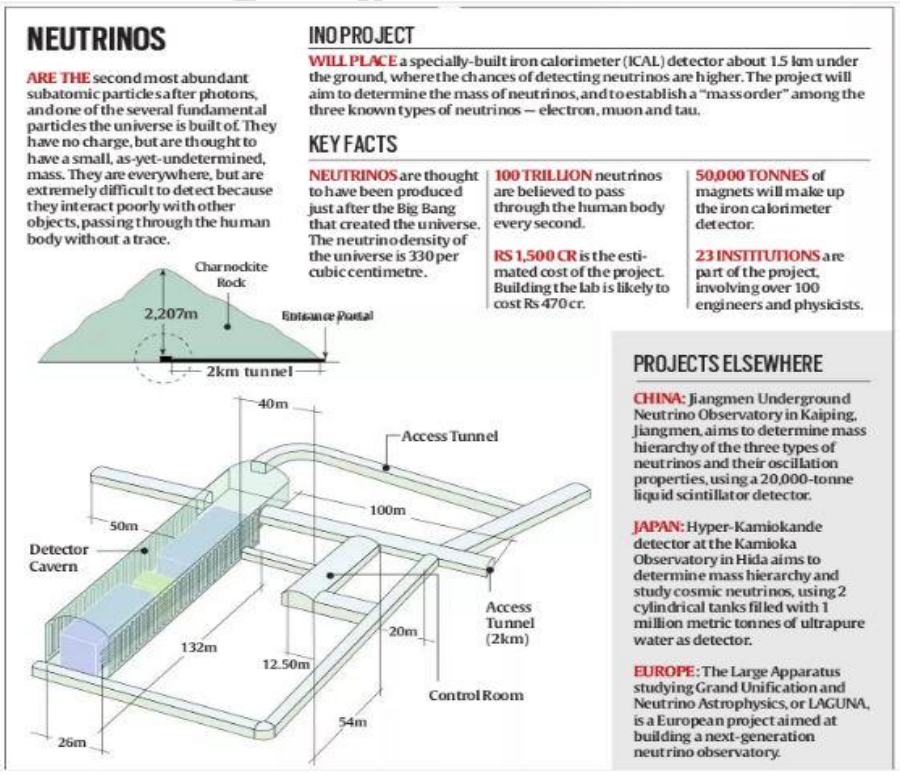
- China is working to set up the world's highest altitude gravitational wave telescope "Ngari No.1" in **Tibet Autonomous Region.**
- It is to detect the faintest echoes resonating from the universe, which may reveal more about the Big Bang.
- The telescope, located 5,250 meters above sea level, will detect and gather precise data on **primordial gravitational waves in the Northern Hemisphere,** which have never been detected.
- The primordial gravitational waves were created about 13.8 billion years ago by the Big Bang explosion.
- The observatory is expected to be operational by 2021.
- Tibet is considered as the best location in the northern hemisphere to detect the G-waves due to thin air and its dry climate, which reduces the influences of moisture on the primordial sub millimeter G-waves.
- China has also announced setting up of **FAST**, a 500-meter aperture spherical radio telescope in southwest China's Guizhou Province.

3.14 Very Large Telescope

- It is the world's most advanced visible-light astronomical observatory.
- It is located on the mountain Cerro Paranal in **Chile** and consisting of four telescopes with mirrors.
- These telescopes can operate individually or together as an interferometer.
- The large telescopes are named Antu, Kueyen, Melipal, and Yepun, which are the names for the Sun, the Moon, the Southern Cross, and Venus in the language of the Mapuche people.
- It successfully integrated the light from all four of its 8.2-meter (27 feet) unit telescopes into a new instrument.

3.15 INO Project

- The neutrino observatory is the most ambitious scientific research facility that India is trying to build.
- Neutrinos are tiny particles, almost massless, that travel at near light speeds.
- They are born from violent astrophysical events like exploding stars, nuclear fusion in the sun and gamma ray bursts.
- Detected for the first time in 1959, though their existence was predicted almost three decades earlier, in 1931, neutrinos were later found to be **omnipresent.**
- They are the **second most abundant particles in the world,** after photons and can move easily through matter.
- These high-energy particles are **produced in natural radioactive decays** and all sorts of nuclear reactions happening in nuclear power reactors, particle accelerators or nuclear bombs.
- But the most **common source** of neutrinos are celestial phenomena i.e., the birth and death of stars, collisions and explosions happening in space.
- **The core of the Sun is an important source of neutrinos.**
- A large number of the neutrinos were produced at the time of the Big Bang, making them good candidates to extract more **information from about the origins of the universe**.
- But because they are **electrically neutral and almost massless,** these neutrinos have an extremely low tendency to interact with other objects.

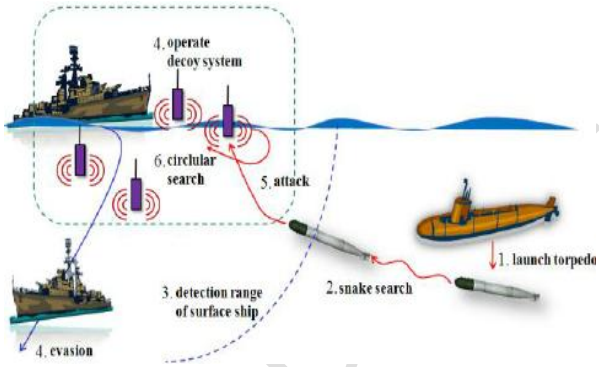


- This is the reason why scientists have to go deep underground to set up special detectors in a bid to catch the faint signals of neutrinos in an environment that is relatively free from 'noise' and disturbance.
- The proposed INO project primarily aims to study atmospheric neutrinos in a 1,300-m deep cavern in the Bodi West Hills in Theni district, Tamil Nadu.
- If completed, it would house the largest magnet in the world.

4. DEFENSE

Artillery

4.1 Maareech



- Maareech is an Advanced Torpedo Defence System (ATDS) that is capable of being fired from all frontline ships.
- It has been designed and developed indigenously by DRDO.
- It is capable of detecting, locating and neutralizing incoming torpedoes.
- It applies counter-measures to protect the naval platform against attack.
- Bharat Electronics Limited, a Defence PSU, would undertake the production of this decoy system.
- Torpedoes are self-propelled weapons with a warhead and can be used under or on the water surface.
- They are one of the mainstay of sea-warfare attack systems.

4.2 Pinaka Mark I

- It is an indigenous multi-barrel unguided rocket launch system developed by DRDO for firing of multiple warheads.
- It was used in the 1999 Kargil conflict.
- It was later transformed in to a short-range precision guided missile and thus renamed as Guided Pinaka – Mark II.
- Mark I version has a range of 40km and Mark II can fire upto 75 km.
- The Pinaka weapon system is an all-weather, indirect fire, free flight artillery rocket system.
- It is primarily a multi-barrel rocket system (MBRL) system.
- It consists of MBRL, Battery Command Post, Loader cum Replenishment Vehicle, Replenishment Vehicle and Digi Cora MET Radar.
- It has high accuracy and equipped with a navigation, guidance and control system with a range of 70 to 80 km.
- It is developed by DRDO.
- A Multiple rocket launcher is a type of rocket artillery system with multiple warheads and it was launched simultaneously by an unguided system.
- Guided Missile is a self-propelled and launched by a precision guided system and it has 4 components such as targeting/missile guidance, flight system, engine and warhead.

4.3 Munitions and their origins

- **HAMMER -** Highly Agile Modular Munition Extended Range Missile – Made in France
- **MICA -** Fire and Forget short and Medium-Range Missile System – Made in France
- **Meteor -** Radar guided beyond-visual-range air-to-air missile – Made in France
- **SCALP -** Beyond visual range air to air missile – Made in France
- **SPICE -** Smart, Precise Impact, Cost-Effective Air-to-Surface missile – Made in Israel
- **Strom Shadow -** General Purpose Long Range Cruise Missile – Made in UK

4.4 Joint Venture Protective Carbine

- It is a Gas Operated Semi Bull-pup automatic weapon, which will replace the 9 mm carbine currently in use by the armed forces.
- It is jointly developed by the DRDO's Armament Research and Development Establishment (ARDE) and Ordnance Factory Board (OFB).
- It has more than 700 rpm rate of fire and the effective range of the carbine is more than 100 m.
- It weighs about 3.0 kg with key features like high reliability, low recoil, retractable Butt, ergonomic design, single hand firing capability, and multiple Picatinny rails etc.
- These features make it a very potent weapon for Counter Insurgency and Counter Terrorism operations by security agencies.

4.5 Asmi

- Asmi (means pride, self respect and hard work) is India's first indigenously developed 9-mm machine pistol.
- Machine pistols are primarily self-loading versions of pistols which are either fully automatic or can also fire bursts of bullets.
- Asmi is jointly developed by ARDE and Indian Army's Infantry School.
- It has an upper receiver made from aircraft-grade aluminum and lower receiver from carbon fibre.
- The 3D printing technology has been used in designing and prototyping of the pistol, including trigger components made by metal 3D printing.
- The weapon has huge potential in armed forces as a personal weapon for heavy weapon detachments, commanders, counter-insurgency and counter-terrorism operations etc.

4.6 Smart Anti Airfield Weapon

- SAAW is indigenously designed and developed by DRDO's Research Centre Imarat (RCI) Hyderabad.
- It is a high precision guided bomb that is light weight as compared to weapon system of the same class.
- This 125 Kg class smart weapon is capable of engaging ground enemy airfield assets up to a range of 100 kms.

Missiles

4.7 Heron UAV

- The IAI Heron is a medium-altitude long-endurance unmanned aerial vehicle (UAV) developed by the Israel Aerospace Industries.
- It is capable of Medium Altitude Long Endurance (MALE) operations of up to 52 hours' duration at up to 10.5 km (35,000 ft).
- It has demonstrated 52 hours of continuous flight, but the effective operational maximal flight duration is less, according to payload and flight profile.
- It is already in use with Indian Air Force, Navy, and the Army and being used extensively at the moment by both Army surveillance and Air Force in the Ladakh sector.
- Indian forces are working towards inducting an armed version of the UAV, under the ambitious 'Project Cheetah' spearheaded by the Indian Air Force.

4.8 Spike Missiles

- Spike is an Israeli fire-and-forget anti-tank guided missile and anti-personnel missile.
- It was developed and designed by the Israeli company Rafael Advanced Defense Systems.
- It is available in man-portable, vehicle-launched, and helicopter-launched variants.

- Indian Army is planning to place orders for more Spike anti-tank guided missiles from Israel under the emergency financial powers granted to the services.

4.9 Man-Portable Anti-Tank Guided Missile (MP-ATGM)

- The MPATGM, or Man Portable Anti-Tank Guided Missile, is an Indian third-generation fire-and-forget anti-tank guided missile derived from Nag ATGM.
- It is currently under development by the DRDO.
- It is fitted with high-explosive anti-tank (HEAT) warhead.
- The MPATGM is equipped with an advanced imaging infrared (IIR) sensor and integrated avionics.
- It reportedly shares many similarities with Spike (ATGM).

4.10 Tsirkon Hypersonic N-Missile

- Russian administration announced on Russian Navy would be equipped with hypersonic nuclear strike weapons and underwater nuclear drones.
- Tsirkon hypersonic cruise missile is designed to be carried on surface ships, it is under final phase of testing.
- The combination of maneuverability, speed, and altitude of the hypersonic missiles makes them capable of traveling at more than five times the speed of sound and therefore difficult to track and intercept.
- Poseidon underwater nuclear drone is intended to be carried by submarines is another weapon under testing.

4.11 Dhruvastra

- Recently trials of India's Helicopter- launched Nag Missile anti-tank guided missile (HELINA), were successfully conducted.
- HELINA now known as Dhruvastra, is developed by DRDO.
- It is a third-generation fire and forget class anti-tank guided missile (ATGM) system that has been mounted on the Advanced Light Helicopter (ALH).
- The system consists of all the weather day and night capability and can easily defeat battle tanks with a conventional armor and explosive reactive armor.
- The missile can also engage targets both in the direct hit mode and as well as top attack mode.

4.12 Hammer Missile

- Highly Agile Modular Munition Extended Range Missiles (HAMMER) is a medium-range modular air-to-ground weapon designed for the French Air Force and the Navy.
- It a rocket-enabled precision missile with a range of 60 km perfectly suited for high altitude.
- India has decided to fit HAMMER missiles on the newly-acquired Rafale jet aircraft
- Earlier Rafale jets with HAMMER missiles carried out airstrikes in Libya, Afghanistan, Iraq, and Syria.
- Apart from the HAMMER missiles, the Rafale aircraft will also be armed with beyond- visual range missiles like Meteor, SCALP, and MICA, increasing their ability to take on incoming targets from a distance.

4.13 Laser Guided ATGM

- Laser guided ATGMs lock and track the targets with the help of laser designation to ensure precision hit accuracy.
- The missile employs a tandem HEAT warhead to defeat Explosive Reactive Armour (ERA) protected armored vehicles.
- It has been developed with multiple-platform launch capability and is currently undergoing technical evaluation trials from gun of MBT Arjun.

- Recently Laser Guided Anti Tank Guided Missile (ATGM) was successfully test fired from MBT Arjun Tank.
- The following agencies collaborated to develop the missile
  1. Armament Research & Development Establishment (ARDE) Pune
  2. High Energy Materials Research Laboratory (HEMRL) Pune,
  3. Instruments Research & Development Establishment (IRDE) Dehradun

4.14 Medium-Range Surface to Air Missile

- Kalyani Rafael Advanced Systems (KRAS), a private manufacturer of advanced weapons systems, will deliver 1000 midsection Medium-Range Surface to Air Missile (MRSAM) to Indian Armed Forces.
- MRSAM of KRAS has a range of more than 70 km.
- It has the ability of direct hit, and its accuracy is so perfect that a flying aircraft on one or two or two max plus can be picked up and hit directly rather than at a proximity distance as such.
- This is one of the most proven weapon systems with the Israeli defence forces, Indian forces, and many other countries.

4.15 Shaurya Missile

- A successful trial of the Shaurya missile was conducted by India.
- The nuclear capable Shaurya missile is a land-based parallel of the submarine launched K-15 missile.
- These ballistic weapons belong to the K missile family.
- They are named after late Dr APJ Abdul Kalam, the centre figure in India's missile and space programmes.
- They are launched from Arihant class of nuclear submarines.
- Shaurya is a canister-based system, which means that it is stored and operated from specially designed compartments.
- In the canister, the inside environment is controlled, thus it will
  1) Make its transport and storage easier,
  2) Improve the shelf life of weapons.
- These recent tests of these systems can be looked at as a strong message to China and Pakistan in light of the present situation in the region.

4.16 K Family Missiles

- The K family of missiles are primarily Submarine Launched Ballistic Missiles (SLBMs).
- They have been indigenously developed by the DRDO.
- The missile has a range of up to 3,500 km and is capable of carrying a nuclear/conventional payload of more than 2 tonnes.
- It is powered by solid rocket propellants.
- It has been designed to be fired from a depth of 50 meters.
- It uses a Ringer Laser Gyro Inertial navigation system.
- It is capable of cruising at hypersonic speed.
- It also features a system of weaving in three dimensions during flight as it approaches its target.
- The development of these naval platform launched missiles began in the late 1990s as a step towards completing India's nuclear triad.
- Nuclear Triad - The capability of launching nuclear weapons from land, sea and air based assets.

- Because these missiles are to be launched from submarines, they are lighter, smaller and stealthier than their land-based counterparts.
- Their land-based counterparts are the Agni series of missiles which are medium and intercontinental range nuclear capable ballistic missiles.
- Land and air variants of the K family have been developed by the DRDO. Shaurya is a land variant of short range SLBM K-15 Sagarika, which has a range of at least 750 kilometers.
- India has also developed and successfully tested multiple times the K-4 missiles from the family which has a range of 3500 km.
- It is reported that more members of K-family with ranges of 5000 and 6000 km are also under development.
- India announced the test launch of K-4 intermediate-range nuclear-capable ballistic missile from INS Arihant, following Pakistan's first-ever test of a nuclear capable Babur-3 submarine-launched cruise missile (SLCM).

4.17 Astra Missile

- Air-to-Air missile, ASTRA, has been successfully flight tested from Su-30 MKI as a part of User trials.
- It was indigenously designed and developed Beyond Visual Range Air-to-Air Missile (BVRAAM) by the DRDO as a part ofIntegrated Guided Missile Development Programme (IGMDP).
- It is designed to be mounted on a fighter aircraft and is also designed to engage and destroy highly manoeuvring supersonic aircraft.
- It was successfully test fired from Su-30 aircraft.
- It has a range of over 70 km and can fly towards its target at a speed of over 5,555 km per hour.
- The missile has all-weather day and night capability. It is capable of engaging targets of different ranges and altitudes.
- Being a 5th Generation missile, it would provide true beyond visual range capability with greater strategic depth.
- It is smoke free, having two-way data link, it provides very less chances to enemy to be alert about it.
- The Astra missile is developed as part of the (**IGMDP**).
- DRDO carried out mission analysis, system design, simulation and post-flight analysis of the weapon system.

4.18 Anti-Tank Guided Missiles

- ATGMs are missile systems that can strike and neutralise armoured vehicles such as tanks.
- They can pierce the armours of tanks and the material that can withstand such ammo.
- In 2018, ATGM **Nag** was successfully tested in desert conditions.
- In 2019, the indigenously developed low weight, fire and forget **Man Portable ATGM** (MPATGM) was successfully tested.
- They are mainly used by infantry units of the Army.
- In 2019, the government said that it has procured **Anti-Tank Spike Missiles** from Israel to meet the requirements of the Indian Army.
- This Laser Guided ATGM has been developed by two facilities of the DRDO's Armament and Combat Engineering Cluster in association with Instruments Research & Development Establishment.
- The laser-guided ATGM mainly differ in one aspect from other ATGMs developed till date.
- With its range limited to 1.5 to 5 kms, it locks and tracks the targets with the help of laser designation to precisely strike the target.
- The missile uses a 'tandem' High Explosive Anti Tank (HEAT) warhead.
- The term tandem refers to the missiles using more than one detonation in order to effectively penetrate the protective armours.

- This missile has the capacity of piercing armoured vehicles which use specially designed armour plates to counter the impact of projectiles.

4.19 Rudram-1 Missile

- DRDO has successfully flight tested indigenously developed Anti-Radiation Missile - Rudram-1.
- It is an air-to-surface missile, which is the first indigenous anti-radiation missile of the country.
- Once the missile locks on the target, it is capable of striking accurately even if the radiation source switches off in between.
- Rudram has been developed for the Indian Air Force - IAF's requirement to enhance its Suppression of Enemy Air Defence (SEAD) capability.

4.20 Anti-Radiation Missiles

- ARM's are designed to detect, track and neutralize the adversary's radar, communication assets and other radio frequency sources, which are generally part of their air defence systems.
- These can locate and target any radiation emitting source.
- These can play a key role in neutralizing any jamming platforms of the enemy or take out radar stations thereby clearing a path for own fighters to carry out an offensive and also prevent own systems from being jammed.
- They uses 'Passive homing head' for Guidance, It is a system that can detect, classify and engage targets (radio frequency sources in this case) over a wide band of frequencies as programmed.

4.21 Akash-NG Missile

- Defence Research and Development Organisation (DRDO) conducted the successful launch of Akash-NG (New Generation) Missile.
- Akash-NG is a new generation **Surface to Air Missile** meant for use by Indian Air Force.
- It aims at intercepting high maneuvering low RCS aerial threats.
- It has a Command and Control system, onboard avionics and aerodynamic configuration.
- It has been developed with better deployability compared to other similar systems with canisterized launcher and much smaller ground system footprint.
- The Multi Function Radar was tested for its capability of integration with the Akash-NG system.

4.22 Helina and Dhruvastra

- Defence Research and Development Organisation (DRDO) has designed and developed anti-tank guided missiles, namely - Army version Helina, and Airforce variant Dhruvastra.
- These are third generation, Lock-on-Before-Launch (**LOBL**) fire-and-forget anti-tank guided missiles that can engage targets both in direct hit mode as well as top attack mode.
- The system has **all-weather day and night capability**.
- They can defeat battle tanks with conventional armour as well as with explosive reactive armour.
- The missiles could be fired in hover and max forward flight against realistic static and moving targets.

4.23 VL-SRSAM Missile System

- Vertical Launch **Short Range** Surface to Air Missile (VL-SRSAM) was launched by DRDO.
- It is indigenously designed and developed by **DRDO**, along with Research Centre Imarat, and the Pune-based Research and Development Establishment (Engineers).
- Once deployed, the VL-SRSAM system will prove to be a force multiplier for the **Indian Navy**.

- With an effective Weapon Control System (WCS), it would neutralize various aerial threats at close ranges including sea-skimming targets.
- [Sea-skimming targets have the capability to avoid detection by radar or infrared sensors.]

4.24 Python-5 Missile

- India's indigenously-developed Light Combat Aircraft Tejas aircraft of Aeronautical Development Agency (ADA) has been cleared to carry fifth generation Python-5 missile as part of its weapons package.
- Python-5 Air-to-Air Missile (AAM), one of the world's most sophisticated guided missiles, would significantly enhance Tejas' combat prowess.
- It is developed by the Israeli company Rafael Advanced Defense Systems.
- It is powered by a solid propellant rocket engine. This dual use missile is suitable for air-to-air and surface-to-air missions.
- With Mach 4 speed, it can engage enemy aircraft from very short ranges and near beyond visual range. Range >20km
- It has lock-on-before launch (LOBL) and lock-on-after launch (LOAL) capabilities.

4.25 Brahmos

- It is a medium-range supersonic cruise missile that can be launched from submarine, ships, aircraft, or land.
- The missile has been jointly developed by India's Defence Research and Development Organisation (DRDO) and Russia's NPOM. The name Brahmos has been taken as a combination of the two rivers Brahmaputra and Moskva.
- It is the fastest supersonic cruise missile in the world.
- Its range was initially capped at 290 km as per obligations of the Missile Technology Control Regime (MTCR). Since India's entry into MTCR, the range has been extended to 450 km and the plan is to increase it to 600km.
- It also provides a much-desired capability to strike from large stand-off ranges with pinpoint accuracy by day or night and in all weather conditions.

Aircrafts

4.26 DRDO Jets for Indian Navy

- Indian Navy expects to have the first Indigenous Aircraft Carrier (IAC-I) Vikrant operational by 2022.
- It currently operates Russian-origin carrier INS Vikramaditya
- With a second carrier to come in, the Navy is already evaluating a global tender for 57 carrier-based twin-engine fighter aircraft.
- Based on new demand, DRDO has offered to develop a twin-engine deck-based fighter for the Navy, which will be ready by 2026.
- It will replace the MiG-29Ks in service which are scheduled to start going out by 2034.

4.27 Hypersonic Technology Demonstrator Vehicle

- HSTDV is an unmanned scramjet demonstration aircraft that can travel at hypersonic speed.
- It uses hypersonic air-breathing scramjet technology.
- The vehicle travelled its desired flight path at a velocity of six times the speed of sound i.e. Mach 6.
- It describes an aircraft's speed compared with the speed of sound in air, with Mach 1 equating to the speed of sound i.e. 343 meter per second.

- The test was conducted from Dr APJ Abdul Kalam Launch Complex at APJ Abdul Kalam Island off the coast of Odisha.
- India became the fourth country to have demonstrated this technology after the USA, Russia and China.
- The successful demonstration is certainly a significant milestone towards Atmanirbhar Bharat.

4.28 Cats Warrior

- It is a programme by the Hindustan Aeronautics Limited (HAL), which will have an unmanned fighter jet controlled by pilots in another fighter jet flying a few hundred kilometres behind.
- Called 'manned–unmanned' teaming, it has the capability to go deep into enemy territory and hit a target.
- The manned jet will remain in own territory and the 'cats warriors' with a set of missileswill fly ahead and hit target 700 kms away.
- The engine of the 'Cats warrior' is developed in house and is tweaked version of the Lakshya pilotless aircraft.

4.29 Tejas

- It is an indigenous fighter aircraft inducted in to Indian Airforce in the year 2016.
- It has recently commenced its operation.
- It is designed by the Aeronautical Development Agency (ADA) and Hindustan Aeronautics Limited (HAL).
- It is a single-seat, single-jet engine, multirole light fighter.
- It is the smallest and lightest multi-role supersonic fighter aircraft in its class.
- It can fire Air to Air Missiles, carry bombs and Precision Guided ammunition.

- It has its root in the Light Combat Aircraft (LCA) programme, which began in the 1980s to replace the ageing MiG-21 fighters.
- MiG-21 fighters are purchased from Russia in 1961.\
- **Recent Developments -** The naval variant of the **LCA Tejas** has made a first successful "Arrested landing" test.
- "Arrested landing" means to rapidly decelerate an aircraft as it lands.
- An "arrested landing" on the deck of an aircraft carrier is a feat achieved by only a handful of fighter jets developed in the US, Russia, the UK, France and China.
- The aircraft has to land on a 100-metre runaway on an aircraft carrier (a normal LCA lands on a one-kilometre runway).
- The Tejas will need to replicate this, out at sea when it attempts to land on the deck of India's only operational aircraft carrier, **INS Vikramaditya**.

Submarines

4.30 Submarines

Class	Type	Boats
Arihant	Ballistic missile submarine (SSBN)	INS Arihant INS Arighat

Chakra (Akula II)	Attack Submarine (SSN)	INS Chakra
Sindhughosh	Attack Submarine	INS Sindhughosh INS Sindhudhvaj INS Sindhuraj INS Sindhuvir INS Sindhuratna INS Sindhukesari INS Sindhukirti INS Sindhuvijay INS Sindhurashtra
Shishumar	Attack Submarine	INS Shishumar INS Shankush INS Shalki INS Shankul
Kalvari	Attack Submarine	INS Kalvari INS Khanderi INS Karanj

**INS Chakra and INS Arihant are Nuclear Powered, whereas the rest are Diesel Powered.*

4.31 INS Sindhuvir

- India will be delivering a Kilo Class submarine INS Sindhuvir to Myanmar Navy as part of defence cooperation.
- Kilo class refers to diesel-electric attack submarines that were designed and built in the erstwhile Soviet Union.
- This will be the first submarine of Myanmar Navy.
- Myanmar is one of India's strategic neighbours and shares a 1,640-kilometer-long border with a number of north-eastern states including militancy-hit Nagaland and Manipur.

4.32 Air Independent Propulsion

- Defence Research and Development Organisation's (DRDO's) Naval Materials Research Laboratory (NMRL) is developing Air Independent Propulsion (AIP) System.
- This is crucial for both the conventional diesel electric submarines and nuclear submarines of the Indian Navy.
    1. Nuclear-powered submarines - Key assets for deep sea operations,
    2. Conventional diesel electric submarines - Vital for coastal defence and operations close to the shore.
- With the AIP system on board, these submarines will

Naval Materials Research Laboratory

- Naval Materials Research Laboratory (NMRL), one of the DRDO laboratories, is the Centre of Excellence for Development of Materials for Naval Applications & Energy Systems.
- It pursues basic research and technology development in several areas - Metallurgy, Polymer, Ceramics, Coating, Corrosion and Electrochemical Protection, Marine Biotechnology, Environmental Sciences.
- Mission
    1. To develop Air Independent Propulsion (AIP) system for Naval Submarine & Fuel Cell technologies.
    2. To provide scientific solutions for all categories of materials & related technologies for Indian Navy.
    3. To undertake research projects on strategic materials for Indian Navy.

need to take in oxygen only once a week.

- So, they will be required to surface much less frequently, thus increasing their lethality and stealth multi-fold.
- These fuel cell-based AIPs of NMRL generate hydrogen onboard. This makes it unique from other AIP systems of the world.
- The project aims at fitting the technology on India's Scorpene class submarine INS Kalvari around 2023.

4.33 INS- Vagir

- Recently Indian Navy's fifth Kalvari-class Diesel Electric attack submarine INS Vagir was launched.
- The features of the vessel are as follows
    1. Superior stealth features such as advanced acoustic absorption techniques, low radiated noise levels, and hydro-dynamically optimised shape.
    2. The ability to attack the enemy using precision guided weapons.
    3. The submarine is designed to operate in all theatres of operation, showcasing interoperability with other components of a Naval Task Force.
    4. It can launch attacks with both torpedoes and tube launched anti-ship missiles, whilst underwater or on surface.
    5. It can undertake multifarious types of missions i.e Anti-Surface warfare, Anti-Submarine warfare, Intelligence gathering, Mine Laying, Area Surveillance, etc.
- The design of Kalvari class of submarines is based on Scorpene class of submarines designed and developed by French defence major Naval Group.
- This class of submarines have Diesel Electric transmission systems and these are primarily attack submarines or 'hunter-killer' type which means they are designed to target and sink adversary naval vessels.
- The modern variants of the Scorpence class of submarines have what is called the Air Independent Propulsion (AIP) which enables non-nuclear submarines to operate for a long time without access to surface oxygen.
- Indian Naval Ship (INS) Vagir is the fifth among the six Kalvari-class submarines being constructed by the public sector shipbuilder Mazagon Dock Ltd (MDL) in Mumbai.
- The other vessels in the class are INS Kalvari, INS Khanderi, INS Karanj, INS Vela and INS Vagsheer.

Other Naval Ships

4.34 Sarthak

- Sarthak is an offshore Patrol Vessel (OPV), 4th in the series of five OPVs deployed by the Coast Guard to enhance maritime security.
- The Ship is fitted with state-of-the-art Navigation and Communication equipment, sensor and machinery.
- The ship is designed to embark and carry a twin-engine helicopter, four high speed boats and one inflatable boat for swift boarding and Search & Rescue operations.

4.35 Project 17A

- Recently Indian Navy had laid the keel of the third ship (Yard- 12653) of the prestigious P17A class stealth frigates.
- The P17A class frigates are being built using indigenously developed steel and fitted with weapons and sensors along with Integrated Platform Management System.
- P17A ships are the first gas turbine propulsion and largest combat platforms ever built at GRSE.
- Project 17A or Nilgiri-class frigate is follow-on of the Project 17 Shivalik-class stealth frigate for the Indian Navy.

- Himgiri, the first of the three Project 17A ships built at Garden Reach Shipbuilders and Engineers Limited (GRSE), has been launched.
- These ships are having stealth features.
- Construction of P17A ships differ in the very concept of warship building by way of adoption of the modern technology 'Integrated Construction (IC)' where the blocks are pre-outfitted before joining to reduce the build period of warships.
- When commissioned the platforms will enhance the combat capability of the Indian Naval fleet.

Other Research, Survey and Tracking Vessels

- Dhruv Class (Missile Range Instrumentation vessel) - INS Dhruv
- Sagardhwani Class (Research vessel) - INS Sagardhwani
- Sandhayak Class (Survey vessels) - INS Nirupak, INS Investigator, INS Jamuna, INS Sutlej, INS Sandhayak, INS Darshak, INS Sarvekshak, along with the INS Nirdeshak (Decommissioned)
- Makar Class (Survey vessel) - INS Makar

4.36 INS Sarvekshak

- Indian Navy Ship (INS) Sarvekshak visited Port Louis, Mauritius and commenced the hydrographic survey of 'Deep sea area off Port Louis'.
- It is a **hydrographic survey ship**, which is part of Research, Survey and Tracking vessels fleet of the Indian Navy (under the Southern Naval Command).
- It is fitted with state-of-the-art survey equipments like Deep Sea Multi-Beam Echo Sounder, Side Scan Sonars and a fully automated digital surveying and processing system. It carries an integral Chetak helicopter.

4.37 INS Shivalik and INS Sindhukirti

- These are the Indian Navy's indigenously conceived design and constructed frontline stealth frigate.
- INS Shivalik is the Shivalik-class advanced, stealth-minded, guided-missile frigate warship.
- It is the first stealth warship built by India at Mazagon Dock Limited in Mumbai s part of the Indian Navy's Project 17.
- It is equipped with a wide range of electronics and sensors.
- In addition, it uses HUMSA (hull-mounted sonar array), ATAS/Thales Sintra towed array systems.
- It is equipped with a mix of Russian, Indian and Western weapon systems.
- It also has improved stealth and land attacking features over the preceding Talwar-class frigates.
- It is the first Indian navy ship to use the CODOG (COmbined Diesel Or Gas) propulsion system.
- INS Sindhukirti is the seventh Sindhughosh-class,diesel-electric submarine of the Indian Navy, built at the Admiralty Shipyard and Sevmash in the Soviet Union.
- It is among the oldest operational submarines in the Navy.
- It has been virtually rebuilt with modern sensors weapons and systems which make it "a hole in the water" for the Navy.

Programs

4.38 Draft Defence Production and Export Promotion Policy 2020

- Recently, the Ministry of Defence (MoD) has formulated a draft Defence Production and Export Promotion Policy 2020 (DPEPP 2020).
- It aims to provide impetus to self-reliance in defence manufacturing under Atmanirbhar Bharat Package.
- The policy aims to achieve a turnover of Rs 1,75,000 Cr (US$ 25Bn) including export of Rs 35,000 Cr (US$ 5 Billion) in Aerospace and Defence goods and services by 2025.
- **The Policy brings out multiple strategies under the following focus areas:**
    1. Procurement Reforms

2. Indigenization & Support to MSMEs/Startups
3. Optimize Resource Allocation
4. Investment Promotion, FDI & Ease of Doing Business
5. Innovation and R&D
6. DPSUs and OFB
7. Quality Assurance & Testing Infrastructure
8. Export Promotion

4.39 Operation Samudra Setu

- Indian Naval Ship Jalashwa departed Colombo, Sri Lanka after having embarked 685 Indian nationals and set course for the port of Tuticorin in Tamilnadu.
- The ship, on her third trip as part of Indian Navy's Operation Samudra Setu under the aegis of Mission Vande Bharat launched by the Government of India.
- Mission Vande Bharat launched has been engaged in bringing Indian nationals home from foreign shores by the sea route.

4.40 Solar Power Plant of Navy

- Recently Indian Navy inaugurated 3 MW Solar Power Plant at Indian Naval Academy, Ezhimala.
- The solar plant is the largest in the Indian Navy and has an estimated life of 25 years.
- This is in line with the 'National Solar Mission' to achieve 100GW of solar power by 2022.
- All components have been indigenously sourced, including 9180 highly efficient monocrystalline solar panels employing the latest technology.
- The project has been executed by Kerala State Electronics Development Corporation Ltd (KELTRON)

4.41 Srijan Portal

- Defence Ministry has launched 'SRIJAN' portal, a one stop shop online portal.
- The portal provides access to the vendors to take up items that can be taken up for indigenization.
- On this portal, DPSUs/OFB/SHQs can display their items which they have been importing or are going to import which the Indian Industry can design, develop and manufacture as per their capability or through joint venture with OEMs.
- The concerned DPSUs/OFB/SHQs, based on their requirement of the items and their guidelines & procedures will interact with the Indian industry for indigenization.

4.42 Naval Innovation and Indigenization Organization (NIIO)

- Union Defence ministry has launched the Naval Innovation and Indigenization Organization (NIIO).
- Draft Defence Acquisition Policy 2020 (DAP 20) envisaged establishment of NIIO by the Service Headquarters.
- The NIIO is a three-tiered organization.
    1. **Naval Technology Acceleration Council (N-TAC)** will bring together the twin aspects of innovation and indigenization and provide apex level directives.
    2. **A working group** under the N-TAC will implement the projects.
    3. **A Technology Development Acceleration Cell (TDAC)** has also been created for induction of emerging disruptive technology in an accelerated time frame.
- The NIIO puts in place dedicated structures for the end users to interact with academia and industry towards fostering innovation and indigenization for self-reliance in defence.

4.43 National Maritime Domain Awareness Centre

- Navy's Information Management and Analysis Centre (IMAC) will become a National Maritime Domain Awareness (NDMA) centre.
- IMAC will become a multi-agency centre with the presence of stakeholders in NDMA.
- Approved by the Defence Acquisition Council in 2012, IMAC became operational in 2014.
- It is the nodal agency for maritime data fusion set up after the 26/11 Mumbai terror attacks.
- Located in Gurugram, IMAC tracks vessels on the high seas.
- It gets data from the coastal radars, white shipping agreements, Automatic Identification Systems transponders fitted on merchant ships, air and traffic management system and global shipping databases.
- It is the nodal centre of the National Command Control Communication and Intelligence System (NC3I).

4.44 Integrated Theatre Command

- An integrated theatre command envisages a unified command of the three Services, under a single commander, for geographical theatres (areas) that are of strategic and security concern.
- The commander of such a force will be able to bear all resources at his disposal from the Army, the Indian Air Force, and the Navy with seamless efficacy.
- The integrated theatre commander will not be answerable to individual Services.
- Integration and jointness of the three forces will avoid duplication of resources.
- The resources available under each service will be available to other services too.
- The services will get to know one another better, strengthening cohesion in the defence establishment.
- The Shekatkar committee has recommended the creation of 3 integrated theatre commands at
    1. Northern for the China border,
    2. Western for the Pakistan border,
    3. Southern for the maritime role.
- As part of defence reforms after the appointment of the Chief of Defence Staff (CDS), the government is working on the formation of integrated theatre commands.

4.45 Secure Application for Internet

- Indian Army has launched a messaging app called Secure Application for Internet (SAI).
- It will provide secure voice, text and video calling services to its soldiers.
- The application supports end-to-end secure voice, text and video calling services for Android platform over internet.
- SAI will be utilised pan Army to facilitate secure messaging within the service.
- SAI scores over on security features with local in-house servers and coding which can be tweaked as per requirements.
- The model (of SAI) is similar to commercially available messaging applications like WhatsApp, Telegram, SAMVAD and GIMS and utilises end-to-end encryption messaging protocol.

4.46 Advanced Chaff Technology

- This technology was developed by the Defence Research and Development Organisation (DRDO) to safeguard the Indian naval ships against enemy missile attack.
- Chaff (or Window) is a passive expendable electronic countermeasure technology used worldwide to protect naval

Others

- Unexploded Ordnance Handling Robot (UXOR) was developed for Indian Air Force and Indian Army. It can handle 1,000 kg of ordnance.
- Sindhu Netra satellite developed by DRDO was deployed in space in 2021 to boost the surveillance capability of India and monitor military warships and merchant shipping in the Indian Ocean Region.

ships from enemy's radar and Radio Frequency (RF) missile seekers.

- The most significant fact of this Technology is that it uses very less quantity of chaff material deployed in the air to deflect enemy's missiles for safety of the ships.
- Defence Laboratory Jodhpur (DLJ), a DRDO laboratory, has developed three variants of this critical technology,
    1. Short Range Chaff Rocket,
    2. Medium Range Chaff Rocket and
    3. Long Range Chaff Rocket.
- This technology is being given to the industry for bulk production in large quantities.
- It can accurately detect nano-gram quantity of military, commercial and homemade explosives. It delivers the results in less than 10 seconds.
- It detects all classes of military, conventional and homemade explosives.

4.47 Aero India

- Aero India is a biennial international military and civil air show.
- It is a premier event that draws international and Indian military and civil aircraft makers, their support industries, military brass and government dignitaries and business visitors.
- It provides a unique opportunity for the exchange of information, ideas and new developments in the aviation industry, in addition to giving a fillip to the domestic aviation industry furthering the cause of Make in India.
- The Yelahanka air base, about 30 km from the city centre Bengaluru, has been hosting the air show in February since it was started in 1996.
- In 2019, it was organised by Hindustan Aeronautics Ltd. (HAL) and in 2021, it will be organised by the Defence Exhibition Organisation, Ministry of Defence.

Defence Exhibition Organisation

- DEO is an autonomous organisation of the Indian Government established in 1981, to promote the export potential of the Indian defence industry.
- It is responsible for organising international exhibitions such as DefExpo and Indian participation at overseas exhibitions.

4.48 Direct Energy Weapons

- Microwave Weapons are supposed to be a type of direct energy weapons, which aim highly focused energy in the form of sonic, laser, or microwaves, at a target.
- These weapons are based on the principle that microwave radiation of a certain kind can cause a buzzing sensation in the head, due to a phenomenon known as the Thermo Elastic effect.
- Such a weaponized microwave beam may cause a very slight expansion of the brain and produce a sound-like pressure, which strictly speaking is not really sound but can be traumatic.
- Broadly speaking, DEWs are of two types
    1. **High-energy lasers -** These laser weapons can knock off rockets and missiles at the speed of light
    2. **High power microwaves -** These weapons can use an electromagnetic explosion to take out the entire communication network of the enemy and destroy its electronic equipment.
- While they both comprise radio waves and light waves, lasers have shorter wavelength and higher frequency while microwaves have longer wavelength and low frequency.
- The idea behind both is to use powerful energy beams to hit targets (and in some cases destroy them) without much collateral damage.
- DEWs can inflict a wide variety of damage on an individual including dizziness, nausea and convulsions.
- The pain and severity of repercussions can be increased by changing the frequency.

- Recently India has denied reports that Chinese forces at the LAC used microwave weapons against Indian troops in eastern Ladakh.

Microwave weapon capabilities of Different countries include

1. **Poly WB-1 -** China had first put on display its "microwave weapon", called Poly WB-1, at an air show in 2014.
2. **Active Denial System -** The United States has also developed a prototype microwave-style weapon, which it calls the "Active Denial System".
3. **Anti-Drone DEW Systems** - India's DRDO has developed two anti-drone DEW systems, and plans are afoot to invest in DEW tech in a big way.

4.49 Defence Land Management System

- Recently Union Defence Ministry has launched the portal for Defence Land Management System (LMS).
- It has been developed by Department of Defence in collaboration with Directorate General Defence Estates (DGDE) and Armed forces.
- The Intra-net portal shall digitize all requests of defence land management received by the Department in future.
- The portal is expected to bring in greater speed, transparency and efficiency into the Land Management System (LMS) of the Department.
- The portal, along with integration of GIS based tool, will improve decision making process by removing duplication/unnecessary communication between various stakeholder groups involved in the decision-making process.
- It will integrate several mapping tools into the existing "Raksha Bhoomi" software, which was launched with the data updated in 2011.
- The technical support for the GIS-based system has been provided by Bhaskaracharya Institute for Space Applications and Geoinformatics (BISAG) which is India's premier organization in GIS based informatics.

Exercises

4.50 Acquisition and Cross-Servicing Agreement (ACSA)

- Recently, India and Japan signed Acquisition and Cross-Servicing Agreement (ACSA) agreement.
- It is a logistics agreement that will allow armed forces of both sides to coordinate closely in services and supplies.
- India has similar agreements with the USA, Australia, France, Oman and Singapore.
- It is aimed at greater maritime cooperation and can upgrade India-Japan naval exercises as both countries are expected to share maritime facilities for mutual benefit.

List of India-Japan Defence Exercises

- JIMEX - Naval Exercise
- SHINYUU Maitri - Air Force Exercise,
- Dharma Guardian - Military Exercise,
- Malabar Exercise – USA + Japan + India Trilateral exercise.

- It establishes the enabling framework for closer cooperation between the armed forces of both countries in reciprocal provision of supplies and services while engaged in the following such as
  1. Bilateral training activities,
  2. United Nations Peacekeeping Operations,
  3. Humanitarian International Relief and other mutually agreed activities.
- The supplies and services include food, water, transportation, airlift, petroleum, clothing, communications and medical services etc.

- It will remain in force for 10 years and will be automatically extended for periods of 10 years unless one of the parties decides to end it.

4.51 Indo-US PASSEX

- Indian and the Australian navies are undertaking Passage Exercise or PASSEX exercises in the Indian Ocean.
- From the Indian side, Indian Naval Ships Sahyadri and Karmuk will be present and Australia will be represented by HMAS Hobart.
- Recently, Indian Naval ships conducted a Passage Exercise (PASSEX) with the U.S. Navy's USS Nimitz carrier strike group near the Andaman and Nicobar Islands.
- Australia is the third country, since June, with which India will conduct the exercises.
- The first was with US Navy's USS Nimitz and the second was the Russian Navy.
- It aims to improve the cooperation between the U.S. and Indian maritime forces and to maximize training and interoperability, which also include air defence.
- It will enhance both sides' ability to counter threats at sea, from piracy to violent extremism.

4.52 Malabar Exercise

- EX-Malabar began as a bilateral naval exercise between India and the U.S. in 1992.
- It was expanded into a trilateral format with the inclusion of Japan in 2015.
- India did not include Australia in the exercises in 2018 and 2019, while the bilateral AUSINDEX naval exercise expanded in scope and complexity.
- The first phase of the Malabar Naval exercise including Australia along with Japan and the U.S., is scheduled to be held next week off the Visakhapatnam coast.
- This is the first time Australia will be joining the exercise after 2007.
- This will bring all four countries of the Quadrilateral grouping together for military games.
- Phase-1 of Malabar will see participation of
  1. U.S. guided missile destroyer USS John S McCain,
  2. Australian long range frigate HMAS Ballarat with integral MH-60 helicopter,
  3. Japanese destroyer JS Onami with integral SH-60 helicopter,
- From Indian Side following fleets will be participating Destroyer INS Ranvijay, Stealth frigate INS Shivalik, Off-shore patrol vessel INS Sukanya, Fleet support ship INS Shakti, Submarine INS Sindhuraj
- The exercise, being conducted as a 'non-contact, at sea only' exercise in view of COVID-19 pandemic.

4.53 Exercise Kavkaz 2020

- Kavkaz 2020, also referred to as Caucasus-2020 is a multilateral strategic command-post exercise, that is about to be held in Russia.
- The invitation for participation to Kavkaz 2020, has been extended to at least 18 countries including China, Iran, Pakistan and Turkey apart from other Central Asian Republics part of the SCO.
- India will take part in the exercise, Indian contingent includes 150 Army personnel and a smaller number of personnel from the Navy and Air Force.

4.54 EX-Indra 2020

- India and Russia are scheduled to hold the bilateral naval exercise, Indra 2020, in the Andaman Sea.
- The exercise will be carried out close to the strategic Strait of Malacca.
- Three Russian navy ships will take part in the exercise with an equal number from the Indian Navy, along with some aircraft.

- This is also the first bilateral naval exercise since all such engagements were suspended due to COVID-19.
- The timing of the exercise comes just after India withdrew from the Kavkaz-2020 multinational exercise in Russia scheduled for later this month.

4.55 JIMEX

- JIMEX series of exercises commenced in January 2012 with special focus on maritime security cooperation.
- It is conducted biennially between the Indian Navy and Japanese Maritime Self-Defense Force (JMSDF).
- The last edition of JIMEX was conducted in October 2018 off Visakhapatnam, India.
- The 4th edition of India - Japan Maritime bilateral exercise JIMEX will be held in the North Arabian Sea from 26th - 28th September 2020.
- Following fleets will participate in the exercise representing the Indian Navy.
  1. Indigenously built stealth destroyer Chennai,
  2. Teg Class stealth frigate Tarkash
  3. Fleet Tanker Deepak P8I Long Range Maritime Patrol Aircraft will also participate in the exercise.
- It will be the first military exercise after the two countries signed a landmark agreement (Acquisition and Cross-Servicing Agreement - ACSA), that will allow their militaries to access each other's bases for logistics support.

4.56 French Military Exercises in Space

- The French military will conduct first military exercises in space, as part of its strategy to become the world's third-largest space power.
- During the drill, the French military will monitor a potentially dangerous space object as well as a threat to its own satellite from another foreign power possessing a considerable space force.
- The new US Space Force and German space agencies are taking part in the French exercises.

4.57 EX-Bongosagar

- Exercise Bongosagar is a bilateral naval exercise between India and Bangladesh, the first edition of the exercise was held in 2019.
- The second edition of the exercise has held recently in Northern Bay of Bengal.
- This year's edition assumes greater significance since it is being conducted during Mujib Barsho, the 100th birth anniversary of Bangabandhu Sheikh Mujibur Rahman.
- It aims to develop interoperability and joint operational skills through the conduct of a wide spectrum of maritime exercises and operations.
- It will be followed by the 3rd edition of India-Bangladesh Coordinated Patrol (IN-BN CORPAT), wherein both countries will undertake joint patrolling along the International Maritime Boundary Line (IMBL).

5. HEALTH

COVID-19

5.1 Covid-19

- The World Health Organization (WHO) has named the new coronavirus disease as 'Covid-19'.
- The WHO, in consultation with the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO), has identified best practices for naming new human diseases.
- These best practices apply to a new disease:

- That is an infection, syndrome, or disease of humans;
- That has never been recognised before in humans;
- That has potential public health impact; and
- Where no disease name is yet established in common usage

- Names that are assigned by the WHO may or may not be approved by the International Classification of Diseases (ICD) at a later stage.
- The ICD, which is also managed by the WHO, provides a final standard name for each human disease according to standard guidelines that are aimed at reducing the negative impact from names while balancing science, communication and policy.
- **Coronavirus** – They are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV).
- A novel coronavirus (nCoV) is a new strain that has not been previously identified in humans.
- Coronaviruses are zoonotic, meaning they are transmitted between animals and people.
- Detailed investigations found that SARS-CoV was transmitted from civet cats to humans and MERS-CoV from dromedary camels to humans.Several known coronaviruses are circulating in animals that have not yet infected humans.
- Coronaviruses are named for the crown-like spikes that protrude from their surfaces, resembling the sun's corona.
- Coronaviruses are among a large number of viruses that are common in people and many animals.
- The new virus, first detected in China, is believed to have originated in bats.

5.2 Latent Virus

- A latent viral infection is an infection that is inactive or dormant.
- Latent infections are essentially static which last the life of the host and occur when the primary infection is not cleared by the adaptive immune response.
- Examples areHerpes simplex viruses type 1 and 2,Varicella-zoster virus,HIV,Epstein-Barr virus (human herpesvirus 4),Cytomegalovirus.
- Latent viral infections can be reactivated into a lytic form (the replication of a viral genome).
- The ability to move back and forth from latent to lytic infections helps the virus spread from infected individuals to uninfected individuals.
- Scientists speculates that SARS-CoV-2 is a latent virus infection which can recur.

5.3 Severe Acute Respiratory Syndrome

- It is a viral respiratory disease of zoonotic origin caused by the SARS coronavirus.
- It leads to shortness of breath and/or pneumonia.
- The only symptom common to all patients appears to be a fever above 38 °C (100 °F).
- There is no vaccine for SARS and no cases have been reported worldwide since 2004.
- Droplets from coughing and sneezing and close human contact likely transmit the SARS virus.
- The respiratory droplets are probably absorbed into the body through the mucous membranes of the mouth, nose, and eyes.
- According to WHO, SARS affected regions include China, Hong Kong, Singapore and Canada.
- Recently, Chinese virologists have found the origins of the SARS outbreak in 2003.
- A single population of horseshoe bats in a cave in Yunnan province in China caused the outbreak.

SARS vs CORANA

- SARS was also caused by a type of coronavirus (SARS-CoV) and is believed to be an animal virus, possibly transmitted from bats to civet cats to human beings.
- This virus first infected human beings in the Guangdong province of Southern China in 2002 and the region is still considered a potential zone of the re-emergence of the SARS CoV.
- The epidemic affected 26 countries and resulted in more than 8,000 cases in 2003.
- SARS is transmitted from person to person, and the symptoms include fever, malaise, headache, myalgia, diarrhea and shivering.
- According to the WHO, fever is the most frequently reported symptom, and cough, shortness of breath and diarrhea follow in the first or second week of illness.
- Other countries where the SARS CoV spread during the epidemic include Hong Kong, Canada, Chinese Taipei, Singapore and Vietnam.

5.4 Four Stages of a Pandemic Transmission

- Four Stages - Imported Transmission, Local Transmission, Community Transmission and Epidemic.
- States and countries are expected by WHO to classify themselves appropriately and point to the kind of public health measures in place.
- **Imported Transmission** is a stage when cases of infected people are imported from affected countries without any local origin in that particular home city or country via the borders and airports.
- This can be controlled through thermal screening and quarantine.
- **Local Transmission** is defined as the transmission through direct contact with an infected person (who possibly had a travel history to other already affected countries) within the country.
- **Community Transmission** takes place when the source of an individual's infection can't be traced and isolated.
- This stage signifies that a virus is circulating in the community and can affect people with no travel history to affected areas or of contact with an infected person.
- **Epidemic** is the Stage 4, which is the most severe stage of an infectious disease spreading within a country.
- In this stage, the disease becomes an epidemic in a country, with large numbers of infections and deaths with no end in sight.

5.5 Community Transmission Tag

- Community Transmission (CT) is a pandemic stage when new cases in the last 14 days can't be traced to those who have an international travel history, when cases can't be linked to specific cluster.
- The WHO guidelines suggest four subcategories within the definition of CT - CT-1 (Lowest Incidence), CT-2, CT-3 and CT-4 (Highest Incidence).
- According to the WHO, since the beginning of the pandemic, India has never marked itself as being in 'Community Transition (CT)'.
- Instead, India is opting for the lower, less serious classification called 'cluster of cases'.
- Countries such as the United States, Brazil, United Kingdom, France have all labelled themselves as being in 'community transmission'.
- Among the 10 countries with the most number of confirmed cases, only Italy and Russia didn't label themselves as being in 'CT'.

5.6 Research on Coronavirus' Proteins

- Research shows that the spike protein of SARS-CoV-2 changes its form after it attaches itself to a human cell.
- A spike protein protrudes from the surface of a coronavirus, like the spikes of a crown or corona.

- In the SARS-CoV-2 coronavirus, the spike protein **initiates the process of infection** in a human cell.
- It attaches itself to a human enzyme (ACE2 receptor) before entering into the cell and makes multiple copies of itself.
- Researchers have freeze-framed the spike protein of SARS-CoV-2 in both its shapes - before and after fusion with the cell using the technique of cryogenic electron microscopy (cryo-EM).
- The images show a dramatic change to the hairpin shape after the spike protein binds with the ACE2 receptor.
- The "after" shape can show itself before fusion without the virus binding to a cell at all. The spike can go into its alternative form prematurely.
- The alternative shape may help keep SARS-CoV-2 from breaking down.
- The rigid shape may explain why the virus remains viable on various surfaces for various periods.
- Post fusion shape can induce antibodies that do not neutralise the virus.
- In effect, the spikes in this form may **act as decoys** that distract the immune system.
- Antibodies specifically targeting the post fusion state would not be able to block viral entry since it would be too late in the process.
- Both the "before" and "after" forms have sugar molecules, called glycans, at evenly spaced locations on their surface.
- Glycans are another feature that helps the virus avoid immune detection.

5.7 Covid - A Vascular Disease

- A new study shows that the SARS-CoV-2's spike proteins, not only help the virus infect its host by latching on to healthy cells, but also play a key role in the disease itself.
- It explained that Covid-19 is not only a respiratory disease, but also a **vascular disease** by demonstrating how the virus damages and attacks the vascular system (comprising the blood vessels) on a cellular level.
- The findings help explain Covid-19's wide variety of seemingly unconnected complications, and could open the door for new research into more effective therapies.
- The exposure of healthy endothelial cells (which line arteries of heart) to the spike protein showed that the spike protein damaged the cells by binding ACE2 (a human protein).
- This binding disrupted ACE2's molecular signalling to mitochondria (organelles that generate energy for cells), causing the mitochondria to become damaged and fragmented.

5.8 SARS-Unique Domain

- From comparisons of the RNA genomes of innocuous coronaviruses with those of the SARS coronavirus, researchers identified a region that only occurred in the latter called the "SARS-unique domain" (SUD).
- Such genomic regions and their protein products might be linked to the extraordinary pathogenicity of SARS and SARS-CoV-2 coronavirus.
- The SARS viruses enhance the production of viral proteins in infected cells, so that many new copies of the virus can be generated.
- Coronaviruses other than SARS-CoV (which causes SARS) and SARS-CoV-2 (which causes Covid-19) do not use this mechanism.
- The new study showed that the SUD proteins of these viruses interact with a human protein called Paip-1, which is involved in the first steps of protein synthesis.
- Together with Paip-1 and other proteins in human cells, SUD binds to the ribosomes, the molecular machines that are responsible for protein synthesis in cells.
- This would lead to an enhancement of the production of all proteins, both those of the host cell and those of the virus.

- However, in cells infected with SARS-CoV or SARS-CoV-2, the messenger RNA molecules that code for host proteins are selectively destroyed by a viral protein named Nsp1.
- As a result of this complicated process, the infected cell produces viral proteins, so that many new copies of the virus can be created.

5.9 Bradykinin Storm

- A recent analysis of samples of patients with the Covid-19 infection has shown a phenomenon called a 'bradykinin storm'.
- SARS-CoV-2 uses a human enzyme called ACE2 to enter into the cells of its host.
- ACE2 lowers blood pressure in the human body and works against another enzyme known as ACE (which has the opposite effect).
- The virus causes the levels of ACE to fall in the lungs, and consequently pushes up the levels of ACE2.
- This happens as a chain reaction and increases the levels of the molecule bradykinin in the cells, causing a bradykinin storm.
- Bradykinin is a compound that is related to pain sensation and lowering blood pressure in the human body.
- Bradykinin storm causes the blood vessels to expand and become leaky, leading to swelling of the surrounding tissue.
- The levels of a substance called hyaluronic acid also increases.
- The bradykinin storm-induced leakage of fluid into the lungs combined with the excess hyaluronic acid would likely result in a Jello-like substance that prevents oxygen uptake and carbon dioxide in the lungs of severely affected Covid-19 patients.
- This rapid accumulation of fluid in the lungs of patients sometimes makes even the most sophisticated intensive care, including ventilators, futile.
- Knowing the mechanism, doctors can target the bradykinin pathway to evolve more therapeutic interventions to offset the severe effects of Covid-19.

5.10 New Corona Variants escape Immune Response

- A new study found out how the fast-spreading variants of the SARS-CoV-2 coronavirus carry mutations that enable the virus to escape some of the immune response created naturally or by vaccination.
- New variants are Brazilian variant (P.1), the United Kingdom variant (B.1.1.7), South African variant (B.135.1) and Indian variant (B.1.617).
- The scientists mapped how important classes of neutralising antibodies bind to the original pandemic strain of SARS-CoV-2 and how the process is disrupted by mutations found in new variants.
- In the study, the researchers focused mainly on three mutations in the SARS-CoV-2 spike protein: K417N, E484K and N501Y.
- Alone or in combination, these mutations are found in most major SARS-CoV-2 receptor binding site, where the virus attaches to host cells.
- Several of these mutations are clustered in one site, known as the "receptor binding site", on the spike protein of the virus.
- But certain new variants with mutations are able to escape the antibody responses - perhaps eventually necessitating updated vaccines.
- Also, the three key viral mutations do not alter other vulnerable sites on the virus outside the receptor binding site.

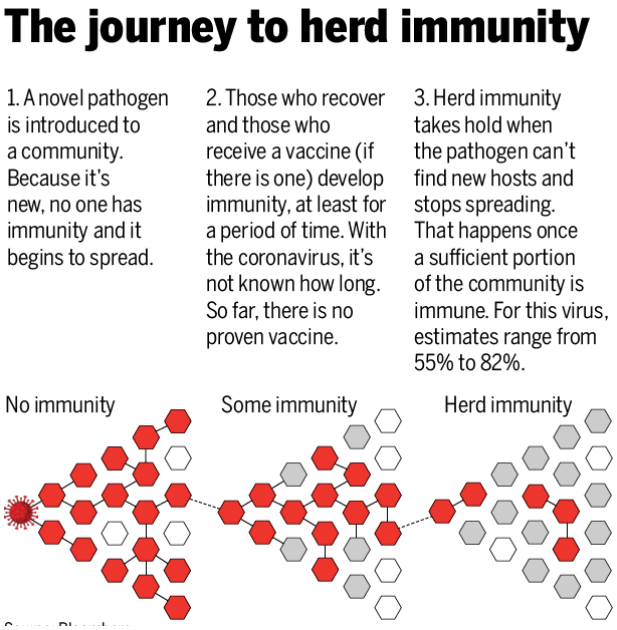
5.11 Double-mutant Variant of Corona

- The World Health Organization said that the B.1.617 variant - first identified in India in December 2020 - was being classified as a variant of global concern.

- The Indian variant B.1.617 is identified with two key mutations and has been detected in the US, Germany, the UK, Australia and Singapore and enhancing viral replication.
- This double mutant strain (with E484Q and L452R mutations) was announced by the National Centre for Disease Control (NCDC) on March end after it was identified in Maharashtra, Delhi, and Punjab.
- The Indian SARS-Cov-2 Consortium on Genomics (INSACOG) - a group of 10 national laboratories - has been conducting genomic sequencing of variants in India.
- B.1.617 has now been found in 8 countries. Approximately 70% of the cases are noted to be from India.
- The double mutation depicts two separate spike protein substitutions on this coronavirus strain.
- Both these variants can alter the structure of the spike protein, making it more efficient in attaching with the host cells and multiplying faster.
- Such mutations can result in immune escape and increased infectivity. They can also create a neutralising impact on the antibodies generated from vaccines or the first infection.

5.12 Serological Survey in Delhi - Herd Immunity

- The serological survey is meant to detect whether the person being tested had developed antibodies against a virus/bacterium.
- The antibodies are proteins produced by the immune system to fight external organisms like viruses that try to enter the body.
- These are produced only after the infection has happened. So, these are specific to the attacking virus or bacterium.
- The presence of antibodies, therefore, is an indication that an infection by that particular virus or bacterium has already occurred.
- Subsequent attempts to infect the body can be thwarted by these antibodies.
- **Antibodies and Immunity** - The mere presence of antibodies does not mean that the person is protected against the disease.
- The amount of antibodies present, and whether it includes what are known as "neutralising antibodies" are also important.
- These are the ones that actually fight the disease.
- Serological surveys are not designed to assess either the quantity of antibodies or detect the presence of neutralising antibodies.



- Also, studies have indicated that the "neutralising antibodies" could lose their effect after 4 months.
- **Herd immunity** - Herd immunity is a stage of an epidemic in which some members of a population group remain protected from infection.
- This comes as a result of a majority of those around them having already developed immunity, either through vaccination or because they have been infected earlier.
- So, everyone in the population group does not need to get infected before the epidemic is over.
- Once a certain proportion of population gets infected, and thus builds immunity, the epidemic begins to slow down and eventually stop.
- **Sero Positivity** means positive result of a blood test for a particular antibody (a substance in the blood that fights a disease).

5.13 Rapid Antigen Detection Test

- India's first Covid-19 self-use Rapid Antigen Test (RAT) kit CoviSelf has been approved by the Indian Council of Medical Research (ICMR). The test is developed in India by Mylab.
- It is a **point-of-care test**, performed outside the laboratory setting.
- It is a quick diagnostic test on swabbed nasal samples. It detects antigens that are found on or within the SARS-CoV-2 virus. Antigens are foreign substances that induce an immune response in the body.
- In India, the ICMR has allowed the use of antigen detection kits developed by the South Korean company S D Biosensor which has a manufacturing unit in Manesar.

Rapid antigen detection test Vs RT-PCR test

- RT-PCR is currently the gold standard frontline test for the diagnosis of Covid-19.
- Like RT-PCR, the rapid antigen detection test too seeks to detect the virus rather than the antibodies produced by the body.
- While the mechanism is different, the most significant difference between the two is **time**.
- As the ICMR has pointed out, the RT-PCR test takes a minimum of **2-5 hours** including the time taken for sample transportation.
- These specifications limit the widespread use of the RT-PCR test.
- It also impedes quick augmentation of testing capacity in various containment zones and hospital settings.
- In a reliable rapid antigen detection test, the maximum duration for interpreting a positive or negative test is **30 minutes**.
- According to the ICMR guidelines, if the test shows a positive result, it should be considered as true positive, and does not need reconfirmation.
- However, those who test negative in the rapid antigen test should then be tested by RT-PCR to rule out infection.
- **Limitations of an antigen test**– The antigen tests are **very specific for the virus.**
- But it also said that they are **not** as **sensitive** as molecular PCR tests.
- Also, the ICMR has said that once the sample is collected in the extraction buffer, it is **stable only for one hour**.
- Therefore, the antigen test needs to be conducted at the site of sample collection in the healthcare setting.
- Also, children tend to shed the virus for longer periods than adults, which may result in differences in sensitivity.

5.14 Mass Spectrometry Covid-19 Test

- Mass spectrometry (MS) is an analytical technique that measures the mass-to-charge ratio of ions.
- Researchers from the New Delhi-based Institute of Genomics and Integrative Biology (IGIB) have developed a new method of coronavirus disease (Covid-19), that uses mass spectrometry.
- Mass spectrometry can detect the presence and quantity of various organic and inorganic compounds by detecting the ions released by them.
- The technique uses mass spectrometry to detect two peptides (building blocks of the viral protein).
- This is the only method that directly observes the RNA as compared to RT-PCR where the proteins have to bind with a primer before we can detect it.
- This eliminates the possibility of a false negative if the quality of the RNA collected it not good and it does not bind or there is lysis (detergent) that prevents the RNA from binding.
- This testing is faster, cheaper, and almost as accurate as the Reverse Transcription-Polymerase Chain Reaction (RT-PCR) test.
- The method eliminates the need for a biosafety lab, which makes it possible for it to be used at airports and railway stations to test passengers before they board a plane or a train.

5.15 FELUDA Covid-19 test

- FELUDA, an acronym for the FNCAS9 Editor-Limited Uniform Detection Assay.
- Feluda paper strip test for SRS-CoV-2 diagnosis has been developed by CSIR-IGIB and has been approved by the Drug Controller General of India for a commercial launch.
- It uses indigenously developed CRISPR gene-editing technology to identify and target the genetic material of SARS-CoV2, the virus that causes Covid-19.
- Similar to a pregnancy strip test, Feluda changes colour if the virus is detected and doesn't need expensive machines for detection.
- It is able to differentiate SARS-CoV-2 from other coronaviruses even if genetic variations between them are minute.
- The trials of this test at the Institute of Genomics and Integrative Biology (IGIB) showed 96% sensitivity and 98% specificity.
- **Sensitivity** is defined as the ability of a test to correctly identify individuals with the disease, while specificity is the ability of the assay to accurately identify those without the disease.

5.16 Ct Value

- The ICMR said that all patients with a Ct value **less than 35** may be considered as Covid-positive while those with a Ct value above 35 may be considered as Covid-negative.
- [Globally, the accepted cut-off for Ct value for Covid-19 varies from 35 to 40, depending on instructions from the equipment's manufacturers.]
- The 'Cycle Threshold value' (Ct value) refers to the number of cycles in RT-PCR tests after which the virus can be detected.
- **Working** - In an RT-PCR test, RNA is extracted from the swab collected from the patient. It is then converted into DNA, which is then amplified.
- Amplification refers to the process of creating multiple copies of the genetic material — in this case, DNA.
- This improves the ability of the test to detect the presence of virus.
- Amplification takes place through a series of cycles and it is after multiple cycles that a detectable amount of virus is produced.
- According to the ICMR advisory, the Ct value of an RT-PCR reaction is the number of cycles at which fluorescence of the PCR product is detectable over and above the background signal.
    1. If a higher the Ct value, it implies that the virus went undetected when the number of cycles was lower.
    2. The lower the Ct value, the higher the viral load - because the virus has been spotted after fewer cycles.
- Although Ct value is inversely correlated with viral load, there is no correlation between a Ct value and severity of disease or mortality in patients with Covid-19 disease.
- The ICMR advised not to use a lower cycle threshold parameter as it would lead to missing several infectious persons.
- Ct values may differ between nasal and oropharyngeal specimens collected from the same individual.

5.17 COVIRAP Testing

- Recently, ICMR has approved a new low-cost Covid-19 diagnostic method named COVIRAP.
- It is developed by the Indian Institute of Technology (IIT), Kharagpur.
- COVIRAP has an automated pre-programmable temperature control unit, a special detection unit on genomic analysis, and a customised smartphone app for results.
- It is better than the FELUDA test because the FELUDA employs a gene editing technology called CRISPR-cas9, which requires a lab testing environment.

- It is reusable technology the same unit can be used for a large number of tests on replacement of the paper cartridge after each test.
- The COVIRAP testing machine can also perform tests other than Covid-19.
- It can be used in influenza, malaria, dengue, Japanese encephalitis, TB etc, which are under the category of isothermal nucleic acid-based tests.

5.18 Isothermal Amplification

- Isothermal amplification of nucleic acids is a process that rapidly and efficiently accumulates nucleic acid sequences at constant temperature.
- The Isothermal Amplification Techniques have been developed as alternatives to Polymerase Chain Reaction (PCR).

5.19 D-Dimer Test

- **D-Dimer** - When a body part is damaged or is bleeding, the body tries to stop the bleeding by clumping together the cells there to make a network using fibrin protein. This makes a blood clot.
- When the healing is done, the body starts to degrade that clot and starts breaking down the fibrin. When the fibrin breaks down, it forms fibrin degradation products or FDPs. One of the FDP is D-Dimer.
- **Test** - The D-Dimer test shows the presence of clots in the lung of the body when COVID becomes serious.
- D dimer is detectable for up to 8 hours after formation until the time the kidney clears it out.
- A higher level of D dimer in the body shows that there is a lot of clot in the body which can be a dangerous sign when affected with COVID.
- So, D-Dimer test is used to assess for severity of COVID disease and if the patient is going to need oxygen in the future.

5.20 m-RNA Vaccine

- It is a coronavirus vaccine based on mRNA, once injected into the body, will instruct the body's cells to create copies of the spike protein.
- The mRNA is coded to tell the cells to recreate the spike protein of the coronavirus SARS-CoV-2, which causes Covid-19.
- It is the spike protein which appears as spikes on the surface of the coronavirus that initiates the process of infection and it allows the virus to penetrate cells, after which it goes on to replicate.
- The mRNA vaccines work by using mRNA or messenger RNA, which is the molecule that essentially puts DNA instructions into action.
- The mRNA vaccines have the advantage that scientists are not growing the virus in the lab, which has been a hindrance sometimes to create enough virus or viral particles to give in a vaccine.
- **HCO19** – It is India's 'first of its kind' mRNA-based COVID-19 vaccine.

Adenovirus-based Vaccine

- Unlike the mRNA vaccine platform used by Pfizer and Moderna, the vector-based vaccine platform technology used by AstraZeneca and Johnson & Johnson have shown lower vaccine efficacy.
- There are studies showing that there is a loss of potency of adenovirus-based vaccine if there are pre-existing antibodies towards the vector.
- Pre-existing antibodies against adenoviruses will stop the adenovirus particles from getting into cells and

mRNA Vaccines

- mRNA vaccines are considered safe as mRNA is non-infectious, non-integrating in nature, and degraded by standard cellular mechanisms.
- They are highly efficacious because of their inherent capability of being translatable into the protein structure inside the cell cytoplasm.
- Additionally, mRNA vaccines are fully synthetic and do not require a host for growth, e.g., eggs or bacteria.
- Therefore, they can be quickly manufactured inexpensively under cGMP conditions to ensure their "availability" and "accessibility" for mass vaccination on a sustainable basis.

making the SARS-CoV-2 spike protein they carry the code for.

- The presence of pre-existing antibodies against adenovirus and those developed after first and second dose of the vaccine becomes particularly important when repeat vaccinations are needed.
- Sooner or later, anti-adenoviral antibodies will inevitably form, complicating the situation for subsequent vaccinations.
- While using the same adenovirus subtypes for repeat vaccinations might result in reduced efficacy in the case of vector-based vaccines, the inactivated vaccines do not face this problem.

5.21 Suspension of Remdesivir

- Remdesivir is a drug with anti-viral properties that was manufactured by US-based Biotechnology Company in 2014, to treat Ebola cases.
- Recently WHO has dropped Remdesivir from the prequalification list which is an official list of medicine for Covid-19.
- The suspension is a signal to countries that WHO, in compliance with the treatment guidelines, does not recommend countries procure the drug for Covid-19.
- WHO concluded that Remdesivir had no meaningful effect on mortality or on other important outcomes for patients, such as the need for mechanical ventilation or time to clinical improvement.

5.22 Emergency Use Authorisation

- The Drugs Controller General of India (DCGI) has given 'Emergency Use Authorisation (EUA)' to three anti-Covid vaccines - Covishield, Covaxin and Russian Sputnik V.
- The DGCI has been issuing EUAs based on clinical trial data. These issues helped in rolling out the world's largest vaccination drive.
- **Working** - During a declared emergency, it may not be possible to have all the evidence that a drug regulator would normally require for approving a drug, vaccine, device or a test.
- So, a drug regulator can issue a EUA to a medical product that isn't fully tested to make it widely available for use, if the regulator is satisfied that the product meets reasonable thresholds for safety and effectiveness.
- But, EUA doesn't mean that a vaccine has skipped essential safety trials.
- Drug regulators must follow a basic thumb rule to approve a medical product - The known potential benefits should outweigh the known potential risks.

5.23 Phases in Vaccine Trial

- Normally, developing vaccines or drugs takes several years. A good part of this goes in carrying out trials to establish their safety and efficacy.
- **Phase 1 trials** - A vaccine is given to a limited sample set of healthy people to assess its safety at higher doses.
- **Phase 2 trials** A vaccine is undertaken on hundreds of people with different health conditions and from different population strata.
- This helps assess both the effectiveness and the side-effects.
- **Phase 3 trials** - It involves much larger sample, representative of the actual population, to assess both safety and efficacy.

5.24 AYUSH-64

- AYUSH-64 is a poly herbal formulation that has been found to help in the treatment of asymptomatic, mild and moderate COVID-19 infection.
- It was developed by the Central Council for Research in Ayurvedic Sciences (CCRAS), a research institution under the Ministry of Ayush.

- Originally developed in 1980 for treatment of Malaria, this drug has notable antiviral, immune-modulator and antipyretic properties. It may also be taken as prophylactic medicine.
- But as a side effect of Ayush-64, loose motions can occur in some patients, which can be self-limiting and does not require any medical intervention.

5.25 DRDO's Oral Drug 2-DG

- The anti-Covid-19 drug, 2-deoxy-D-glucose (2-DG) was developed by the Institute of Nuclear Medicine and Allied Sciences (INMAS), a lab of the Defence Research and Development Organisation (DRDO).
- The Drugs Controller General of India had cleared the formulation for emergency use as an adjunct therapy in moderate to severe Covid-19 patients.
- **Working** - The drug is available in powder form in a sachet, and can be taken orally after dissolving in water.
- The drug accumulates in virus-infected cells, and prevents the growth of virus by stopping viral synthesis and energy production.
- Its selective accumulation in virally-infected cells makes it unique.
- **Advantages** - 2-DG being a generic molecule and an analogue of glucose, it can be easily produced and made available in large quantities.
- The molecule helps in faster recovery of patients hospitalised with Covid-19, and reduces their dependence on supplemental oxygen.
- In efficacy trends, the patients treated with 2-DG showed faster symptomatic cure than Standard of Care (SoC) on various endpoints.

5.26 Oxygen Express

- Indian Railway is running Oxygen Expresses with Liquid Medical Oxygen (LMO) tankers in response to the fight against Covid-19.
- First Oxygen Express is going to start its journey from Visakhapatnam to Mumbai through Ro-Ro service of Indian Railways.
- A green corridor was created between Lucknow to Varanasi for another Oxygen Express that started its journey from Lucknow to Bokaro via Varanasi to fulfil the requirements of Medical Oxygen.
- **Liquid Medical Oxygen (LMO)** is supplied and stored as a liquid at very low temperatures, in vessels and storage tanks.
- LMO must be supplied at the medical oxygen purity of 99.5% (min). In hospitals, the converted Medical Oxygen, a gas at normal temperatures, is supplied via a medical gas pipeline system.

5.27 Oxygen Concentrators

- By affecting the lungs, Covid-19 reduces the oxygen level dangerously.
- Oxygen concentrators can be used by the patient to enhance oxygen levels to clinically acceptable levels (Oxygen Therapy).
- **Working** - Oxygen concentrators will suck in atmospheric air and filter other gases, and compress oxygen. It increases the oxygen concentration.
- Depending on need, the litres of oxygen per minute have to be regulated.
- Oxygen concentrators can supply between 0.1 litres per minute (LPM) to 5 to 10 LPM. A concentrator has 92-95% pure oxygen.

Types of Oxygen Concentrators

- **Continuous flow oxygenconcentrator** will provide the same flow of oxygen every minute unless it is turned off irrespective of whether patient is breathing it in or not.
- **Pulse dose oxygen concentrator** detects breathing pattern and dispenses oxygen when it detects inhalation.
- The oxygen dispensed per minute will vary in second case.

- **Usage -** Oxygen concentrators can be used when the oxygen requirement of the patient is a maximum of 5 litres per minute.
- Only mild to moderately ill Covid-19 patients (who have an oxygen saturation level between 90 and 94) should use an oxygen concentrator at home, until they get hospital admission.
- Anyone with oxygen saturation depleting below 80-85 may need higher flow of oxygen and will have to switch to an oxygen cylinder or liquid medical oxygen supply or get hospitalised.
- They are useful for patients with post-COVID complications which needs oxygen therapy.
- However, patients using oxygen concentrator themselves without suitable medical advice can be harmful.
- **Production** - Besides multi-national brands, several Indian start-ups, funded under the CAWACH, have developed efficient and cost effective Oxygen Concentrators.
- [CAWACH (Centre for Augmenting War with Covid 19 Health Crisis) is a programme of Department of Science & Technology.]
- Given their usefulness during the second wave of Covid Pandemic, 1 lakh Oxygen Concentrators are being procured through PM CARES fund.

5.28 Oxygen Saturation

- Oxygen level is measured by oxygen saturation, known as SpO2, which is a measure of the amount of oxygen-carrying haemoglobin in the blood.
- A healthy individual will have an arterial oxygen saturation of 95% – 100%.
- **WHO** - If the oxygen saturation is 94% or lower, the patient needs to be treated quickly. A saturation of less than 90% is a clinical emergency.
- **Union Ministry of Health** -A patient with oxygen concentration less than or equal to 93% requires hospital admission, while those with below 90% is classified as a severe disease, requires admission in ICU.

5.29 Black Fungus

- Black fungus or mucormycosis, a rare but serious fungal infection, is being detected frequently among Covid-19 patients in some states.
- **Causes** - Mucormycosis is caused by a group of moulds known as mucormycetes present naturally and abundantly in the environment.
- Sinuses or lungs of such individuals get affected after they inhale fungal spores from the air. It can lead to loss of the upper jaw and even the eye.
- It mainly affects people who are on medication for health problems that reduces their ability to fight environmental pathogens and sickness.
- **Symptoms -** The disease often manifests in the skin and also affects lungs and brain. The symptoms include,
    - Sinusitis - nasal blockade or nasal discharge (blackish/bloody);
    - Pain and redness on the cheek bone, eyes; one-sided facial pain, numbness or swelling; Blackish discoloration over nose/palate;
    - Loosening of teeth, jaw involvement;
    - Blurred or double vision with pain;
    - Thrombosis, necrosis, skin lesion;
    - Chest pain, pleural effusion, bloody vomits, altered mental status.
- **Vulnerable -** Vulnerable groups include those patients with diabetes mellitus, cancer, or those who have had an organ transplant.
- Those who are in immunosuppression by steroids, prolonged ICU stay, and comorbidities — post transplant/malignancy, voriconazole therapy.

- **Prevention -** Use masks if visiting dusty construction sites. Wear shoes, long trousers, long-sleeved shirts and gloves while handling soil, moss or manure. Maintain personal hygiene including a thorough scrub bath.
- **Diagnosis** - It depends on the location of the suspected infection.
- A sample of fluid from respiratory system may be collected for testing in the lab; or a tissue biopsy or a CT scan of lungs, sinuses etc may be done.
- **Treatment** - Mucormycosis needs to be treated with antifungal medicine. In some cases, it can require surgery.
- To maintain adequate systemic hydration, the treatment includes infusion of normal saline (IV) before infusion of amphotericin B and antifungal therapy, for at least 4-6 weeks.

5.30 White Fungus

- As the central government asks states to notify black fungus or mucormycosis an epidemic, an infection called white fungus has been found to affect some people. It is more dangerous than black fungus.
- **Causes** - White fungus infection can be caused due to low immunity, or if people come in contact with things that contain these moulds.
- Diabetes patients, cancer patients, and those who are taking steroids for a long period of time are more at risk of getting infected.
- White Fungus is affecting those coronavirus patients who are on oxygen support. It is directly affecting the lungs of these patients.
- It is the main reason of Leucorrhoea in women - flow of a whitish, yellowish, or greenish discharge from the vagina.
- **Symptoms** - Patients of white fungus show Covid-like symptoms but test negative; the infection can be diagnosed through CT-Scan or X-ray.
- White fungus affects lungs, stomach, kidney, brain, nails, skin, private parts and mouth of the infected person.
- **Prevention** - White Fungus infection can be prevented by sanitising the surroundings. The oxygen or ventilator must be sanitised properly.

5.31 Campaign on COVID-19 Vaccination

- A multipronged nationwide mass awareness campaign on Covid-19 vaccination is organized by the Indian National Young Academy of Sciences (INYAS).
- This campaign will be carried out through an android-based mobile app COVACNEWS made by INYAS for ensuring information at the fingertips.
- Indian National Young Academy of Sciences – It was constituted by the Indian National Science Academy (INSA) in 2014 based on the recommendations of the INSA-constituted committee with Rajesh Gopakumar as chair.
- This academy came into existence as an activity of INSA in 2015.
- **Members** - 100 members, not exceeding the age of 40 years at the time of induction (20 new members shall be inducted as members each year.)
- Each person may remain a member for a fixed period of 5 years.
- **Advisory Board for INYAS** - INSA President, 6 Vice-Presidents and Executive Director.

Indian National Science Academy

- Formerly known as National Institute of Sciences of India (NISI), the INSA was established in 1935. The name was changed to INSA in 1970.
- **Objective** - To promote science in India and harness scientific knowledge for the cause of humanity and national welfare.
- In 1945, the institute was recognized by the Government of India as the premier scientific society of India, representing all branches of science.
- In 1968, it was designated as the adhering organization in India to the International Council for Science (ICSU) on behalf of the Government.

5.32 Mission COVID Suraksha

- It is led by the Department of Biotechnology and implemented by Biotechnology Industry Research Assistance Council (BIRAC).
- It has an end-to-end focus from preclinical development through clinical development and manufacturing and regulatory facilitation for deployment.
- This will help accelerate development of vaccine candidates and ensure that these are brought closer to licensure.
- Phase-I of the Mission has been allotted Rs.900 Crore for a period of 12 months. A total of 10 vaccine candidates have been supported by Department of Biotechnology so far at both academia and industry.

Diseases in News

VIRAL DISEASES

5.33 G4 Virus

- Recently, scientists have identified a "newly emerged" strain of influenza virus that is infecting Chinese pigs and that has the potential of triggering a pandemic.
- Named G4, scientists believe that it has descended from the H1N1 strain that was responsible for the 2009 swine flu pandemic.
- A Pandemic happens if a new strain emerges that can easily spread from person to person.
- It has the capability of binding to human-type receptors (like, the SARS-CoV-2 virus).
- However, it is not clear whether the new strain can transmit from one human to another.

H1N1 Pandemic

- H1N1 causes respiratory disease called Swine flu, transmitted from human to human.
- It was known in the past to occur in people who had been in the vicinity of pigs.
- While humans typically do not get infected by such a virus that circulates among pigs, when they do, it is called "variant influenza virus".
- The virus is transmitted by short-distance airborne transmission, particularly in crowded enclosed spaces.
- The treatment includes antiviral therapy with medicines like Oseltamivir (Tamiflu), peramivir (Rapivab).

5.34 African Swine Fever Virus

- Chinese scientists have found a natural mutation in the African swine fever virus (ASFV) that could be less deadly than the strain that ravaged the world's largest pig herd in 2018 and 2019.
- ASFV is an intra cytoplasmically-replicating DNA arbovirus - a sole member of the family Asfarviridae.
- ASF is a severe viral disease that affects wild and domestic pigs resulting in a highly lethal haemorrhagic fever, but doesn't affect humans.It has almost 100% case fatality rate (CFR).
- **Transmission** of the ASFV could be through,
    1. Direct contact with an infected or wild pig (alive or dead),
    2. Indirect contact through ingestion of contaminated material such as feed or garbage, or through biological vectors like ticks.
- **Symptoms** - High fever, depression, loss of appetite, haemorrhages in the skin, anorexia, vomiting, diarrhoea and sudden deaths in pigs.
- **Diagnosis** - Laboratory testing to differentiate it from Classical Swine Fever (CSF), whose signs may be similar to ASF.
- Even so, while ASF is lethal, there is no approved vaccine, which is also a reason why animals are culled to prevent the spread of infection.

5.35 Avian influenza outbreak

- Bird flu or Avian influenza is a disease caused by infection with avian flu Type A viruses.

- These viruses are found naturally in wild aquatic birds around the world and can infect domestic poultry as well as other bird and animal species.
- Based on their molecular characteristics and potency, these viruses are divided into,
    1. Low pathogenic avian influenza (LPAI) A viruses - Causes mild or no disease, and
    2. Highly pathogenic avian influenza (HPAI) A viruses - Causes severe infection that leads to high mortality.
- Avian influenza A viruses can infect birds through contact with infected wild birds or other infected poultry, as well as surface contamination.
- Human infections, though rare, happen when sufficient quantity of bird flu virus enters a person's nose, eyes or mouth, or through inhalation.
- **Recent Occurrences -** After India declared itself free from avian influenza, new cases of avian influenza subtypes have been reported now.
- Four States — Rajasthan, Madhya Pradesh, Himachal Pradesh and Kerala are the epicentres in this outbreak.
- The two subtypes (H5N1 & H5N8) have targeted different birds — crows in Rajasthan & Madhya Pradesh, migratory birds in Himachal Pradesh and poultry in Kerala.
- H5N1 has caused deaths of over 2,000 migratory birds in Himachal Pradesh.H5N8 led to the death of thousands of poultry in Kerala, hundreds of crows in Rajasthan and Madhya Pradesh.
- Migratory birds have been largely responsible for long-distance transmission of the virus into India.
- It also spreads through local movement of residential birds and poultry.
- Though avian influenza virus cross the species barrier and occasionally infecting humans, but human-to-human spread is reported rarely.
- Mutations of an avian influenza A virus and a human influenza A virus in a person can create a new influenza A virus.
- This can result in sustained transmission between humans thus increasing the risk of a pandemic influenza.

5.36 Measles and Rubella Elimination

- Recently, the *Maldives and Sri Lanka* have become the first two countries in the WHO's South-East Asian Region (WHO SEAR) to have eliminated both measles and rubella ahead of the 2023 deadline.
- The Maldives reported its last endemic case of measles in 2009 and of rubella in October 2015.
- Sri Lanka reported the last endemic case of measles in May 2016 and of rubella in March 2017.
- In September 2019, member countries of WHO SEAR set *2023 as the target for the elimination of measles and controlling rubella.*
- Earlier Bhutan, DPR Korea and Timor-Leste are countries in the region which have eliminated measles.Earlier Bangladesh, Bhutan, Maldives, Nepal, Sri Lanka and Timor-Leste have controlled Rubella.
- A country is verified as having eliminated measles and rubella when there is no evidence of endemic transmission of the respective viruses for ***over three years*** in the presence of a well-performing surveillance system.
- The vaccine being given in the MR campaign is produced in India and is WHO prequalified.

Measles

- It is a highly contagious viral disease and is a cause of death among young children globally.
- It is transmitted via droplets from the nose, mouth or throat of infected persons.
- It is particularly dangerous for children from the economically weaker background, as it attacks malnourished children and those with reduced immunity.
- It can cause serious complications, including blindness, encephalitis, severe diarrhoea, ear infection and pneumonia.

Rubella

- Rubella is a contagious, generally mild viral infection that occurs most often in children and young adults.
- It is also called German measles.
- Rubella infection in pregnant women may cause death or congenital defects known as Congenital Rubella Syndrome (CRS) which causes irreversible birth defects.

5.37 Ebola Outbreak in Guinea

- **Guinea** has declared an Ebola outbreak for the first time since an outbreak ended in 2016.
- Ebola Disease is viral disease, which is also known as Ebola haemorrhagic fever.
- It is transmitted from **animal to human** through infected fruit bats, gorillas, monkeys, forest antelope or porcupines or in the rainforest.
- It is transmitted from **human to human** via direct contact (through broken skin, blood, secretions, organs or mucous membranes) with the infected or dead person.
- **Symptoms** include impaired kidney and liver function, fever, fatigue, muscle pain, sore throat, vomiting and diarrhoea.
- **Diagnosis** can be done through RT-PCR assay, ELISA assay, Antigen-capture detection tests, Serum neutralization test, etc.

5.38 Chapare virus

- US researchers have recently discovered a rare Ebola-like illness that is believed to have first originated in rural Bolivia in 2004.
- The virus is named Chapare after a rural province in the northern region of central Bolivia, in which it was first observed.
- It belongs to the same Arenavirus family that is responsible for illnesses such as the Ebola virus disease (EVD).
- They are generally carried by rats and can be transmitted through direct contact with the infected rodent, its urine and droppings, or through contact with an infected person.
- The virus causes Chapare Hemorrhagic Fever (CHHF), with symptoms like Hemorrhagic fever much like Ebola.
- Viral hemorrhagic fevers are a severe and life-threatening kind of illness that can affect multiple organs and damage the walls of blood vessels.
- Virus can spread from person to person, it spreads only through direct contact with bodily fluids.
- The disease is also known to be most commonly transmitted in more tropical regions, particularly in certain parts of South America where the small-eared pygmy rice rat is commonly found.
- Since there are no specific drugs to treat the disease, patients generally receive supportive care such as intravenous fluids.
- The recent biggest outbreak of the 'Chapare virus' was reported in 2019, when three healthcare workers contracted the illness from two patients in the Bolivian capital of La Paz.

5.39 Acute Encephalitis Syndrome

- A child has recently been diagnosed with Acute Encephalitis Syndrome (AES) in Bihar.
- AES, locally called chamki bukhar (fever causing seizure), usually surfaces during summer in the flood-prone districts of north Bihar.
- It is characterized by acute-onset of fever and a change in mental status (mental confusion, disorientation, delirium, or coma) along with new-onset of seizures in a person of any age at any time of the year.
- It most commonly affects children and young adults and can lead to considerable morbidity and mortality.

- Viruses are the main causative agents in AES cases, although other sources such as bacteria have also been reported.
- Japanese encephalitis virus is the major cause of AES in India (5%-35%).Influenza A virus, West Nile virus, Chandipura virus, mumps, measles, dengue, Nipah, Zika are the other causes of AES in India.
- Due to the wide range of causal agents and the rapid rate of neurological impairment, clinicians face the challenge of a small window period between diagnosis and treatment.
- Widely reported areas - Assam, Bihar, Jharkhand, Karnataka, Manipur, Meghalaya, Tripura, Tamil Nadu, UP.

5.40 Viral Nervous Necrosis

- Viral nervous necrosis (VNN) is an acute and serious viral disease caused by Betanodavirus or Nervous Necrosis Virus (NNV).
- Formerly known as Viral Encephalopathy and Retinopathy, VNN affects many marine, brackishwater and freshwater fishes resulting in 100% mortality in larval and early juvenile stages.
- VNN causes necrosis and vacuolation of the brain, spinal cord, and eyes, which leads to abnormal swimming behavior, and ultimately death.
- Infected adults remain as carriers and transmit the virus to offspring through eggs.
- The practical way to control the disease and prevent vertical transmission is to vaccinate fingerlings and adult fish.
- Nodavac-R is the first indigenous vaccine for viral nervous necrosis affecting fishes developed by the Central Institute of Brackish water Aquaculture (CIBA) in Chennai.
- Red-spotted grouper nervous necrosis virus (RGNNV) is the only genotype prevalent in India and most other tropical countries.
- Nodavac-R, which could be injected to fingerlings, can be used in all species susceptible to VNN such as milkfish, mangrove red snapper etc.
- It would prevent VNN in fish hatcheries and bring down the incidence of VNN in grow-out farms.

5.41 Kyasanur Forest Disease

- This disease was first identified in Kyasanur forest of Shimoga district, Karnataka during an investigation of monkey mortalities in 1957.
- It is caused by Kyasanur Forest Disease (KFD) virus, which primarily affects humans and monkeys.
- **Transmission** - In nature, the virus is maintained mainly in hard ticks, monkeys, rodents and birds.
- It is transmitted via the bite of Haemaphysalis ticks and contact with carcasses of dead monkeys.
- **Symptoms** - The disease causes chills, frontal headache, body ache, and high fever for 5 to 12 days with a case fatality rate of 3 to 5%.
- **Severity** - Since its identification in 1957 and up to 2012, several cases and outbreaks have been reported every year, especially in five districts of Karnataka with average cases of about 400 to 500 per year.
- After 2012, the KFD has also been reported from adjoining states - Tamil Nadu, Kerala and Maharashtra. Eventually, KFD emerged as a grave public health problem spreading through the entire Western Ghats.
- The microchip-based Truenat KFD Point of Care Test (PoCT) has been found to be highly sensitive in the rapid diagnosis of Kyasanur forest disease (KFD), also known as monkey fever.
- It includes a portable battery-operated Polymerase Chain Reaction (PCR) analyser, which is a universal cartridge-based sample pre-treatment kit and nucleic acid extraction device.

5.42 Cat Que virus (CQV)

- CQV belongs to the Simbu serogroup virus of the genus Orthobunyavirus.
- It was first isolated in 2004 from mosquitoes in northern Vietnam. It has also been reported in China.

- It comes under the category of Arthropod-borne viruses.
- Arthropods are a group of invertebrate animals including insects, spiders etc.
- It is found in pigs and Culex mosquitoes. Birds such as the Jungle Myna may also act as a host.
- Mosquitoes of Culex species also cause Japanese Encephalitis.
- It infects both humans and livestock species, where Humans are infected through mosquito bites.
- Recently Indian Council of Medical Research (ICMR)-National Institute of Virology has noted the presence of antibodies against the Cat Que virus (CQV) in two human serum samples.
- This indicates that the CQV virus may become a public health pathogen and may lead to a pandemic if it spreads.
- The positivity in human serum samples and the replication capability of CQV in mosquitoes points towards a possible disease-causing potential in the Indian scenario.

5.43 Vaccine Technology Transfer

- ICAR-Indian Veterinary Research Institute transferred the Vaccine Technology for Classical Swine Fever (CSF) and Sheep pox to M/s Hester Biosciences through Agrinnovate India Limited.
    a) Indigenous Live Attenuated CSF Cell Culture Vaccine (IVRI-CSF-BS)
    b) Indigenous Live Attenuated Sheep Pox Vaccine [SPPV Srin 38/00]
- These two are the first indigenous Vaccines to be developed in India.

Live Attenuated Indigenous CSF Cell Culture Vaccine

- The CSF is an important disease of pigs that causes 100% mortality.
- In India, the disease is controlled by a lapinized CSF vaccine (Weybridge Strain, U.K.) produced by killing large numbers of rabbits.
- To avoid this, the ICAR-IVRI earlier developed a Cell Culture CSF Vaccine using the Lapinized Vaccine Virus from foreign strain.
- IVRI-CSF-BS developed by using Indian field isolates has a huge export potential (As it has very high titre, the Vaccine can produce a large number of doses easily.)
- The vaccine has been found to induce protective immunity from day 14 of the Vaccination till 18 Months.

Indigenous Live Attenuated Sheep Pox Vaccine

- Sheep pox is a severe viral disease in sheep which is economically important in small ruminants.
- A live attenuated Sheep Pox Vaccine using indigenous strain was developed by the IVRI for preventive vaccination in sheep population.
- It uses indigenous Sheep Pox Virus Strain [SPPV Srin 38/00] and could grow in the Vero cell line. So, the Vaccine production is easily scalable.
- It is potent and immunogenic for sheep aged more than 6 months of age. It protects the Vaccinated animals for a period of 40 months.

Agrinnovate India Limited

- Agrinnovate India Ltd. (AgIn) was incorporated under the Companies Act, 1956 (No. 1 of 1956) in 2011.
- It is a "for profit" Company owned by Department of Agricultural Research & Education (DARE), Ministry of Agriculture.
- It acts as an effective interface between Indian Council of Agricultural Research (ICAR - an autonomous organization under DARE) and the Stakeholders of agricultural sector (at National and International level).
- It will have a significant purpose of securing, sustaining and promoting global agricultural development.

BACTERIAL DISEASES

5.44 Scrub Typhus

- Recently an outbreak of Scrub Typhus has caused 5 deaths and 600 infections in Nagaland's Noklak district bordering Myanmar.
- It is a bacterial disease caused by Orientia tsutsugamushi through bites of Larval Mites of family trombiculid, also called Chiggers.
- The symptoms of the disease include fever, headache, body aches, and sometimes rash.
- There is no vaccineavailable for the disease.
- The occurrence the disease is found rural areas of Southeast Asia, Indonesia, China, Japan, India, and northern Australia.

Typhus

- Typhus is a group of bacterial infectious diseases that include epidemic typhus, scrub typhus, and murine typhus.
  1. Epidemic typhus is due to Rickettsia prowazekii spread by body lice.
  2. Scrub typhus is due to Orientia tsutsugamushi spread by chiggers.
  3. Murine typhus is due to Rickettsia typhi spread by fleas.
- Napoleon's army was infected with Epidemic Typhus during his invasion of Russia in 1812 causing it to retreat.

5.45 Diphtheria

- Diphtheria is a highly contagious infection, primarily caused by the bacterium Corynebacterium diphtheria.
- It is mainly spread by coughs and sneezes or through close contact with someone infected. It can affect the nose, throat and sometimes the skin.
- In most cases, the bacteria cause acute infections, driven by the diphtheria toxin - the key target of the vaccine.
- However, non-toxigenic C. diphtheria can also cause disease, often in the form of systemic infections.
- Researchers have found that Diphtheria has started to become resistant to several classes of antibiotics and may become immune to vaccination.
- The disease is once more becoming a major global threat because of the impact of COVID-19 on vaccination schedules in different parts of the world, coupled with a rise in the number of infections.

5.46 Defeating Meningitis by 2030: A Global Roadmap

- In 2020, the WHO's World Health Assembly endorsed the first-ever resolution on meningitis prevention and control and approved Defeating Meningitis by 2030: A Global Road Map.
- Meningitis is a serious infection or inflammation of meninges, the three-membrane thin lining that lie over the brain and spinal cord.
- It can be caused by a viral, bacterial, or fungal infection, but bacterial cases are the most dangerous.
- Types of meningitis and their causal agents:
  - Bacterial meningitis - Streptococcus pneumoniae, Listeria monocytogenes, Haemophilus influenzae, Neisseria meningitides
  - Viral meningitis - Herpes simplex virus and HIV
  - Fungal meningitis - Cryptococcal meningitis is a fungal form
- It could trigger headache, brain fever and a person suffering from meningitis may also experience stiffness in neck.
- Survivors frequently suffer deafness, cognitive impairment, and limb amputation due to sepsis.
- This first global road map on meningitis sets out three visionary goals to:
  1. Eliminate epidemics of acute bacterial meningitis(meningococcus, pneumococcus, Haemophilus influenzae and group B streptococcus);
  2. Reduce cases of and deaths from vaccine-preventable bacterial meningitis;

3. Reduce disability and improve quality of life after any meningitis.

- To achieve these goals, the road map identifies goals across 5 pillars - Prevention and epidemic control; diagnosis and treatment; disease surveillance; support & care for the affected; advocacy and engagement.

5.47 Leprosy

- It is chronic, curable infectious disease caused by the bacterium Mycobacterium leprae.
- It affects the skin, the peripheral nerves, mucosal surfaces of the upper respiratory tract, and eyes.
- Symptoms include light-coloured or red skin patches with reduced sensation, numbness and weakness in hands and feet.
- Claw hands, drop foot, eye damage, skin nodules, lesions and ulcers are some of the visible impairments associated with leprosy.
- The disease is treatable with multi-drug therapy within 6-12 months, which combines three drugs to kill the pathogen and cure the victim.
- India officially became leprosy free in 2005.

Leprosy in Himachal

- Himachal Pradesh is doing a door-to-door surveillance campaign to screen the state's entire population for symptoms of leprosy.
- For the first time in years, none of the new cases detected this year in Himachal had visible deformity or 'Grade 2 disability'.
- This indicates that the earlier a patient is diagnosed, the fewer the disability and disfigurement.

5.48 Pneumosil

- It is India's first indigenously created vaccine against pneumococcal disease, developed by Pune-based Serum Institute of India (SII).
- It was developed through collaboration with the health organisation PATH, and the Bill and Melinda Gates Foundation.
- This pneumococcal conjugate vaccine (PCV) will be available in the market at an affordable price in single and multi dose presentations.
- It targets the pneumococcal bacterium, which causes pneumonia and other serious life-threatening diseases such as meningitis and sepsis.
- The vaccine also makes SII the world's third supplier of PCVs under the pneumococcal Advance Market Commitment.
- Pneumococcal disease is a significant contributor under-five mortality rate worldwide.
- In view of its widespread fatality, the World Health Organization (2018) recommended the inclusion of PCV in routine childhood immunisation programmes in all countries.

5.49 Bubonic plague

- Bubonic plague is a rare but serious zoonotic disease.
- It is caused by bacterial infection and transmitted by fleas from rodents.
- It mainly results from the bite of an infected flea, and also from exposure to the body fluids from a dead plague-infected animal.
- There are no reports of human-to-human transmission of bubonic plague.
- It is one of the three plagues caused by bacterium Yersinia pestis.
- The other two being Septicaemic plague and Pneumonic plague.
- According to the WHO it can kill an adult in less than 24 hours, if not treated in time.
- Vaccine for the bubonic plague is available for individuals with high exposure to the plague.

- Recently a city in northern China sounded an alert after a suspected case of bubonic plague or 'Black Death' was reported.

5.50 Shigellosis

- Shigellosis is a highly contagious intestinal disease caused by family of bacteria called Shigella.
- Usually a person gets infected after taking contaminated water or stale food. It can be transmitted after using a common toilet also.
- The main symptoms of the infection include diarrhoea, often containing blood or mucus in stool, stomach pain, cramps, fever and vomiting.
- An infected person shows minor symptoms in a day or two but it may take a week or so to show acute symptoms.
- Children under 10 are most susceptible to contract the infection, though the elderly can also get infected.
- For controlling the spread, super-chlorination of wells and inspection of eateries, including hotels should be done in the affected region.

5.51 Campylobacter Jejuni

- Campylobacteriosis is an infection by the Campylobacter bacteria. It is more commonly known as C. jejuni.
- It is among the most common bacterial infections of humans, often a foodborne illness.
- It produces bloody diarrhea or dysentery syndrome, mostly including cramps, fever and pain internally.

5.52 Haemorrhagic Septicaemia

- Six elephants died of haemorrhagic septicaemia (Sahana disease) in Karlapat Wildlife Sanctuary in Odisha's Kalahandi district.
- Haemorrhagic septicaemia is a **contagious bacterial disease** that occurs in parts of Asia and Africa**.**
- It infects animals that come in contact with **contaminated** food and water or soil or through **respiratory secretions**.
- It spreads through contact with infected animals, contaminated clothes, equipment and ingestion or inhalation of the bacteria.
- It generally spreads in the period right **before and after the monsoons**. It can affect cattle, buffalo and other animals.
- Respiratory tract and lungs of the animals are affected, leading to severe **pneumonia** and is often fatal.

Karlapat Wildlife Sanctuary

- Karlapat Wildlife Sanctuary is located in Kalahandi districtof **Odisha**.
- It lies within the Eastern Highlands moist deciduous forests ecoregion.
- It was notified as a wildlife sanctuary in 1992.
- It is home to tigers, leopards, sambars, nilgais, barking deer, mouse deer and variety of birds like green munia, great eared-nightjar and various reptiles, apart from elephants.

DISEASES CAUSED BY PARASITES, PROTOZOANS

5.53 Malaria Elimination Certificate

- El Salvador has become the first country in Central America to get the malaria-free certificate from WHO.
- Malaria elimination certificate is awarded to a country when the chain of indigenous transmission of the disease has been disrupted nationwide for at least **three consecutive years**.

- It is a life-threatening disease caused by **Plasmodium parasites**.
- It is transmitted to people through the bites of infected female ***Anopheles mosquitoes***.The mosquito transmits the parasite in to bloodstream and after it gets matured it begin to infect red blood cells.
- There are 5 parasite species that cause malaria in humans, and 2 of these species P. falciparum and P. vivax pose the greatest threat.
- It is preventable and curable.
- An infected mother can also pass the disease to her baby at birth. This is known as congenital malaria.
- Malaria is transmitted by blood, so it can also be transmitted throughan organ transplant, a transfusion and use of shared needles or syringes.

- Countries that eliminated malaria - Algeria, Paraguay, Argentina, Morocco, Armenia, Turkmenistan, Maldives, Kyrgyzstan, Uzbekistan, Sri Lanka.
- Half the global malaria-related deaths (2019) were in 6 African countries - Nigeria, Democratic Republic of the Congo, Tanzania, Burkina Faso, Mozambique and Niger.
- World Malaria Report 2020 - In India, malaria infections fell by 14.4 million (2000-2019), the largest reduction in South-East Asia. In 2019, India accounted for 86% of all malaria deaths in the region.

5.54 Human African Trypanosomiasis

- Recently Togo has become the first country in Africa to eliminate human African Trypanosomiasis. Togo did not report any cases in the past 10 years.
- Human African Trypanosomiasis or sleeping sickness, is a disease caused by parasites transmitted through infected tsetse flies. If untreated, it can become fatal.
- Sleeping sickness is currently found in 36 sub-Saharan African countries, according to the WHO.
- There are two types of sleeping sickness.
- **Trypanosoma brucei gambiense** – This occurs due to the parasite found in 24 countries in west and central Africa.
- It caused more than 88 per cent of reported cases of sleeping sickness in 2019, according to updated estimates made available by the WHO.
- **Trypanosoma brucei rhodesiense -** This parasite found in 13 countries in eastern and southern Africa.
- This type accounted for the remaining 12 per cent of reported cases in 2019.

5.55 Soil-Transmitted Helminthiases (STH)

- Soil-Transmitted Helminthiases (STH), also known as parasitic intestinal worm infection.
- It is known to have detrimental effects on children's physical growth and well-being and can cause anaemia and under-nutrition.
- As per WHO Report on STH published in 2012, in India there were an estimated 64% children in the age group (1-14 years) at risk of STH.
- The National Centre for Disease Control (NCDC) completed the baseline STH mapping across the country by the end of 2016.
- The data showed varied prevalence ranging from 12.5 % in Madhya Pradesh to 85% in Tamil Nadu.
- Regular deworming as advised by the World Health Organization eliminates worm infestation among children and adolescents living in areas with high STH burden.
- According to recent reports 14 States have shown reduction in the Soil-Transmitted Helminthiases (STH) and 9 states have shown substantial reduction in STH follow up prevalence survey.

5.56 Eliminating Lymphatic Filariasis

- Lymphatic filariasis (LF) or Elephant Foot is a painful and profoundly disfiguring disease.

- It is caused by three species of thread-like nematode(roundworms) of the family Filariodidea.Wuchereriabancrofti is responsible for 90% of the cases.
- Infection occurs when filarial parasites are transmitted to humans through mosquitoes injecting microfilariae into blood.
- It is one of the Neglected Tropical Diseases.
- It impairs the lymphatic system and can lead to the abnormal enlargement of body parts, causing pain, severe disability and social stigma.
- It can be eliminated by stopping the spread of infection through preventive chemotherapy with safe medicine combinations repeated annually.
- Global Program to Eliminate Lymphatic Filariasis (GPELF) was organised by the WHO in 2000.
- According to the WHO, it is stated to be the second leading cause of long-term disability.
- Healthy nutritional behaviours can lead to the elimination of the disease.
- It can be checked by improvements in the districts' nutritional status, in addition to disability alleviation and mass drug administration (MDA).
- MDA is an annual dosage of anti-filarial drugs given to eligible people in affected areas. This triple-drug therapy is being scaled up by the Centre.
- So, it will help achieve ***India's goal of Lymphatic Filariasis elimination by 2021.***

5.57 Nano Medicine for Visceral Leishmaniasis

- Visceral Leishmaniasis (VL) is also called as Kala- Azar is caused by the protozoan Leishmania parasites.
- It is transmitted to humans through infected sandflies.
- It is one of the most neglected tropical diseases.
- It is characterized by irregular bouts of fever, substantial weight loss, swelling of the spleen and liver, and anaemia (which may be serious).
- The parasite migrates to the internal organs such as the liver, spleen, and bone marrow, and, if left untreated, may result in the death.
- India itself accounts for half the global burden of the disease.
- If the disease is not treated, the fatality rate in developing countries can be as high as 100% within 2 years.
- Around 95% of which is reported from Bangladesh, Brazil, China, Ethiopia, India, Kenya, Nepal, Somalia, South Sudan, and Sudan.
- Scientists from the Institute of Nano Science & Technology (INST), have developed an oral Nano medicine, for combating Visceral Leishmaniasis (VL).
- The Oral Nano medicine has been developed with the help of surface-modified solid lipid nanoparticles based combinational cargo system.
- The oral therapeutics could help in the control and elimination of VL.

OTHER DISEASES – AUTO IMMUNE, GENETIC, COVID ASSOCIATED

5.58 Guillain Barre Syndrome

- Recently some patients infected with Covid-19 have been found suffering from Guillain Barre Syndrome (GBS).
- Guillain Barre Syndrome is a very rare autoimmune disorder in which the patient's immune system attacks nerves.
- The exact cause of Guillain-Barre syndrome is unknown, but as per the WHO, GBS is often preceded by an infection.

- This could be a bacterial or viral infection. It may also be triggered by vaccine administration or surgery.
- In the past, patients of Middle East respiratory syndrome (MERS), Zika virus, Human Immunodeficiency Virus (HIV), Herpes virus and Campylobacter jejuni have shown symptoms of GBS.
- Symptoms of GBS include - Weakness or tingling sensations, which usually start in the legs, and can spread to the arms and face.
- Difficulty with facial movements, including speaking, chewing or swallowing. Double vision, rapid heart rate, low or high blood pressure.
- Complication will leads to respiratory failure as the worst outcome, or weakness and effect on walking and limb movement.
- Intravenous immunoglobulin (IVIG) and Plasma therapy can be used as treatments.

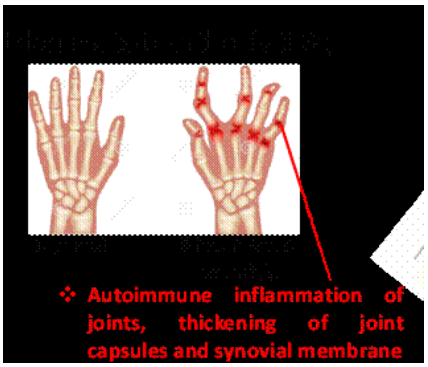
5.59 Saviour Sibling Experiment

- Thalassemia is an inherited blood disorder where the haemoglobin count is low in blood and such persons require frequent blood transfusions.
- Thalassemia major is the most severe form of beta thalassemia.
- It develops when beta globin genes are missing.
- The symptoms of thalassemia major generally appear before a child's second birthday.
- The severe anaemia related to this condition can be life-threatening.
- The only way to save a patient with Thalassemia major is through a bone marrow transplant, from a human leukocyte antigen HLA-identical donor.
- India recently carried out a 'saviour sibling' experiment, in which baby's bone marrow was used to save another child.
- A one-year-old sibling has saved her brother's life by donating her bone marrow.

5.60 Sickle Cell Diseases

- SCD is group of disorders that cause red blood cells to become misshapen and break down.
- With sickle cell disease, an inherited group of disorders, red blood cells contort into a sickle shape.
- The cells die early, leaving a shortage of healthy red blood cells (sickle cell anemia) and can block blood flow causing pain (sickle cell crisis).
- Infections, pain and fatigue are symptoms of sickle cell disease.
- Treatments include medication, blood transfusions and rarely a bone-marrow transplant.
- Treatment can help, but this condition can't be cured.

5.61 Rheumatoid Arthritis



- Rheumatoid arthritis (RA) is a long-term autoimmune disorder that primarily affects joints.
- It typically results in warm, swollen, and painful joints.
- Most commonly, the wrist and hands are involved, with the same joints typically involved on both sides of the body.
- This may result in a low red blood cell count, inflammation around the lungs, and inflammation around the heart.
- While the cause of rheumatoid arthritis is not clear, it is believed to involve a combination of genetic and environmental factors.
- Pain medications, steroids, and NSAIDs are frequently used to help

with symptoms.

- Element Zinc is vital for maintaining normal bone homeostasis, and its levels are reported to get reduced in rheumatoid arthritis patients and arthritis-induced animals.
- It is also known that oral supplementation of zinc in the form of zinc gluconate have very low bioavailability in humans.
- Institute of Nano Science & Technology (INST) has formulated nanoparticles with chitosan and loaded these nanoparticles with zinc gluconate for reducing the severity of rheumatoid arthritis.
- Zinc gluconate-loaded chitosan nanoparticles exerted superior therapeutic effects compared to the free form of zinc gluconate.
- Chitosan is nontoxic, biocompatible, biodegradable natural polysaccharide.It is one of the most abundant biopolymers obtained from the exoskeleton of crustaceans have shown absorption promoting characteristics.

5.62 Ovarian Cancer

- Ovarian cancer affects the female organs that produce eggs (ovaries).
- It often goes undetected until it has spread within the pelvis and stomach.At this late stage, ovarian cancer is more difficult to treat and can be fatal.
- It often has no symptoms in the early stages.Later stages are associated with symptoms, but they can be non-specific, such as loss of appetite and weight loss.
- The symptoms of this cancer tend to mimic other gastrointestinal conditions acidity, ascites or a bloated feeling.
- Surgery and chemotherapy are generally used to treat ovarian cancer.
- The crude incidence rate for ovarian cancer in India is 5 to 6 per 1,00,000. Stage IIIC cancers account for nearly 75%, with survival among them being around 30-40%.

5.63 G6PD deficiency

- Glucose-6-phosphate dehydrogenase (G6PD) deficiency is an inherited condition usually occurring in males.
- It is condition causing red blood cells to break down in response to certain medication, infections or other stresses.
- It's more common in those of African and Mediterranean descent.
- Triggers include infections, stress, fava beans, aspirin and other drugs.
- When symptoms are triggered, they include fever, dark urine, abdominal and back pain, fatigue and pale skin.
- Most people recover in a few days without treatment.However, patients are at risk of recurrent episodes, so avoidance of triggers is critical.
- The deficiency is chronic and cannot be cured.

5.64 Harlequin Ichthyosis

- Odisha reported its first-ever case of a baby born with harlequin ichthyosis in Ganjam district. India's first case was recorded in Nagpur, Maharashtra in 2016.
- The disease is an **extremely rare genetic disorder** that resulted in thickened skin forming over nearly the entire body at birth.
- **Causes** - The disease is caused due to mutations in the ABCA 12 gene (a mutated gene inherited from the parents).
- The ABCA12 protein plays a major role in transporting fats in cells which make up the outermost layer of skin.
- Severe mutations in the gene lead to the absence or partial production of the ABCA12 protein, which results in lack of lipid transport.

- **Symptoms** - The skin form large diamond-shaped plates across the body that are separated by deep cracks (fissures).
- The skin is dry and scaly, almost like fish skin and hence the term 'icthyosis' ('ikthus', Greek for fish).
- The facial features of the baby, including the mouth, eyes and ears may be deformed, which may restrict breathing and eating. The infants could not survive for long and succumbed to the disease days after birth.
- **Occurrence** - The disease affects one in three million births. There are around 200 to 250 such cases across the world.

5.65 Silicosis

- Silicosis is an interstitial lung disease caused by breathing in tiny bits of silica, a common mineral found in many types of rock and soil.
- Over time, exposure to silica particles causes permanent lung scarring, called pulmonary fibrosis.
- When silica dust enters the lungs, it causes inflammation which over time leads to the development of scar tissue that makes breathing difficult.
- This is a progressive disease that normally takes 10–30 years after first exposure to develop.
- Cigarette smoking adds to the lung damage caused by silicosis.
- Quitting smoking is an important part of managing the disease.
- Complications from silicosis can include tuberculosis, lung cancer, chronic bronchitis, autoimmune disorders and kidney disease
- There is no cure for silicosis, but treatment is available, and employers and workers can take steps to prevent it.
- Silica is the most abundant mineral in the earth's crust. So, any occupation that involves chipping, cutting, drilling, or grinding soil, granite, slate, sandstone, or other natural material can cause exposure to silica dust.
- Some high-risk occupations are Construction work, Ceramics manufacturing, Mining and hydraulic fracturing (fracking)
- National Human Rights Commission (NHRC) recently rapped the West Bengal government for inaction and lack of appropriate response in compensating silicosis-affected people in the state.

5.66 Kawasaki Disease

- Around the world, children with Covid-19 infection have often shown some symptoms similar to those associated with a rare illness called Kawasaki disease
- It typically affects children aged under five with symptoms like red eyes, rashes, and a swollen tongue with reddened lips often termed strawberry tongue and an inflamed blood vessel system all over the body.
- There is constant high fever for at least five days, it also affects coronary functions in the heart.
- The causes of the Kawasaki Disease are not yet known.
- The strawberry tongue may or may not be present in those with Covid-19. In Covid-19 cases, even adolescents are presenting these symptoms.
- Steroids remain a key treatment to reduce inflammation.

5.67 Lung fibrosis

- It is the inflammation of the tissue around the air sacs of the lungs leading to fatigue and shortness of breath.
- The lungs become stiff and the ability of oxygen to enter the blood circulation diminishes.
- It usually occurs in elderly people but it is now common among Covid-19 patients.
- While the majority of patients affected by Covid-19 virus will stabilise or improve over time, some will progress to advanced lung fibrosis.

- Hence large numbers of fibrosis cases may potentially result from the pandemic.
- It is too early to determine it.
- In the case ofa 45-year-old non-smoker ,who was in ICU with severe Covid-19 ARDS progressed to end stage fibrotic lung disease within 28 days, despite receiving steroids.
- However, those with moderate or severe disease, with persisting symptoms or radiological abnormalities, would require further investigation.
- Anti-fibrotic drugs are believed to be useful in patients with acute severity of interstitial lung disease (ILD).

5.68 Tinnitus

- Tinnitus is the perception of noise or ringing in the ears.
- Tinnitus isn't a condition itself — it's a symptom of an underlying condition, such as age-related hearing loss, ear injury or a circulatory system disorder.
- Tinnitus can significantly affect quality of life.
- One may experience fatigue, stress, sleep problems, trouble concentrating, memory problems, depression, anxiety and irritability, etc. Although it can worsen with age, for many people, tinnitus can improve with treatment.
- Treating an identified underlying cause sometimes helps. Other treatments reduce or mask the noise, making tinnitus less noticeable.
- Treatments may include hearing aids, sound-masking devices, medicines, and ways to learn how to cope with the noise.
- New research has found that Tinnitus is being exacerbated by Covid-19 and also by the measures being taken to fight the infection.
- It found that 40% of those displaying symptoms of Covid-19 simultaneously experience a worsening of their tinnitus.

5.69 Non-Alcoholic Fatty Liver Disease

- Ministry of Health & Family Welfare is going to integrate Non-Alcoholic Fatty Liver Disease (NAFLD) withNational Programme for Prevention & Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke(NPCDCS).
- Non-Alcoholic Fatty Liver Disease (NAFLD) is an important cause of liver disease in India (9-32%).
- **Conditions** - It is a distinct hepatic condition where there is accumulation of excess fat in the liver of people who drink little or no alcohol, causing fatty liver.
- Non-alcoholic steatohepatitis (NASH) is a more serious condition that may lead to severe liver cell inflammation and scarring, and cirrhosis.
- **Symptoms** - Abdominal pain, fatigue, slightly enlarged liver, patchy, dark discoloration of the skin (acanthosis nigricans) over the neck and under the arm.
- **Causes** - NAFLD is a part of the metabolic syndrome characterized by diabetes, or pre-diabetes (insulin resistance), being overweight or obese, elevated blood lipids such as cholesterol and triglycerides, and high BP.
- Several factors that may contribute to the development of NASH are:
    1. Oxidative stress (between pro-oxidant and anti-oxidant chemicals imbalance that lead to liver cell damage)
    2. Release of toxic inflammatory proteins (cytokines) by the patient's own inflammatory cells, liver cells, or fat cells
    3. Liver cell necrosis or death, called apoptosis
    4. Adipose tissue inflammation and infiltration by white blood cells
    5. Gut microbiota (intestinal bacteria) causing liver inflammation

- **Screening/Diagnosis** - Blood testing or radiologic investigations such as abdominal ultrasound or CT scan.
- **Treatment** - Weight reduction, controlling diabetes and treating elevated cholesterol levels, decrease in the amount of liver inflammation through anti-oxidant, anti-apoptotic and anti-cytokine medications.

5.70 AEG12 Protein

- The researchers from the US National Institutes of Health have found that mosquito protein AEG12 strongly inhibits the flaviviruses that cause yellow fever, dengue and Zika, and also weakly inhibits coronaviruses.
- AEG12 works by destabilising the viral envelope, breaking its protective covering. It does not affect viruses that do not have an envelope.
- At the molecular level, AEG12 rips out the lipids (the fat-like portions of the membrane that hold the virus together) and exchanges them for the ones it really prefers.
- To bioengineer AEG12 as a viable therapy for Covid-19, researchers will have to identify compounds that will make it target viruses only (as AEG12 also breaks opens red blood cells.

5.71 Superinfections

- Researchers at Sweden's KarolinskaInstitute have tried to answer why influenza infections lead to an increased risk of bacterial pneumonia.
- They have described findings leading to so-called "superinfections".
- They cite the example of Spanish flu, which was an influenza pandemic that swept across the world in 1918–20.
- Unlike many other pandemics, the Spanish flu hit young healthy adults, due to the superinfections caused by bacteria, in particular pneumococci.
- Researchers looked at mechanisms behind this increased susceptibility.
- They found that different nutrients and antioxidants leak from the blood. This creates an environment in the lungs that favours growth of bacteria.
- The bacteria adapt to the inflammatory environment by increasing the production of HtrA enzyme.
- HtrA weakens the immune system and promotes bacterial growth in the influenza-infected airways.
- The results of the research could be used to find new therapies for double infections between the influenza virus and pneumococcal bacteria.

NON-COMMUNICABLE DISEASE

5.72 Global Diabetes Compact

- It was launched by the WHO to better fight the diabetes while marking the centenary of the insulin discovery.
- It is the only major Non-Communicable Disease (NCD) for which the risk of dying early is going up.
- It is a major co-morbid condition linked to severe COVID-19 infections.
- **Type 1 diabetes** occurs when a person's body doesn't make insulin, as the immune system attacks and destroys the cells in the pancreas that make insulin.
- It is usually diagnosed in children and young adults, still it can appear at any age. (Juvenile diabetes).

Diabetes

- The number of people with diabetes has quadrupled in the last 40 years.
- About half of all adults with type 2 diabetes remain undiagnosed and 50% of people with type 2 diabetes don't get the insulin they need.
- The Compact will bring together in all WHO materials available for the prevention and management of diabetes, both existing and new.
    1. Prevention side - Reducing obesity, mainly among young people.
    2. Treatment side - Scaling up access to diagnostic tools and medicines, mainly in low- and middle-income countries.
- It will set standards for tackling the diseases in the form of 'global coverage targets' for ensuring a wider reach of diabetes care.
- The bodies will also release a 'global price tag' that will calculate the costs and benefits of meeting these targets.

- People with type 1 diabetes need to take insulin every day to stay alive (Insulin-dependent diabetes).
- **Type 2 diabetes** is the most common type of diabetes that occurs when a person's body does not make or use insulin well.
- It can develop at any age. However, it occurs most often in middle-aged and older people.
- **Gestational diabetes** develops in some pregnant women. Most of the time, this type of diabetes goes away after the baby is born.
- However, if one have had gestational diabetes, they have a greater chance of developing type 2 diabetes later in life.
- **Other types of diabetes** - Monogenic diabetes (an inherited form of diabetes), and cystic fibrosis-related diabetes.

ISSUES

5.73 Human Growth Hormone (hGH)

- Human Growth Hormone (hGH) is produced in the body and secreted by the pituitary gland near the base of the brain.
- HGH helps in bone, organ and cartilage growth and also helps in repairing damaged muscles.
- When the gland releases the growth hormone, it results in the secretion of a protein called IGF-1 from the liver.
- The IGF-1 protein is what ultimately stimulates the growth of bones, muscle, and other tissues.
- hGH is banned both in-competition as well as out-of-competition by the World Anti- Doping Agency (WADA) as hGH is known to increase muscle mass, strength as well as tissue-repairing effects.
- Recently a 2018 Commonwealth Games silver medalist, has been handed a provisional four-year suspension after his blood sample tested positive for human Growth Hormone (hGH).

5.74 Inflammageing

- Inflammageing refers to the inhibition of one's immunity as the body's inflammation reaches higher levels as one ages.
- As this happens, our bodily defence systems respond more slowly to bacterial and viral infections, leaving the elderly more vulnerable.
- It is characterized by chronic low-grade inflammation, which occurs without an infection.
- While inflammation is essential to the immune response, inflammageing is not.
- The state of elevated inflammation can worsen many age-related diseases, and further inhibit the response from an already declining immune system.
- The most severe Covid-19 cases have occurred mostly in older people, researchers are investigating whether inflammageing has a role.

5.75 Bio-Markers

- A biomarker is a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes or pharmacological responses to a therapeutic intervention.
- Biomarkers may be used alone or in combination to assess the health or disease state of an individual.
- Researchers at the Cancer Institute (WIA) have identified a panel of five protein markers in the blood that can help with an early diagnosis of a common and lethal form of ovarian cancer.
- Combination of five markers - CA125, IGFBP2, SPP1, TSP1 and ADI were used for the study.

Report on API's

- Active Pharmaceutical Ingredient (API) is a substance or mixture of substances contained in a medicine that is intended to cause pharmacological activity.
- Technology Information, Forecasting and Assessment Council (TIFAC) has recently released a report on 'Active Pharmaceutical Ingredients'.
- Highlights - The pharmaceutical industry in India is third largest in the world, in terms of volume, behind China and Italy, and fourteenth largest in terms of value.
- However due to availability of cheap imports, the local manufacturing of APIs is very less.
- Of the total imports of APIs and intermediates into India, China accounts for 65-70%.
- The report has recommended to create mega drug manufacturing clusters with common infrastructure in India.
- Along with the report, a white paper titled 'Focused Interventions for Make in India : Post COVID 19' was also released.

5.76 Indian Brain Templates (IBT)

- National Institute of Mental Health and Neuro Sciences (NIMHANS) has developed Indian Brain Templates (IBT) and a brain atlas.
- Brain Template is a gross representation from various brain images to understand brain functionality in diseased conditions.
- India currently uses Montreal Neurological Index (MNI) template, it is based on Caucasian brains, which are different from Asian brains.
- Over 500 brain scans of Indian patients were studied to develop five sets of Indian Brain Templates (IBT) and a brain atlas.
- IBT provides a scale that will measure an Indian brain.
- When most brain scans are taken, they need to be compared to a standard brain template, a model or standard for making comparisons from a group of individual brain scans.
- Brain Atlas has been developed for five age groups covering late childhood to late adulthood (six to 60 years).
- These new population and age-specific Indian brain templates will allow more reliable tracking of brain development and ageing.
- The templates and atlas will provide more precise reference maps for areas of interest in individual patients with neurological disorders like strokes, brain tumours, and dementia.
- These will also help pool information more usefully in group studies of the human brain and psychological functions, aiding in understanding of psychiatric illnesses.

5.77 Protein-Antibody Conjugates

- The researchers from University of Massachusetts, in the U.S. have designed nanoparticles called Protein–Antibody Conjugates (PACs).
- The PACs combines two different approaches that can be used for targeted drug delivery to treat diseases. They are,
    1. **Biologics**, where the idea is to target a defective protein in the system by delivering proteins to it.
    2. **Antibody–drug conjugates** - Drug molecules can be attached to the antibody, forming drug–antibody conjugates.
- PACs have a protein attached to the antibody that can precisely deliver drugs to specific cells. This could have an impact on incurable diseases.
- PACs can be used to treat undruggable cases, because with proteins we can design drug molecules that will bind to the target.

5.78 Antimicrobial Resistance

Antimicrobial resistance is growing exponentially and is becoming a global health and development threat.

- Antibiotic resistance (AMR) occurs when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them.
- Globally, about 35% of common human infections have become resistant to available medicines.
- About 700,000 people die every year because antimicrobial drugs are becoming less effective to combat pathogens.
- India being the largest consumer of antibiotics in the world, AMR is a serious problem.
- According to **The Lancet** study, in India approximately 58,000 new-born children die annually from sepsis because antimicrobial drugs are becoming less effective.
- Human activity has significantly accelerated the process of microorganisms developing resistance to antimicrobial agents.
- The misuse and overuse of antimicrobials for humans, livestock and agriculture is seen as cause for AMR.
- Water is seen as major mode for the spread of AMR, especially in places with inadequate water supply, sanitation and hygiene.
- India has a capacity to treat only about 37% of the sewage generated annually & rest is discharged into natural water bodies without treatment.
- The release of untreated effluents from households, health, pharmaceutical facilities and agricultural run-off is propagating resistant microorganisms.
- **Initiatives to combat AMR -** UNEP in its 2017 **Frontiers Report**, identified AMR as one of six emerging issues of environmental concern.
- In 2017, the UN Environment Assembly advocated for understanding the role of environmental pollution in spreading AMR.
- UN agencies are working together to develop the **One Health AMR Global Action Plan** that addresses the issue in human, animal, and plant health and food and environment sectors.
- In 2020, MoEF&CC issued draft standards which sets the residue limits of 121 antibiotics to be released from drug production units.
- Governments need to factor in new research before it is becoming a threat to human & environment.

5.79 Candida Auris

- Researchers found Candida Auris on remote beaches of Andaman and Nicobar Islands that can potentially bring next pandemic.
- Candida Auris, a multidrug-resistant fungus, has become a 'superbug' as it is able to resist main anti-fungal treatments.
- C. Auris survives on the skin before entering the body through wounds.
- Once in the bloodstream, it causes severe illness and can lead to sepsis - a condition that kills up to 11 million people a year globally.
- **Spread** - C. auris spreads from one patient to another in hospitals, targeting people with weakened immune systems.
- It spreads through contact with contaminated environmental surfaces or equipment. It is difficult to identify with standard lab methods.
- **Symptoms** may not be noticeable, as patients infected with C. auris are often patients in the hospital with another serious illness or condition.

GOVERNMENT INITIATIVES & PROGRAMMES

5.80 Plasma Bank

- For the first time in India, Delhi Administration has inaugurated a plasma bank in the city and urged recovered Covid-19 patients to donate their plasma.
- Delhi's Plasma Bank is opened at the Institute of Liver and Biliary Sciences (ILBS).
- The Plasma Bank is a first-of-its-kind initiative in the entire country and appealed to recovered patients to donate their plasma.
- The recovered Covid-19 patients can donate their plasma after 14 days of their COVID-19 negative report.
- A healthy person between the age group of 18-60 years and with no comorbidities can be a donor and the patient should have recovered at least three weeks before donating and tested negative for Covid-19 twice.

5.81 Swasthya Portal

- Union Tribal Affairs Minister has e-launched "Swasthya" Portal.
- It is the first of its kind comprehensive platform for health and nutrition related information of the tribal population of India.
- Ministry of Tribal Affairs in collaboration with Piramal Swasthya, the Centre of Excellence has developed this Tribal Health and Nutrition Portal.
- It has a dashboard, knowledge repository, partner segment, Sickle Cell Diseases (SCD) support corner.
- It encourages people with Sickle Cell disease or trait to register themselves.
- The dashboard presents data curated from multiple sources for the 177 identified high priority tribal districts.

5.82 Health Data Management Policy

- National Health Authority (NHA) has released the Draft Health Data Management Policy of the National Digital Health Mission (NDHM).
- NHA is the apex agency of the Government of India responsible for the implementation and management of Ayushman Bharat and the National Digital Health Mission (NDHM) across the country.
- The draft health data management policy acts as a guidance document to set out the minimum standard for health data privacy protection.
- It aims to create a National Digital Health Ecosystem through provision of a wide-range of data, information and infrastructure services ensuring the privacy of health-related personal information.

5.83 Longitudinal Ageing Study of India (LASI)

- Union Ministry of Health & Family Welfare has launched the Longitudinal Ageing Study in India (LASI) in 2016.
- It will assess the needs of its elderly people and frame policies accordingly.
- The survey will take into account study on 60,000 elderly people over 25 years plan and will be the largest survey of its kind.
- LASI project will be jointly funded by the Union Health Ministry, United Nation's Population Fund-India and United States National Institute on Ageing.
- The survey would be undertaken by the Mumbai based International Institute for Population Sciences (IIPS), in collaboration with Harvard School of Public Health (HSPH) and University of Southern California (USC).
- It will provide Union Health Ministry sufficient data on older population in the country that in turn would be used to develop a scientifically validated data needed for their health, economic and social analysis of the older population.
- It will investigate various health structures, and impact of social determinants on health of the elderly.

- It will provide scientific data for framing evidence-based policy for elderly citizens and help in expanding the scope of health and social security policy and programmes for older population.

5.84 Trans Fat Free India

- Trans fats, or trans-fatty acids, are a form of unsaturated fat.
- They come in both natural and artificial forms.
- Natural, or ruminant, Trans fats occur in the meat and dairy from ruminant animals, such as cattle, sheep, and goats.
- They form naturally when bacteria in these animals' stomachs digest grass.
- However, artificial Tran's fats otherwise known as industrial Trans fats or partially hydrogenated fats are hazardous to your health.
- These fats occur when vegetable oils are chemically altered to stay solid at room temperature, which gives them a much longer shelf life.
- Artificial Tran's fats may increase your risk of heart disease.
- In 2018 the World Health Organization launched a plan to eliminate trans-fat from the global food supply.
- Recently union government proposed to make India Trans Fat free by 2022, a year ahead of target set by World Health Organization.
- Food Safety and Standards Authority of India (FSSAI) has capped the amount of Trans Fatty Acids (TFA) in oils and fats to 3% for 2021 and 2% by 2022 from the current permissible limit of 5%.
- This was done through an amendment to the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations.
- This revised regulation applies to edible refined oils, vanaspati (partially hydrogenated oils), margarine, bakery shortenings, and other media of cooking such as vegetable fat spreads and mixed fat spreads.
- The World Health Organisation (WHO) has called for the elimination of industrially-produced TFAs from the global food supply by 2023.

5.85 Integrated Health Information Platform

- The Integrated Health Information Platform (IHIP), the world's biggest online disease surveillance platform, was launched.
- India is the first country in the world to adopt such an **Advanced Digital Surveillance System**.
- IHIP is the next generation highly refined version of the presently used Integrated Disease Surveillance Programme (IDSP) digital platform.
- It will track 33 diseases now as compared to the earlier 18 diseases.
- It will provide health information system developed for real time, case-based information, integrated analytics, advanced visualization capability that will enable evidence-based policy making.

5.86 Aahaar Kranti

- This is a mission that aims to spread the message of the need for a nutritionally balanced diet and to understand the importance of accessibility to all local fruits and vegetables.
- It was launched by Vijnana Bharati (Vibha) and Global Indian Scientists' and Technocrats' Forum (GIST).
- Motto - 'Uttam Aahaar Uttam Vichaar' or 'Good Diet-Good Cognition'.
- It is designed to address the peculiar problem being faced by India and the world called 'hunger and diseases in

International level

- The UN has declared 2021 as the International Year of Fruits and Vegetables, which vibes very well with Aahaar Kranti.
- The UN Sustainable Development Goal (SDG) # 3 emphasizes on human well-being. This makes Aahaar Kranti more meaningful.

abundance'.

- It proposes to address the current situation of hunger by working to apply the knowledge of Ayurveda-based nutrition to practice, to renew the focus on nutritionally balanced diets Uttam evam santulit aahaar in locally sourced fruits and vegetables and to rouse the people to the values of India's traditional diet, to the healing powers of local fruits and vegetables, and to the miracles of a balanced diet.
- It will train the teachers, who will pass on the message to many students and through them to their families and ultimately the society at large.
- The messages will be imparted through the curriculum or as games or instructions in all vernacular languages besides English and Hindi.
- Council of Scientific and Industrial Research (CSIR)'s Pravasi Bharatiya Academic and Scientific Sampark is collaborating, and various central and state government ministries and agencies are involved.

5.87 Poshan Gyan

- NITI Aayog, in partnership with the Centre for Social and Behaviour Change, Ashoka University, and Bill and Melinda Gates Foundation, launched Poshan Gyan.
- Poshan Gyan is national digital repository on health and nutrition.
- It was conceptualized as a source, enabling the search of communication materials on 14 thematic areas of health and nutrition across diverse media types, languages, target audiences, and sources.
- It introduces a unique crowd sourcing feature that allows anyone to submit communication material for inclusion on the website, followed by a review by a designated committee.
- It will help to make nutrition a 'Jan Andolan' (People's Movement).

5.88 National Policy for Rare Diseases 2021

- The Union Ministry of Health and Family Welfare has notified the National Policy on Rare Diseases, 2021.
- Though the document specifies increasing the government support for treating patients with a 'rare disease' - from Rs. 15 lakh to Rs. 20 lakh - caregivers say this doesn't reflect actual costs of treatment.
- According to the policy, rare diseases include genetic diseases, rare cancers, infectious tropical diseases, and degenerative diseases.
- **Centres of Excellence** - The government would notify selected Centres of Excellence at premier government hospitals for comprehensive management of rare diseases.
- These Centres would be provided a one-time grant to a maximum of ₹ 5 crore each for infrastructure development for screening, tests, treatment.
- **Patient registry of rare diseases** is to be constituted under the Indian Council of Medical Research (ICMR).
- **Categorisation** - A 'rare disease' has been categorised into 3 groups.
    1. **Group 1 diseases** - include osteopetrosis and immune deficiency disorders, among others - would be eligible for a one-time curative treatment cost of up to Rs. 20 lakh.
    2. **Group 2 diseases** require long-term treatment with low cost.
    3. **Group 3 Diseases** require long-term treatments with high cost.
- For Group 1 diseases, Rs. 20 lakh assistance will be provided to the patients with these disease that require a one-time treatment under 'Rashtriya Arogya Nidhi'
- These beneficiaries should conform to definition of Pradhan Mantri Jan Arogya Yojana and were treated in government tertiary care hospital.
- For Group 2 diseases, the States could consider supporting patients of these diseases that can be managed with special diets or hormonal supplements or other relatively low cost interventions.
- For the diseases, such as Hurler Syndrome, Gaucher's disease, that requires annual treatment expenses from Rs 10 lakh to Rs 1 crore, a digital platform is to be set up to raise donations and corporate funding.

- It aims to create **Administrative Committee** that will develop guidelines to determine which rare diseases to fund.
- **Detection** - The policy aims to screen and detect rare diseases at early stages, which will in turn help in their prevention.
- It aims to achieve this through the help of Health and Wellness Centres, District Early Intervention Centres and counselling.

5.89 Anamaya

- Anamaya is the Tribal Health Collaborative (THC), which is an initiative of Ministry of Tribal Affairs (MoTA) supported by Piramal Foundation and Bill and Melinda Gates Foundation (BMGF).
- **Aim** - To end all preventable deaths among Indian tribal communities, and enhance the health and nutrition status of the tribal communities of India on a Mission Mode.
- It is a multi-stakeholder initiative that brings together governments, philanthropists, national and international foundations, NGOs/CBOs.
- It will begin its operations with 50 tribal, Aspirational Districts (with more than 20% ST population) across 6 high tribal population states.
- Over a 10-year period, the work of the THC will be extended to 177 tribal Districts as recognised by the MoTA.
- A roadmap was laid out by the MoTA to address tribal health issues through the Tribal Health Action Plan.
- As part of this Collaborative, the MoTA will set up,
    1. 'Tribal Health Cell' to strengthen the primary healthcare systems, invest in tribal health research, devise mechanisms to implement the Tribal Health Action Plan, etc.,
    2. 'National Council on Tribal Health' to drive policy initiatives in tribal health, and to monitor the implementation of the Tribal Health Action Plan
- National Council on Tribal Health with MoTA and Ministry of health as co-chair and have representatives drawn from various ministries.

5.90 MANAS App

- Initiated by the Office of the Principal Scientific Adviser to the Government of India, the Mental Health and Normalcy Augmentation System (MANAS) App aims to **promote wellbeing** across age groups.
- The initial version of MANAS focuses on promoting positive mental health in the age group of 15-35 years.
- It is a comprehensive national digital wellbeing platform and an app developed to augment mental well-being of Indian citizens. It was jointly executed by,
    1. National Institute of Mental Health and Neuro-Sciences (NIMHANS), Bengaluru,
    2. Armed Forces Medical College (AFMC), Pune and
    3. Centre for Development of Advanced Computing (C-DAC), Bengaluru.
- MANAS app was endorsed as a national program by the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC).
- **Motto** - Uttam Mann, Saksham Jan
- It integrates the health and wellness efforts of various government ministries, scientifically validated indigenous tools with gamified interfaces developed by many national bodies and research institutions.
- This multi-lingual app is based on life skills and core psychological process, with universal accessibility, delivering age-appropriate methods and promoting positive attitude focusing on wellness.

5.91 Swarna Jayanti Fellowship

- Recently Department of Science & Technology (DST) has selected 21 scientists for the Swarna Jayanti fellowship.

- The Swarna Jayanti Fellowships scheme was instituted by the Government of India to commemorate India's 15th year of Independence.
- It provides special assistance and support to a selected number of young scientists with a proven track record to enable them to pursue basic research in frontier areas of science and technology.
- The award consists of a Fellowship of Rs. 25000 per month in addition to the salary drawn from the parent Institute along with a Research Grant of Rs. 5 lakh per annum by DST for a period of 5 years.
- In addition to fellowship, grants for equipment, computational facilities, consumables, contingencies, national and international travel, and other special requirements, if any, is covered based on merit.
- The fellowships are scientist specific and not institution-specific, very selective, and have close academic monitoring.
- Scientists selected for the award are allowed to pursue unfettered research with a freedom and flexibility in terms of expenditure as approved in the research plan.
- The project should contain innovative research ideas and it should have a potential of making impact on R&D in the discipline.
- The project submitted by the selected Fellows are considered for funding by the Science & Engineering Research Board (SERB) as per SERB norms.

5.92 Strategic Policy & Facilitation Bureau

- Union Ministry of AYUSH and M/s Invest India will form a collaboration to set up a strategic policy unit called "Strategic Policy & Facilitation Bureau (SPFB)".
- It aims to facilitate planned and systematic growth of the Ayush Sector.
- This Bureau will support the Ministry in strategic and policy making initiatives that shall help pave the way to reach the full potential of the Sector and stimulate growth and investment.
- The activities to be undertaken by the SPFB would includeKnowledge Creation and Management,Strategic & Policy-Making Support,State Policy Bench marking,Investment Facilitation,Issue Resolution.
- The Ministry of AYUSH would assist the Bureau in responding to investment proposal, issue and queries and fund Invest India for undertaking activities assigned.
- The Ministry will also support the Bureau in building links with various stakeholders such as industry associations, affiliate bodies of Ministry and Industry representation.

5.93 Initiatives related to Tuberculosis

- The National Strategic Plan (NSP) for Tuberculosis (2017-25) was approved by Union Ministry for Health and Family Welfare in 2017.
- It is being implemented in the entire country with the goal of Ending TB by 2025.
- Under NSP, 20%, 22% and 24% of the funds have been earmarked for social welfare assistance for 2017-18, 2018-19 and 2019-20 respectively.
- **Tribal TB Initiative** was launched by the Ministry of Health and Ministry of Tribal Affairs.
- It aims to fulfil the Prime Minister's goal of 'TB MuktBharat' by 2025, five years ahead of the global deadline.
- ***NIKSHAY Portal*** - It is the web enabled patient management system for TB control under the National Tuberculosis Elimination Programme (NTEP).
- It is developed and maintained by the Central TB Division (CTD), Ministry of Health and Family Welfare in collaboration with the National Informatics Centre (NIC), and WHO.
- It functions as the National TB Surveillance System and enables reporting of various surveillance data to the Government of India.
- For those private sector providers who notify TB patient on Nikshay, an incentive of Rs.500 on notification and another Rs.500 for updating the patient's treatment outcome are provided.

- ***NIKSHAY Poshan Yojana*** – It is a centrally sponsored scheme under National Health Mission (NHM) implemented from 2018.It provides Rs. 500 per month to all TB patients towards **nutritional support** for the duration of their treatment.
- Beneficiaries - Notified TB patients across all States and UTs in India.
- **TB Harega Desh Jeetega** - A new and aggressive campaign launched in 2019 along with the National TB Prevalence Survey was launched.
- Patient forums have been established in over 95% of all districts within the first 100 days of the launch of the campaign.
- ***India TB Report 2020*** – It wasreleased recently by the Union Minister of Health & Family Welfare.
- According to the report, National Tuberculosis Elimination Programme has comprehensively moved closer to near-complete online notification of all TB cases in the country through the NIKSHAY portal.
- Under the programme, in 2019, Nagaland and Tripura have been awarded for being the best performing among small states (Population - less than 50 lakh)
- Gujarat, Andhra Pradesh and Himachal Pradesh were awarded as best performing States among larger states (Population - more than 50 lakh)
- Dadra & Nagar Haveli and Daman & Diu were chosen as the best performers in the category of Union Territory.
- ***Stop TB Partnership Board*** - The Partnership was conceived following the meeting of the First Session of the Ad Hoc Committee on the TB Epidemic held in London in 1998.
- Established in 2000, the 'Stop TB Partnership' is an international body with a mandate to eliminate Tuberculosis (TB) as a public health problem by aligning actors all over the world.
- Through **Amsterdam Declaration**, the Partnership gave a call for collaborative action from ministerial delegations from 20 countries that bear the highest burden of TB.
- It has 1500 partner organizations - International, non-governmental and governmental organizations and patient groups.
- Secretariat - Geneva, Switzerland.
- It launched the Global Plan to End TB 2018-2022.
- The union minister for Health and Family Welfare has been appointed Chairman of the 'Stop TB Partnership Board' for a three year term, commencing July 2021.

5.94 Intensified Mission Indradhanush

- Ministryof Health and Family Welfare launched Intensified Mission Indradhanush (IMI) 3.0 and its portal.
- Focus of IMI 3.0 -Children and pregnant women who have missed their vaccine doses during the pandemic, and also people from migration areas and hard to reach areas.
- Mission Indradhanush was launched in 2014 to achieve full immunisation coverage for all children and pregnant women at a rapid pace.
- Intensified Mission Indradhanush (IMI) was launched from Vadnagar in 2017 and its second version (2.0) 2.0 is going to be launched from Dec 2, 2019.
- Through IMI, Government aims to reach each and every child upto 2 years of age and all those pregnant women who have been left uncovered under the routine immunisation programme/Universal Immunisation Programme (UIP).
- It aims to achieve targets of full immunization coverage in 272 districts in 27 States.
- Since its first phase, Mission Indradhanush has covered 690 districts. The present 8th campaign will target achieving 90% Full Immunization Coverage (FIC) in all districts of the country.
- Every year the Universal Immunization Programme caters to the vaccination needs of 2.65 crore children and 2.9 crore pregnant women against 12 Vaccine Preventable Diseases.
- The UIP basket has vaccines for the following diseases i.e

1. BCG for ***TB***, OPV for ***poliomyelitis***,
2. monovalent measles vaccine for ***measles***,
3. Rota Virus vaccine for ***Diarrhoea***,
4. JEV for ***JapaneseEncephalitis***&
5. Pentavalent Vaccine for DPT (***diphtheria***, ***pertussis***i.e whooping cough &***tetanus***) and
6. Vaccine for ***Hepatitis B***&***Pneumonia*** due to Hib.
7. Measles-rubella vaccine (MR)

5.95 Guidelines on Food Systems and Nutrition

- The members of the United Nations Committee on World Food Security (CFS) endorsed the first-ever voluntary guidelines on food systems and nutrition to end hunger and malnutrition.
- [CFS is an intergovernmental platform for stakeholders to work towards ensuring food security and nutrition for all. It is hosted and co-funded by the Food and Agriculture Organization.]
- These guidelines would support countries to eradicate hunger and malnutrition by utilising a comprehensive food systems approach.
- The guidelines would complement the work and mandate of other international bodies. (eg): UN Decade of Action on Nutrition 2016-2025.

5.96 COVAX Program

- Ghana has become the first country in the world to receive a shipment of coronavirus vaccines under the COVAX program.
- Covid-19 Vaccines Global Access (COVAX) is a global initiative aimed at equitable access to COVID-19 vaccines.
- It is led by the Global Alliance for Vaccines and Immunizations (GAVI), the World Health Organization (WHO), the Coalition for Epidemic Preparedness Innovations (CEPI), and others.
- It wants to vaccinate roughly 20% of the population in the 92 Advance Market Commitment (AMC) countries, which include middle and lower-income nations that cannot afford to pay for COVID-19 vaccines.
- This means countries with a Gross National Income (GNI) per capita of less than US $4000 and some other countries which are eligible under the World Bank International Development Association (IDA).
- The funding is partly coming from high and middle-income countries that will also receive a share of the vaccines produced for COVAX.

5.97 SAAMAR Campaign

- Jharkhand government launched the SAAMAR (Strategic Action for Alleviation of Malnutrition and Anaemia Reduction) campaign to tackle malnutrition in the state.
- SAAMAR campaign aims to identify anaemic women and malnourished children through Anganwadi Centres, and subsequently they will be treated at the nearest Malnutrition Treatment Centre.
- The campaign converges various govt. departments and engagement with school management committees, gram sabhas among others.
- It has been launched with a 1000 days target, under which annual surveys will be conducted to track the progress.
- It also tries to target Primarily Vulnerable Tribal Groups (PVTGs).
- SAMAAR will capitalize on the Tejaswini Project functioning in the 17 districts of the state where youth communities of adolescent girls and women are being trained in various skills, entrepreneurship and for jobs.
- All these adolescent girls and women will be educated on nutritional behaviour, and will be given a health and nutrition card.

5.98 GMO Threshold

- The Food Safety and Standards Authority of India (FSSAI) had ordered that the food crops imported into India would need a 'non-GM-origin-cum-GM-free certificate' issued by a competent authority.
- The FSSAI has set 1% threshold for Genetically Modified Organisms (GMO) in 24 imported food crops.
- The 'Coalition for a GM-Free India' said that this threshold is unacceptably high.
- It wants to limit the threshold for presence of GMO in imported food products to 0.01% as Indian labs can detect as little as 0.01%.
- It also urged the health ministry to extend similar regulations to fish, cotton, seeds and animal feed.
- The task of regulating GMO levels in imported consumables was initially with Genetic Engineering Appraisal Committee (GEAC), Environment ministry.
- Its role in this was diluted with the enactment of the Food Safety and Standards Act, 2006 and FSSAI was asked to take over approvals of imported goods.

6. BIO-TECHNOLOGY

Introduction

6.1 Stem Cells

- Stem cells differ from other kinds of cells in the body.
- They have the remarkable potential to develop into different cell types in the body during early life and growth.
- They have three unique properties.
  1. They are capable of dividing and renewing themselves for long periods;
  2. They are unspecialized; and
  3. They can give rise to specialized cell types.
- Commonly, stem cells come from **two main sources**:
  1. **Embryonic Stem Cell -** Embryos formed during the blastocyst phase of embryological development.
  2. **Adult stem cells** – Exist throughout the body after embryonic development and are found inside of different types of tissue such as the brain, bone marrow, blood, blood vessels, skeletal muscles, skin, and the liver
- The capacity to differentiate into specialized cell types and be able to give rise to any mature cell type is referred to as potency.
- When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell.
- **Totipotent stem cells** can differentiate into embryonic and extra embryonic cell types. These cells are produced from the fusion of an egg and sperm cell and can construct a complete, viable organism.
- The only totipotent cells are the fertilized egg and the cells produced by the first few divisions of the fertilized egg are also totipotent.
- **Pluripotent stem cells** are the descendants of totipotent cells and can differentiate into nearly all cells, i.e. cells derived from any of the three germ layers.
- These are true stem cells, with the potential to make any differentiated cell in the body. **Embryonic Stem Cells** come under this category.
- **Multipotent stem cells** can differentiate into a number of cells, but only those of a closely related family of cells (i.e) it can only differentiate into a limited number of types.

- Eg. The bone marrow contains multipotent stem cells that give rise to all the cells of the blood but not to other types of cells.
- **Oligopotent stem cells** can differentiate into only a few cells, such as lymphoid or myeloid stem cells.
- **Unipotent cells** can produce only one cell type, their own, but have the property of self-renewal, which distinguishes them from non-stem cells.
- Such Unipotent cells include muscle stem cells.

B Cells and T Cells

- The principle of immunisation or vaccination is based on the property of 'memory' of the immune system.
- In vaccination, a preparation of antigenic proteins of pathogen or inactivated/weakened pathogen (vaccine) is introduced into the body.
- The antibodies produced in the body against these antigens would neutralise the pathogenic agents during actual infection.
- The vaccines also generate memory – B and T-cells or lymphocytes that **recognise the pathogen quickly on subsequent exposure** and overwhelm the invaders with a massive production of antibodies.

Similarities between B and T cells

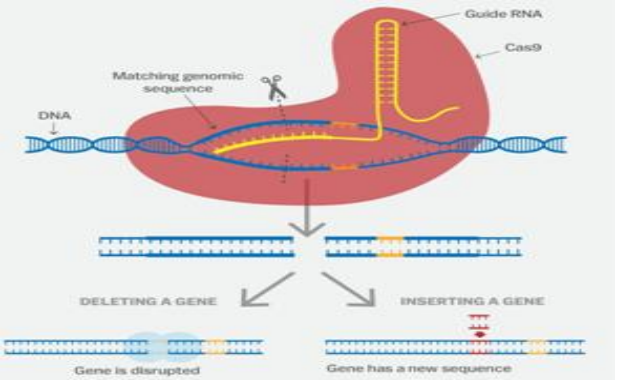
- B cells and T cells are the White Blood Cells of the immune system that are responsible for adaptive immune response in an organism.
- Both B and T cells are structurally similar and originate in bone marrow.
- Both the cells are non-phagocytic and are a part of lymphatic system.

Differences	**B-Cells**	**T-Cells**
Production	Bone marrow	Bone marrow
Maturity	Bone marrow	Thymus
Location	Outside lymph node	Inside lymph node
Attacks by	Connecting to the surface of invading bacteria and virus	Connecting only to the outside of the virus antigen
Life Span	Short	Long
Secretion	Antibodies	Lymphokines
Types	Only one active type	Helper and Killer Cell types

6.2 Gene Editing

- Genetic modification involves the introduction of foreign DNA into an organism.On the other hand, gene editing involves editing of the organism's native genome.
- CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a gene editing technology.
- It allows researchers to permanently modify genes in living cells and organisms by targeting specific stretches of genetic code to edit DNA at precise locations.
- This is done by introducing a protein (Cas9) containing the code of a defective gene.
- The protein then seeks out parts of the defective DNA that match this code.
- It then attaches itself to it, cuts it out, and then the DNA is allowed to repair itself by getting rid of the defect.
- It can be used to target multiple genes simultaneously and can also activate gene expression instead of cutting the DNA.

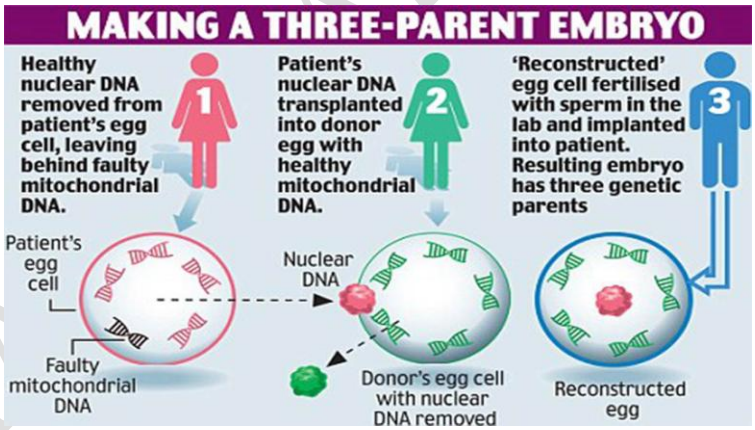
- This can be used to correct mutations at precise locations in the human genome to treat genetic causes of diseases.
- Correcting the mutation in an embryo ensures that the child is born healthy and the defective gene is not passed on to future generations.
- Apart from being used as a gene-editing tool, CRISPR CAS-9 can also function as a diagnostic tool.
- It can recognise target DNA very quickly and identify viruses such as Zika and dengue very efficiently.



- When an alien bacteria or virus invades the body, CRISPR is "programmed" to recognise the alien material. It then uses CAS-9, an enzyme produced by the CRISPR system to bond with the alien DNA and excise it.

6.3 Three Parent Baby

- A child could inherit from the mother, neurodegenerative disorder, which causes problems with movement or mental functioning.
- The three Parent Baby technique will thus use mitochondrial donation therapy for the women.
- By taking the mitochondrial DNA from a healthy donor "mother", the genetic conditions will not be passed on to the child.



- **Procedure** - To perform MRT (mitochondrial replacement therapy) doctors fertilise an egg from the affected woman with her partner's sperm using normal IVF techniques.
- IVF (In Vitro Fertilization) is the process of fertilization by extracting eggs, retrieving a sperm sample, and then manually combining an egg and sperm in a laboratory dish.
- In MRT, instead of letting the egg that develop into an embryo, the chromosomes are taken out and dropped into a healthy donor egg that has had its own chromosomes removed.
- The resulting embryo now has DNA from both parents, as usual, plus mitochondrial DNA from the donor.
- **Concerns** - The procedure has been seen as controversial because any offspring from such a procedure will then have DNA from three parents.
- However, mitochondrial DNA is separate from core DNA in cells. Thus, there will be no impact on the personality or looks of the offspring from the third DNA set.
- This comes as a move to prevent passage of incurable genetic diseases from mothers to offsprings.
- There are concerns on the other hand that parents would misuse the technique to get "genetically modified" babies.

6.4 Gene Therapy for Cancer

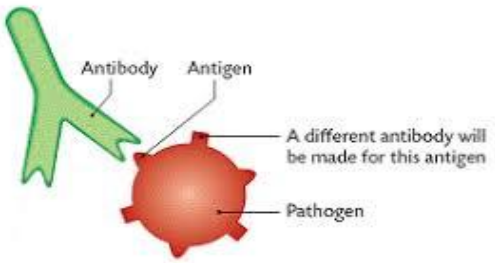
- Gene Therapy is a treatment that uses a patient's own immune cells called T-cells along with white blood cells to fight against diseases.
- These cells are removed from a patient, sent to a lab, and encoded with a viral vector, reprogrammed, and returned to the patient.

SOMATIC CELL GENE THERAPY	GERM LINE GENE THERAPY
Therapeutic genes transferred into the **somatic cells.**	Therapeutic genes transferred into the **germ cells.**
Eg. Introduction of genes into bone marrow cells, blood cells, skin cells etc.	Eg. Genes introduced into eggs and sperms.
Will not be inherited later generations.	**It is heritable** and passed on to later generations.
At present all researches directed to correct genetic defects in somatic cells.	For safety, ethical and technical reasons, it is not being attempted at present.

- It is called as CAR-T cell therapies and the treatments are called **Yescarta**and **kymriah**.
- Gene therapy also involves replacing mutated gene with functional gene and introducing new gene into body to help fight a disease.
- There are two types of gene therapy such as Somatic cell Gene therapy and Germ line therapy.

6.5 Human Antibodies in Lab

- Scientists have recently produced human antibodies in the laboratory for the first time. It could usher the rapid development of new vaccines to treat a wide range of infectious diseases.
- **Antibodies,** also called immunoglobulins, are proteins manufactured by the body that help fight against foreign substances called **antigens.**
- When an antigen enters the body, it stimulates the immune system to produce antibodies which attach, or bind themselves to the antigen and inactivate it.



- Antigens can be bacteria, viruses, or fungi that cause infection and disease. They can also be substances, called allergens that bring an allergic reaction.
- Antibody molecules are typically Y-shaped, with a binding site on each arm of the Y.
- It is produced by plasma cells (B-cells).
- When an individual B cell recognises a specific pathogen-derived "antigen" molecule, it can proliferate and develop into plasma cells that secrete large amounts of antibody capable of binding to the antigen and fending off the infection.
- There are five classes of antibodies, each having a different function. They are IgG, IgA, IgM, IgD, and IgE.
- The region of the antigen that interacts with the antibodies is called **epitopes.**
- The variable region of the antibody that specially binds to an epitope is called **paratope.**

6.6 Golden Rice

- In the late 1990s, German scientists developed a genetically modified variety of rice called Golden Rice.
- It was claimed to be able to fight Vitamin A deficiency, which is the leading cause of blindness among children and can also lead to death due to infectious diseases such as measles.
- Rice is naturally low in the pigment beta-carotene, which the body uses to make Vitamin A.
- Golden rice contains this, which is the reason for its golden colour.

RECENT DEVELOPMENTS

6.7 Guidelines for Recombinant DNA Technology in India

- Biosafety refers to policies and procedures adopted to avoid risk to human health and safety and to the conservation of the environment as a result of the use of GMOs for research and trade
- Under the Biosafety Research programme, main emphasis is given to facilitate the implementation of biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989 to ensure safety from the use of GMOs and products thereof in research and application to the users as well as to the environment.
- A three tier mechanism comprising
- Institutional Biosafety Committees (IBSC) at the Institute/company.
- Review Committee on Genetic Manipulation (RCGM) in the Department of Biotechnology.

- Genetic Engineering Approval Committee (GEAC) in the Ministry of Environment & Forests (MoE&F) for granting approval Genetically Engineered (GE) crops.

6.8 Indian Biosafety Knowledge Portal

- It was launched in 2019 through which the Department receives all new applications related to research proposals.
- This has made the whole process transparent and time bound.
- It is a webbased portal, with a major thrust to reach out to researchers, industry and other stakeholders to provide latest scientific information and regulatory guidance related to authorization of Genetically Modified Organisms/Living Modified Organisms (GMOs/LMOs) and products thereof.

6.9 Draft Guidelines for Stem Cell Research

- Indian Council of Medical Research (ICMR) has recently issued the revised draft National Guidelines for Stem Cell Research, in association with the Department of Biotechnology (DBT).
- The guidelines seek to ensure standards on various processes related to stem cell treatment.
- It stated that commercial banking of all biological materials, **other thanUmbilical Cord Blood (UCB)**, is prohibited until further notification.
- ICMR quoted that at present there is no scientific evidence to substantiate clinical benefits with the use of stem cells other than UCB. Yet its procurement and banking has become a commercial activity.
- Thus the banking of stem cells derived from cord tissue, placenta, tooth extract, adipose tissue, dental pulp, menstrual blood and olfactory ensheating cells is not permitted.
- ICMR has approved the stem-cell treatment for 30 odd categories of diseases mostly cancer.
- It listed 20 types of indications (diseases) for adults and another 13 categories of indications for children below 18 years, where stem cell treatments are permitted.
- The guidelines also mention that every other therapeutic use of stem cells shall be treated as investigational and conducted only in the form of a clinical trial after obtaining necessary regulatory approvals.
- These guidelines are applicable to all stakeholders including individual researchers, organizations, sponsors, oversight/regulatory committees and all others associated with both basic and clinical research involving any kind of human stem cells and their derivatives.
- It does not apply to research using non-human stem cells or tissues.
- Intellectual Property Rights (IPRs) associated with the outcome of research on stem cells may have commercial value.
- The option of sharing such IPRs should be indicated in the informed consent form which must be procured before the commencement of the research.

6.10 Earth BioGenome Project

- The Earth BioGenome Project aims to sequence the genomes of the roughly 1.5 million known animal, plant, protozoan and fungal species collectively known as eukaryotes.
- The project will characterize the genomes of all of Earth's eukaryotic biodiversity over a period of 10 years.
- It was officially launched in London with an estimated cost of US$4.7 billion.
- The last project of a similar scale and importance was the 13-year Human Genome Project which was completed in 2003.
- **Eukaryotes** - The branch of complex life consisting of organisms with cells that have a nucleus inside a membrane—lag far behind the bacteria and archaea.

7. NUCLEAR TECHNOLOGY

7.1 ITER

- International Thermonuclear Experimental Reactor (ITER) is world's largest experimental fusion facility in France.
- It is most complex science project in human history, started in 2010.
- It will use hydrogen fusion, controlled by superconducting magnets, to produce massive heat energy.
- The magnetic fusion device has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.
- This nuclear fusion facility is an international cooperation among the European Union, Russia, the US, Japan, China, India and South Korea.
- It is the first industrial-scale fusion reactor and it will illuminate the way to produce clean, cheap, and abundant energy for millions of years.
- It will start generating a molten mass of electrically-charged gas "plasma" inside a core by 2025.

7.2 Thorium-BasedNuclear Reactors

- India's three-stage nuclear power programme was formulated by **Homi Bhabha** in the 1950s to secure the country's long-term energy independence.
- The Three-Stage Nuclear Power Programme are,
    a. Stage I – Pressurized Heavy Water Reactor [PHWR]
    b. Stage II – Fast Breeder Reactor
    c. Stage III – Thorium Based Reactors
- Thorium as a viable and sustainable option in the Stage III.
- **India** has **20 Uranium (U238) -based nuclear reactors** producing **4,385 MW of electricity** already in operation and has another 6 under construction, 17 planned, and 40 proposed.
- The conversation, "nuclear good but uranium dangerous" leads towards a suitable altenatvie to Uranium as '**Thorium**'.
- Thorium sits in the same row as of Uranium on the periodic table, as Elements in the same row share characteristics.
- The key similarity is that both can absorb neutrons and transmute into fissile elements.That means Thorium could be used to fuel nuclear reactors, just like Uranium.
- It is more abundant in nature than uranium.
- It not fissile on its own, which means reactions can be stopped when necessary.
- It produces waste products that are less radioactive, and generates more energy per ton.
- Also, Thorium reactors do not produce plutonium, which is what needed to make a nuke.
- Most of the world's thorium exists as the useful isotope, which means it does not require enrichment.
- India is a home to a quarter of the world's known Thorium reserves and notably lacking in uranium resources.
- So, India envisions meeting 30% of its electricity demand through thorium-based reactors by 2050.
- However, it is not possible to build a nuclear reactor using Thorium (Thorium-232) alone due to its physical characteristics.
- Thorium has to be converted to Uranium-233 in a reactor before it can be used as fuel.
- Development of technologies pertaining to utilisation of Thorium has been a part of ongoing activities in Department of Atomic Energy.

- Efforts are currently on to enlarge the present Thorium related R&D work to a bigger scale towards development of technologies for Thorium based reactors.

Nuclear Power Plants	Types of Nuclear Reactor
Rawatbhata, Rajasthan	Pressurized Heavy Water Reactor (PHWR)
Kaiga, Karnataka	PHWR
Kakrapar, Gujarat	PHWR
Narora, UP	PHWR
Kalpakkam, TN	PHWR & Pressurized Fast Breeder Reactor
Tarapur, Maharashtra	PHWR & Boiling Water Reactor (BWR)
Kudankulam, TN	Water-Water Energetic Reactor (VVER)

7.3 KSTAR

- Korea Superconducting Tokamak Advanced Research (KSTAR) often referred to as South Korea's artificial sun, is South Korea's magnetic fusion device.
- It is placed at the Korean Institute of Fusion Energy.
- It is a part of joint research conducted with Seoul National University and Columbia University of the US.
- It recently reached an ion temperature of over 100 million degrees Celsius for 20 seconds.
- By comparison, the KSTAR was able to achieve a temperature of over 6.6 times more than that of Sun's (which is, 15 million degrees Celsius).
- The newly developed Internal Transport Barrier Mode was crucial to achieve this record-breaking time.

7.4 Nuclear Command Authority

- It is responsible for command, control and operational decisions regarding India's nuclear weapons programme.
- Organisational structure of NCA includes Political Council and Executive Council.
- Executive Council is headed by National Security Advisor and Political Council is headed by Prime Minister.
- The Executive Council gives its opinion to the Political Council, which authorises a nuclear attack when deemed necessary.
- This kind of organisational structure is created to prevent the accidental or unauthorised use of nuclear weapons.
- Strategic Forces Command is a part of Nuclear Command Authority, responsible to operationalize the directives of NCA and for the management and administration of the country's tactical and strategic nuclear weapons stockpile.
- SFC is headed by Commander-in-chief of the rank of Air Marshal.
- It will have the sole responsibility of initiating the process of delivering nuclear weapons and warheads, after acquiring explicit approval from the NCA.

7.5 Nuclear Recycle Board

- Nuclear Recycle Board functions as an entity within Bhabha Atomic Research Centre (BARC) and operates under the purview of BARC Safety Council.

- Nuclear Recycle Board is responsible for the design, construction and construction and operation of nuclear recycle plants involving reprocessing and waste management.
- The operation and maintenance of nuclear recycle facilities in the back end of Pressurized Heavy Water Reactor (PHWR) fuel cycle is under the purview of Nuclear Recycle Board.

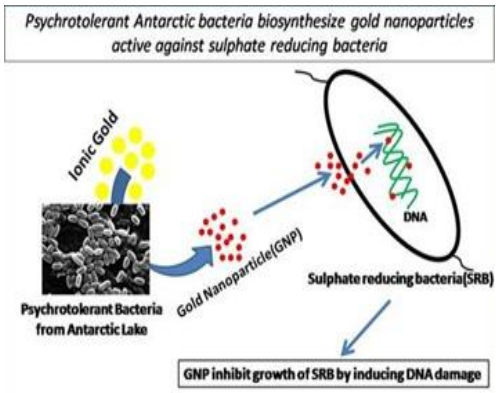
8. INNOVATIONS

8.1 Science, Technology and Innovation Policy 2020

- The government finalised a draft 'Fifth Science, Technology and Innovation Policy, 2020'.
- The aim is to -
  - attract, nurture, strengthen, and retain critical human capital through a people-centric STI ecosystem
  - double the number of full-time equivalent (FTE) researchers, gross domestic expenditure on R&D (GERD) and private-sector contribution to GERD every 5 years
  - build individual and institutional excellence in STI with the aim of reaching the highest levels of global recognition and awards in the coming decade
- **STI (Science, Technology and Innovation) Development Bank** will direct long-term investments in select strategic areas.
- For large-scale mission-mode programmes, rules of lending will be modified for an easier flow of finance.
- **Strategic Technology Development Fund** is to be set up to home-grow strategic technologies in areas such as nuclear science, space, cyber technology and biotechnology.
- This fund is managed by a Strategic Technology Development Board.
- It will also provide finance to the private sector and higher education institutions for research with specific goals.
- An **engagement portal** exclusively to bring together Indian scientists and technocrats worldwide and to engage with Indian researchers is being planned.
- **Science diplomacy** - Role of S&T in defining foreign policy priorities will be vitalized. Apart from 'S&T for diplomatic benefits', 'diplomacy for S&T development' is to be promoted.

8.2 Gold Nanoparticles

- National Centre for Polar and Ocean Research (NCPOR) and Goa University (GU) has successfully synthesized gold nanoparticles.
- They used psychrotolerant Antarctic bacteria through a non-toxic, low-cost, and eco-friendly way for the synthesis.
- The study revealed genotoxic effect of GNPs on a Sulphate reducing bacteria (SRB).
- It displayed enough anti-bacterial properties by inhibiting the growth of SRB and its sulphide production by damaging the genetic information of the DNA of the bacterial cell.
- Geno toxicity describes the property of a chemical agent that is capable of damaging the genetic information of DNA and thus causing mutation of the cell, which can lead to cancer.



- These GNPs can be used as a composite therapeutic agent clinical trials, especially in anti-cancer, anti-viral, anti-diabetic, and cholesterol-lowering drugs

8.3 Mini-LEDs

- Apple would announce new devices sporting the Mini-LEDs technology.
- Mini-LEDs (Mini-Light Emitting Diodes) are very small LEDs (0.2 mm or even smaller) that collectively produce the backlight on LCD panels.
- Sitting behind the LCD matrix, they offer granular control over light intensity and hence a better contrast ratio.
- This technology, where the backlight is divided into multiple zones is called **Local Dimming** and is a common feature in LCD displays.
- The super 'mini' size of Mini-LEDs allows the backlight to be divided into many more Local Dimming zones.
- However, Mini-LEDs are slightly bigger in size than the Micro-LEDs.
- Micro-LEDs panels are an extension of OLED panels, on a more precise scale. They mean smaller individual LED panels in an OLED screen.
- **Importance** - Mini-LEDs are the best of both worlds between traditional LCDs and OLED (Organic LEDs) panels.
- They bring the contrast of OLED panels and are set to be much easier and cheaper to make than OLED displays.
- The ease of making a Mini-LED panel (compared to an OLED or Micro-LED panel) also means they can be used to construct small displays.

LCD Displays

- They consist of a single backlight that throws light on our screen.
- The LCD matrix, which controls the contrast, selectively blocks out some parts of the backlight to produce contrast on the individual pixels.
- But due to this, when one pixel is supposed to show a bright colour, and the pixel next to it is supposed to show a dark colour, the single backlight throws some extra light meant for the bright pixel on the dark pixel too.
- This reduces the contrast, causing what is called **bleeding**.

OLED Displays

- In this, each pixel has its own lighting, so this is an emissive technology.
- This allows the screen to have granular control over, which pixel is supposed to show more light and which one is not.
- OLEDs typically have a better contrast ratio compared to LCDs.

8.4 SHUDH

- IIT Kanpur has developed an Ultraviolet (UV) sanitizing product named SHUDH.
- It is a smartphone operated Handy Ultraviolet Disinfection Helper (SHUDH).
- It has six UV lights of 15 Watts each that can be individually monitored from a distance.
- The device at its full operation can disinfect a 10x10 squared feet room in about 15 minutes.
- SHUDH can assist in killing the spread of corona virus at the highly prone places such as hospitals, hotels, malls, offices and schools.

8.5 Supramolecules in Capacitors

- Researchers from Indian Institute of Science Education and Research (IISER), Bhopal, are developing a novel dielectric material for capacitors.
- Supramolecular chemistry and crystal engineering was used to design, synthesise and crystallise organic materials with high dielectric constants.
- 'Supramolecular chemistry' is the study of large molecules formed by weak and reversible (non-covalent) bonds.
- These materials will be developed from non-toxic organic compounds that have dielectric constants comparable to inorganic material.

Dielectric material

- Dielectric material is the key component of capacitors - devices that store electrical charges (like batteries).
- These are a class of electrical insulators that can store electrical charges in the presence of an externally applied electric field.
- The charge stored is measured in terms of the 'dielectric constant' - the more the charge stored, the higher the constant.

8.6 Innovation in Super Capacitor

- Super Capacitor / Ultra capacitors are next-generation energy storage device.
- They have ultrafast charging characteristic as compared to conventional capacitors and lithium-ion batteries (LIB).

- In a super capacitor, electrode, electrolyte are the pivotal components which directly determine the electrochemical behavior of the super capacitors.
- Recently International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) has developed a low-cost, environmentally friendly, super capacitor electrode.
- It is derived from industrial waste cotton which can be used as an energy harvester storage device.
- Natural seawater is explored as an alternative aqueous electrolyte.
- It may replace the existing aqueous-based electrolytes for the economic fabrication of supercapacitor.
- The device shows great potential for practical application, and integration with solar cell.

8.7 Damaru-Inspired Lattice

- IIT Kanpur developed a 'Dambaru' or 'Damaru' inspired Lattice.
- A lattice is an ordered array of points describing the arrangement of particles that form a crystal.
- IIT Kanpur has demonstrated that one can get a wider variation of propagation and stop bands with the use of these micro-structured hour-glass shaped meta-structure in the lattice unit.

- These meta-structures have application in electro-magnetic and sonic wave absorption which could create 'invisibility' of an object in optical or acoustic domain.
- IIT Kanpur has shown the nature of stiffness of a vibrating medium could be altered by controlling the lattice micro-structure from regular honeycomb to auxtetic honeycomb structure.
- This has wide applications in the field of vibration isolation in high speed trains, stealth submarines and helicopter rotors.
- This work is sponsored by a SPARC project of MHRD.

8.8 Einsteinium

- Berkeley Lab's scientists have reported some of the properties of element 99 in periodic table called "Einsteinium", named after Albert Einstein.
- It was discovered in 1952 in the debris of the first hydrogen bomb (Detonation of a thermonuclear device called "Ivy Mike" in the Pacific Ocean).
- [When Ivy Mike was detonated in 1952, as part of a test at island Elugelab on the Eniwetok Atoll in the South Pacific, it was 500 times more destructive than the explosion that occurred at Nagasaki.]
- It is difficult to create and is highly radioactive.
- Einsteinium-254 is the more stable isotope of the artificial element, has a half-life of 276 days.
- The most common isotope of the element, Einsteinium 253 has a half-life of 20 days.
- Because of its high radioactivity and short half-life of all einsteinium isotopes, even if the element was present on Earth during its formation, it has most certainly decayed.
- This is the reason that it needs to be manufactured using very precise and intense processes.

8.9 Cadmium doped Silver Antimony Telluride

- Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) has found a new material called Cadmium doped Silver Antimony Telluride ($AgSbTe_2$), which is lead-free.
- Bengaluru-based JNCASR is an autonomous institution of the Department of Science & Technology (DST), Government of India.
- This new material can efficiently convert waste heat to electricity to power our small home equipment and automobile.
- This single material has three seemingly different properties - high electrical conductivity of metals, high thermoelectric sensitivity of semiconductors, and low thermal conductivity of glasses.
- Thermoelectric energy conversion allows generation of electrical voltage when one end of a material is heated while keeping the other side cold.
- As there is no lead in this new material, it can be used for mass-market applications.

8.10 Efficient Removal of Heavy Metals

- The Indian Institute of Technology (IIT) Mandi has developed a reusable fibrous membrane filter using a biopolymer-based material that helps to separate out the heavy metals from water samples.
- These membranes contain adsorbents (materials that attract and hold the metals) that has large amount of a biopolymer, **Chitosan**, derived from crab shells that are mixed with a synthetic polymer, Nylon.
- Normally, the fibres used to make regular cartridge filter-assemblies are processed by a method called melt blowing, but the IIT Mandi has used a process called "solution blowing".
- **Solution blowing** produces fibres that are nanometres in diameter, which increases their surface area tremendously and results in better adsorption of heavy metals.
- Apart from producing nanofibres, solution blowing processes can enable blending of natural polymers with synthetic polymers.
- While normally absorbent fibres bind to the target metal only at their surface, in their nanofibre membranes, the adsorption happens at the sub-surface scale as well. This increases the metal removal efficiency.
- Recovery of the adsorbed metal in a metal-hydroxyl nitrate form is easy.

Heavy Metal Pollution

- Heavy metals are Arsenic, lead, mercury, chromium, cadmium, copper, aluminium, etc.
- Heavy metals are released into the water through anthropogenic activities such as manufacturing, electroplating, mining, etc.
- Heavy metals in water could lead to several neurological diseases in humans including Alzheimer's, Parkinson's and multiple sclerosis.

8.11 Aluminium-air Batteries

- State-owned Indian Oil Corporation Ltd. has entered into a joint venture with Israel-based battery technology start-up Phinergy to develop aluminium-air technology based battery systems.
- These batteries utilise oxygen in the air which reacts with an aluminium hydroxide solution to oxidise the aluminium and produce electricity.
- These batteries are said to be a lower cost and more energy-dense alternative to lithium-ion batteries, which are currently in use in India.
- These batteries can be used for electric vehicles and stationary storage, as well as hydrogen storage solutions.
- One of the key downsides of aluminium-air batteries is that they cannot be recharged like lithium-ion batteries. So, large scale use of these battery based vehicles requires several battery swapping stations.
- Aluminium plates in aluminium-air battery is converted into aluminium trihydroxide over time and that aluminium can be reclaimed from aluminium trihydroxide or even traded directly for industrial uses.

8.12 Diatom Test

- Maharashtra Anti-Terrorism Squad (ATS) relied on a diatom tests for leads in the alleged murder case of Mansukh Hiran.
- Diatom test helps in diagnosing the death caused by drowning. It tests diatoms in the body being tested.
- Diatoms are photosynthesizing algae found in aquatic environment including fresh and marine waters, soils, etc., (almost anywhere moist).
- If the person is **alive** when he enters the water, the diatoms will enter the lungs when the person inhales water while drowning. These diatoms are then carried to different body parts by blood circulation.
- If a person is **dead** when is thrown in the water, then there is no circulation and there is no transport of diatom cells to various organs.
- **Positive** - Diatom analysis is considered positive only when the number of diatoms recovered from the body is more than a minimal limit.
- Diatoms extracted from the body would be correlated with the samples from the water body where the drowning took place to ascertain the place of drowning.
- **Negative** - The test will be negative if the person died instantly after falling into the water.
- Diatom test is reliable unless and until the deceased person has been drinking water from the same source of water before his death.

8.13 Magnetic Hyperthermia-Mediated Cancer Therapy (MHCT)

- Scientists from Institute of Nano Science & Technology (INST) are making efforts to make magnetic hyperthermia-mediated cancer therapy as desired therapy for inoperable tumours.
- INST is an autonomous institute of Department of Science and Technology (DST).
- Magnetic hyperthermia-mediated cancer therapy (MHCT) is a non-invasive cancer treatment.
- The technique involves the delivery and localization of magnetic materials within the targeted tumour site followed by subsequent application of an alternating magnetic field (AMF), thereby generating heat at the tumour site.
- It can efficiently act against deep-seated inaccessible solid tumours like glioblastoma and is highly thermo-sensitive towards normal cells with minimal toxicity against healthy counterparts.
- Scientists are on the lookout for new materials which can make this treatment more efficient.

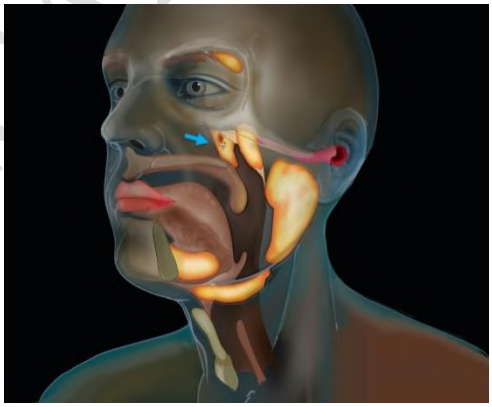
8.14 Flavonoids

- Flavonoids are part of the polyphenol class of phytonutrients (plant chemicals) found in almost all fruits and vegetables.
- Along with carotenoids (organic pigments), they are responsible for the vivid colours in fruits and vegetables.
- Polyphenols have historically been used in Chinese and Ayurvedic medicine and are associated with skin protection, brain function, blood sugar and blood pressure regulation.
- These are powerful antioxidants with anti-inflammatory and immune system benefits as well.
- A diet rich in flavonoids can protect from diseases related to heart, liver, kidney, brain and other infectious diseases.
- Recently, scientists from Agharkar Research Institute (ARI), found the first synthetic route for producing flavonoids molecules related to the treatment of tuberculosis and chikungunya.
- It will ensure their availability at all seasons without the dependence on natural timings of the plantations.
- It is for the first time that scientists have been able to synthesize the flavonoid molecules such as rugosa flavonoids, podocare flavone and isoflavone in a lab.
- These three molecules have so far been isolated from plants only and are found to inhibit tuberculosis and chikungunya.

8.15 Hydrogen Evolution Reaction

- Hydrogen is projected as one of the next generation low carbon fuels.
- The future of use of hydrogen as a fuel lies in the design of efficient electro catalysts for facilitating electrochemical splitting of water to produce hydrogen.
- The effectiveness of the electro catalyst for the hydrogen (H2) evolution reaction (HER) largely depends on its ability to lower the potential of an electrochemical reaction maximally, and cost of synthesis (production).
- The commercially used Platinum (Pt) / Carbon (C) catalysts are efficient but expensive and suffer from metal ion leaching or electro catalyst corrosion when used for long duration.
- Metal-organic frameworks (MOFs) and coordination polymers (COPs) are envisioned as the next generation catalysts.
- Centre for Nano and Soft Matter Sciences (CeNS) an autonomous institute under Department of Science and Technology, have synthesized a novel COP consisting of palladium Pd(II) ions.
- The recent invention serve as a source of active sites for H-adsorption, and benzene tetra mine (BTA) chelating ligands capable of better charge transfer.

8.16 Tubarial Salivary Glands



- Researchers at the Netherlands Cancer Institute have identified a set of salivary glands deep in the upper part of the throat.
- The gland is named as "Tubarial Salivary Glands".
- The new organ was discovered while scientists were studying prostate cancer cells using PSMA PET-CT technology.
- The discovery may be important for cancer treatment.
- The newly discovered glands are about 1.5 inches (3.9 centimeters) in length on average and are located over a piece of cartilage called the torus tubarius.
- The glands probably lubricate and moisten the upper throat behind the nose and mouth.
- So far, this nasopharynx region behind the nose was not thought to host anything but microscopic, diffuse, salivary glands.
- Until now, there were three known large salivary glands in humans:
  1. Under the tongue,
  2. Under the jaw and back of the jaw,
  3. Behind the cheek.

8.17 Super Conductor in Room Temperature

- Recently, researchers have created a material that is superconducting at room temperature.
- A mixture of carbon, hydrogen and sulphur was put in a microscopic niche carved for this experiment.
- However, it only works at a pressure of 267 Gigapascals (GPa), which is equivalent to about three-quarters of pressure at the centre of Earth (360 GPa).
- As the experimental temperature was lowered, resistance to a current passed through the material dropped to a vanishingly small value below the critical temperature (Tc).
- The transition of the sample to become superconductive occurred the best at transition temperature of around 15°C at 267 GPa.

8.18 Diamagnetism

- It is a very weak form of magnetism that is induced by a change in the orbital motion of electrons due to an applied magnetic field.
- This magnetism is non-permanent and persists only in the presence of an external field.
- The magnitude of the induced magnetic moment is very small, and its direction is opposite to that of the applied field.
- ***Meissner Effect*** - When a material makes the transition from the normal to the superconducting state, it actively excludes magnetic fields from its interior and this is called the Meissner effect.
- This constraint to zero magnetic fields inside a superconductor is distinct from the perfect diamagnetism which would arise from its zero electrical resistance.

9. INTELLECTUAL PROPERTY RIGHTS

9.1 Different Categories of IPR

PATENT

- An exclusive statutory right granted for an invention – **a product or process** that provides a new way of doing something or that offer a new technical solution to a problem.
- There are 2 types of patent – product and process patent.
- Patent gives Monopolyrightfor a limited period of time.
- 3 conditions should be satisfied before applying for patent. They are,
    - Utility for the society (USEFULNESS)
    - Must have an element of 'NOVELTY'
    - NON-OBVIOUSNESS
- Legal Basis – It is protected under Indian patent law 1970 and its amendments.
- Valid Time Period - generally 20 years.

TRADE MARK

- Trade Mark is a distinctive sign that identifies certain goods or services produced or provided by an individual or a company.
- Trade Mark is allocated to a visual symbol such as name, label, numerals, combination of colours, logo etc.
- Legal Basis –It is protected under Trade marks act 1999.
- Time period – renew indefinitely with payment of fees for every 10 years.

INDUSTRIAL DESIGN

- It refers to the ornamental or aesthetic aspects of an article – 3D features such as shape or 2D features like patterns, lines colours and technical features are not protected
- Industrial Design must be new or original
- Legal basis – It is protected under Design act 2000
- Time period – generally 5 yrs + maximum renewal to 15 years

COPYRIGHT

- Copyright is given to authors of literary and artistic works for their artistic creations such as books and other writings, musical composition, paintings, sculptures, films, computer programmes.
- It is protected under Copyright act 1957
- Time period
    - Literary, dramatic, musical and other artistic works – lifetime of author + 60 years

- Government work, sound records, photography.. – 60 years

- Copyright does not cover - Names, titles or short phrases, Ideas, Facts and works lacking originality.

TRADE SECRET

- Trade secret covers any confidential business information that provides a competitive edge to an enterprise.
- It includes Manufacturing or industrial secrets or commercial secrets
- It is being protected without registration
- Time period – unlimited
- There is no specific law to deal with this but cases for violation can be filed under contract act 1872.

GEOGRAPHICAL INDICATORS (GI)

- A name or sign used on goods that have a specific geographical origin and posses qualities or a reputation due to that place of origin.
- Its purpose is to create unique identification to customers and thereby creating more demand for products.
- It is given to both man-made and natural products.
- However it is a community right rather than individual or company.
- It is protected under Geographical indications of goods (registration and protection) act, 1999.
- It is managed by Cell for IPR promotion and Management (CIPAM) under the Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry.
- At the International level, GI is governed by World Trade Organisation's (WTO's) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).
- TIME PERIOD – 10 years + renewed for any time
- The first product in India to be accorded with GI tag was Darjeeling tea in the year 2004-05.
- Some of the examples of registered Indian GIs areTirupathi Laddu, Kangra Paintings, Nagpur Orange, Kashmir Pashmina etc.

9.2 KAPILA

- In 2020, the Government has launched the Kalam Program for Intellectual Property Literacy and Awareness (KAPILA) Campaign for creating Intellectual Property Literacy and patent awareness.
- The objectives of the scheme include creating awareness regarding,
  1. Intellectual Property Rights (IPR) in Higher Education Institutions (HEIs),
  2. Enabling of IP protection of inventions originating from faculty and students of HEIs,
  3. Development of Credit Course on IPR,
  4. Training program on IPR for faculty and students of HEIs and
  5. Sensitization and development of vibrant IP filing system.

9.3 Propel India

- Propel India mission is one of the 3 missions launched under National Digital Communications Policy in 2018.
- It aims to enable Next Generation Technologies and Services through Investments, Innovation and IPR generation.
- It also aims to attract investments of USD 100 Billion in the Digital Communications Sector, expand IoT ecosystem to 5 Billion connected devices, and accelerate transition to Industry 4.0 by 2022.
- The objective of the mission are as follows
  1. Creation of innovation led Start-ups in Digital Communications sector.
  2. Creation of Globally recognized IPRs (Intellectual Property Rights) in India.

3. Development of Standard Essential Patents (SEPs) in the field of digital communication technologies.
4. Train/ Re-skill 1 Million manpower for building New Age Skills.

10. IT & COMPUTER

10.1 Report on Non-personal Data Governance

A report by the Committee of Experts on Non-Personal Data Governance Framework was released recently.

- The report has sought to bring some clarity to a pack of contentious issues in India's data privacy space.
- It has defined, but with a limited success, non-personal data.
- It has delved into subjects such as ownership of data, undertaking a data business and data sharing.
- It suggests setting up a Non-personal Data Regulatory Authority.
- This authority would manage India's vast and emerging data space, while nurturing a creative and egalitarian technology architecture.
- ***Definition of Non-Personal Data*** - It considers non-personal data to be data that is not related to an identified or identifiable natural person.
- This would include data on weather conditions, from sensors installed on industrial machines, from public infrastructure, etc.
- Another category of this data could pertain to information that initially was personal data but were later made anonymous.
- The aggregated data to which certain data transformation techniques are applied to the extent that the specific events related them are no longer identifiable can qualify as anonymous data.
- The data transformation techniques that can be used to anonymise personal data are not clearly defined.
- ***Classification of Data*** - The report suggests that data can be classified into three categories — public, community and private non-personal data.
- This classification is based on the data's ownership and origin of creation.
- The report defines and identifies stakeholders such as data principal, data custodian, data trustee and data trust.
- The roles of these parties are still not delineated.
- ***Controversies*** - The report is not free of the ambiguities embedded in earlier policy papers on the subject, including the Personal Data Protection (PDP) Bill.
- This 2019 bill, which awaits Parliament approval, gives rise to long-term concerns.
- The suggestions of the report end up giving the State immense powers to determine non-personal data and use that for its interests.
- This doesn't augur well for a democracy, besides hurting business interests.
- Another controversial idea is the suggestion to create a Non-Personal Data Authority.

10.2 Data Sharing Protocol of Aarogya Setu App

- The Ministry of Electronics & Information Technology (MeitY) has issued a data-sharing and knowledge-sharing protocol for the Aarogya Setu app.
- The data collected by the Aarogya Setu app is broadly divided into four categories which is collectively called response data.
- **Demographic data** includes information such as name, mobile number, age, gender, profession and travel history.
- **Contact data** is about any other individual that a given individual has come in close proximity with and the geographical location at which the contact occurred.

- **Self-assessment data** means the responses provided by that individual to the self-assessment test administered within the app.
- **Location data** comprises the geographical position of an individual in latitude and longitude.
- According to the protocol, the response data may be shared by the app's developer (National Informatics Centre) with the,
    - Ministries and departments of Central/State/Union Territory/local governments,
    - National and State Disaster Management Authorities,
    - Public health institutions of the governments and
    - Other third parties
- The data can be shared only if it is strictly needed to directly formulate or implement appropriate health responses.
- For research purposes, the data can be shared with Indian universities or research institutions and research entities registered in India.
- The guidelines also empower universities and research entities to share the data with other such institutions.
- These entities can share only if such sharing is in furtherance of the same purpose for which it has sought approval to access such data.
- The protocol says the response data that can be shared has to be in **de-identified form**.
- Except for demographic data, the data must be stripped of information that may make it possible to identify the individual personally.
- These data must be assigned a randomly generated ID.
- To an extent, the NIC shall **document the sharing** of any data and maintain a list of the agencies with which data has been shared.
- The protocol also calls for any entity with which the data has been shared to not retain the data beyond **180 days** from the day it was collected.
- The protocol reads back to the Disaster Management Act, 2005 to establish the penalties in case of violation of the protocol.
- It also has a **sunset clause**, which calls for the empowered group to review the protocol after 6 months.
- Unless extended, the protocol will be in force only for 6 months from the date of issue.
- Any entity which accesses anonymised response data shall not reverse anonymise such data or re-identify individuals in any manner.
- If any person takes any action which has the effect of such data no longer remaining anonymised,
- Any rights granted to them shall stand terminated, and
- They shall be liable for penalties under applicable laws for the time being in force.

10.3 Param Siddhi

- Recently, Param Siddhi has achieved global ranking of 63 in TOP 500 most powerful non-distributed computer systems in the world.
- Param Siddhi is the high performance computing-artificial intelligence (HPC-AI) supercomputer established under National Supercomputing Mission (NSM).
- It is installed in the Centre for Development of Advanced Computing's (C-DAC) unit.
- The AI system will strengthen application development of packages in areas such as advanced materials and computational chemistry & astrophysics.
- The National Super Computing Mission (NSM) is rapidly boosting high power computing in the country through its various phases to meet the increasing computational demands.

- These super computers are used by academia, researchers, MSMEs, and startups in areas like oil exploration, flood prediction as also genomics, and drug discovery.
- The highlight of the NSM is to build more Peta Flops, High-Performance Computing (HPC) Facilities with convergence of Artificial Intelligence (AI).

Other Super Computers of India

- **Pratyush -** It is a supercomputer used for weather forecasting at the Indian Institute of Tropical Meteorology, Pune.
- It is the 4.O Peta flops (PF) high performance computer.
- It was ranked 78th on the November edition of the list.
- **Mihir -** It is installed at the National Centre for Medium Range Weather Forecast in Noida.
- It was ranked 146th on the November edition of the list.
- **Param Super Computers** and its locations
    1. PARAM Shivay - IIT-BHU
    2. PARAM Shakti - IIT-Kharagpur
    3. PARAM Bhrahma - Indian Institute of Science, Education and Research (IISER), Pune.

10.4 Dhruva Chip

- It is a home-grown receiver chip developed by IIT-Bombay.
- It can be used in smartphones and navigation devices to find locations and routes within the country.
- It will receive signals from India's NAVIC group of navigation satellites as well as the US GPS-based satellites to determine these accurately under all weather conditions.
- It can receive in multiple frequency bands and handle weak signals.
- Such signals can be converted into digital bits and processed by any standard digital signal processor (DSP) to determine one's location precisely.
- It will help receive and clean up the signals received from NAVIC, which are 36,000 km above from the earth's surface.
- This Project was funded by the Ministry of Electronics and Information Technology (MeitY).
- SAMEER (Society for Applied Microwave Electronics Engineering and Research) is the nodal agency.
- NAVIC - Navigation with Indian Constellation is India's geo-positioning system with 9 satellites designed by ISRO to provide accurate positioning within the country.

10.5 Quantum Supremacy

- In 2019, Google built a computer that could perform a computation in 200 seconds that would take the fastest supercomputers about 10,000 years, reaching quantum supremacy.
- Now, Chinese researchers claim their new prototype is able to process 10 billion times faster than Google's prototype.
- They have built a quantum computer prototype that is able to detect up to 76 photons through Gaussian boson sampling, a simulation algorithm.
- That's exponentially faster than existing supercomputers.
- Quantum computing has become yet another front in the U.S.-China tech race.

10.6 QKD Technology

- Quantum Key Distribution (QKD) technology of the DRDO underwent a successful trial between two laboratories in Hyderabad, where security was validated for a range of 12 km long over a fibre optic channel.

- QKD is primarily a mechanism to undertake secure communication, which utilises a cryptographic protocol involving various components of quantum mechanics.
- It enables two communicating sides to come up with random secret keys shared by both of them and known exclusively to them.
- Only they can use it to encrypt and decrypt messages, thus achieving highly secure communication.

10.7 Quantum State Interferography

- Scientists from Raman Research Institute (RRI), have found a new way of inferring the state of a system (both two-dimensional qubits as well as higher-dimensional "qubits") from an interference pattern, which they term 'Quantum State Interferography'.
- A qubit is a 2-dimensional quantum system and requires usually 2 complex numbers to be determined towards state estimation
- Scientists are experimenting with new ways to manipulate quantum states so that they can be harnessed for computing, communication, and metrology.
- Quantum State Interferography, can help make such manipulations simpler so that several crucial operations in quantum technologies become less cumbersome.
- The setup requires only two interferometers from which many interferograms can be obtained to reconstruct the state.

10.8 5G

- Department of Telecommunications (DoT) has sought inputs on sale and use of radio frequency spectrum over next 10 years, including 5G bands.
- 5G or fifth generation is the latest upgrade in the long-term evolution (LTE) mobile broadband networks.
- 5G works in 3 bands, namely low, mid and high frequency spectrum.
- **Low band spectrum** shows promise in terms of coverage and speed of internet and data exchange, but the maximum speed is limited to 100 Mbps (Megabits per second).
- It can be used and installed for commercial cell phone users who may not have specific demands for very high speed internet, but it may not be optimal for specialised industrial needs.
- **Mid-band spectrum** offers higher speeds compared to the low band, but has limitations in terms of coverage area and penetration of signals.
- It may be used for specialised industrial needs.
- **High-band spectrum** offers the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength.
- Internet speeds in the 5G spectrum has been tested to be as high as 20 Gbps (giga bits per second), while in 4G it is at 1 Gbps.

10.9 Cyber Attack

- Maharashtra State Cyber Cell probe had found 14 Trojan horses in the servers of the Maharashtra State Electricity Transmission Company.
- This announcement came after a US-based cyber security firm Recorded Future reported that 'Red Echo' group, linked to the Chinese government, had targeted India's power distribution systems.
- The kind of infrastructure sought to be accessed by Red Echo, such as Regional Load Despatch Centres, has minimal espionage possibilities.

Shadow Pad

- ShadowPad is a backdoor Trojan malware, which means it opens a secret path from its target system to its command-and-control servers.
- Via this path, information can be extracted or more malicious code delivered.
- ShadowPad is built to target supply-chain infrastructure in sectors like transportation, telecommunication, energy and more.
- Trojanised softwares, or softwares that have dangers hidden in them, are the primary mode of delivery for ShadowPad.
- Recorded Future in its report notes large overlaps in the systems used by Red Echo and 'APT41/Winnti/Barium'.

- Recorded Future found many IP addresses linked to critical Indian systems communicating for months with AXIOMATICASYMPTOTE servers, which connected to Red Echo.
- These servers had domains spoofing those of Indian power sector entities configured to them.
- AXIOMATICASYMPTOTE servers act as command-and-control centres for a malware known as ShadowPad.

10.10 SolarWinds Hack

- It is a cyberattack, which was first discovered by the US cyber security company FireEye.
- Named as Campaign UNC2452, this attack had targeted various public and private organisations around the world.
- It has emerged as one of the biggest ever targeted against the US government, its agencies and several other private companies.
- The kind of attack on the US government agencies and companies is called a 'Supply Chain' attack.
- This means that instead of directly attacking the federal government or a private organisation's network, the hackers target a third-party vendor, which supplies software to them.
- In this case, the target was an IT management software called Orion, supplied by the Texas-based company SolarWinds.

10.11 Real Mango

- Real Mango software is an illegal software developed for booking Tatkal tickets.
- It synchronizes bank OTP with It bypasses captcha used while booking tickets.
- help of a mobile app and feeds it to the requisite form automatically.
- The software auto-fills the passenger details and payment details in the forms. It logs in to the IRCTC website through multiple IRCTC Ids.
- Following these steps multiple tickets can be booked. And it leads to swift online tickets booking by agents whereas common people may not get the tickets booked on their own.
- Recently Railway Protection Force (RPF) has disrupted the operation of illegal software called "Real Mango" - used for cornering confirmed Railway reservation.
- The information supplied by RPF will help the Centre for Railway Information Systems (CRIS) to strengthen security features in the Passenger Reservation System (PRS).

10.12 Google's Online Cloud Storage

From June 1, 2021 Google's online cloud storage policy will undergo a major change.

- Regular Google Account Users will get 15GB of free storage space towards the user's Gmail, Drive and Photos.
- However, this free space is not counted for photos uploaded in Google Photos app.
- Usually, photos of higher resolution are compressed & saved without running out of space on the free account.
- **New Changes -** From June 1, 2021, Google Photos will not be free & will be counted towards the account storage.
- Photos & videos of original resolution which are uploaded will not be affected as they are counted against the online storage available in your account.
- Further, users who are dependent on Google Photos will have to make payments for using its cloud service.
- Under its **Google One program**, it starts at 200GB for Rs 210 per month, 2TB for Rs 650 per month or Rs 6500 per year, 10TB at Rs 3,250 per month and 20TB at Rs 6,500 per month.
- All photos and videos uploaded before June 1, 2021 will continue to remain free, will not be counted against the storage & won't be deleted.
- But all those uploaded post June 1, 2021 will be counted against the Google's free space.

- If more photos and videos uploaded, users have to pay for their services.
- However, existing paid Google One account users will not be affected by these changes.
- As per its new policy, Google will delete content from inactive accounts (accounts inactive for more than two years).
- Account can be kept active by periodically visiting Gmail, Google Photos and Google Drive.
- Those who are within their storage quota and in good-standing will not be affected.If the storage limit is exceeded for 2 years, content will be deleted. & Google will warn before it decides to delete.

11. NANO TECHNOLOGY

11.1 Nanofibers

- Researchers at Massachusetts Institute of Technology have constructed small molecules which when added with water form nanofibers.
- These hard and rigid molecules become so tough that they it can hold about 200 times their own weight.
- Nanofibers are fibers with diameters in the nanometer range.
- They can be generated from different polymers and hence have different physical properties and application potentials.
- The diameters of nanofibers depend on the type of polymer used and the method of production.

11.2 Nanosniffer

- It is the world's first Microsensor based Explosive Trace Detector (ETD) developed by an Indian Institute of Technology (IIT) Bombay incubated startup called NanoSniff Technologies.
- Its core technology is protected by patents in the U.S. & Europe.
- Nan oSniffer is an advanced, affordable and a 100% Made in India product in terms of research, development & manufacturing.
- It will reduce dependency on imported ETD devices.

12. GOVERNMENT PROGRAMMES/INITIATIVES

12.1 Vigyan Jyoti Programme

- Vigyan Jyoti programme has been expanded to 50 more districts across the country for the year 2021-22, adding to the existing 50 districts.
- It encourages girls to take interest in science and build a career in Science, Technology, Engineering and Mathematics (STEM).
- It was launched by the Department of Science & Technology (DST) to create a level-playing field for the meritorious girls to pursue STEM.
- It had been running successfully in Jawahar Navodaya Vidyalayas (JNV) since 2019.
- As a first step, it has been started at school level for girls of Class IX to Class XII to encourage them to pursue STEM courses in reputed institutions of the country.

Other Women-centric Programs of DST

- Indo-US Fellowship for Women in STEMM (WISTEMM) program where women scientists can work in research labs of USA,
- Consolidation of University Research for Innovation and Excellence in Women Universities (CURIE) program to improve R&D infrastructure in women universities
- Gender Advancement for Transforming Institutions (GATI) program to develop a Charter and a framework to assess Gender Equality in STEM.

12.2 Gandhian Young Technological Innovation

- Union Ministry of Science & Technology announced Gandhian Young Technological Awards in two categories.
- The awards and appreciations are given under these two categories to encourage technology students to move towards setting up Biotech and other start-ups.
- **SITARE-GYTI -** Students Innovations for Advancement of Research Explorations - Gandhian Young Technological Innovation (SITARE-GYTI) under Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology (DBT).
- The SITARE-GYTI awards are given every year to the most promising technologies developed by the students in life sciences, biotechnology, agriculture, medical devices etc.
- **SRISTI-GYTI** - Sustainable Technological Innovations-Gandhian Young Technological Innovation (SRISTI-GYTI) given by SRISTI.
- This award is given to students in other engineering disciplines.

12.3 FIST Scheme

- The Fund for Improvement of Science and Technology (FIST) Advisory Board (FISTAB) meeting was held recently.
- The FIST Scheme was launched in 2000 to strengthen the Science and Technology (S&T) infrastructure.
- It has played a pivotal role in the strengthening of both the teaching and research infrastructure in different academic and research institutions.
- It is considered as complimentary support for enabling Departments/ Centres/ Schools/ Colleges to pursue research activities more effectively.
- The duration of support for each project will be for a period not exceeding 5 years.

12.4 India Science Research Fellowship

- The India Science Research Fellowship (ISRF) is given for Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka, Thailand researchers to work in Indian Universities and Research Institutions.
- It was launched by the Department of Science and Technology (DST), and it is implemented since 2015.
- ISRF programme acts as a platform to establish research cooperation with neighbouring countries of India.
- The scholars have been selected based on research proposal, experience, academic merit and publication record.

PM's Science, Technology, and Innovation Advisory Council

- It facilitates the PSA Office to assess the status in specific science and technology domains, comprehend challenges in hand, formulate specific interventions, develop a futuristic roadmap and advise the PM.
- The Office of the PSA coordinates to facilitate and ensure the implementation of significant interventions by concerned government departments, agencies, and ministries.
- The PM-STIAC Secretariat is based at Invest India.
- It provides support to the Office of the PSA on project management and monitoring of the aforesaid interventions and national missions.

12.5 SERB-POWER

- Recently, the union minister for Science and Technology has launched SERB-POWER (Promoting Opportunities for Women in Exploratory Research) Scheme.
- SERB is a statutory body of the Department of Science and Technology (DST) with the mandate to plan, promote and fund internationally competitive research in emerging areas.
- The scheme has two components of fellowship and research grants.
- The scheme is designed exclusively for women scientists to mitigate gender disparity in science and engineering research in various science and technology (S&T) programmes in Indian academic institutions and research and development (R&D) laboratories.

- ***Eligibility Criteria***:
  1. Women researchers in 35-55 years of age.
  2. Up-to 25 Fellowships per year and not more than 75 at any point in time.
- ***Duration***: Three years, without the possibility of extension. Once in a career.
- Grants will be regulated through terms of reference conforming to SERB-Core Research Grant (CRG) guidelines.
- SERB-PRISM portal is an e-platform that offers real time information regarding all research projects sanctioned by SERB from 2011 onwards.
- It would work as a comprehensive tool to help forge stronger scientist-scientist, and science-society connections.
- Among other things, it will help researchers to look at research trends, locate critical equipment in their vicinity and help seek collaborations across disciplines.

12.6 Guidelines for Geo-spatial Sector

- Ministry of Science and Technology released new guidelines for the Geo-spatial sector in India, which deregulates existing protocol and liberalises the sector to a more competitive field.
- Under the current policy regime, there are strict restrictions on the collection, storage, use, sale, dissemination of geo-spatial data and mapping.
- The sector is dominated by the Indian government and government-run agencies such as the Survey of India.
- Private companies must navigate a system of permissions from different government departments (depending on the kind of data to be created), to collect, create or disseminate geo-spatial data.
- Deregulation would eliminate the requirement of permissions and scrutiny, even for security concerns.
- Now, Indian companies can self-attest, conforming to government guidelines without having to be monitored by a government agency.

Geospatial Data

- Geospatial data is data about objects, events, or phenomena that have a location on the surface of the earth.
- The location may be **static** in the short-term, like the location of a road, an earthquake event, or **dynamic** like a moving vehicle, the spread of an infectious disease.
- Geospatial data usually combines,
  1. Location information,
  2. Attribute information (the characteristics of the object, event, or phenomena concerned), and
  3. Temporal information or the time at which the location and attributes exist.
- It involves information of public interest such as roads, localities, rail lines, water bodies, and public amenities.

12.7 AIM-PRIME

- AIM-PRIME (Program for Researchers on Innovations, Market-Readiness & Entrepreneurship) aims to translate science-based deep-tech research to startups & ventures across India.
- **Partners** - Atal Innovation Mission has joined hands with Bill & Melinda Gates Foundation (BMGF) to launch this initiative, which will be implemented by Venture Center, a technology business incubator.
- **Beneficiaries** - The program is open to technology developers (early-stage deep tech start-ups, and scientists/ engineers/ clinicians) with strong science-based deep tech business ideas.
- It is also open to CEOs and Senior incubation managers of AIM Funded Atal Incubation Centers that are supporting deep tech entrepreneurs.
- **Working** - It aims at addressing specific issues through in-depth learning, training and guidance over a period of 12 months.
- AIM-PRIME program is specifically tailored for the rapid scaling up of deep-tech science ventures in India, providing not just the necessary intellect and support but also the exposure they rightly deserve.

12.8 DSIR-PRISM Scheme

- DSIR-PRISM Scheme will be aligned with three National Initiatives like Unnat Bharat Abhiyan (UBA), Smart India Hackathon (SIH) and Rural Technology Action Group (RuTAG), IIT Delhi.
- Dept. of Scientific and Industrial Research - Promoting Innovations in Individuals, Startups and MSMEs (DSIR-PRISM) scheme supports individual innovators enabling inclusive development of India.
- It aims at transforming an innovator into a technopreneur by promoting and funding implementable and commercially viable innovations created for the society.
- PRISM extends its support to any citizen of the country through Direct Benefit Transfer for idea development, prototype development and pilot scaling, and patenting in the core technology areas.
- **Areas** - Affordable Healthcare, Water, Sewage Management, Green Technology, Clean Energy, Industrially Utilizable Smart Materials, Waste to Wealth aligned with our National objectives.
- PRISM considers the Intellectual Property (IP) as a belonging to the innovators.
- The grant is given in two phases: Phase I and Phase II, catering to both the initial innovation stage and the advanced enterprise setup phase through DSIR outreach-cum-cluster innovation centres across India.

12.9 EatSmart Cities Challenge

- Ministry of Housing and Urban Affairs launched the EatSmart Cities Challenge which is a competition among cities to recognize their efforts in adopting and scaling up the initiatives under Eat Right India.
- The 'Eat Right India' movement was initiated by Food Safety and Standards Authority of India (FSSAI) under the aegis of Ministry of Health & Family Welfare.
- This unique challenge, in partnership with Smart Cities Mission will,
    1. Motivate Smart Cities to develop a plan that supports a healthy, safe and sustainable food environment with the support of institutional, physical, social, and economic infrastructure.
    2. Strengthen the food safety and regulatory environment,
    3. Urge the consumers to make better food choices in India's major cities and can set an example for other cities to follow.
- The challenge is open to all Smart Cities, capital cities of States /UTs, and cities with a population of more than 5 lakh.
- At the end of first phase of the challenge, 11 cities will be selected for deeper engagement for an extended period to implement their vision.

13. AWARDS

13.1 Noble Prize for Medicine or Physiology

- Americans Harvey J Alter and Charles M Rice, and British scientist Michael Houghton were awarded the Nobel Prize for Medicine or Physiology, 2020 for the discovery of the Hepatitis C Virus.
- The discovery helped in finding a cure for the disease, and effective anti-viral drugs are now available.
- The Nobel statement said that the scientists' work characterised this form of hepatitis to be a distinct clinical entity.
- They said that it was caused by an RNA virus of the Flavivirus family, now known as HCV.
- Tests have also been developed to identify blood containing this virus, so that infected blood is not given to any patient.
- The Nobel award comes with a gold medal and prize money of 10 million Swedish kronor (over USD 1,118,000) and was created by Swedish inventor Alfred Nobel.
- The 1976 Medicine Nobel was awarded for the discovery of the Hepatitis B virus (HBV), and the development of the first-generation HBV vaccine.

13.2 Nobel Prize for Physics

- The Nobel Prize in Physics for the year 2020 was awarded to three astrophysicists Roger Penrose from the UK, Reinhard Genzel from Germany, and Andrea Ghez from the USA.
- Einstein's General Theory of Relativity explains gravity, as objects try to follow a straight line through a universe whose geometry is warped by matter and energy.
- As a result, planets, as well as light beams, follow curving paths.
- Roger Penrose received half of this year's prize for the discovery that a black hole formation is a robust prediction of the general theory of relativity.
- Dr Penrose proved that if too much mass accumulated in too small a place, collapse into a black hole was inevitable.
- At the boundary of a black hole, called the event horizon, one would have to go faster than the speed of light to escape it, which is impossible.
- At the center of a black hole, where the density became infinite, the laws of physics, would no longer apply.
- Genzel and Ghez (fourth woman to win the Nobel Prize in Physics) received the second half of the prize for the discovery of a supermassive black hole at the centre of the Milkyway galaxy, now known to be the Sagittarius A*.

13.3 Nobel Prize for Chemistry

- Recently, Emmanuelle Charpentier of France and Jennifer A Doudna of the USA have been awarded the 2020 Nobel Prize in Chemistry for developing CRISPR/Cas9 genetic scissors.
  - It is for the first time a Nobel science prize has gone to a ***women-only team.***
  - Charpentier, while studying the *Streptococcus pyogenes*, a harmful bacterium, discovered a previously unknown molecule, tracrRNA.
  - TracrRNA was part of bacteria's ancient immune system, CRISPR/Cas, that disarmed viruses by cleaving (cutting) their DNA.
  - CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a gene editing technology.
  - It allows researchers to permanently modify genes in living cells and organisms by targeting specific stretches of genetic code to edit DNA at precise locations.
  - This is done by introducing a protein (Cas9) containing the code of a defective gene.
  - The protein then seeks out parts of the defective DNA that match this code.
  - It then attaches itself to it, cuts it out, and then the DNA is allowed to repair itself by getting rid of the defect.
  - It can be used to target multiple genes simultaneously and can also activate gene expression instead of cutting the DNA.
  - This can be used to correct mutations at precise locations in the human genome to treat genetic causes of diseases.