



IAS PARLIAMENT

Information is a Blessing

A Shankar IAS Academy Initiative

TARGET 2018

SCIENCE & TECHNOLOGY

Shankar IAS Academy™

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TARGET 2018

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TARGET 2018
SCIENCE AND TECHNOLOGY

1. SPACE TECHNOLOGY

I. TYPES OF ORBITS

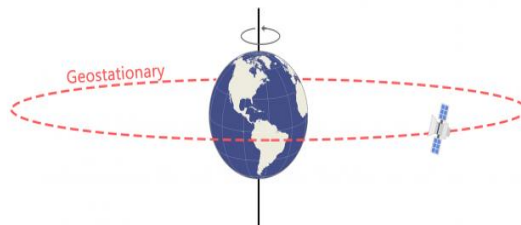
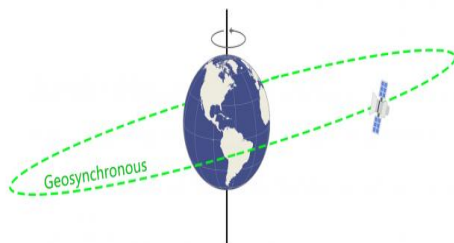
- There are many different satellite orbits that can be used.
- The satellite orbit that is chosen will depend on factors including its function, and the area it is to serve.
- The lower the satellites orbit the Earth, the stronger the gravitational pull, and this means that the satellite must travel faster to counteract this pull. Further away the gravitational field is less and the satellite velocities are correspondingly less.
- A satellites orbit the Earth in one of two basic types of orbit 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, Medium Earth Orbit, Geosynchronous orbit etc.

| SATELLITE ORBIT DEFINITIONS | | | |
|-----------------------------|----------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ORBIT NAME | ORBIT INITIALS | ORBIT ALTITUDE (KM ABOVE EARTH'S SURFACE) | DETAILS / COMMENTS |
| Low Earth Orbit | LEO | 200 - 1200 | |
| Medium Earth Orbit | MEO | 1200 - 35790 | |
| Geosynchronous Orbit | GSO | 35790 | Orbits once a day, but not necessarily in the same direction as the rotation of the Earth - not necessarily stationary |
| Geostationary Orbit | GEO | 35790 | Orbits once a day and moves in the same direction as the Earth and therefore appears stationary above the same point on the Earth's surface. Can only be above the Equator. |
| High Earth Orbit | HEO | Above 35790 | |

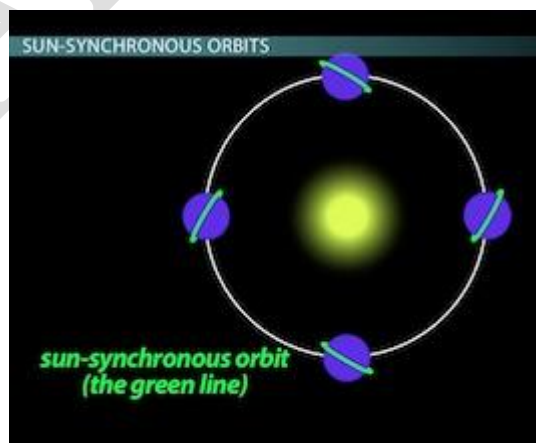
- Most satellites, the International Space Station, the Space Shuttle, and the Hubble Space Telescope are all in Low Earth Orbit.
- LEO is convenient for installing new instruments, fixing things that are broken, and inspecting damage.
- A **geosynchronous orbit**, located at 35,790 km has the same orbital 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 this type of orbit 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.



II. LAUNCH VEHICLES

- Launch Vehicles are used to carry spacecraft to space.
- India has two **operational launchers**: Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).

1.1. PSLV

- It is the **third 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.
- There are three variations in PSLV such as 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** for its second stage, known as the Vikas engine.
- **Stage III**: It uses **solid rocket motor** that provides the upper stages high thrust after the atmospheric phase of the launch.

- **Stage IV:** The uppermost stage of PSLV, comprising of two Earth storable **liquid engines**.
- It can take up to 1,750 kg of payload to Sun-Synchronous Polar Orbits of 600 km altitude.
- It can take up to 1,425 kg of payload to Geosynchronous and Geostationary orbits, like satellites from the IRNSS constellation.
- Some of the recent PSLV launches are PSLV-C40/Cartosat-2 series, PSLV-C39/IRNSS 1H (unsuccessful), PSLV-C38, C37 (Cartosat-2 series), PSLV-C36/RESOURCESAT-2A etc.

1.2 GSLV

- It is the **fourth generation launch vehicle** and is the largest launch vehicle (GSLV Mark II) developed by India.
- It is a three stage vehicle with four liquid strap-on boosters.
- **Stage I:** It uses **solid rocket** motor with 4 liquid strap-ons.
- **Stage II:** It uses **liquid rocket** engine (similar to vikas engine of PSLV stage II).
- **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.
- It can take up to 5000 kg of pay load to Low Earth Orbits.
- It can take up to 2500 kg of payload to Geosynchronous Transfer Orbit (GTO) which are primarily INSAT class of communication satellites.
- Some of the recent launches are GSLV-F09/GSAT-9, GSLV-F05/INSAT – 3DR, GSLV-D5/GSAT-14.
- The next variant of GSLV is GSLV Mk III, with indigenous high thrust cryogenic engine and stage

1.3 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.
- It is designed to carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO) or about 10 tons to Low Earth Orbit (LEO), which is about twice the capability of GSLV Mk II.
- The cryogenic upper stage C25 is powered by CE-20 which is India's largest cryogenic engine.
- It is having the capability of launching 4000 kg classes of communication satellites to Geosynchronous Transfer Orbit (GTO) and 8000 kg payload to Low Earth Orbit.
- It launched GSAT-19 Mission through its GSLV MK III D1 mission and LVM-3 /CARE (Crew module Atmospheric Re-entry Experiment) mission.

Cryogenic Engine

- Cryogenics is the science that addresses the production and effects of very low temperatures.
- A cryogenic rocket engine is a rocket engine that uses a cryogenic fuel or oxidizer.
- That is, its fuel or oxidizer (or both) 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.
- That's why cryogenic upper stage engines are used in GSLV.

1.4 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:**
 - i. Hypersonic aero thermodynamic characterisation of wing body
 - ii. Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes
 - iii. Integrated flight management
 - iv. Thermal Protection System Evaluation
- It was successfully flight tested in 2016 from Sriharikota.

III. TYPES OF SATELLITES

1.5. Communication Satellites

- 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.
- It provides services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations.

1.6. Earth Observation Satellites

- Indian Remote Sensing (IRS) series of satellites in Sun-synchronous polar orbit are Earth observation satellites.
- Currently, 13 operational satellites are 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.
- There are 4 satellites in **Geostationary orbit** - INSAT-3D, Kalpana & INSAT 3A, INSAT -3DR which is also used for resource mapping.
- Data from these satellites are used for several applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management.

1.7. Navigation Satellites

- Satellite navigation systems are used to meet the emerging demand of positioning, navigation and timing and also civil aviation requirements.
 - i. **GPS Aided GEO Augmented Navigation (GAGAN)**
 - It is implemented jointly with 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.
 - ii. **Indian Regional Navigation Satellite System (IRNSS) : NavIC**
 - ISRO started work on the IRNSS programme in 1999 after the Kargil War, where Indian defence forces could not use American GPS in the conflict zone to locate its soldiers.
 - IRNSS is an independent regional navigation satellite system to provide accurate position information service which serves users in primary and extended service area.
 - Primary Service Area - Users in India as well as the region extending up to 1500 km from its boundary.



- Extended Service Area - lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.
- It consists of 7 satellites, 3 satellites (IRNSS 1C,1F,1G) in Geostationary orbit (GEO) and 4 satellites (IRNSS 1A,1B,1D,1E) in Geo Synchronous Orbit (GSO) orbit with inclination of 29° to the equatorial plane.
- IRNSS 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.
- All the satellites were successfully launched and will be visible all the time in the Indian Region.
- Some applications of IRNSS are:
 - Terrestrial, Aerial and Marine Navigation
 - Disaster Management
 - Vehicle tracking and fleet management
 - Integration with mobile phones
 - Precise Timing
 - Mapping and Geodetic data capture
 - Terrestrial navigation aid for hikers and travellers
 - Visual and voice navigation for drivers

Recent Development in IRNSS

- IRNSS 1A has later become redundant due to failure of its rubidium atomic clocks, which are critical for providing precise time and accurate positional data.
- Thus ISRO planned to send IRNSS 1H as a replacement satellite to IRNSS 1A.
- However the mission to send the satellite by PSLV-C39 was failed after a heat shield failed to separate.
- The heat shield is a protective cover provided around the satellite to help it withstand the adverse temperatures felt when a rocket is launched into space.
- Separation of the heat shield occurs mid-flight when the rocket leaves Earth's atmosphere.
- The performance of PSLV-C39 went as per plan up to the point where the satellite had to be inserted in orbit but the heat shield prevented it from being deployed in space.

Time Synchronisation

- NAVIC will also soon synchronise its clocks to time provided by the National Physical Laboratory, a CSIR body.
- The synchronisation would help IRNSS to end its dependence on the United States Naval Observatory (USNO) for time synchronisation.
- Currently, IRNSS provides accurate positional information services with respect to Coordinated Universal Time as per the time maintained by atomic clocks at the USNO.

1.8. Space Science and Exploration Satellites

i. AstroSat

- It is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously.
- It aims at understanding the high energy processes in binary star systems containing neutron stars and black holes, to estimate magnetic fields of neutron stars, to study star birth regions and high energy processes in star systems lying beyond the Milky way galaxy.
- One of the unique features of AstroSat mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.
- AstroSat with a lift-off mass of 1515 kg was launched by **PSLV-C30** into a 650 km orbit inclined at an angle of 6 deg to the equator.
- The minimum useful life of the AstroSat mission is expected to be 5 years.



- Recently, Cadmium Zinc Telluride Imager (CZTI), an x-ray telescope aboard AstroSat has detected a gamma ray burst.
- A gamma ray burst is light emanating from a bursting star, for example, an exploding supernova, that may lead to the formation of a black hole.
- This outburst was also independently discovered by a Chinese-European mission called POLAR.

ii. **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)
 - Lyman Alpha Photometer (LAP)
- It was launched by **PSLV – C25** with lift off mass of 1337 Kg in Martian Orbit.

iii. **Chandrayaan-1** – It is India's first mission to Moon launched in 2008 by PSLV-C11.

- The spacecraft was orbiting around the Moon at a height of 100 km from the lunar surface for chemical, mineralogical and photo-geologic mapping of the Moon.
- India was the captain and carrying the payloads built in UK, USA, Bulgaria Germany and Sweden.
- The mission comprised an orbiter and an impactor launched by ISRO's workhorse PSLV.
- Chandrayaan-1's greatest discovery was the widespread presence of water molecules in the lunar soil and a related molecule "hydroxyl", which consists of one atom each of hydrogen and oxygen.
- Scientists have recently created the first map of water trapped in the uppermost layer of the moon's soil using data from Chandrayaan-1.
- The data reveals that the amount of water increases toward the poles and does not show significant difference among distinct compositional terrains.
- Water in the lunar soil could be attributed to solar wind. But there are exceptions too.
- Rather than coming from solar wind, the water in those localised deposits likely comes from deep within the moon's mantle and erupted to the surface in lunar magma,

iv. **Chandrayaan-2** – It will be an advanced version of the previous Chandrayaan-1 mission to Moon.

- It is configured as a two module system comprising of an Orbiter Craft module (OC) and a Lander Craft module (LC) carrying the Rover developed by ISRO.
- It is the first time India attempts to land a rover on the moon's South Pole.
- Only USA Russia and China were able to soft land successfully on the lunar surface and these landings were near the lunar equator.
- The purpose of the mission is to collect data on the lunar topography, mineralogy, elemental abundance, lunar exposure and signatures of water-ice.

1.9 **University/Academic Institute Satellites**

- **KalamSat**, named after former president of India APJ Abdul Kalam, is the world's smallest and lightest satellite built by students from Tamil Nadu and launched by NASA.
- This is the first time that an Indian student's experiment has been carried out by NASA.
- It weighs about 64 grams which is lighter than a smart phone and made of reinforced carbon fibre polymer.
- It is 3D printed satellite and it is for the first time that 3-D printing technology is being used in space.
- The main role of the satellite will be to demonstrate the performance of 3D-printed carbon fibre.

- **NIUSAT** is an Indian University/Academic Institute satellite from Noorul Islam University in Tamil Nadu State.
- It launched by PSLV-C38 to Sun Synchronous Polar Orbit to provide multispectral imagery for agricultural crop monitoring and disaster management support applications.
- **PISAT** is a nano satellite from PES University, Bengaluru for remote sensing applications.
- **PRATHAM** is a satellite from IIT Bombay to estimate the Total Electron Count (TEC) over India and Paris (France).
- The Total Electron Content (TEC) is the total number of electrons present along a path between a radio transmitter and receiver and it is a descriptive quantity of ionosphere of the earth.
- **SWAYAM** is a satellite from College of Engineering, Pune to provide point to point messaging services to the HAM Community (Amateur radio operators).

IV. INDIAN MISSIONS

1.10 GSAT-9

- **South Asia Satellite** GSAT-9 is a Geostationary Communication satellite launched by **GSLV-F09** with a lift off mass of 2230 kg.
- The primary objective of GSAT-9 is to provide various communication applications in Ku-band with coverage over South Asian countries.
- It is launched for the South Asian Association for Regional Cooperation (SAARC) region.
- This idea was mooted by India in 18th SAARC summit.
- Afghanistan, Bangladesh, Bhutan, Nepal, Maldives and Sri Lanka are the users of the multi-dimensional facilities provided by the satellite.
- The benefits the countries would receive in communication, telemedicine, meteorological forecasting and broadcasting.
- Its mission life is 12 years.

1.11 GSAT-17

- GSAT-17 communication satellite was launched into a Geosynchronous Transfer Orbit (GTO) by **Ariane-5 launch vehicle** from French Guiana.
- Later it was manoeuvred in to Geostationary Orbit with the help of Liquid Apogee Motor in the satellite.
- It also carries equipment for meteorological data relay and satellite based search and rescue services being provided by earlier INSAT satellites.
- Its mission life is 15 years.

1.12. GSAT 19

- GSAT-19 Communication satellite was launched by **GSLV Mk III-D1** in Geosynchronous Transfer orbit, with a lift-off mass of 3136 kg.
- It carries Ka/Ku-band high through transponders for communication purpose.
- It also carries Geostationary Radiation Spectrometer (GRASP) to monitor and study the nature of charged particles and the influence of space radiation on satellites and their electronic components.

1.13 CARTOSAT

- Cartosat is a series of **Earth Observation Satellites** placed in Polar Sun Synchronous Orbit (PSSO) with liftoff mass of 710kg.
- The series of satellites were carried by PSLV-C37, PSLV-C38 and PSLV-C40.
- The objective is to provide high-resolution scene specific spot imagery.
- The imageries from Cartosat-2 series satellite will useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps.

- It will also be useful in various other Land Information System (LIS) and Geographical Information System (GIS) applications.

PSLV-C40

- ISRO has launched 31 satellites (India's Cartosat-2 series and **30 other co-passenger satellites**), in a single mission using PSLV-C40 in January, 2018.
- The co-passenger satellites comprises microsatellites and nanosatellites from India and **six countries**, namely, Canada, Finland, France, Republic of Korea, UK and USA.

PSLV-C37

- ISRO has launched Cartosat-2 series and **103 co-passenger satellites** in a single mission using PSLV-C37.
- The co-passenger satellites comprised of 101 nano satellites from Kazakhstan, Israel, The Netherlands, Switzerland, UAE and USA, as well as two Nano satellites (INS-1A and INS-1B) from India.
- The 101 International customer Nano satellites were launched as part of the commercial arrangements between Antrix Corporation Limited (Antrix), a Government of India company under Department of Space (DOS), the **commercial arm of ISRO** and the International customers.

1.14 RESOURCESAT-2A

- RESOURCESAT-2A is a **Remote Sensing satellite** intended for resource monitoring and carried by PSLV-C36.
- It is intended to continue the remote sensing data services provided by RESOURCESAT-1 and RESOURCESAT-2, launched in 2003 and 2011 respectively.
- It is placed in Sun Synchronous Polar Orbit.

1.15 SCATSAT-1

- SCATSAT-1 is a continuity mission for Oceansat-2 Scatterometer launched by PSLV-C35 in sun synchronous polar orbit.
- Its application is in the field of **Climate & Environment**. It will provide data products for weather forecasting, cyclone detection and tracking services to the users.

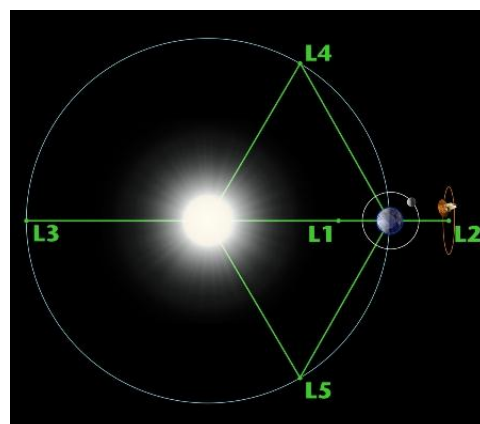
1.16. INSAT-3DR

- INSAT-3DR similar to INSAT-3D is an advanced meteorological satellite of India.
- Its application is in the field of **Climate and Environment, Disaster Management System**.
- It will provide service continuity to earlier meteorological missions of ISRO and further augment the capability to provide various meteorological as well as search and rescue services.
- It was carried by **GSLV-Fo5** and placed in Geosynchronous Transfer Orbit.
- It carried about 1255 kg of propellant which is mainly required to raise the satellite from the Geosynchronous Transfer Orbit (GTO) to its final Geostationary Orbit.

1.17. 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 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.

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 L5 points are called Trojans and Earth's only known Trojan asteroid, 2010 TK7 is found in the region.

1.18. NISAR

- NASA-ISRO Synthetic Aperture Radar satellite (NISAR) is the world's most expensive earth imaging satellite.
- It will be launched by 2020 and it will be the first satellite mission to use two different radar frequencies (L-band and S-band).
- The S-band is being built by ISRO and L-band by NASA.
- It is expected that the NISAR satellite will be launched in 2021 from India using the Geo-synchronous Satellite Launch Vehicle (GSLV).
- One of the main purposes of the mission is to observe Earth and establish a general pathway for future joint missions for Mars exploration.
- It will take weekly snapshots of earth that will provide time lapse images of the motion of tectonic plates, ice sheets and changes in vegetation over land in agriculture and forests.
- NISAR will provide a means of resolving highly spatial and temporally complex processes ranging from ecosystem disturbances, to ice sheet collapse and natural hazards including earthquakes, tsunamis, volcanoes, and landslides.

1.19. 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.

1.20. HySIS

- Hyperspectral Imaging Satellite (HySIS) is a full-fledged earth observation satellite, going to be launched by ISRO.
- Hyperspectral or Hyspex imaging enables distinct identification of objects on earth by reading the spectrum for each pixel of a scene from space.
- The satellite has the Hyperspectral imager which can identify 55 spectral or colour bands from 630 km above ground.
- It can be used for monitoring of environment, finding oil and minerals apart from military surveillance.
- Hyspex was first tried out in Chandrayaan-1 mission which mapped the lunar mineral resources.

V. GLOBAL MISSIONS

NASA

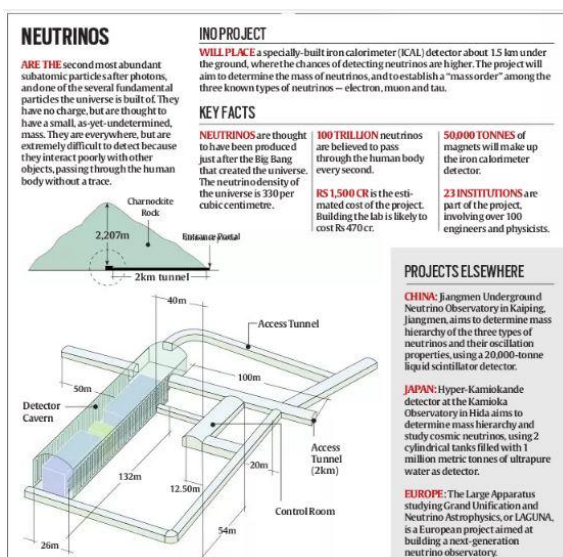
1.21 Cassini Space Craft

- Cassini was launched from Cape Canaveral, Florida in 1997 and it arrived in Saturn in 2004.
- It is a joint project of NASA, European space agency mission and Italian space agency
- It is the fourth space probe to visit Saturn (after pioneer 11, Voyager1, Voyager 2) and the first to enter orbit.
- Its design includes a Saturn Orbiter and a Lander called "Huygens" for the **moon Titan**.
- The European Huygens landed on Saturn's big moon Titan in 2005.
- The data collected by it suggest the possibility of hosting life in Saturn's **moon Enceladus**.
- This was the first landing ever accomplished in the outer solar system.
- After 20 years in Space, NASA's Cassini Spacecraft has made its final death plunge in Saturn recently.
- It is a well planned demise to prevent any damage to Saturn's ocean bearing moons Titan and Enceladus.

1.22 Voyager 1 and Voyager 2

- The primary mission was the exploration of Jupiter and Saturn. After making a string of discoveries the mission was extended.
- The current mission objective of the Voyager Interstellar Mission (VIM) is to explore beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence i.e Sun's magnetic field and outward flow of the solar wind.
- Earlier Voyager 2 went on to explore Uranus and Neptune, and is still the only spacecraft to have visited those outer planets.
- Voyager 1 made the historic entry into interstellar space, the region between stars, filled with material ejected by the death of nearby stars millions of years ago.

1.23 Curiosity



Titan

- Titan is the largest moon of Saturn.
- Scientists recently identified negatively charged molecules called 'carbon chain anions' in the atmosphere of Titan using the data collected by Cassini Spacecraft.
- These linear molecules in carbon chain anions are understood to be building blocks towards more complex molecules, and may have acted as the basis for the earliest forms of life on Earth.

Enceladus

- Enceladus is a small moon with an ocean of liquid water beneath its icy crust.
- Clouds of gas erupting out of Enceladus contain hydrogen.

- It is a rover deployed by NASA in its Mars Exploration Program to assess whether Mars ever had an environment able to support small life forms called microbes.
- The rover will analyze samples scooped from the soil and drilled from rocks in order to detect chemical building blocks of life (e.g., forms of carbon) on Mars and will assess what the martian environment was like in the past.
- It carries a radioisotope power system that generates electricity from the heat of plutonium's radioactive decay.
- The rover captured **mesas and buttes** on Mars geological layer called as Murray formation, which is formed from the lakebed mud deposits.
- Butte otherwise called as Murray Butte is an isolated hill with steep, flat top side and with often vertical sides.
- Mesa is an elevated area that has wider top than its height, while Butte has a top that is narrower than its height.

1.24 Dawn Mission

- Dawn mission was launched by NASA deploying spacecrafts to study the asteroid Vesta and dwarf planet Ceres.
- It is the only mission ever to orbit two extraterrestrial targets and will characterize the early solar system and the processes that dominated its formation.
- Vesta and Ceres are celestial bodies believed to have accreted early in the history of the solar system.
- Dawn orbited giant asteroid Vesta for 14 months from 2011 to 2012, then continued on to Ceres, where it has been in orbit since March 2015.
- NASA has recently authorized a second extension of the Dawn mission at Ceres.
- During this extension, the spacecraft will descend to lower altitudes than ever before at the dwarf planet, which it has been orbiting since 2015.

Ceres and Vesta

- Ceres is the earliest known and smallest of the dwarf planet.
- It is also the largest object in the asteroid belt between Mars and Jupiter.
- Thus Ceres is both dwarf planet and asteroid.
- Vesta is the second most massive body in the asteroid belt, surpassed only by Ceres.
- It is known as the brightest asteroid and the first asteroid to be visited by a spacecraft.
- The International Astronomical Union defines three criteria to classify any object as a “planet”
 - i. It needs to be in orbit around a any fully fledged star.
 - ii. It needs to have enough gravity to pull itself into a spherical shape.
 - iii. It has cleared the neighbourhood around its orbit
- This last criterion is the point at which planets and **dwarf planets** differ. Dwarf planets have other objects in its orbit around its star.
- IAU recognizes five named dwarf planets: Ceres, Pluto, Eris, Haumea, and Makemake. Except Ceres, other dwarf planets are also known as “Plutoids”.
- **Asteroids**, or minor planets, are small and often irregularly shaped celestial bodies.
- The known majority of them orbit the Sun in the so-called main asteroid belt, between the orbits of the planets Mars and Jupiter.
- An asteroid is coined a **Near Earth Asteroid (NEA)** when its trajectory brings it within 1.3 Astronomical Units (AU) from the Sun and hence within 0.3 AU of the Earth's orbit.
- The largest known NEA is Ganymed. NEA's are also known Potentially Hazardous Asteroid.

1.25 Europa Clipper Mission

- NASA's Europa mission which is set to be launched in 2022 will conduct detailed reconnaissance of **Jupiter's moon Europa**.

- The mission will place a spacecraft in orbit around Jupiter in order to perform a detailed investigation of Europa.
- Europa shows strong evidence for an ocean of liquid water beneath its icy crust and which could host conditions favorable for life.

1.26 Lucy and Psyche

- Lucy and Psyche are NASA's two robotic missions to **explore asteroids**. The Mission will open new windows to the history of our Solar System.
- The Psyche mission will explore 16 Psyche, a giant metal asteroid in the asteroid belt between Mars and Jupiter.
- The Psyche mission is targeted to be launched in October of 2023.
- The Lucy Mission will explore the environment of **Jupiter's Trojan asteroids** and is scheduled to launch in 2021.
- Lucy will be the first space mission to study the Trojans and it will be launched in 2021.
- Trojans are bodies that are present in Lagrange points.

1.27. Magnetospheric Multiscale (MMS) Mission

- NASA's MMS mission was launched in 2015.
- MMS consists of four identical spacecraft that orbit around Earth to study a little-understood phenomenon called "**Magnetic Reconnection**".
- MMS will travel directly through areas near Earth known to be magnetic reconnection sites.
- Reconnection occurs when magnetic field lines of sun and Earth cross and release a gigantic burst of energy.
- On the sun-side of Earth, reconnection can link the sun's magnetic field lines to Earth's magnetic field lines, allowing material and energy from the sun to funnel into Earth's magnetic environment.
- On the night side of Earth, reconnection is believed to help trigger aurora, also known as the northern and southern lights.

1.28. MAVEN

- The Mars Atmosphere and Volatile Evolution (MAVEN) mission is part of NASA's Mars Scout program, launched in 2013.
- The mission will explore MARS's upper atmosphere, ionosphere and interactions with the sun and solar wind.
- An important aspect of the MAVEN mission is studying how early Mars lost much of its atmosphere.
- This atmospheric loss may have been partially responsible for Mars' transition from a planet capable of supporting liquid surface water to the dry, desert world we know today.
- Recently, MAVEN has avoided its head-on collision with phobos, the natural satellite of Mars.

1.29. Insight Mission

- InSight, short for Interior Exploration using Seismic Investigations, Geodesy and Heat Transport, is a Mars lander going to be launched by NASA this year.
- It is the first outer space robotic explorer to study in-depth the "inner space" of Mars - its crust, mantle, and core.
- It also measures tectonic activity and meteorite impacts on Mars.
- This mission is part of **NASA's Discovery Program** for highly focused science missions that ask critical questions in solar system science.
- It will be a first test of miniaturized **CubeSat technology** at another planet, which researchers hope can offer new capabilities to future missions.

Phobos

- Phobos is one of the smallest moons in the solar system orbiting around the Mars.
- It is the only natural satellite in the solar system that encircles its planet in a time shorter than the parent planet's day.
- Red planet Mars has another natural satellite Deimos.
- Phobos is the innermost and largest of the two.
- Recently, NASA's Hubble Space Telescope has beamed back images of the moon Phobos in its orbital trek around the red planet.

- It is similar in design and will rely on proven technologies used on NASA's **Mars Phoenix mission**, and will send a lander to the Martian surface to spend two years to investigate interiors of Mars.
- Previous missions to Mars have investigated the surface history of the Red Planet by examining features like canyons, volcanoes, rocks and soil.

1.30. 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.
- **Juno** was launched in 2011 and entered Jupiter orbit in 2016.
- **OSIRIS-REx**, launched in September 2016 towards asteroid Bennu for detailed studies from 2018 to 2021 and a sample return to Earth in 2023.

1.31. New Horizons

- It is the first mission to the Pluto system and Kuiper Belt and fastest spacecraft ever launched.
- It was launched in 2006 to explore Pluto and its largest moon, Charon, which are known as "ice dwarfs."
- The mission seeks to understand where Pluto and its moons "fit in" with the other objects in the solar system, such as the inner rocky planets (Earth, Mars, Venus and Mercury) and the outer gas giants (Jupiter, Saturn, Uranus and Neptune).

Kuiper Belt - It is a ring of objects between Neptune and the edge of the solar system full of dwarf planets, hundreds of thousands of icy rocks and comets.

Penitentes on Pluto

- Penitentes are snow and ice features formed by erosion and characterized by bowl-shaped depressions.
- Scientist has found the evidence of penitentes on Pluto using the images from the **New Horizons spacecraft** in 2015.
- Until now, Earth is the only planet in the solar system to have Penitentes.
- Unlike in Earth, Penitentes in Pluto are mainly made from methane and nitrogen due to its different environment i.e. thinner air, dimmer sun and much colder conditions. They are much larger than earth's counterparts.

1.32. Juno Spacecraft

- Its mission is to measure Jupiter's composition, gravity field, magnetic field, and polar magnetosphere.
- Recently, it completed a close flyby of Jupiter and its Great Red Spot.
- Jupiter's Great Spot is a 16,000-km wide storm monitored since 1830 and possibly existing for more than 350 years.
- Recently, the spacecraft reached "Perijove", the point at which an orbit comes closest to Jupiter's centre.

1.33. OSIRIS-REx

- The Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) spacecraft will travel to a near-Earth asteroid, called **Bennu**.
- It will bring sample back to Earth for study and help scientists investigate how planets formed and how life began, as well as improve our understanding of asteroids that could impact Earth.
- It was launched in 2016 and the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.

1.34. Rosetta

- The mission of Rosetta spacecraft is to catch a comet and land a probe on it.
- It was launched in 2004 and the spacecraft arrived in the Comet 67P/Churyumov-Gerasimenko in 2014.

Comet 67P –It makes regular visits to the inner solar system, as it orbits the sun every 6.5 years between the orbits of Earth and Jupiter.

- Rosetta is the first spacecraft to accompany a comet as it enters the inner solar system, as well as the first to attempt landing on a comet.
- The mission included the Philae lander, which made the first touchdown on the comet but it did not stay down.
- In 2016, it made a planned final plunge into its comet, ending its mission.

1.35. Advanced Weather Satellite

- NASA has recently launched a next-generation satellite Joint Polar Satellite System-1 (JPSS-1), designed to monitor weather around the world and help improve forecasts.
- It is a joint venture between the US space agency and the National Oceanic and Atmospheric Administration (NOAA), US scientific agency.
- It will orbit the Earth 14 times each day from one pole to the other at 512 miles above the planet.
- It is the first in NOAA's series of four, next-generation operational environmental satellites used for severe weather prediction and environmental monitoring.
- Four smaller satellites called CubeSats, part of NASA's educational nano-satellite program, are to be released on the same mission.

1.36. CubeSat

- CubeSats are a class of research spacecraft called nanosatellites.
- CubeSats are built to standard dimensions of 10 cm x 10 cm x 11 cm unit and typically weigh less than 1.33 kg per unit.
- NASA's CubeSats are deployed from a Poly-Picosatellite Orbital Deployer, or P-POD.
- They require Micropropulsion devices which use **ultra-purified water as propulsive agent**.
- It uses Film-Evaporation MEMS Tunable Array (FEMTA) thrusters which uses capillaries small enough to harness the microscopic properties of water.
- The thrusters deliver precise low-thrust for scientific, commercial and military space applications.
- It can be manoeuvred in space with tiny bursts of water vapour to perform a variety of tasks, from high-resolution imaging and internet services to disaster response, environmental monitoring and military surveillance.
- They are used to demonstrate spacecraft technologies that are targeted for use in small satellites or that present questionable feasibility and are unlikely to justify the cost of a larger satellite and can also serve purposes such as Earth observation or amateur radio.

1.37. Cyclone Global Navigation Satellite System (CYGNSS)

- CYGNSS mission by NASA will use eight micro-satellites to measure wind speeds over Earth's oceans, increasing the ability of scientists to **understand and predict hurricanes**.
- Each satellite will take information based on the signals from four GPS satellites.
- CYGNSS orbit is designed to measure only in the tropics, where hurricanes are most often found.
- The CYGNSS satellites themselves will not broadcast. It will only receive signals broadcast to them from GPS satellites already orbiting the Earth and the reflection of the same satellite's signal reflected from the earth.

1.38. NICER

- NASA will launch the world's first mission devoted to studying rapidly spinning **neutron stars**.
- Neutron stars are the **remnants of massive stars** that, after exhausting their nuclear fuel, exploded and collapsed into super-dense spheres about the size of New York City.
- Although neutron stars **emit radiation across the spectrum**, observing them in the energetic X-ray band offers the greatest insights into their structure and the high-energy phenomena that they host, including starquakes, thermonuclear explosions, and the most powerful magnetic fields known in the cosmos.

1.39. TDRS-M

- Tracking and Data Relay Satellite-M (TDRS-M) is a next generation communication satellite recently launched by NASA.

- It is the third and final in a series of next generation communications satellites.
- TDRS-M will become part of NASA's Space Network providing navigation and high-data-rate communications to the International Space Station, NASA's Hubble Space Telescope, rockets and a host of other spacecraft.
- TDRS-M will expand the capabilities and extend the lifespan of the Space Network by receiving and transmitting mission data well into the next decade.

1.40. CHESS rocket

- NASA is launching a new CHESS sounding rocket which will study vast interstellar clouds to understand about the earliest stages of star formation.
- Deep in space between distant stars, vast clouds of neutral atoms and molecules, as well as charged plasma particles called the interstellar medium that may evolve into new stars and even planets.
- It will measure light filtering through the interstellar medium to study the atoms and molecules within, which provides crucial information for understanding the life-cycle of stars.

1.41 Solar Probe Plus mission – Parker Solar Probe

- NASA plans to send its first robotic spacecraft to the Sun which is about 149 million kilometres from the Earth.
- In 2017, NASA renamed the spacecraft from the Solar Probe Plus to the Parker Solar Probe in honor of astrophysicist Eugene Parker.
- The spacecraft will travel directly into the sun's atmosphere about 4 million miles from the star's surface.
- Parker Solar Probe has three detailed science objectives:
 1. Trace the flow of energy that heats and accelerates the solar corona and solar wind.
 2. Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
 3. Explore mechanisms that accelerate and transport energetic particles.
- The mission is to study why the surface of the Sun, called the photosphere, is not as hot as its atmosphere, called the corona.
- The surface temperature of the Sun is only about 5,500°C but the atmosphere above it is an over two million degrees Celsius.
- The mission may also ascertain why the Sun occasionally emits high-energy particles that are a danger to unprotected astronauts and spacecraft.
- NASA has designed an 11.4 centimetres carbon-composite shield designed to withstand temperatures of 1,370°C outside the spacecraft.

Temperature in the 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.

1.42 Age of Moon

- The new research on the minerals brought by the "**Apollo Mission**" by NASA to the Moon reveals the new age of Moon.
- The minerals are called as "Zircons" and it is the best mineral in preserving the geological history of moon.
- The research found that the moon formed only about 60 million years after the birth of solar system.
- The moon was formed by a violent, head-on collision between the early Earth and a **planetary embryo called "Theia"**.



- The Earth's collision with Theia created a liquefied moon, which then solidified and most of the moon's surface was covered with magma right after its formation.

1.43. EcAMSat Mission

- EcAMSat – E.coli Anti-Microbial Satellite Mission was scheduled to be launched by NASA to International space station.
- E.Coli is a common bacterial pathogen linked to urinary tract infections and foodborne illnesses.
- The mission is intended to investigate spaceflight effects on bacterial antibiotic resistance and its genetic basis.
- It aims to determine the lowest dose of antibiotic needed to inhibit the growth of E.coli.
- It will help to determine the appropriate dosages of antibiotics to protect astronaut health during long-duration human space flight and how antibiotic effectiveness may change as a function of stress on Earth.
- The launch was later postponed.

1.44. NASA's Mission to explore Ionosphere

- NASA has announced two missions to explore the little-understood area of 96 km above Earth's surface.
- The two missions Global-scale Observations of the Limb and Disk (GOLD) and Ionospheric Connection Explorer (ICON) will team up to explore the ionosphere.
- ICON will be in low-Earth orbit, at 560 km above Earth, like a close-up camera while GOLD will be in a geostationary orbit over the Western Hemisphere, about 35,398 km above the planet's surface.
- It will help in full-disk view of the ionosphere and the upper atmosphere beneath it every half hour.

1.45. NASA's Kilopower Project

- NASA has invented a small nuclear reactor Kilopower,
- It can generate a reliable power supply by using uranium-235 reactor core.
- This power system could provide up to 10 kilowatts of electrical power enough to run two average households continuously for at least 10 years.
- This reactor will be used for electronic propulsion systems and for providing safe and plentiful energy for future robotic and human missions for Mars and beyond.

1.46. Asteroid Impact and Deflection Assessment (AIDA) Mission

- AIDA is a dual-mission concept, involving two independent spacecraft NASA's Double Asteroid Redirection Test (DART), and ESA's Asteroid Impact Mission (AIM).
- It is an international collaboration among the European Space Agency (ESA) and NASA.
- It will be the first demonstration of the kinetic impact technique to change the motion of an asteroid in space.
- Kinetic Impact technique is one of the technologies for preventing the Earth impact of a hazardous asteroid.
- AIDA's primary objective is to demonstrate, and to measure the effects of, a kinetic impact on a small asteroid.
- Its target is the binary near-Earth asteroid **Didymos**, whose 150-meter size is more typical of the size of asteroids that could pose a more common hazard to Earth.
- DART spacecraft will achieve the kinetic impact by deliberately crashing itself into the asteroid at a speed of approximately 6 km/s.
- The collision will change the speed of the asteroid in its orbit around the main body by a fraction of one percent, enough to be measured using telescopes on Earth.

1.47. Transiting Exoplanet Survey Satellite (TESS)

- The mission will find exoplanets that periodically block part of the light from their host stars, events called **transits**.
- The mission is scheduled to be launched later in 2018.
- It will survey 200,000 of the brightest stars near the sun to search for transiting exoplanets.
- The transit method of detecting exoplanets looks for dips in the visible light of stars.

- It is the next step in the search for planets outside of our solar system, including those that could support life.

1.48. ICESat-2 and GRACE

- NASA will launch the next generation of two missions, ICESat-2 and GRACE-2 (Gravity Recovery and Climate Experiment) in 2018.
- This is to continue the long-term record of how Earth's ice sheets, sea level, and underground water reserves are changing.

Other Space Agencies

1.49. Belle – II

- It is an experiment carried out by **The High Energy Accelerator Research Organisation (KEK), Japan** to study violations of the standard model and dark matter.
- It has a six layer highly sensitive particle detector which indirectly probe new physics using intense electron-positron beams unlike direct search experiments being carried out in Large Hadron Collider.
- The experiment has a significant Indian participation. The particle detector at the heart of Belle –II has been built by an Indian Scientists Tariq Aziz and Gagan Mohanty from Tata Institute of Fundamental Research
- Recently, the experiment has been rolled out. It has a grand collaboration of 700 Scientist from 23 countries.

1.50. Quasi-Zenith Satellite System

- Quasi-Zenith is a regional terrestrial positioning network system launched by **Japan**.
- The satellite system consists of 4 satellites which will operate at an altitude of between 33,000 and 39,000 km above the earth in **geosynchronous orbit**.
- Its function is to improve GPS data accuracy for smartphones and vehicle navigation systems and complementary use of GPS.
- Japan recently launched its fourth and final quasi-zenith satellite into orbit.
- These satellites will be to establish communications during a malfunction of traditional networks due to a natural disaster.

1.51. Japan launches first military communications satellite

- The Kirameki-2 satellite is the first military communication satellite launched by H-2A rocket from the Tanegashima Space Center in southern Japan.
- It is the first of three satellites that will replace three civilian ones currently used by Japan's military.
- The new satellites will allow military units to communicate on a high-speed and high-capacity network.

1.52. China's first Cargo Spacecraft

- Tianzhou-1 is the china's first cargo spacecraft launched by Long March Rocket form Hainan province.

1.53. Chang'e 4

- China has recently announced its plans to launch a lunar probe, Chang'e 4, in 2018.
- Chang'e 4 is a Chinese lunar exploration mission.
- The mission will incorporate an orbiter, a robotic lander and rover.
- It will be China's second lunar lander and rover.
- Chang'e-4 will follow China's successful Chang'e-3 mission which soft-landed on the Moon in 2013. The present Chang'e-4 will make China the world's first country to launch a lunar probe on far side of moon

1.54. Lunar Palace

- Chinese students will live in a laboratory simulating a lunar-like environment for up to 200 days as Beijing prepares for its long-term goal of putting humans on the moon.
- The volunteers will live in the sealed lab (dubbed the "**Yuegong-1**", or "Lunar Palace") to simulate a long-term, self-contained space mission with no input from the outside world.
- Human waste will be treated with a bio-fermentation process, and experimental crops and vegetables grown with the help of food and waste byproducts.

- The Lunar Palace is the **world's third bioregenerative life-support base**, and the first developed in China.

1.55. Venus Satellite

- The Venus satellite (Vegetation and Environment Monitoring New Micro-Satellite) is an earth-observation micro-satellite.
- It is designed jointly by **Israel's** agency and **France's** National Centre for Space Studies (CNES).
- The scientific mission will monitor Earth's vegetation using a camera capable of recording 12 narrow spectral bands.
- The microsatellite will send high-resolution photos to track climate change and aid efforts to tackle desertification, erosion, and pollution.

1.56. Remove Debris Mission

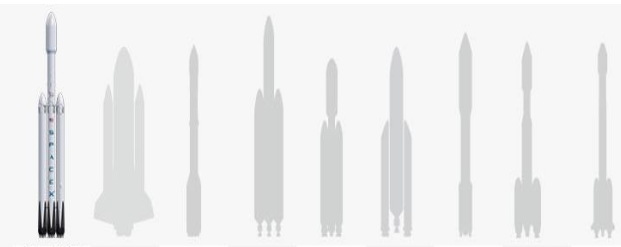
- The RemoveDEBRIS mission, scheduled to be launched later this year, is being led by the Surrey Space Centre (SSC) at the University of Surrey, **UK**.
- It is co-funded by the European Commission and other partners, including prominent European space companies and institutions.
- The mission started five years ago, aims to be a forerunner of missions to start removing some of the largest objects in space.
- It is expected to be launched to the International Space Station (ISS) in a capsule on board a SpaceX rocket.

1.57. SENTINEL-5P

- European satellite** Sentinel-5P sends images of global air pollution
- The Sentinel-5P satellite is designed to make daily global maps of the gases and particles that pollute the air.
- Sentinel-5P is the latest spacecraft in a fleet of Earth observers being commissioned by the European Union and the European Space Agency.
- It was launched into an 824 kilometre high orbit by a Russian rocket on October 13 this year.
- It carries an instrument called Tropomi – a spectrometer that observes the reflected sunlight coming up off the Earth, analysing its many different colours.
- This helps detect the presence of trace gases such as nitrogen dioxide, ozone, sulphur dioxide, methane, and carbon monoxide in the atmosphere.
- ISRO satellite** - The Next Generation Earth Monitoring and Observation and Aerosol Monitoring (NEMO-AM) satellite will monitor air pollutants.

1.58. Falcon Heavy

- Falcon Heavy is a reusable super heavy-lift launch vehicle designed and manufactured by SpaceX, a private American aerospace manufacturer.
- Its first test flight carrying a red sports car was successfully launched from florida pad used by NASA.
- It is the most powerful operational rocket in the world.
- It can lift about twice the payload at one third of the cost by Delta 4 rocket which was the most powerful rocket till now.
- This lift capacity allows launching heavier satellites into low Earth orbit, or reaching higher geostationary orbits to keep station over the same part of Earth.
- Its three first-stage boosters are designed to be reusable.



| LAUNCH VEHICLE | FALCON HEAVY | SPACE SHUTTLE | PROTON M | DELTA IV HEAVY | TITAN IV-B | ARIANE 5 ES | ATLAS V 551 | JAPAN H2B | CHINA LM3B |
|----------------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| PAYLOAD TO LOW EARTH ORBIT (LEO) | 63,800 kg 140,660 lb | 24,000 kg 53,790 lb | 23,000 kg 50,710 lb | 22,560 kg 49,740 lb | 21,680 kg 47,800 lb | 20,000 kg 44,090 lb | 18,510 kg 40,810 lb | 16,500 kg 36,380 lb | 11,200 kg 24,690 lb |

1.59. Starlink Constellation

- Recently SpaceX launched the Paz mission with two experimental satellites Tintin A and Tintin B.
- These two satellites, if successful will pave the way for Starlink, a constellation of satellites that would provide a cheap, high speed, global Internet connection.
- Starlink will have 12,000 small satellites in two layers — low earth orbit (LEO) and very low earth orbit (VLEO).

| | | |
|----------------|------------------------------|-----------------------------|
| Type of orbit | Low earth orbit (LEO) | Very low earth orbit (VLEO) |
| Frequency Band | Operate in Ku, Ka and V band | Operate in V band |
| Altitude | 1110-1325 km | 335-346 km |

- The LEO constellation will provide high-speed broadband services around the world; the VLEO constellation will enhance capacity.
- The UN Broadband Commission for Sustainable Development estimated in 2016 that 57% of the world's population was offline.
- Paz mission is mainly about the Spanish radar imaging satellite with applications such as border control, intelligence, military operations, environmental monitoring.

VI. PLANETARY SYSTEMS

1.60 Rogue Planet

- A rogue planet or starless planet is a planetary-mass object that orbits the galaxy directly.
- They have either been ejected from the planetary system in which they formed or have never been gravitationally bound to any star or brown dwarf.

1.61 Habitable exoplanet next to Earth

- The exoplanets are planets that exist outside Earth's solar system.
- The term "habitable zones" refers to a planet where water could exist in a liquid state on a planet's surface if there's sufficient atmospheric pressure.
- Astronomers have located the habitable zone "**The Wolf 1061**", a planetary system that is 14 light years away from the Earth.
- One of the planets in the wolf planetary system, **Wolf 1061c**, is entirely within the habitable zone which has an atmosphere more similar to Venus.
- But the climate of Wolf 1061c is quite chaotic compared to earth, since the orbit around its star changes at a much faster rate than earth. The earth also experiences climate change due to change in its orbit around the sun which resulted in ice age previously.

1.62 TRAPPIST-1

- TRAPPIST-1 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.

1.63 MAMMOTH-1

- A nebula is an interstellar cloud of dust, hydrogen, helium and other ionized gases.
- Astronomers have spotted an enormous, glowing blob of gas i.e Enormous Lyman-Alpha Nebula (ELAN) named Mammoth-1.
- It is in the middle of a region with an extraordinary concentration of galaxies called a "protocluster,".
- It has no obvious source of power for the light it is emitting.
- It is the brightest and among the largest of these rare objects.

1.64 Northwest Africa 7635

- It is a meteorite discovered in Algeria, Africa in 2012.
- It has given insight into volcanic activity on Mars.
- The largest Volcano in the solar system, Olympus Mons, is found on Mars.
- But by analysing the chemical composition NA7635, scientists learnt that Mars had a single volcano that continuously erupted for 2 billion years.
- Martian volcanoes can grow to such enormous proportions because unlike Earth, Mars doesn't have plate tectonics that constantly shuffle the surface.
- So the magma for the volcano in Mars gets hot magma from its interiors for billions of years continuously.

1.65. Super Earth

- Scientists have discovered a new Earth-like planet, Super Earth, orbiting a red dwarf star "**LHS 1140**" about 40 light-years away.
- The astronomers estimate the age of the planet to be at least five billion years.
- The red dwarf star LHS 1140 is much smaller and cooler than the sun and the super Earth LHS 1140b is ten times closer to its star than the Earth.
- The super Earth has a mass around 7 times greater than the Earth and receives about half as much sunlight from its star as the Earth and lies in the middle of the habitable zone.
- The greater mass and higher density of the super Earth implies that the exoplanet is probably made of rock with a dense iron core.

1.66. Mapping of the Universe with Quasar position

- Astronomers have created the first map of the large-scale structure of the universe based entirely on the positions of quasars.
- Quasars are the incredibly bright and distant points of light powered by super-massive black holes.
- The amazing brightness of quasars is due to the supermassive black holes found at their centres.
- As matter and energy fall into a quasar's black hole, they heat up to incredible temperatures and begin to glow.
- To make their map, scientists used the Sloan Foundation Telescope to observe an unprecedented number of quasars.

1.67. Pluto Mountains

- Two mountain ranges on Pluto have been named after Tenzing Norgay and Edmund Hillary respectively by the International Astronomical Union (IAU).
- These are the first geological features on the planet to be named following the close flyby by the New Horizons spacecraft in July 2015.
- IAU has officially approved the naming of 14 features on the dwarf planet for the first time.
- IAU is the internationally recognised authority for naming celestial bodies and their surface features.
- Tenzing Norgay and Sir Edmund Hillary were the first to reach the summit of Mount Everest and return safely.

1.68. Black Planet

- Astronomers have discovered a black planet using hubble space telescope.
- It is formally called as WASP-12b, an exoplanet that reflects almost no light, making it appear essentially pitch black.
- It orbits its parent star WASP-12A, about 1400 light year away.
- Its albedo is 0.064, whereas the albedo of earth is 0.3 and moon is 0.12.
- It is categorized as a hot Jupiter since its radius almost twice that of Jupiter and a year of just over one Earth day.
- Albedo – Fraction of light falling on a surface that is reflected.
- Exoplanet – A Planet that orbits a star other than a sun.

1.69. Lunar Station

- Russia and the United States agreed to co-operate on a NASA-led project to build the first lunar space station.
- The project envisages building a crew-tended spaceport in lunar orbit that would serve as a gateway to deep space and the lunar space.

1.70. Proxima Centauri

- Proxima Centauri is the closest star to Sun.
- It is a faint red dwarf lying four light years away in the southern constellation of Centaurus.
- It is orbited by the Earth-sized Proxima b which is the closest exoplanet to the solar system.
- Scientists have recently detected dust belts around Proxima Centauri, by the Atacama Large Millimeter Array (ALMA) Observatory in Chile.
- The presence of dust belts indicates the presence of an elaborate planetary system hosted by it.

1.71. Kepler 90i

- NASA has recently announced that it found another solar system with 8 planets.
- The historic discovery was made by new scientific analysis of data obtained by the Kepler space telescope.
- Kepler 90 is the first star to host as many planets as our own solar system.
- The new planet “Kepler 90i” is a small rocky planet, but very close to the sun which is hotter than Earth
- It is located 2,500 light years from Earth and it orbits its home star every 14 days and is about 30% bigger than Earth.
- The planets in the Kepler 90 system orbit much closer to their host star than Earth is to the sun.
- It is similar to the seven planets in the TRAPPIST-1 system, previously thought to be the next biggest solar system.

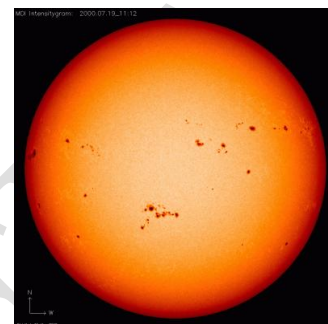
1.72. Super Blood Blue Moon

- “Super Blood Blue Moon” is a rare cosmic event that combines an extra big Super moon, a Blue moon and a total lunar eclipse.
- **Super moon** – It occur when the full moon coincides with the Moon’s closest orbit point (perigee) to Earth.
- During a super moon, the moon appears 14% larger and 30% brighter.
- The farthest distance between the moon and the Earth is termed ‘apogee’, while the perigee is the nearest point.
- **Lunar Eclipse** – It occurs when the Sun, the Earth and the Moon are so aligned that the full moon passes through the shadow of Earth.
- The moon gliding into Earth’s shadow will gradually turn in to orange or red.
- This is because the sunlight passing through the Earth’s atmosphere break down and red part gets scattered by the atmosphere and falls on the Moon’s surface.
- For this reason, a totally eclipsed moon is called a “Blood Moon”.

- **Blue Moon** – It refers to the second full moon (or second lunar eclipse) in a month.
- The Moon does not turn blue but historically the second full Moon of an English calendar month is termed as a Blue Moon.
- Typically, it happens every two years and eight months.
- The world is going to witness this event on Jan 31st in parts of western North America, Asia, the Middle East, Russia and Australia

1.73. 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.



1.74. KELT-9

- Scientists have discovered the hottest known planet in the universe “KELT-9b” orbiting a massive star KELT-9 every day and a half.
- The planet is located 650 light years from Earth and 2.8 times more massive than Jupiter.
- It is tidally locked to its star as the moon is to Earth.
- The day side of the planet is perpetually bombarded by stellar radiation which makes the planet is so hot that molecules such as water, carbon dioxide and methane cannot form there.

1.75. Perseids

- Comet Swift-Tuttle is the largest object known to repeatedly pass by Earth. Its nucleus is about 16 miles (26 kilometers) wide.
- It last passed nearby Earth during its orbit around the sun in 1992, and the next time will be in 2126.
- Earth passes through the dust and debris it leaves behind every year, creating the annual **Perseid meteor shower**.
- During meteor shower, the pieces of comet debris heat up as they enter the the atmosphere and burn up in a bright burst of light and streaking a vivid path across the sky.
- Perseid meteor shower can be seen best in the Northern Hemisphere and down to the mid-southern latitudes.
- When they're in space, the pieces of debris are called "**meteoroids**," but when they reach Earth's atmosphere, they're designated as "**meteors**."
- If a piece makes it all the way down to Earth without burning up, it graduates to "**meteorite**."
- **Geminids Meteor shower** - The Geminids are associated with the near-Earth object **3200 Phaethon**.
- A near-Earth object (NEO) is an asteroid or comet whose orbit periodically brings it within approximately 195 million kilometers of the Sun.

Asteroid and 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**.

1.76. 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.

1.77. Farthest known galaxy

- NASA has spotted the farthest known galaxy in the universe, a primitive cluster of stars just 500 million years old.
- The galaxy was named SPT0615-JD.
- Preliminary analysis suggests that the galaxy is less than 2,500 light-years across.

1.78. Ancient Spiral Galaxy

- Scientists have discovered the most ancient spiral galaxy in the universe that existed 11 billion years ago.
- The galaxy, known as A1689B11, existed just 2.6 billion years after the Big Bang.
- Researchers used the Gemini North telescope in Hawai'i to verify the vintage and spiral nature of the galaxy.
- Spiral galaxies are exceptionally rare in the early universe.
- In spiral galaxy, the stars and gas clouds are concentrated mainly in one or more spiral arms.

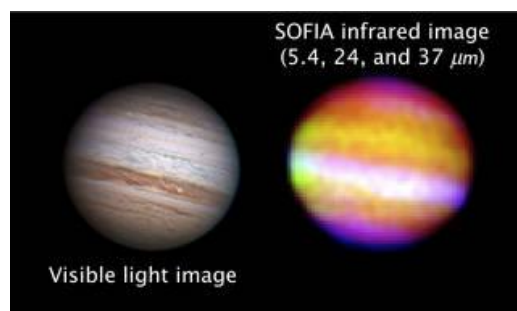
1.79. Tabby's star

- Tabby's star is the "most mysterious star in the universe" as it kept dimming and brightening irregularly, following no pattern.
- Officially called KIC 8462852, the star is 1,000 light years away from the Earth and 1,000 degrees hotter than the Sun.
- There was a 20% decrease in brightness and the dip lasted from five to 80 days.
- A recent report showed that the dimming is caused by ordinary dust particles, the majority of them at a size less than one micrometre.

VII. TELESCOPES AND OBSERVATORIES

1.80. SOFIA

- SOFIA, the Stratospheric Observatory for Infrared Astronomy, is the largest airborne observatory in the world.
 - It consists of an extensively modified Boeing aircraft carrying a reflecting telescope with an effective diameter of 2.5 meters.
 - The observatory is based at NASA's Armstrong Flight Research Center in Palmdale, California.
 - The project is implemented by NASA and German Aerospace Center (DLR).
 - Many objects in space emit almost all their energy at infrared wavelengths. Often, they are invisible when observed in ordinary visible light.
 - Thus SOFIA observes universe in infrared wavelengths to get the expanded views.
 - It is preparing for its 2018 campaign for observing Saturn's giant moon Titan.
- Jupiter in Visible and Infrared Image



1.81 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.

1.82 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.
- Ngari observatory will be among the world's top primordial gravitational wave observation bases, alongside the South Pole Telescope and the facility in Chile's Atacama Desert.
- China has also announced setting up of **FAST**, a 500-meter aperture spherical radio telescope in southwest China's Guizhou Province.

1.83. Chandra X-ray Observatory

- NASA's Chandra X-ray Observatory is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.
- It is a space based telescope. Since the Earth's atmosphere absorbs the vast majority of X-rays, they are not detectable from Earth-based telescopes
- Chandra is an Earth satellite in a 64-hour orbit, being operated in space since 1999.
- Chandra is one of the Great Observatories, along with the Hubble Space Telescope, Compton Gamma Ray Observatory (1991–2000), and the Spitzer Space Telescope.



1.84. 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.
- Hubble Telescope 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.

1.85. 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 2019 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".

1.86. Giant Magellan Telescope

- The telescope will be one member of the next class of **giant ground-based telescopes**.
- It is going to be commissioned in 2023.
- It is proposed to be located in Chile's Atacama Desert, one of the highest and driest locations on earth.
- It will have a resolving power 10 times greater than the Hubble Space Telescope.

1.87. SPARCS telescope

- Star-Planet Activity Research CubeSat, or SPARCS, is a new NASA-funded space telescope and will be launched in 2021.
- It will be launched into the Earth's orbit that will monitor the flares and sunspots of small stars using ultraviolet light to assess how habitable the environment is for planets orbiting them.
- It will study the habitability and high-energy environment around stars called "M dwarfs".
- M dwarf is the smallest kind of star with masses ranging from about 50 percent of the Sun's mass down to about 8 percent of the Sun's mass.

1.88. 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.

1.89. Giant Metrewave Radio Telescope (GMRT)

- GMRT serves as a unique facility for radio astronomical research using the metre wavelengths range of the radio spectrum.
- It is located at a site about 80 km north of **Pune**.
- It is an array of thirty fully steerable parabolic radio telescopes of 45 metre diameter, observing at metre wavelengths
- 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.

1.90. ARIES Telescope

- ARIES telescope is a joint collaboration between Indian, Russian, and Belgian scientists
- The telescope is located at **Devasthal, Nainital** at a height of 2,500 metres
- The telescope will be used in the study and exploration of planets, stars, magnetic field and astronomical debris.
- The high end technology incorporated in the telescope enables it to be operated with the help of remote control from anywhere in the world.

1.91. National Large Solar Telescope

- National Large Solar Telescope (NLST) is a proposed ground based 2-m class optical and near infra-red (IR) observational facility in our country.
- It is designed to address the scientific issues related to origin and dynamics of solar magnetic fields.
- The instrument has a broad scope to support and substantiate the solar atmospheric observations from space-based ADITYA mission and ground based MAST telescope (Udaipur).

VIII. OTHERS

1.92. Space Activities Bill

- The Department of Space has released a draft Space Activities Bill, 2017.
- Currently, space activities are regulated by policies such as the Satellite Communication Policy, 1997 and Remote Sensing Data Policy, 2011.
- The proposed Bill addresses the need for a legal environment for orderly performance and growth of the space sector.
- It aims at encouraging both the public and private sectors to participate in the space programme.
- The Bill specifically facilitates for the participation of non-governmental/private sector agencies in space activities in India.

Key Provisions

- The provisions of the legislation shall apply to every citizen of India.
- And also to all sectors engaged in any space activity in India or outside India.
- **Regulatory mechanism** - The central government is responsible for setting mechanisms and promoting space activity.
- This includes exploration and use of outer space, and development of the sector.
- The central government can:
 1. grant, transfer, or terminate licenses to any person for commercial space activities
 2. provide professional and technical support, and authorisation to launch or operate space objects
 3. regulate the procedures for conduct and operation of space activity by monitoring the conformity with international space agreements to which India is a party
 4. ensure safety requirements and investigate any incident or accident in connection with the operation of a space activity
- **Licences** - A non-transferable licence shall be provided by the Central Government to any person carrying out commercial space activity.

- A license granted by the central government includes -
- permission for the central government to inspect any space activity and documents related to space activity
- obligation on the licensee to insure himself/herself against any liability incurred due to any activity authorised by the license
- **Liabilities** - A licensee should compensate the central government against claims brought against the government.
- This would be regarding damages arising out of commercial space activities covered under the license.
- **Penalties** - The draft Bill provides for penalties in case of:
 1. unauthorised commercial space activity
 2. furnishing false information or documents
 3. causing environmental damage
 4. entry into prohibited areas
 5. disclosure of restricted information
- Protection of action taken by the central government i.e. no legal proceedings can lie against the central government with respect to anything done in good faith in pursuance of space activity.
- **IPR** - Intellectual property rights developed during the course of space activity will be protected under the law.
- Further, any intellectual property right developed onboard a space object in outer space will be deemed to be the property of the central government.

1.93. World's most powerful X-ray laser

- The world's most powerful X-ray laser has begun operating at a facility in Hamburg, Germany.
- It will help scientists to recreate the conditions deep inside the sun and produce film-like sequences of viruses and cells.
- It will help unravel ways to make new antibiotics and even create a new form of diamond.
- The machine, called the European X-ray Free Electron Laser (XFEL), acts as a high-speed camera that can capture images of individual atoms in a few millionths of a billionth of a second.
- XFEL is the world's third major X-ray laser facility. Projects in Japan and the US have already spawned major advances in structural biology and materials science.
- The facility hosts the world's longest superconducting linear accelerator, designed to provide the energy needed to generate X-ray flashes a billion times brighter than the best conventional radiation sources.
- It will also house a powerful optical laser to go alongside the X-ray gun, which scientists will use to exert extraordinary pressures on materials in order to reproduce conditions similar to those at the centre of the Earth or inside the Sun.

1.94. New form of Matter

- Scientists have proven the existence of new form of matter called excitonium.
- There are five known phases, or states, of matter: solids, liquids, gases, plasma and Bose-Einstein condensates.
- The main difference in the structures of each state is in the densities of the particles.
- Excitonium is a condensate.
- It is made up of particles known as excitons, which are made from an escaped electron.
- It exhibits phenomena like a superconductor.



2. DEFENCE TECHNOLOGY

2.1 Swathi

- It is a Weapon Locating Radar (WLR), developed by DRDO's Electronics & Radar Development Establishment (LRDE).
- It provides fast, automatic and accurate location of all enemy weapons like mortars, shells and rockets firing within in its effective zone of coverage.
- It simultaneously handles multiples projectiles fired from different weapons at different locations.
- The system is capable of adjusting the fire of our own artillery weapon too.
- Thus WLR has two roles to perform i.e. Weapon Location Mode for enemy Artillery and Direction of Own artillery Fire (DOOAF) Mode for our own Artillery.

2.2 Recce Vehicle

- The NBC Recce Vehicle Mk-I, is developed by Vehicles Research & Development Establishment (VRDE).
- It is designed for carrying out post event reconnaissance (recce) of Nuclear, Biological and Chemical Contaminated areas.
- It is capable of collecting solid and liquid samples of biologically contaminated areas, mark the nuclear and chemical contamination zone and transfer the recce data speedily to support formations.

2.3 Tapas-201

- DRDO successfully carried out the maiden flight of TAPAS 201 (RUSTOM – II) recently.
- It is a Medium Altitude Long Endurance (MALE) UAV.
- It is being developed to carry out the Intelligence, Surveillance and Reconnaissance (ISR) roles for the three Armed Forces with an endurance of 24 hours.
- It is capable to carry different combinations of payloads like Medium Range Electro Optic (MREO), Long Range Electro Optic (LREO), Synthetic Aperture Radar (SAR), Electronic Intelligence (ELINT), Communication Intelligence (COMINT) and Situational Awareness Payloads (SAP) to perform missions during day and night.
- RUSTOM-1 is also a MALE - UAV developed by DRDO with an endurance of 12-15 Hours.

2.4 Quick Reaction Surface to Air Missile (QRSAM)

- It is an indigenously developed short range surface to air missile.
- The missile has a strike range of 25 to 30 kms.
- It has an all- weather weapon system capable of tracking and firing, and it is the second developmental trial of the state-of-the-art missile with an aerial target.
- Recently, it was successfully test-fired from a test range from the launch pad Chandipur, along the Odisha coast.

2.5 Brahmos

- The BrahMos 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.
- It has an effective strike range of around 290-300 km.
- 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.

2.6 Nirbhay

- It is India's first indigenously designed and developed Long Range Sub-Sonic Cruise Missile.
- It can be deployed from multiple platforms.



- It was successfully test fired from the Integrated Test Range (ITR), Chandipur, Odisha.
- The missile has the capability to loiter and cruise at 0.7 Mach, at altitudes as low as 100 m.
- The Mach number is defined as the ratio of the speed of the aircraft to the speed of sound i.e Mach 1 means the velocity is equal to the speed of sound.
- When the velocity exceeds the speed of sound is called supersonic and if it is less than the speed of sound it is called subsonic.

2.7 Barak-8

- A missile system is being jointly developed by DRDO India and M/s Israel Aerospace Industry (IAI).
- Israel refers this missile as Barak-8 missile system (upgraded version of BARAK Missile System).
- It includes Long Range Surface-to-Air Missile (LR-SAM) and Medium Range Surface-to-Air Missile (MR-SAM).
- LR-SAM is the Ship Launch Version and Project MR-SAM is the Land Launch Version of Barak-08 Missile system.
- MR-SAM detects incoming enemy aircraft while they are well over 100 km away and destroys them at range upto 70 km.
- LR-SAM has got long range engagement capability to penetrate in deep water/land to intercept all types of aerial targets (like Subsonic & Supersonic Missiles, Fighter Aircraft, Maritime Patrolling Aircraft (MPA), Helicopter and Sea Skimming Missiles).

2.8 AKASH Missile

- It is a short-range surface-to-air missile (SR SAM) system with indigenous radio frequency seeker.
- It has a range of 25 km.
- It can simultaneously engage multiple targets in all weather conditions.
- It also has a large operational envelope from a low altitude of 30 metres to a maximum of up to 20 km.

2.9 AGNI- V

- Recently India test-fired Agni-V, an Inter-Continental Ballistic Missile in its final operational configuration.
- Agni V is a nuclear capable missile, which can reach the northern-most parts of China with its strike range of over 5,000-km.
- The missile is over 50-tonne and designed to carry a 1.5-tonne nuclear warhead.
- It is considered to be a credible strategic deterrent against India's aggressive foes.
- It is part of the Agni series surface to surface missiles indigenously developed by DRDO under the Integrated Guided Missile Development Program (IGMDP).

2.10 Prithvi-II

- India successfully test-fired its indigenously developed nuclear capable Prithvi-II missile from a test range in Odisha.
- The surface to surface missile has strike range of 350 km.
- It is capable of carrying 500-1,000 kilogram of warheads and is thrust by liquid propulsion twin engines.
- The state-of-the-art missile uses advanced inertial guidance system with manoeuvring trajectory to hit its target.

2.11 ASTRA

- The ASTRA weapon system is an indigenously developed air-to-air Beyond Visual Range (BVR) missile developed by the DRDO.
- It comprises a launcher and a missile and it is designed as a BVR missile with a long range of 110 km and short range of 20 km.
- BVR missiles are the latest in air-to-air combat.
- It will be inducted into IAF later this year and this would be the IAF's first indigenous air-to-air BVR missile.

- It was recently test fired from Russian-origin Sukhoi-30 MKI fighter aircraft.

2.12 Ballistic Missile Defence Programme

- India's Ballistic Missile Defence (BMD) system is concentrated on tracking and destroying incoming hostile missiles both inside (endo) and outside (exo) the earth's atmosphere.
- The BMD program includes a two-tiered system consisting of two interceptor missiles, namely Prithvi Air Defence (PAD)/ Pradyumna for high altitude interception (50-80 km) and Advanced Air Defence (AAD)/ Ashwin Ballistic Missile Interceptor for lower altitude interception (15-30 km).
- The Prithvi Defence Vehicle (PDV) is being developed by DRDO which is set to replace the existing PAD.
- Terminal High Altitude Area Defense (THAAD) is the name of an American anti-ballistic missile defense system designed to shoot down short-, medium-, and intermediate-range ballistic missiles.

2.13 PINAKA

- Pinaka Rocket Mark-II is a multiple rocket launcher produced developed by DRDO.
- It has been now equipped with a navigation, guidance and control kit and has been transformed to a Guided Pinaka.
- This conversion has considerably enhanced the range and accuracy of Pinaka.

2.14 Anti-Tank Missile Nag

- DRDO Successfully Test-fires Anti-tank Missile Nag in Rajasthan.
- Nag is a third-generation, **fire-and-forget**, anti-tank guided missile developed by India's state-owned DRDO to support both mechanised infantry and airborne forces of the Indian Army.
- The missile incorporates an advanced passive homing guidance system and possesses high single-shot kill probability.
- It is designed to **destroy modern main battle tanks** and other heavily armoured targets.
- Nag can be launched from land and air-based platforms.

2.15 Spike and Nag Missile

- **Spike** missile is an **Israeli** fourth generation anti-tank guided missile.
- It is developed and designed by Israeli company Rafael Advanced Defence Systems.
- India is looking to purchase it, which will compete with the **Nag** missile, developed by the Defence Research and Development Organisation (**DRDO**).

2.16 K-4 Missile

- The entire K family of missiles is a series of submarine-launched ballistic missiles (SLBM) developed by India to boost its second-strike capabilities.
- 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 Ring 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.
- Indian scientists claim that the missile is highly accurate with a near zero circular error probability.
- 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).

2.17 Muntra

- Muntra is the country's first **unmanned tank** developed by Defence Research and Development Organisation (DRDO).

- Muntra is unmanned, remotely operated tank which has three variants such as Muntra-S, Muntra-M and Muntra-N.
- Muntra-S is the country's first tracked unmanned ground vehicle developed for unmanned surveillance missions.
- Muntra-M is for detecting mines, and Muntra-N is for operation in areas where there is a nuclear radiation or bio weapon risk.

2.18 Smart Anti-Airfield Weapon (SAAW)

- It is an indigenously designed 120 kg. class smart weapon.
- It is capable of engaging ground targets with high precision up to a range of 100 kms.
- It has higher precision and is much cheaper compared to missiles.
- It is intended against runways, bunkers, aircraft hangers and other reinforced structures.



2.19 KAB-1500 bombs

- India has announced its first proposal for procurement of 240 KAB-1500 bombs, from Russia.
- It is a precision guided weapon which uses laser for precision guidance.
- It will be used in IAF's Sukhoi Su-30MKI fighter jets.
- It is designed to destroy ground targets such as railway lines, ammunition depots, bridges, military facilities and ships.
- The bomb has folding fins that allow it to manoeuvre while being guided to the target.

2.20 Smart Anti Airfield Weapon

- The Defence Research and Development Organisation (DRDO) have successfully tested Smart Anti Airfield Weapon (SAAW).
- It is an indigenously developed light weight glide bomb, capable of targeting large enemy infrastructure, like airfields.
- It is a long range precision-guided anti-airfield weapon.
- It is guided through precision navigation system.
- It can reach the targets at greater than 70 km range with high accuracies.

2.21 NETRA

- Netra is the first indigenously built Airborne Early Warning and Control System (AEW&C) developed by DRDO.
- It is light-weight autonomous UAV for long range surveillance and reconnaissance operations.
- This radar system is mounted on Embraer aircraft which gives 240-degree coverage of airspace.
- It helps to detect and track aircraft, missiles, ships and vehicles.
- The other countries which have developed AEW&C are United States, Russia and Israel.
- For the first time, an IL-78 refueller aircraft has recently carried out air-to-air refuelling of the Embraer aircraft.
- Air-to-air refuelling allows the aircraft to stay airborne much beyond their limits, allowing better exploitation of capabilities.

2.22 IL-78 Refueller Aircraft

- It is a multi-purpose four-engine turbofan strategic airlifter designed by the Russia.
- The IAF is one of the few air forces in the world to operate mid-air refuellers. It now operates six Russian IL-78 refuellers.

- The name of the air-to-air refuelling method is 'Probe and Drogue'.

2.23 Dakota DC3 Aircraft

- Air Chief Marshal (ACM) B.S. Dhanoa received a restored World War-II DC3 Dakota aircraft from an IAF veteran.
- The gift deed was signed between ACM Dhanoa and Air Cdre (Retd) Chandrasekhar at a handover ceremony.
- The DC3 Dakota aircraft Parashurama bearing the Tail Number VP-905 will be part of the IAF's vintage fleet.
- DC-3 transport aircraft, the world's first successful commercial airliner, readily adapted to military use during World War II.

2.24 ATAGS

- Advanced Towed Artillery Gun System (ATAGS) is a indigenous artillery gun which has set a new world record in range by hitting targets at a distance of 48 km.
- It is being jointly developed by the DRDO and the private sector.
- The development is being done through a consortium based model, similar to that adopted for the pinaka multi-barrel rocket launch system.
- The Army has not inducted any new artillery gun since the Bofors in the 1980's.
- Last year, India signed a contract for 145 M-777 Ultra-Light Howitzers from the US.

2.25 Trawl System

- DRDO has recently undertaken the indigenous development of Trawl System.
- Trawl System is employed for breaching of land mines and creating a vehicle safe lane, for the advancement of mechanized forces in combat zone.
- The indigenous development is an important step towards achieving self-reliance in area of critical military equipment under 'Make in India' initiative.

2.26 Integrated Automatic Aviation Meteorological System (IAAMS)

- It is an ambitious project of the Indian Navy to modernise the meteorological infrastructure of the nine Naval Air Stations (NAS).
- INS Rajali at Arakkonam was identified for setting up this sophisticated system.
- It is equipped with the state of the art Meteorological Sensors viz., Radar Vertical Wind Profiler, Transmissometer, Ceilometer and Automatic Weather Observation System,
- It undertakes automatic and continuous recording of relevant weather parameters.
- It has a special alarm feature that alerts the duty staff during abnormal change of weather that may affect safe flying.
- The project will give a major fillip to aviation safety, through automation of weather monitoring process.

2.27 PROJECT-15B

- The Project 15B/ Visakhapatnam Class destroyer is a class of guided missile destroyers.
- It comprises of four ships - Visakhapatnam, Mormugao, Paradip and Porbandar all of which are being built by the Mazagon Dock Limited (MDL), for the Indian Navy.
- Visakhapatnam and Mormugao are already launched.
- Project 15B is an improved variant of the Kolkata-class destroyers.
- In 2011, the government had sanctioned four 15B ships at the cost of Rs 29,700 crore.
- The Project 15B ships retain the hull design of Kolkata-class destroyers (Project 15A), but will also incorporate advanced stealth features and a high degree of automation.
- Project 15A includes INS Kolkata, INS Kochi and INS Chennai.
- Similarly Project 15A is a follow-on of the Project 15 i.e Delhi-class destroyers, which include INS Delhi, INS Mumbai and INS Mysore.



2.28 Scorpene-class submarine

- Recently, **INS Khanderi**, the second of the six Scorpene class submarines has sailed out from Mumbai harbour.
- The first Scorpene-class submarine **INS Kalvari** has already undergone various trials and is expected to be inducted into the Indian Navy later this year.
- Six Scorpene-class submarines are being built under '**Project 75**' of the Indian Navy.
- The Project 75I-class submarine is a follow-on of the Project 75 Kalvari-class submarine for the Indian navy.
- Under this project, the Indian Navy intends to acquire 6 diesel-electric submarines, which will also feature advanced **Air Independent Propulsion (AIP) systems** to enable them to stay submerged for longer duration and substantially increase their operational range.
- The submarines of Scorpene class are propelled by diesel-electric engines and Torpedo is mounted as a primary weapon.
- It will have both anti-surface and anti-submarine warfare.
- It also features an additional air-independent propulsion (AIP) system.
- Conventional diesel-electric submarines have to surface every few days to get oxygen to recharge their batteries. With AIP systems, they can stay submerged for much longer periods.

2.29 INS Karanj

- The Indian Navy has launched the third Scorpène class submarine Karanj.
- It has been constructed by shipbuilder Mazagon Dock Limited (MDL) with collaboration of French shipbuilding major Naval Group (formerly DCNS).
- The submarine will undergo rigorous tests for the next one year before it is commissioned.

2.30 Project 28

- Project 28 is a class of anti-submarine warfare corvettes currently in service with the Indian Navy.
- They are the first anti-submarine warfare stealth corvettes to be built in India.
- The Project was approved in 2003, with construction of the lead ship, INS Kamorta commencing on 2005.
- Three of the four corvettes, INS Kamorta and INS Kadmat, INS Kiltan were commissioned in 2014, 2016 and 2017 respectively.
- INS Kavaratti is under construction and slated to be completed by end of 2017.

2.31 INS Chakra

- INS Chakra belongs to Akula-class nuclear powered Submarine.
- It was taken from Russia on a 10 year lease period.
- Originally named as K-152 Nerpa, it was handed over to the Indian Navy in 2011.
- Though it is a nuclear powered submarine, it carries only conventional weapons and not nuclear tipped missiles.
- It is based at INS Virbahu, the submarine base in Visakhapatnam.
- It is the second nuclear submarine after the indigenously built INS Arihant.
- INS Arihant is capable of launching nuclear-tipped submarine ballistic missiles.

2.32 INS Vikramaditya

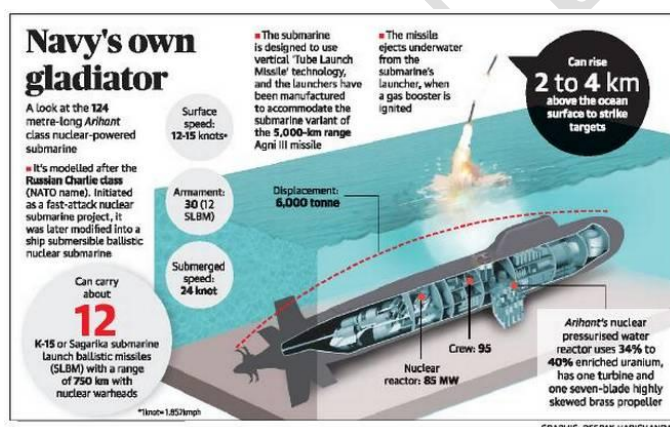
- US team members of joint working group (JWG) on aircraft carrier cooperation have been allowed to visit and operate Russian built Aircraft INS Vikramaditya.
- INS Vikramaditya is a Kiev class aircraft carrier which was commissioned by Russian Navy in 1987 under the name Baku.
- It was later renamed as Admiral Gorshkov and later offered to India in 2004.
- It is the biggest and heaviest ship to be operated by the Indian Navy.

2.33 INS Vishal

- INS Vishal is a follow up of INS Vikrant class air craft carriers.
- It is currently being built by Cochin Shipyard limited for the Indian Navy.
- It is intended to be the first supercarrier to be built in India.
- It would be a 65,000-70,000 tonne, nuclear-powered vessel that launched aircraft with an "electro-magnetic aircraft launch system (EMALS)".
- EMALS uses electro-magnetic energy to catapult aircraft to launch speed.
- India's selection of EMALS would allow the US a place in the design of the ship.

2.34 INS Arihant

- INS Arihant is India's only operational ship submersible ballistic nuclear (SSBN) asset.
- It is its most dependable platform for a second-strike.
- This is because the other options, land-based and air-launched, are easier to detect.
- Arihant has been immobilised after 'accident' 10 months ago
- It can stay undetected deep underwater for long periods and ranges far and wide.
- INS Arihant and other nuclear launch platforms are operationally handled by the Strategic Forces Command.
- They report to the Nuclear Command Authority chaired by the Prime Minister.
- However, over 100 nuclear warheads are not mated with missiles or bombs and remain in civilian custody of the Atomic Energy Department and the DRDO.



2.35 INS Aridhaman

- It is India's second strategic **nuclear submarine** which is going to be launched soon.
- Aridhaman belongs to Arihant class submarine, carrying ballistic missiles and powered by light water nuclear water.
- It will carry K-15 and K-4 ballistic missiles as does INS Arihant.
- K-4 is an intermediate range ballistic missile that can hit targets as far as 3500 km.
- INS Arihant was inducted into service in 2016.
- It made India the only country apart from the five permanent members of the UN Security Council to operate a homemade nuclear U-boat.
- Nuclear submarines are those that are powered by onboard nuclear reactors whereas conventional submarines generate energy by burning diesel, which requires air.

2.36 INS Kiltan

- It is the indigenously-built **anti-submarine warfare stealth corvette**.
- It has been recently inducted into the Indian Navy.
- It is the latest indigenous warship after Shivalik Class, Kolkata Class and sister ships INS Kamorta and INS Kadmat.
- It is India's first major warship to have a superstructure of carbon fibre composite material resulting in improved stealth features.
- The ship derives its name from one of the islands in Aminidivi group of the Lakshadweep and Minicoy group of islands.



2.37 INS Sukanya

- The Sukanya-class patrol vessels are large, offshore patrol craft in active service with the Indian Navy.
- Currently there are 3 lead ships under this class – INS Sukanya, Subhadra and Suvarna.
- INS Sukanya has recently participated in the bilateral exercise CORPAT (Coordinated Patrol) between India and Indonesia.
- The exercise is aimed to foster closer maritime ties with countries located on the rim of the Indian Ocean.

2.38 ICGS Vajra

- The Indian Coast Guard ship 'Vajra', was decommissioned in Paradip.
- The Indian Coast Guard ship rendered three decades of service in maritime security along the northeast coastal waters.
- The ship monitored the coastal activities along with Odisha and West Bengal.
- It was built by Mazagon Dock, named 'Vajra', after the weapon of Lord Indra, and commissioned on 1988.

2.39 Vikram Class offshore Patrol Vessel

- Vikram is the first of a series of seven offshore patrol vessels (OPV).
- OPV are long-range surface ships capable of coastal and off-shore patrolling, policing maritime zones, control & surveillance, anti-smuggling and anti-piracy operations.
- It is the country's first-ever such defence craft to be built in a private shipyard (L&T).
- It is likely to be inducted into the Indian Coast Guard in April 2018.

2.40 INS Vagli

- It is a **Submarine** designed by **Russia** and commissioned into the Indian Navy in 1974 and decommissioned in 2010.
- After its decommissioning, Tamil Nadu government has decided to set it up as a maritime museum near the shore temple of Mamallapuram, a UNESCO World Heritage Site.
- In its recent report, the CAG has questioned the wasteful resource incurred in setting up the museum due to lack of proper planning.

2.41 US-2 Amphibian

- It is Japan's aircraft, designed for air-sea rescue work.
- The Indian government has been keen on acquiring the US-2i as part of their expanding bilateral strategic partnership.
- The aircraft requires only one fourth of the distance that commercial airlines require for takeoff and landing.
- The aircraft has an approximate operational range of 4500 km and a cruise speed of 480 km/hr. It does not require runway construction.

2.42 Shaurya

- Shaurya is an Indian Coast Guard ship, recently commissioned in Goa.
- It is the fifth in the series of six 105-metre offshore patrol vessels (OPVs).
- It features integrated bridge system, integrated machinery control system, power management system and high-power external fire fighting system.

2.43 Navika Sagar Parikrama

- It is a project wherein a team of women officers of the Indian Navy would circumnavigate the globe on an Indian-built sail boat INSV Tarini.
- This is the first ever Indian circumnavigation of the globe by an all-women crew.
- The project is considered essential towards promoting Ocean Sailing activities in the Navy.

2.44 INS Tarasa

- INS Tarasa, a Water Jet Fast Attack Craft was commissioned into the Indian Navy.



- It is primarily designed for extended coastal and offshore surveillance and patrolling.

2.45 Kamov Ka-226T

- Russia plans to deliver 10 Kamov Ka-226T military helicopters to India in a first tranche as part of a \$1-billion deal, signed in Indo-Russia Summit in Moscow, 2015.
- The Kamov 226T is a light weight, twin-engine multi-role chopper offers services for both military and civilian purposes.
- It will replace India's ageing fleet of Cheetah and Chetak.
- The military version is capable of working in extreme and difficult weather conditions such as hot climate, marine areas and high mountains.
- The helicopter has a maximum speed of 250 km/hour and maximum takeoff weight is 3,600 kg.

| 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.*

2.46 Indra-2017

- The eighth edition of India-Russia 'Indra' exercise between the armies of the two strategic partners had taken place in mountainous Vladivostok in Russia.
- The main focus of the joint exercise was counter-terrorism.
- The Indian Army and the Indian Navy has been having the military exercise 'Indra' with Russia separately. The Indian Air Force had participated in an exercise 'AviaIndra' with Russian air force in 2014.
- This year will see the first ever Tri-services exercise INDRA-2017.

2.47 International Maritime Search and Rescue Exercise (IMMSAREX)

- Bangladesh, the current Chair of Indian Ocean Naval Symposium (IONS) is scheduling a International Maritime Search and Rescue Exercise (IMMSAREX) in November in the Bay of Bengal.
- The IONS is a regional forum of Indian Ocean littoral states, launched in 2008.
- The Voluntary initiative seeks to increase maritime co-operation among navies of the littoral states of the Indian Ocean Region.
- It presently has 23 members and 9 observers.
- China will be participated in the Rescue Exercise as an observer.

2.48 Mega War Games

- India and Russia will hold a mega war game in October involving their armies, navies and the air forces to further ramp up military ties.
- It will be the first time both Russia and India carry out an **integrated tri-services exercise**.
- It will be for the first time India will participate in a tri-services exercise with a foreign country with such large scale participation by the Navy, the Army and the Air Force.
- The armies, navies and air forces of Russia are holding bilateral exercises separately such as
 - Exercise INDRA – Joint Exercise conducted by both Armies
 - Exercise INDRA NAVY - Joint Exercise conducted by both Navies
 - Exercise AVIAINDRA-14 - Joint Exercise conducted by both Air Forces.

2.49 Mitra Shakti

- It is **India-Sri Lanka** joint military exercise.
- It had started in 2012 as a response to China's efforts to increase its influence in South Asia and the Indian Ocean region.
- This year exercise, fifth in the series will be held in Pune.
- The armies of India and Sri Lanka also serve together in the United Nations Peacekeeping missions.

2.50 VARUNA

- Recently, India and France discussed about enhancing the scope of their joint exercises, in particular the **VARUNA naval exercise** scheduled in early 2018.
- Both countries will also actively explore additional measures to facilitate operational level interactions between their respective armed forces.

2.51 Shekatkar Committee

- The 11 member committee headed by Lt. Gen. Shekatkar was appointed by Defence Ministry to recommend reforms in Indian Army, Navy and Air Force for enhancing combat compatibility
- They submitted the report in December, 2016.
- They gave 99 recommendations including, increasing the deployment of soldiers for active combat in the Indian Army and redeployment of civilian in different wings of the Armed Forces and improving efficiency of National Cadet Corps (NCC).
- The first batch of reforms has been accepted recently by Defence ministry and will be operationalized in 2019.

2.52 Pralay Sahayam

- Ministry of Defence hosted a multi-agency exercise "Pralay Sahayam" on the banks of Hussain Sagar Lake in Hyderabad.
- The event demonstrated efforts of all central and state agencies, NDRF and the Armed Forces towards jointly tackling an urban flooding scenario in Hyderabad.

2.53 Exercise Yudh Abhyas – 2017

- It is a joint military training, being conducted at Joint Base Lewis McChord, Washington, USA between India and USA, as part of the ongoing defence cooperation.

- It is one of the largest joint running military training and defence corporation endeavors between India and USA.
- It will provide an opportunity to the armed forces of both countries to train in an integrated manner at Battalion level with joint planning at Brigade level.
- Multiple scenarios will be rehearsed with a view to understand each-other's organisational structure and battle procedures.
- Experts from both sides will also hold expert academic and military discussions to share each other's experiences on varied topics for mutual benefit.

2.54 Exercise Blue Flag

- Blue Flag is a bi-annual multilateral exercise which aims to strengthen military cooperation amongst participating nations.
- This year **Indian Air Force** will be a part of this exercise which is going to be conducted in Israel.
- This is the first time the Indian Air Force is operating with **Israeli Air Force** in a multilateral exercise setting.
- The exercise would provide a platform for sharing of knowledge, combat experience and in improving operational capability of the participating nations.

2.55 Prabal Dostyk

- It is a joint training exercise between the **Indian Army and the Kazakhstan Army**.
- It is aimed at enhancing the military ties between the two countries.
- The 2017 version is going to be conducted in Bakloh, Himachal Pradesh.

2.56 SAMPRITI

- It is **Indo-Bangladesh Training** Exercise aimed to strengthen and broaden the aspects of interoperability and cooperation between the Indian and Bangladesh Armies.
- It is the seventh such exercise in the SAMPRITI series and being organized in Mizoram this year.

2.57 ENCORE

- The Eastern Naval Command Operational Readiness Exercise (ENCORE), Theatre Level Readiness and Operational Exercise concluded on the Eastern Seaboard by the Indian Navy and Indian Air Force aircrafts.
- The exercise was conducted in phases to test various facets of war-fighting capabilities of the combat units.
- The exercise was conducted in real time covering a vast expanse of Indian Ocean Region (IOR).

2.58 Operation Cactus

- In 1988 a group of Maldivians led by Abdullah Luthufi tried to overthrow then Maldivian Government.
- The attempt was a failure due to the intervention of the Indian Armed Forces.
- The operation was code named as Operation Cactus.
- INS Godavari and Betwa were used by the Indian Navy in the operation

2.59 Exercise MILAN

- Milan is a eight-day mega naval exercise with an aim to expand regional cooperation and combat unlawful activities in critical sea lanes.
- The exercise is being hosted by the Indian Navy under the aegis of the Andaman and Nicobar Command.
- It is a biennial exercise that will host navies from 16 countries.
- 'Milan' was first held in 1995 with the participation of five navies.
- The aim of the initiative was to have an effective forum to discuss common concerns in the Indian Ocean Region and forge deeper cooperation among friendly navies.

3. BIOTECHNOLOGY

3.1 Stem Cells

- Stem cells differ from other kinds of cells in the body.
- They have the remarkable potential to develop into 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.

3.2 Miniature Eyes

- Researchers from Hyderabad have successfully grown miniature eye-like organs that closely resemble the developing eyes of an early-stage embryo.
- The miniature eyes were produced using **induced pluripotent stem (iPS) cells**.
- iPS are a type of pluripotent stem cell that can be generated directly from adult cells through **epigenetic reprogramming**.
- The iPS cells are produced by genetically manipulating human skin cells to produce embryonic-like stem cells that are capable of forming any cell types of the body.

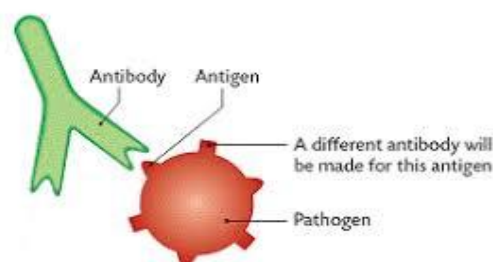
3.3 Draft Guidelines for Stem Cell Research

- 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 than Umbilical 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 ensheathing 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.

3.4 Human Antibodies in Lab

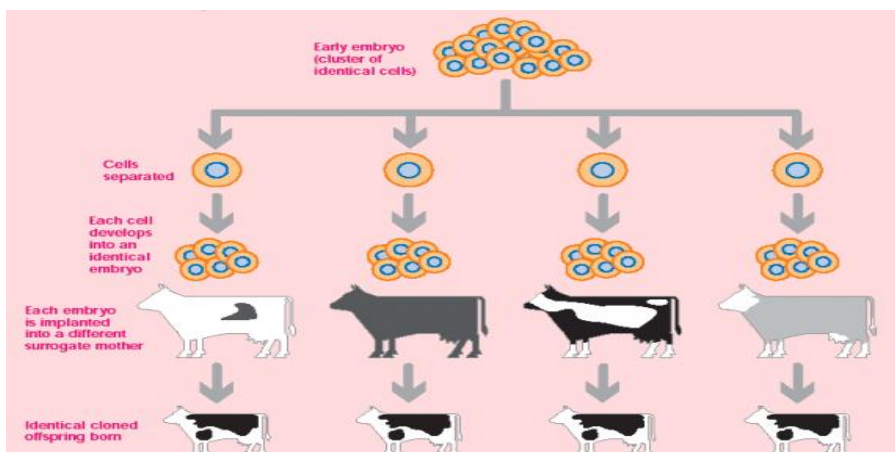
- Scientists have recently produced human antibodies in the laboratory for the first time. It could usher the rapid development of new vaccines to treat a wide range of infectious diseases.
- **Antibodies**, also called immunoglobulins, are proteins manufactured by the body that help fight against foreign 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**.



3.5 Embryo Transfer Technology

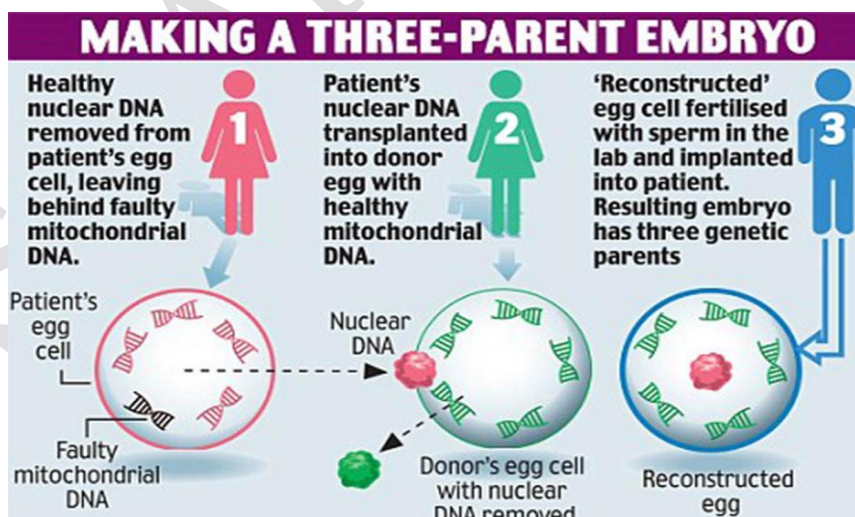
- Government has undertaken a Mass Embryo Transfer programme in Indigenous Breeds under National Mission on Bovine Productivity.
- Embryo transfer refers to a step in the process of assisted reproduction in which embryos are placed into the uterus of a female with the intent to establish a pregnancy.
- It is implemented with the objective of conservation and development of indigenous breeds under RashtriyaGokul Mission.
- Under this programme, embryos of higher genetic merit indigenous bovines are being transferred in to surrogate cows.

- Embryos of Indigenous breeds such as Sahiwal, Gir, Red Sindhi, Ongole, Deoni and Vechur have been proposed to be transferred under this programme.



3.6 Three Parent Baby

- Authorities in the UK have permitted doctors to create the country's first 'three-parent' babies.
- 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.

3.7 Gene Editing

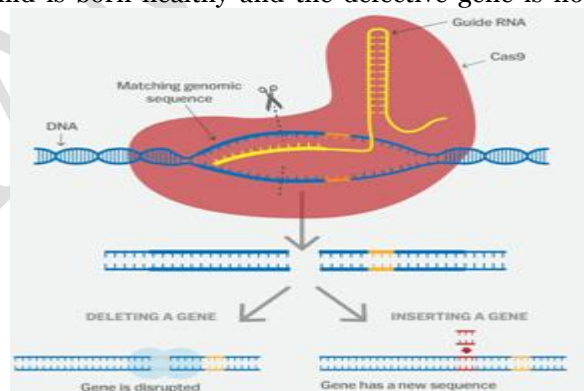
- CRISPR –Cas9 is the most recent prominent genome editing technique.
- CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats.
- It allows researchers to permanently modify genes in living cells and organisms by targeting specific stretches of genetic code to edit DNA at precise locations.
- 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.
- 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.
- 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.

Genome

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

Recent Developments

- Recently, a team in china has corrected genetic mutations in three normal human embryos using this technique and it is the first to describe the results of using CRISPR in viable human embryo.
- Researchers has recently used genome editing tool “CRISPR – Cas9” to partially treat the genetic deafness in mice.
- A single mistake in “Tmc1 gene” causes loss of inner ear hair cells leading to deafness.
- For the first time, scientists in the US have successfully used gene-editing tools on human embryos to correct defective DNA that cause inherited diseases.



3.8 Groundnut crop free of toxin

- Researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad have recently used the gene silencing technique to keep groundnuts free of **aflatoxin** contamination.
- Aflatoxin is a toxin produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*.
- Researchers deployed two strategies to prevent groundnuts being infected by the fungus.
- One is inserting two alfalfa (flowering plant of pea family) genes to enhance immunity against fungal infection and growth.
- Another is preventing aflatoxin production even in case of any infection through a plant-induced **gene silencing technique**.

Gene Silencing Technique

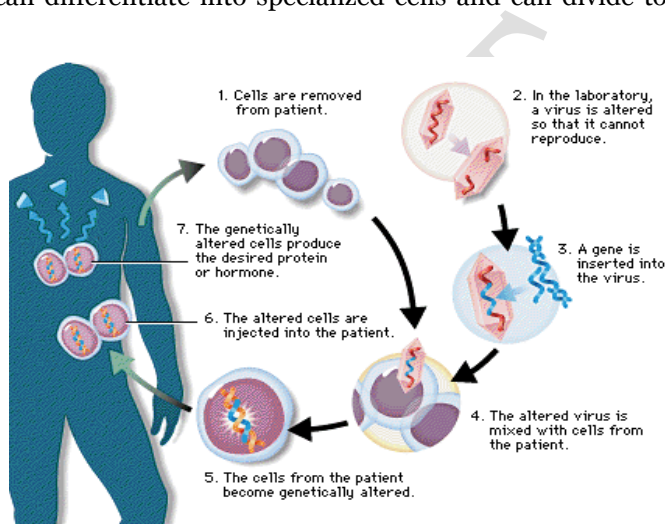
- Gene silencing is a technique that aims to reduce or eliminate the production of a protein from its corresponding gene.
- It generally describe the “switching off” of a gene by a mechanism other than genetic modification
- It occurs when RNA is unable to make a protein during translation (gene expression).
- In the groundnut case, the researchers designed two small RNA molecules that silence the fungal genes which produce aflatoxin.
- When the fungus and plant come in contact with each other the small RNA molecules from the plant enter the fungus and prevent it from producing aflatoxin (protein) by its corresponding gene.

3.9 Human Egg grown to maturity in lab

- Scientists have succeeded for the first time in growing human eggs in a laboratory from the earliest stages in ovarian tissue all the way to full maturity.
- It is the first-time human egg was developed outside the human body.
- If the success rate and safety measures are improved, the process may help in preserving the fertility of cancer patients, improving fertility treatments, and deepening scientific understanding of the biology of the earliest stages of human life.
- Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide to produce more stem cells.
- There are two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues.

3.10 Gene Therapy for Cancer

- The United States has recently approved the first gene therapy to fight childhood leukaemia.
- 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.
- 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.



Leukaemia

- Leukemia is cancer of the blood cells. Most blood cells form in the bone marrow.
- In leukemia, immature blood cells become cancer.
- These cells do not work the way they should and they crowd out the healthy blood cells in the bone marrow.
- It occurs most often in persons older than 55 years, but it is also the most common cancer in children younger than 15 years.
- Different types of leukemia depend on the type of blood cell that becomes cancer.
- For example, lymphoblastic leukemia is a cancer of the lymphoblasts (white blood cells, which fight infection). White blood cells are the most common type of blood cell to become cancer.

| SOMATIC CELL GENE THERAPY | GERM LINE GENE THERAPY |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> Therapeutic genes transferred into the somatic cells. Eg. Introduction of genes into bone marrow cells, blood cells, skin cells etc. Will not be inherited later generations. At present all researches directed to correct genetic defects in somatic cells. | <ul style="list-style-type: none"> Therapeutic genes transferred into the germ cells. Eg. Genes introduced into eggs and sperms. It is heritable and passed on to later generations. For safety, ethical and technical reasons, it is not being attempted at present. |

3.11 Bio film

- Bio films are communities of microorganisms that attach to each other and to surfaces.
- They are able to act as barriers to antibiotics.
- During times of hostile conditions, such as increased temperature and presence of antibiotics, bacteria tend to come together and form a bio film to protect them.

- The stress response pathway is crucial for bacteria to survive during hostile conditions.
- Scientists have recently found two new molecules capable of destroying bio film forming bacteria.
- When the molecules combined with antibiotics, it showed efficacy in treating infections caused by multi-drug resistant pathogens.

3.12 Biomarker

- Researchers have recently identified a peptide (biomarker) that could lead to the early detection of Alzheimer's disease.
- Biomarkers are indicators that help in determining the presence or severity of a disease.
- The idea is to establish molecular signatures for complicated cases.
- It is used to have a sound knowledge of the disease progression in different individuals suffering from the disease.
- Alzheimer's is the most common form of dementia, a general term for memory loss.
- It is a progressive disease, where dementia symptoms gradually worsen over a number of years.

3.13 Kinome

- It is the complete set of protein kinases that make up the genome of an organism.
- A protein kinase is an enzyme that modifies other proteins by chemically adding phosphate groups to them.
- It constitutes 2% of all human genes and 30% of all human proteins are modified by kinase activity.

3.14 Flink

- Functional Living Ink (Flink) is a new printing material developed by scientists from Switzerland.
- Flink contains different bacteria as ink which makes it possible to print objects with biochemical properties.
- It allows printing using different inks containing different species of bacteria at different concentrations in order to produce objects exhibiting several properties.
- The ink is composed of a biocompatible hydrogel along with bacteria to give it a structure.
- The culture medium for the bacteria is mixed into the ink so that the bacteria have all the prerequisites for life.

3.15 Plants that can glow

- Scientists have recently found a way to induce plants to give off dim light by embedding specialised nanoparticles into their leaves.
- It is considered as a major step towards using plants to illuminate the workspace, providing low-intensity indoor lighting or transforming trees into self-powered streetlights.
- Scientists embed 3 components in to a different type of nanoparticle carrier.
- It includes luciferase, luciferin and co-enzyme A.
- Luciferase is an enzyme. It is used by the fireflies that give their glow.
- Luciferase acts on a molecule called luciferin, causing it to emit light.
- Co-enzyme A molecule helps the process along by removing a reaction byproduct that can inhibit luciferase activity.
- Optimising the concentration and release rates of these components will boost the light emitted and duration of light.

3.16 Curcumin to treat cancer

- Scientists have recently found that nanoparticles loaded with curcumin can target and destroy neuroblastoma tumour cells.
- Curcumin is the bioactive component of turmeric. A bioactive compound is a compound that has an effect on a living organism, tissue /cell.
- Researchers have attached curcumin to cerium oxide nanoparticles and tested the nano-curcumin formulation.

- The formulation induced substantial cell death in neuroblastoma cells while producing no or only minor toxicity in healthy cells.

3.17 Molecular robot

- Recently scientists have created the world's first 'molecular robot' millionth of a millimetre in size.
- To put that size into context, a billion of these robots piled on top of each other would still only be the same size as a single grain of salt.
- These tiny robots can be programmed to move and build molecular cargo using a tiny robotic arm.
- It can be used to build molecules and may help discover novel drugs.

3.18 Food irradiation Centres

- Under the integrated cold chain scheme, to tide over shortages, post-harvest losses, price rise and to preserve fruits and vegetables, **four irradiation projects** have been approved in U.P, Haryana, Karnataka and Rajasthan recently.
- In irradiation centres, food products are subjected to a low dosage of radiation to treat them for germs and insects, increasing their longevity and shelf life.
- Food can be irradiated only in a food irradiation plant authorised by the Atomic Energy Regulatory Board and licensed by the competent Government Authority.
- The irradiation doses are recommended by the International Atomic Energy Agency (IAEA).

3.19 BIO International Convention

- The BIO International Convention is hosted by the Biotechnology Innovation Organization (BIO).
- Recently, BIO 2017 was held in San Diego and India is represented by Minister of State for Science and Technology and Earth Sciences.
- The key benefits of attending the BIO International Convention are access to global biotech and pharma leaders via BIO One-on-One Partnering, exposure to industry thought-leaders and networking opportunities.
- BIO is the largest trade organization in the world that represents the biotechnology industry.
- The organization was found in 1993 and its members include companies that make Pharmaceutical drugs, biofuels, industrial enzymes, and genetically modified crops.
- The Biotechnology Heritage Award presented annually at the Biotechnology Innovation Organization (BIO).
- The award recognizes individuals who have made significant contributions to the development of biotechnology through discovery, innovation, and public understanding.

3.20 Major Programmes Undertaken by the Department of Biotechnology

Health and Medicine

- **National Biopharma Mission** - was launched by DBT in a bid to create a globally competitive biopharmaceutical industry.
- This brings together industry and academia to promote entrepreneurship and indigenous manufacturing in the bio-pharmaceutical sector.
- This flagship program is run in collaboration with the **World Bank** and will be implemented by the Biotechnology Industry Research Assistance Council (BIRAC), a Public-Sector Enterprise set up by DBT.
- **Brucella-free villages Program** - A pilot was launched in 50 villages covering 10 states by providing for diagnostic kits.
- Brucellosis is a zoonotic disease, seen in animals, and causes economic losses of about 28,000 crores per year.
- **Ready to Use Food (RUTF)** – A nutritional supplement with brand name **BIB POSHAN** and was developed with financial support from DBT.
- This RUTF is issued in 200g packets and supports food formulations to address Severe Acute Malnutrition in children.

- RUTF is made as a paste that can be safely given to a child at home and is given for a fixed amount of time to get a child back to its normal growth.
- **Iron fortification** – Iron fortification in rice and wheat was taken up by the DBT to address Anaemia.
- Anaemia is caused by Iron deficiency and is widespread globally.
- 40% of the children in school going age are reported to be anaemic.
- Cereal flour fortification with iron (Fe) is the most cost-effective and sustainable way in reducing the prevalence of IDA.

Environment

- **Green remediation** – This is a technology for wastewater treatment.
- DBT is participating in the Swachh Bharat Abhiyan through a range of initiatives including bioremediation of filthy water.
- A DBT supported project has developed phytoremediation treatment process for the degradation of dyes from "textile industrial effluent".
- **Rapid Anaerobic Digester Technology** - Developed by the DBT-ICT research centre, this can process both industrial and municipal waste.
- This can handle any bio-waste and generate biogas within 24 hours, with a methane yield of greater than 90% and generates zero waste.
- It is now being scaled up to 2 demonstration /commercial plants.
- **Demetalizer Kit** – Surface water and groundwater around mines are often laced with heavy metals, making them unsuitable for use.
- De-metallizer kit has been developed from biopolymers for removing such heavy metal ions from the surface and underground water bodies.

Sanitation

- **Bio-toilets** - In an effort to promote cleaner toilets that use lesser resources, DBT in collaboration with the Bill and Melinda Gates Foundation (BMGF) has supported many novel bio-toilet technologies.
- Six new bio-toilet technologies have so far been supported and different aspects of waste collection and management process addressed.
- Also, as the waste in septic tanks is a rich source of nutrients for fertilizers, a Goa-based company, has converted this waste to sanitized soil and fertilizers.
- The technology is to improve septic tanks by converting them into "decentralized wastewater treatment system".
- **The Rhino Digester** – Localised treatment of organic waste generated in apartments and societies is an urgent requirement in rapidly developing cities.
- Hence, Rhino Digester was developed, which is a cost-effective appliance for decentralized waste processing, for which trial runs have started.
- It has been designed to be installed at the society, apartment or organization, and can convert all organic content of the waste into readily usable resources.

Agriculture

- **Biotech KISAN scheme** – A farmer-centric programme with the objective to demonstrate, scale-up and address issues of local farmers related to water, soil, seed and marketing, with validated technologies.
- This programme is also expected to create strong a strong interaction platform between scientists and farmers.

Bio-energy

- **Ethanol Project** - DBT, in collaboration with ICT Mumbai has developed a technology to convert biomass to ethanol with speed and efficiency.
- While biomass to bio-fuel conversion takes about 4 to 7 days with prevalent technologies, the new technology does the same in about 18-20 hours.

- It produces about 300 litres of ethanol per ton of biomass and can be blended with petrol to be used in vehicles as fuel.
- Also, **India's first biomass to ethanol plant** for technology demonstration was opened **at Kashipur, Uttarakhand**.
- Subsequently, the technology was transferred to Bharat Petroleum Corporation Limited (BPCL) and Hindustan Petroleum Corporation Limited (HPCL) to build commercial-scale biomass ethanol plants.

Business Opportunities

- **Scented Rice** – North-Eastern Region (NER) of India possesses a rich diversity of Aromatic Rice (AR).
- Aromatic rice varieties, especially “**Joha and Black rice**” are of high value both in terms of their unique and deliciousness and medicinal properties.
- But as these are also poor yielders and susceptible to pest attacks, an innovative approach using biotechnology improve yield has been adopted.
- **Phyto-Pharma Plant Mission** - DBT has announced a Rs.50 crore mission aiming at conservation and cultivation of endangered and threatened endemic medicinal plants of North East India.
- The mission will also involve discovering new botanical drugs for unmet medical needs using the rich traditional ethno-botanical knowledge of the North-East.
- It would, therefore, help in improving the availability of authentic raw material for the phyto-pharmaceutical industry, and enhancing farmer incomes.

Research

- **Brahmaputra Biodiversity and Biology Boat (B4)** – This is a unique mission to construct a laboratory on a boat for doing research at different locations in the North-East Region.
- This well-equipped laboratory would contain facilities for analysis of all components of the entire ecosystem of the river and surroundings.
- This lab will link all the local research institutions as well as national and international laboratories along the Brahmaputra.
- B4 will have the capability to analyse soil, water, environment, plant and animal life, human health and agriculture.

4. HEALTH

4.1 Hepatitis C

- Union Health Ministry has recently announced that National Action Plan on Hepatitis C will be ready by the end of this year.
- Hepatitis is an inflammation of the liver caused by blood borne Hepatitis Virus.
- There are 5 main hepatitis viruses, referred to as types A, B, C, D and E.
- The most common modes of infection are through exposure to contaminated blood or blood products and invasive medical procedures using contaminated equipments.
- It can also be transmitted sexually and be passed from an infected mother to her baby.
- Hepatitis C virus (HCV) is mostly transmitted through exposure to infective blood.
- The incubation period for Hepatitis C is 2 weeks to 6 months.
- Currently, there is no vaccine for hepatitis C; except Hepatitis C, all other hepatitis viruses have safe and effective vaccination to prevent them.
- Note: Hepatitis B is included in India's Universal Immunisation Programme (UIP).

4.2 Avian Influenza

- Influenza is an **acute viral infection** of the respiratory tract and is caused by three types of **RNA viruses** called influenza types A, B and C.
- Influenza type A viruses are known to infect people, birds, pigs, horses, whales, seals and other animals, but wild birds represent the natural hosts for these viruses. Thus it is called as **bird flu virus**.

- H5N8 and H5N1 are subtypes of the Influenza A virus and are considered as highly pathogenic.
- The recent outbreak in Bangalore is caused by H5N1.
- H5N1 virus is transmitted from infected birds to animal species including mammals through their saliva, blood, feces, etc.

4.3 Avian Influenza A(H7N9)

- It is a subtype of influenza viruses.
- This particular A(H7N9) virus was first found in March 2013 in China.
- Since then, infections in both humans and birds have been observed.
- The disease is of concern because most patients have become severely ill.
- Most of the cases of human infection with this avian H7N9 virus have reported recent exposure to live poultry or potentially contaminated environments.
- This virus does not appear to transmit easily from person to person, and sustained human-to-human transmission has not been reported.
- However, Lab experiments on a new strain of the H7N9 bird flu suggest the virus can transmit easily among animals and can cause lethal disease.
- This raise alarm that the virus has the potential to trigger a global human pandemic.

4.4 Swine Flu

- Swine flu is a respiratory disease caused by influenza viruses H1N1 and H3N2.
- They infect the respiratory tract of pigs.
- Swine flu viruses may mutate which makes them easily transmissible among humans.
- They could spread -
 - by airborne respiratory droplets (coughs or sneezes)
 - by saliva
 - by touching a contaminated surface
 - by skin-to-skin contact
- Symptoms of swine flu in humans are similar to most influenza infections.
- These include fever (100 F or greater), cough, nasal secretions, fatigue, and headache.
- The incubation period for the disease is about 1 to 4 days.
- Swine flu is contagious about one day before symptoms develop to about 5 to 7 days after symptoms develop.
- Some patients may be contagious even for a longer time span.
- The most serious complication of the flu is pneumonia.

4.5 Japanese Encephalitis

- It is a mosquito-borne viral infection of the brain.
- Japanese encephalitis virus (JEV) is a flavivirus related to dengue, yellow fever and West Nile viruses, and is spread by mosquitoes.
- There is no cure for the disease. Treatment is focused on relieving severe clinical signs and supporting the patient to overcome the infection.
- JEV is transmitted to humans through bites from infected mosquitoes of the Culex species.
- The virus exists in a transmission cycle between mosquitoes, pigs and/or water birds (enzootic cycle).
- Safe and effective JE vaccines are available to prevent disease and it is one of the vaccines given under Universal Immunisation Programme of India.

4.6 Cholera

- After the 2010 earthquake in Haiti, there was a sudden outbreak of cholera.
- According to a recent study, bacterial strains similar to those found in Haitian cholera were present in Delhi as early as 2004, showing that the disease may have originated in the Indian subcontinent.
- Cholera is an acute diarrhoeal infection caused by ingestion of food or water contaminated with the bacterium *Vibrio cholerae*.
- Diarrhoea can be so severe that it leads within hours to severe dehydration and electrolyte imbalance. It can be successfully treated with oral rehydration solution.
- Cholera transmission is closely linked to inadequate access to clean water and sanitation facilities.
- During the 19th century, cholera spread across the world from its original reservoir in the Ganges delta in India.

4.7 Trachoma

- Trachoma is a chronic disease of the eye caused by infection with the bacterium *Chlamydia trachomatis*.
- It causes blindness or visual impairment. It is the cause for about 1.4% of all blindness worldwide.
- Blindness from trachoma is irreversible.
- It is caused by poor environmental and personal hygiene and inadequate access to water and sanitation.
- According to the National Trachoma Survey Report (2014-17), **India has become free from Trachoma** with an overall prevalence found to be only 0.7%, much below the criteria set by WHO.
- According to WHO, active trachoma is considered eliminated if the prevalence of active infection among children below 10 years is less than 5%.
- Trachoma is no longer a public health problem in India.
- The disease is found to be affecting the population in certain pockets of north Indian states like Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh and the Nicobar Islands.

4.8 Lymphatic filariasis

- Lymphatic filariasis is commonly known as elephantiasis.
- It is caused by infection with parasites classified as nematodes (roundworms), which are transmitted to humans through mosquitoes.
- Mosquitoes are infected with microfilariae by ingesting blood when biting an infected host.
- Infection is usually acquired in childhood causing hidden damage to the lymphatic system.
- Its visible manifestations may occur later in life, causing temporary or permanent disability.

4.9 Severe Acute Respiratory Syndrome (SARS)

- 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.

Coronavirus

- A coronavirus is a common form of virus that typically causes upper-respiratory tract illnesses

- Six different kinds of coronavirus are known to infect humans.
- Four of these are common, and most people will experience at least one of them at some time in their life.
- The two other types cause SARS and Middle East Respiratory Syndrome (MERS). These are less common but far more deadly.
- Before SARS appeared, coronaviruses had not been particularly dangerous to humans, but they had been known to cause severe diseases in animals

4.10 Kala Azar

Elimination is defined as reducing the annual incidence of Kala Azar to less than 1 case per 10,000 people at the sub-district level.

- India has missed the 2017 deadline for elimination of Kala Azar.
- Visceral leishmaniasis (VL), also known as kala-azar, is caused by the protozoan *Leishmania* parasites.
- It is transmitted to humans through infected sandflies.
- It is characterized by irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anaemia.
- The parasite migrates to the internal organs such as the liver, spleen, and bone marrow, and, if left untreated, may result in the death.
- It is endemic to the Indian subcontinent in 119 districts in four countries (Bangladesh, Bhutan, India and Nepal).
- India itself accounts for half the global burden of the disease.
- Further, a little-known skin condition called Post Kala Azar Dermal Leishmaniasis (PKDL), a red flag for transmission of Kala Azar has been growing steadily over the past few years.
- Scientists tested ancient remedy to fight against Kala Azar.
- The compound called **mahanine**, isolated from leaves of *Murraya koenigii* (a curry plant commonly used in Indian kitchens), has been found to inhibit the growth of kala-azar parasite.

4.11 Polio

- Polio is a highly infectious disease caused by a virus.
- It invades the nervous system, and can cause total paralysis (Acute flaccid Paralysis) in a matter of hours.
- The virus is transmitted by person-to-person spread mainly through the faecal-oral route or, less frequently, by a common vehicle (for example, contaminated water or food) and multiplies in the intestine.
- Initial symptoms are fever, fatigue, headache, vomiting, stiffness of the neck and pain in the limbs.
- There is no cure for polio, it can only be prevented.
- Polio mainly affects children under 5 years of age. Polio vaccine, given multiple times, can protect a child for life.
- Of the 3 strains of wild poliovirus (type 1, type 2, and type 3), wild poliovirus type 2 was eradicated in 1999 and no case of wild poliovirus type 3 has been found since the last reported case in Nigeria in November 2012.
- India reported its last polio case in 2011 and is also declared polio-free by WHO in 2014.
- Today, only 3 countries in the world have never stopped transmission of polio (Pakistan, Afghanistan and Nigeria).

Pulse polio campaign

- Pulse Polio is an immunisation campaign established by the GoI to eliminate poliomyelitis in India by vaccinating (Oral Polio Vaccine) all children under the age of five years.
- Vellore (Tamil Nadu) was the first Indian town to become polio-free through the pulse strategy, and rest of India adopted the strategy in 1995.
- The two remaining viruses that are circulating in Pakistan and Afghanistan are WPV-1 and WPV-3.
- Once we stop these two viruses in their tracks, OPV will be phased out and replaced globally with IPV.
- **Oral Polio Vaccine (OPV)** contains weakened but live polio virus, which can cause paralytic polio.
- The vaccine-virus is excreted by immunized children, it can move from one person to another.



- On the one hand, a vaccinated person protects unvaccinated people she comes in contact with by spreading immunity through faeces.
- But on the other, such circulation allows the virus to stick around and mutate to a more virulent form, raising the spectre of vaccine-derived poliovirus (VDPV).
- This makes OPV a double-edged sword.
- VDPV, like imported wild polio, can cause outbreaks in under-immunised population.
- It is for this reason that the eradication of polio worldwide requires OPV to be stopped and replaced with the **Inactivated Polio Vaccine (IPV)**.
- IPV is an injectable form of polio vaccine administered alone or in combination with other vaccines including the OPV (oral polio vaccine).
- IPV does not cause VDPV but protects children equally well against polio.

Universal Immunization Programme

- Universal Immunization Programme was launched in 1985.
- The program now consists of vaccination for 12 diseases:
 - 1) tuberculosis
 - 2) diphtheria
 - 3) pertussis (whooping cough)
 - 4) tetanus
 - 5) poliomyelitis
 - 6) measles
 - 7) Hepatitis B
 - 8) diarrhoea
 - 9) Japanese Encephalitis
 - 10) Rubella
 - 11) Pneumonia (Haemophilus Influenza Type B)
 - 12) Pneumococcal diseases (Pneumococcal Pneumonia and Meningitis)
- The Indradhanush mission, launched in 2014, is to fast track the universal immunization programme.
- The mission aims at increasing the immunisation coverage to 90% by 2018.

4.12 Typbar TCV

- Typbar TCV (Typhoid conjugate vaccines) is Bharat Biotech's typhoid vaccine and it is the first typhoid vaccine, clinically proven to be administered to children from 6 months of age to adults.
- Typbar TCV has recently received pre-qualification from the World Health Organisation (WHO).
- Typhoid conjugate vaccines (TCVs) are innovative products that have longer-lasting immunity than older vaccines and require only fewer doses.
- Also, it can be given to young children through routine childhood immunization programs and reportedly confers long term protection against typhoid fever.

Typhoid

- Typhoid is an infection caused by the **bacterium** *Salmonella typhimurium* (S. typhi).
- The bacterium lives in the intestines and bloodstream of humans.
- S. typhi enters through the mouth and spends 1 to 3 weeks in the intestine. After this, it makes its way through the intestinal wall and into the bloodstream and finally spreads into other tissues and organs.
- It spreads between individuals by direct contact with the feces of an infected person.
- It infects humans due to contaminated food and beverages.
- Transmission is always human to human as no animal carry this disease.

- Increasing resistance to antibiotic treatment is increasingly making it easier for typhoid to spread.
- Overcrowded populations in cities and inadequate and/or flooded water and sanitation systems add to the cause

4.13 Rotavac

- Bharat Biotech's diarrhea vaccine ROTAVAC gets WHO pre-qualification
- The WHO pre-qualification paves the way for health and humanitarian organizations such as UNICEF to procure it for public health vaccination programs across the world.
- Rotavirus is the most common cause of severe diarrhea and kills more than 200,000 children every year.
- ROTAVAC is also included in the Universal Immunization Program

WHO's pre-qualification

- A WHO pre-qualification enables better procurement and supplies of this vaccine.
- The vaccine could now be supplied to UNICEF, Pan-American Health Organisation (PAHO) and GAVI supported countries (Global Alliance for Vaccines and Immunization).
- The WHO prequalification marks an important milestone in the global effort to rid the world of typhoid fever.
- It can pave the way for countries to introduce the vaccine into their immunisation programmes.
- This will help reduce the burden of typhoid disease, especially among the vulnerable populations.

4.14 Human Papilloma Virus (HPV)

- The National Technical Advisory Group on Immunization (NTAGI) has recommended the introduction of HPV vaccine in the UIP.
- NTAGI is an advisory body that recommends vaccines for India's Universal Immunization Programmed (UIP).
- Human Papilloma Virus (HPV) is a group of more than 150 viruses. It is usually harmless and goes away by itself.
- However, some types cause papilloma or warts in parts of the body.
- HPV spreads by skin-to-skin contact and is the most common sexually transmitted infection.
- HPV is commonly associated with cervical cancer.
- India has one of the world's highest burdens of HPV-related cancer and around 67,000 women die from this disease each year.
- HPV vaccines offered by private firms face clinical trial issues in India on concerns of side-effects.

4.15 Noro Virus

- The ongoing 23rd Olympic Winter Games at the South Korean city of Pyeongchang, has been hit by an extraordinary outbreak of disease caused by Norovirus.
- Noro virus is similar to rota virus that induces diarrhoea.
- It infects people across all age groups and is highly contagious.

| | |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TRANSMISSION | Primary route is oral-faecal Also through contaminated food, water and surface |
| SYMPTOMS | Sudden onset of vomiting and/or diarrhea Nausea and abdominal pain headaches Body aches and fever Extreme cases, loss of fluids could lead to dehydration. |
| VACCINE | At present not available. |
| PREVENTION | Precautionary hand washes after using lavatory and before cooking and eating |

| |
|-------------------------------------------------------|
| Disinfecting the surfaces are the ways to prevent it. |
|-------------------------------------------------------|

4.16 Usutu Virus

- It belongs to “flavivirus” family along with tick-borne encephalitis, West Nile, and Dengue virus.
- The virus is of African origin and it was first detected in Austria in 2001.
- It caused a severe bird die-off, mainly of blackbirds and songbirds.
- Besides wild birds, humans can also be infected with the virus through mosquito bites.
- This year, already the virus is detected in songbirds in Austrian region.

4.17 Hunter's Syndrome

- Researchers have recently successfully attempted gene editing inside the human body to correct a defect in the DNA that causes Hunter's syndrome.
- It is a disorder where the body can't break down sugar that builds bones, skin, tendons and other tissue.
- These sugars can build up and damage the body.
- It appears in children as young as 18 months. It mainly occurs in boys, although very rarely it has been observed in girls.
- There's no cure for Hunter syndrome.

4.18 Fluorosis

- Fluorosis is a slow, progressive, crippling disease which affects every organ, tissue and cell in the body.
- According to WHO, the fluoride concentration in drinking water should not exceed 1.5mg/l.
- Thus, fluorosis is caused by excessive exposure to fluoride, beyond a concentration of 1.5 mg/l.
- It adversely affects the foetal cerebral function and neurotransmitters. Reduced intelligence in children is associated with exposure to high fluoride levels.
- Dental fluorosis is a defect in the tooth enamel caused by excessive fluoride consumption, is not treatable and the strains are permanent.
- Skeletal fluorosis is developed by the disturbance of calcium metabolism in the formation of bones in the body. It results in the softening and weakening of bones, resulting in deformities.
- The main sources of fluoride in groundwater are the rocks such as charnockite, quartzite, pegmatite, laterite etc.

4.19 Leptospirosis

- Recent, Mumbai floods has created ground for spreading of Leptospirosis.
- Leptospirosis is a bacterial infection in rodents and other wild and domesticated species.
- It is a zoonotic disease (i.e) spread from animals to humans caused by bacteria of the genus Leptospira.
- It is transmitted to humans by exposure through water contaminated by urine from infected animals.
- The infection in man is contracted through skin abrasions and the mucosa of the nose, mouth and eyes. Human-to-human transmission is rare.
- In most of the cases, leptospirosis only causes mild flu-like symptoms, such as headache, chills and muscle pain.
- However, in some cases the infection is more severe and can cause life-threatening problems, including organ failure and internal bleeding.
- Severe form of leptospirosis is known as **Weil's disease**.

4.20 Haemoglobinopathies

- Hemoglobinopathy is a kind of genetic defect that results in abnormal structure of one of the globin chains of the hemoglobin molecule.
- Common hemoglobinopathies include sickle-cell disease and Thalassemia, and other variant anaemia.

- Thalassemia usually results in underproduction of normal globin proteins, often through mutations in regulatory genes.
- Despite Public Health being a State subject, union Ministry of Health and Family Welfare has recently issued comprehensive guidelines for Haemoglobinopathies.
- The guidelines provide for screening of every pregnant woman during ANC, pre-marital counselling at the college level and onetime screening for variant anaemia for all children in class VIII.

4.21 Haemophiliacs

- Haemophilia is a genetic and life-threatening bleeding disorder that affects the blood's ability to clot due to the absence of clotting proteins called factors.
- It is one of the few new diseases included under the Rights of Persons with Disabilities Act 2016.
- The erstwhile Right of Persons with Disabilities Act 1995 considered only seven categories, namely blindness, low vision, locomotive disability, hearing impairment, mental retardation, mental illness and leprosy, but not haemophilia.
- According to a study conducted by the World Federation of Haemophilia in 2016, almost half of the world's haemophilia population lives in India.
- The country lags severely in providing the facility of free "clotting factor concentrates", which helps in stopping the bleeding and is the first step in treatment of patients with severe haemophilia.

4.22 Kyasanur Forest Disease (KFD)

- Kyasanur Forest disease (KFD) or Monkey Fever is a tick-borne **viral hemorrhagic fever** endemic to South Asia.
- The disease is caused by a virus belonging to the family Flaviviridae, which also includes yellow fever and dengue fever.
- The Hard ticks (*Hemaphysalis spinigera*) are the reservoir of the disease and are known to thrive in the Western Ghats and transmit the disease to humans
- The symptoms of the disease include a high fever with frontal headaches, followed by haemorrhagic symptoms, such as bleeding from the nasal cavity, throat, and gums, as well as gastrointestinal bleeding.
- The virus has been detected in monkeys in parts of Bandipur National Park, Karnataka and re-emerging source has been found in cashew plantations in Goa.

4.23 IMD to forecast Malaria, Chikungunya

- India Meteorological Department's National Climate Centre in Pune is traditionally tasked with forecasting the monsoon and documenting monsoon-related statistics.
- The centre was later reorganised to provide such climate services which includes five-day and 15-day forecasts of heat-waves, cold waves.
- It is now working on a forecasting system to give 15-day warnings on the likelihood of a malaria or chikungunya outbreak, over different regions.

Malaria

- Malaria 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.
- In 2016, nearly half of the world's population was at risk of malaria.
- 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 through:
 1. an organ transplant

2. a transfusion
3. use of shared needles or syringes

Chikungunya

- It is a **viral disease** transmitted to humans by infected mosquitoes.
- It causes fever and severe joint pain. Other symptoms include muscle pain, headache, nausea, fatigue and rash.
- The disease shares some clinical signs with dengue and zika, and can be misdiagnosed in areas where they are common.
- There is **no cure for the disease**. Treatment is focused on relieving the symptoms.
- The proximity of mosquito breeding sites to human habitation is a significant risk factor for chikungunya.
- The disease mostly occurs in Africa, Asia and the Indian subcontinent. However a major outbreak in 2015 affected several countries of the Region of the Americas.

4.24 Implantable pancreas

- Researchers from IIT Guwahati, have successfully created an implantable bioartificial pancreas.
- Pancreas encapsulates insulin-producing cells which is capable of naturally producing insulin in a sustained manner.
- If successful in animal and human trials, it can be used for treating people with **type 1 diabetes**.
- Type 1 diabetes arises when the body's immune system kills the insulin-producing beta cells.
- Without insulin, cells cannot absorb sugar (glucose), which they need to produce energy.
- In **type 2 diabetes**, the body isn't able to use insulin the right way. This is called insulin resistance.
- As type 2 diabetes gets worse, the pancreas may make less insulin. This is called insulin deficiency.
- Type 1 cannot be prevented but Type 2 can be prevented or delayed with a healthy lifestyle.

4.25 Measles-Rubella Vaccination campaign

- Central Government has completed the phase I of Measles-Rubella vaccination campaign and phase II has been rolled out.
- Under the vaccination campaign, all children in the age group of 9 months to 15 years will be vaccinated against measles-rubella.
- Following the campaign, MR vaccine will become a part of routine immunization and will replace measles vaccine, currently given at 9-12 months and 16-24 months of age of child.
- India, along with ten other WHO South East Asia Region member countries, has resolved to **eliminate measles and control rubella**/congenital rubella syndrome (CRS) by 2020.
- Measles is a highly contagious infection and one of the major childhood killer diseases, caused by the measles virus that spreads through air.
- Complications include diarrhea, blindness, inflammation of the brain, and pneumonia among others.
- Unlike measles, rubella is a mild viral infection that mainly occurs in children.
- But infection during early pregnancy may result in a child born with congenital rubella syndrome (CRS) or miscarriage.

4.26 National Deworming initiative

- Health Ministry is going to launch 2nd round of National Deworming initiative to tackle Worm Infections in children
- National Deworming initiative aimed to protect children in the ages of 1-19 years from intestinal worms (also known as Helminths).
- Albendazole tablets will be given to all targeted children through Anganwadi centres and schools (incl. Private schools).
- According to WHO, India has the highest burden of Soil-Transmitted Helminths (STH) in the world.

- National Deworming Day is organised twice in a year and it is the largest ever single-day public health campaign in the world.

4.27 Sohum

- Sohum is the **indigenously developed newborn hearing screening device**.
- The aim is to screen two percent of hospital-born babies to check for hearing response in the first year.
- This innovative medical device has been developed under the School of International Biodesign (SIB) programme of Department of Biotechnology (DBT).
- SIB is a flagship Programme aimed to develop innovative and affordable medical devices as per clinical needs of India and to train the next generation of medical technology innovators in India.
- This Programme is implemented jointly by AIIMS and IIT Delhi in collaboration with International partners.

4.28 Womb Transplant

- The first birth as a result of a womb transplant in the United States has occurred recently.
- A doctor in Sweden, Mats Brannstrom, is the first in the world to deliver a baby as a result of a uterus transplant.
- The transplant helps women who had been born without uterus to bear children.
- Firstly, in vitro fertilization to retrieve and fertilize their eggs will take place to produce embryos.
- Then the embryos will be in frozen condition until they are ready to attempt pregnancy.
- After the uterus transplant, the embryos can be thawed and implanted.

4.29 India Health Fund

- The India Health Fund (IHF), an initiative by Tata Trusts, in collaboration with the Global Fund has come forward to financially support innovations and technologies designed to combat tuberculosis and malaria.
- The IHF aims to support new products and strategies that impact the entire lifecycle of TB and malaria, from prevention to post-cure recovery.
- The fund will support the long-term exercise aligned with the country's goal of eliminating TB by 2025 and malaria by 2030.
- The two diseases account for over 4.23 lakh deaths and around 15 million lab-confirmed cases every year.

4.30 Iodine Bindi

- The iodine bindi project named Life Saving Dot-Jeevan Bindi was conceived and incubated in Singapore. It was implemented in the state of Maharashtra by NGOs.
- Under the project, an iodine patch, designed like a regular bindi, is distributed free to tribal women in Maharashtra.
- The tribals in Nashik, Ahmednagar don't consume iodized salt and they are usually deficient in this nutrient.
- The bindi when stuck on the forehead delivers the daily required amount of iodine (100-150 micro grams) to the body by absorption through the skin.
- Iodine deficiency causes a host of disorders like goitre, impaired mental development and thyroid issues, which, in turn, have been linked to breast cancer and fibroids.
- According to data from National Iodine Deficiency Disorders Control Programme, more than 71 million Indians suffer from iodine deficiency disorders.
- Iodine supplementation is targeted more at women of child-bearing age, because during gestation, pregnancy and lactation women need twice the amount of iodine they usually require.
- Children born to mothers deficient in this nutrient are low in IQ and also suffer from cretinism, a neurological condition.

4.31 Viral load testing for all People Living with HIV/AIDS (PLHIV)

- Ministry of Health has launched free 'Viral load testing to people living with HIV/AIDS.
- Viral load kits are used to determine the severity of an infection before deciding on the treatment regimen that is appropriate for HIV patients.

- The viral load is used to monitor the effectiveness of Antiretroviral Therapy (ART) over time.
- It measures the amount of HIV genetic material (RNA) in the blood and reports how many copies of the virus are present.
- The routine viral load testing will optimize the utilization of first line regimens, thus preventing drug resistance and ensuring the longevity of people living with HIV.
- India has the third largest population of people with HIV after South Africa and Nigeria, according to UNAIDS.
- Only 49% of patients in India were on antiretroviral therapy (ART) in 2016.

4.32 WHO – Antibiotics Protocol

- World Health Organisation has recently revised the antibiotics classes in its list of essential medicines to fight against antimicrobial resistance.
- Antimicrobial resistance is the phenomenon of bacteria becoming resistant even to the most potent drugs.
- This is the biggest revision of the antibiotics section in the 40-year history of the essential medicines list (EML).
- WHO has divided the drugs into three categories such as “Access, Watch and Reserve”.
- Different categories specify which are to be used for common ailments and which are to be kept for complicated diseases.
 - i. **First-line ‘access’** group of antibiotics to be available at all times,
 - ii. Other drugs are placed under a **‘watch’ category** as second choice,
 - iii. **‘Reserve’ category** drugs have to be deployed as a last resort.
- First-line access group includes **amoxicillin**, a widely-used antibiotic to treat infections such as pneumonia.
- Watch category drugs should be dramatically reduced to avoid further development of resistance. Eg. **Ciprofloxacin**, used to treat urinary tract infection.
- The third group, ‘reserve’, includes antibiotics such as **colistin** and some cephalosporins that should be considered last-resort options.

4.33 Child Friendly HIV drug

- **Lopinavir syrup** is a child-friendly HIV drug produced by Cipla, which is the sole manufacturer of the drug.
- It stopped production consequent to non-payment by the Health Ministry.
- The drug’s adult version has to be swallowed whole and thus cannot be administered to infants and young children.
- Recently, The Central Drugs Standard Control Organisation (CDSCO) has registered the child-friendly HIV drug in oral pellet form which opened up the crucial supplies from Cipla to National AIDS Control Programme.

4.34 National Aids Control Programme

- The National AIDS Control Programme (NACP), launched in 1992, is being implemented as a comprehensive programme for prevention and control of HIV/AIDS in India.
- National AIDS Control Board (NACB) was constituted and an autonomous National AIDS Control Organization (NACO) was set up to implement the project.
- **NACP phase I (1992- 1999)** was implemented with an objective of slowing down the spread of HIV infections so as to reduce morbidity, mortality and impact of AIDS in the country.
- **NACP phase II (1999-2007)** was launched with 2 objectives (i) to reduce the spread of HIV infection in India, and (ii) to increase India’s capacity to respond to HIV/AIDS on a long-term basis.
- **NACP phase III (2007-12)** was launched with the goal of **Halting and Reversing the Epidemic** by the end of project period.
- NACP III has given desired results and has been quoted as a global success.
- **NACP Phase IV (2012-17)** aimed to consolidate the gains of NACP III.

- Objectives of NACP Phase IV:
 - i. Reduce new infections by 50 percent (2007 Baseline of NACP III).
 - ii. Provide comprehensive care and support to all persons living with HIV/AIDS and treatment services for all those who require it.

4.35 MTCT of HIV

- A recent study shows complete elimination of mother-to-child transmission of HIV is possible.
- Mother-to-child transmission MTCT is the primary route of transmission of HIV among children.
- Babies are infected during pregnancy, labour, delivery or while breastfeeding.
- **Multidrug Therapy** - India is following the World Health Organisation (WHO) recommended 'multidrug therapy', which is a combination of three drugs — tenofovir, lamivudine and efavirenz (TLE).
- Affected women need to take it all their lives and nevirapine syrup for six weeks only for their babies.
- Multidrug therapy is usually adequate to drastically reduce a mother's viral load.
- **Caesarean** - During a baby's journey through the vaginal passage, contact with abrasions, secretions and blood, which contain the virus, increases the risk of transmission.
- Elective caesarean section and no breastfeeding will limit the transmission.

Status of MTCT

- Currently 5% of babies born to those who are HIV-positive get infected, if transmission rate is below 2% it is considered as elimination.
- According to NACO, only about 52.7% of pregnant mothers seek skilled care out of an estimated 27 million pregnancies in a year.
- An estimated 35,200 pregnancies occur in HIV-positive women and more than 10,300 infected babies are born annually, without any intervention.

4.36 Antimicrobial resistance

- Antimicrobial resistance (AMR) is the ability of a microbe to resist the effects of medication previously used to treat them.
- The term includes the more specific "antibiotic resistance", which applies only to bacteria becoming resistant to antibiotics.
- Resistant microbes are more difficult to treat, requiring alternative medications or higher doses, both of which may be more expensive or more toxic.
- Microbes resistant to multiple antimicrobials are called multidrug resistant (MDR); or sometimes superbugs.
- AMR has emerged as a global public health concern as rampant usage of antibiotics for human and veterinary purposes has resulted in the development of antibiotic-resistant bacteria (ARB) in the guts of humans and animals, which are subsequently released in to the environment.
- India and China are the largest producers of antibiotics and contributes for 80 per cent of total antibiotics production globally.
- Due to the rising global concern UN also declared Nov 13-19 as **World Antibiotic Resistance Week**.

AMR Scenario in India

- According to the **Scoping report on Antimicrobial Resistance in India** commissioned by the Department of Biotechnology,
- In 2014, India was the highest consumer of antibiotics, followed by China and the United States.
- However, the per capita consumption of antibiotics in India is much lower than in several other high income countries.
- In India high antibiotic resistance rates were reported among bacteria that commonly cause infections in the community and healthcare facilities.
- The resistance to carbapenem class of antibiotics (one of the last-resort antibiotics to treat serious bacterial infections in humans) among various bacteria was extremely high.
- Antibiotic-resistant bacterial infections are also increasingly reported among neonates.

- Factors such as high consumption of a broad spectrum of antibiotics, antibiotic fixed-dose combinations and antibiotic consumption in animal food contribute to AMR.
- In India, effluents generated from these industries are treated as per the pharmaceutical wastewater discharge guidelines prescribed by the Central Pollution Control Board.
- Unfortunately, the current standards do not include antibiotic residues, and they are not monitored in the pharmaceutical industry effluents.
- The health ministry has identified AMR as one of the top 10 priorities for the ministry's collaborative work with WHO, which is highlighted in the National Health Policy 2017.

AMR in global scenario

- There is no consensus guideline on the antibiotic residue discharge limits in industrial waste even outside India.
- The uncontrolled discharge of untreated urban waste is another major source for AMR in many low and middle income countries.
- The existing **Good Manufacturing Practices (GMP)** under the WHO (2016) framework is, however, restricted to drug safety and does not include environmental safeguards.
- In 2015, a global action plan (GAP) on AMR was developed by the WHO, the Food and Agricultural Organization and the World Organization for Animal Health.
- It highlights the need for the integrated approach in multiple sectors such as human health, animal husbandry, agriculture and environment in consideration of the "One-Health" approach to overcome the AMR issues.

4.37 Global Antimicrobial Resistance Surveillance System (GLASS)

- It was developed by World Health Organisation (WHO) in 2015 to support the global action plan on antimicrobial resistance.
- The aim is to support global surveillance and research in order to strengthen the evidence base on antimicrobial resistance (AMR) and help informing decision-making and drive national, regional, and global actions.
- Its objectives are
 1. Foster national surveillance systems and harmonized global standards;
 2. estimate the extent and burden of AMR globally by selected indicators;
 3. analyse and report global data on AMR on a regular basis;
 4. detect emerging resistance and its international spread;
 5. inform implementation of targeted prevention and control programmes; and
 6. assess the impact of interventions.
- Early implementation of GLASS covers the period 2015–2019.
- It initially focus on surveillance data related to AMR in humans, such as foodborne AMR, monitoring of antimicrobial use and surveillance of infections associated with health care.
- It released the first set of surveillance data on anti-microbial resistance recently.
- Key Findings of GLASS are
 1. AMR is widespread in both high and low income countries.
 2. The most commonly reported resistant bacteria were *Escherichia coli* (*E. coli*), *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Salmonella* spp.
 3. There is an alarming spike in the cases resistant to penicillin and ciprofloxacin.

5. NUCLEAR TECHNOLOGY

5.1 Kovvada

- Kovvada is a new nuclear plant to be set up in the State of **Andhra Pradesh**.
- It is a proposed light water nuclear reactor in Srikakulam District.

- Recently, the land acquired for the construction of the nuclear power plant was handed over to Nuclear Power Corporation of India Limited (NPCIL).

5.2 Pressurized Heavy Water Reactor

- Government of India has accorded approval for the construction of 10 indigenous Pressurized Heavy Water Reactors (PHWRs).
- The reactors are planned at Kaiga in Karnataka, Gorakhpur in Haryana, Chutka in M.P, and MahiBanswara in Rajasthan.
- A PHWR is a nuclear power reactor commonly using un-enriched natural Uranium as its fuel, and heavy water (deuterium oxide, D₂O) as its coolant and moderator.
- Indian PHWRs: Tarapur (Maharashtra), Rawatbhata (Rajasthan), Kalpakkam (T.N), Narora (U.P), Kakrapar (Gujarat) and Kaiga (Karnataka).

5.3 Nuclear Command Authority (NCA)

- 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.

5.4 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.

Nuclear power reactors in India

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



Kudankulam, TN

Water-Water Energetic Reactor (VVER)

6. INTELLECTUAL PROPERTY RIGHTS

6.1. 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 Monopoly right for 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 possess 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 are Tirupathi Laddu, Kangra Paintings, Nagpur Orange, Kashmir Pashmina etc.

Recent developments

- The Cell for IPR Promotions & Management (CIPAM) under the aegis of the DIPP has launched a logo and tagline/slogan contest for Geographical Indications (GIs) of India on MyGov.in website.
- CIPAM has also launched "Gift a GI" campaign to enhance the visibility and thus help in branding and promotion of registered GI products.
- CIPAM has also launched a social media campaign to promote Indian Geographical Indicators (GIs) with #LetsTalkIP.

6.2. GIs in recent news

1. **Tamil Nadu is the first** among the states in India with regard to **the number of GI tags for its products**, while Uttar Pradesh comes second.
 - Darjeeling Tea was the first Indian product to get a Geographic Indication in the early 2000s.
 - Tamil Nadu has submitted 50 products of which 24 have been approved by the registry.
 - The most famous among these is the Kanchipuram silk.
 - Coimbatore wet grinder, artisans of Vadasery in Nagercoil who make dazzling jewellery of a unique kind for temples, Tanjavur Dancing Doll are some of the products that have obtained the GI certificate.
2. The **hand-crafted stone sculptures of Mamallapuram** have been recently granted the Geographical Indications (GI) tag.
 - The exquisite rock-sculpting techniques exhibited in Mamallapuram date back to early 7th century CE.
 - The Pallava dynasty, which ruled the area between 6 and 9th centuries A.D., is responsible for the development of port town as a centre of art and architecture.
 - Mahendravarman (AD 580-630), his son Narasimhavarman I Mamalla (AD 630-668), Paramesvaravarman (A.D. 672-700) and Narasimhavarman II Rajasimha (A.D. 700-728) had contributed the most of sculptures.
 - Mamallapuram was named after the king Narasimhavarman Pallava, who was also known as Mamallan (great wrestler).
 - Sculptors use blue metal for stone sculptors instead of granite which has high density and very costly.
3. West Bengal state has recently won the GI tag for Rasgulla.
 - West Bengal and Odisha have been engaged in a legal battle over the origin of the syrupy Rasgulla since June 2015.
 - **Banganapalle mangoes** from Andhra Pradesh, **Tulapanji rice** from West Bengal will also get a GI tag this year by the Indian patent office.
4. The other five products which have received this tag this year include



- i. Pochampally Ikat of Telangana;
- ii. Gobindobhog Rice of West Bengal;
- iii. Durgi Stone Carvings and
- iv. Etikoppaka Toys of Andhra Pradesh; and
- v. Chakshesang Shawl of Nagaland

5. **Etikoppaka Toys** are made from the soft wood of Ankudi Karra (*Wrightia tinctoria*) tree and they are painted with natural dyes, which is prepared from seed, lacquer, bark, roots and leaves.

- The dyes are non-toxic.
- The art of making such toys is known as turned wood Lacquer craft
- With this, Etikoppaka toys join elite products from Andhra Pradesh such as Kondapalli toys, Tirupati laddu, Bobbili Veena, Srikalahasthi Kalamkari, Uppada Jamdani sarees and Shadow puppets.

6. Some of the registered GIs - State Wise

- **Jammu & Kashmir** – Pashmina Hand-Knotted Carpet, Papier Mache, Walnut Wood Carving
- **Himachal Pradesh** - Kangra Paintings, Kullu Shawl, Chamba Rumal
- **Sikkim** - Large Cardamom
- **Nagaland** - Chakshesang Shawl.
- **Assam** - Muga Silk, Joha Rice, Tezpur Litchi.
- **Manipur** - Shaphee Lanphee, Wangkhei Phee, Moirang Phee and Kachai Lemon.
- **Tripura** - Tripura Queen Pineapple.
- **Meghalaya** - Khasi Mandarin, Memong Narang
- **Bihar** - Madhubani Paintings, Bhagalpur Silk, Sikki Grass Work
- **Rajasthan** - Blue Pottery of Jaipur, Kathputlis, Sanganeri Hand-Block Printing
- **Maharashtra** - Puneri Pagadi, Nashik Valley Wine, Mahabaleshwar Strawberry, Warli Painting
- **Telangana** - Silver Filigree of Karimnagar, Hyderabad Haleem, Narayanpet Handloom Sarees.
- **Karnataka** - Channapatna Toys & Dolls
- **Puducherry** - Villianur Terracotta Works
- **Kerala** - Aranmula Kannadi, Palakkadan Matta Rice, Balaramapuram Saris and Fine Cotton Fabrics.

6.3. Scheme for IPR Awareness

- 'Scheme for IPR Awareness – **Creative India; Innovative India**' has been launched by Cell for IPR Promotion and Management (CIPAM) under the aegis of the Department of Industrial Policy and Promotion.
- It aims to conduct IPR awareness workshops in academic institutions (schools and colleges) and the industry including MSMEs and Startups, as also IP training and sensitization programmes for enforcement agencies and the judiciary.
- Workshops will cover all vital IP topics including international filing procedures, promotion of Geographical Indications and highlighting the ill effects of piracy and counterfeiting.

6.4. Technology and Innovation Support Centre (TISC)

- Department of Industrial Policy and Promotion (DIPP) under Ministry of Commerce is establishing TISC under the World Intellectual Property Organizations (WIPO) TISC program.
- DIPP has recently signed an Institutional agreement with Anna University, Chennai to establish India's second TISC.
- TISC in Punjab is the India's first TISC.
- It provides innovators in developing countries with access to locally based, high quality technology information and related services.

- It will help the innovators to exploit their innovative potential and to create, protect, and manage their Intellectual Property Rights (IPRs).
- The objective is to foster creativity and innovation, thereby promoting entrepreneurship and enhancing social, economic and cultural development.

6.5. Traditional Knowledge Digital Library (TKDL)

- TKDL is an Indian initiative to prevent exploitation and to protect Indian traditional knowledge from wrongful patents mainly at International Patent Offices.
- TKDL contains **Indian traditional medicine knowledge** in a digitized format and is available in five international languages (English, French, German, Spanish and Japanese).
- Indian traditional medicine knowledge in TKDL pertains to traditional books related to Ayurveda, Unani and Siddha.
- **CSIR** is the implementing agency for TKDL. Funds under the scheme are provided only to CSIR and no funds have been allocated to any state.

7. OTHER TECHNOLOGICAL INTERVENTIONS

7.1 Project Brainwave

- It is launched by Microsoft, a deep learning platform for real-time artificial intelligence (AI) and capable of processing requests as fast as it receives it.
- Artificial intelligence (AI) is areas of computer sciences that emphasizes the creation of intelligent machines that work and react like humans.
- Some of the activities computers with artificial intelligence are designed for include Speech recognition, Learning, Planning, Problem solving.

7.2 First Hyperloop Transport System

- Hyperloop Transportation Technologies (HTT) has signed an agreement with the Andhra Pradesh government to set up first Hyperloop transport system in India.
- The system will connect the city centres of **Amravati and Vijayawada**.
- The technology uses a high-speed train that promises travel at twice the speed of a commercial aircraft.
- Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube.
- The project will be implemented in PPP mode.

7.3 Memristors & AI

- Artificial neural networks (ANNs) are computing systems that can learn and progressively improve performance on tasks by considering examples.
- Researchers have recently developed a new type of neural network chip that can dramatically improve the efficiency of teaching machines to think like humans.
- It improves a typical neural network's capacity and reduces the required training time.
- They have been created in the past with larger optical components.
- Now the researchers have created their system using memristors.
- Memristors are a special type of resistive device that can both perform logic and store data.
- This contrasts with typical computer systems, where processors perform logic separate from memory modules.
- Hence they require less space and can be integrated more easily into silicon-based electronics.

7.4 Task force on artificial intelligence

- The Department of Defense Production constituted a task force headed by Tata Sons Chairman N Chandrasekaran to study use of artificial intelligence.
- It has potential to provide military superiority apart from driving technology-driven economic growth.

- Similarly, in 2017, the then Commerce and Industry minister constituted the 'Task force on AI for India's Economic Transformation' chaired by V. Kamakoti of IIT Madras

7.5 5G technology

- Union telecom ministry had announced 5G technology will be rolled out from 2020.
- This would entail accelerating the BharatNet programme for deploying connectivity infrastructures
- 5G is the fifth generation wireless network which promises ultra-reliable, very fast speeds and high bandwidth mobile connectivity and supports massive interconnected devices spread across wide areas like Internet of things (IoT).
- It made the worldwide debut in the winter Olympics at Pyeongchang, South Korea.
- Previous generations like 3G were a breakthrough in communications. 3G receives a signal from the nearest phone tower and is used for phone calls, messaging and data.
- 4G works the same as 3G but with a faster internet connection and a lower latency (the time between cause and effect).
- 5G provides peak speeds of 20 times, compared with 4G.
- To qualify for a 5G a connection should meet most of these eight criteria:
 - 1 to 10Gbps connections to end points in the field
 - 1 millisecond end-to-end round trip delay
 - 1000x bandwidth per unit area
 - 10 to 100x number of connected devices
 - (Perception of) 99.999 percent availability
 - (Perception of) 100 percent coverage
 - 90 percent reduction in network energy usage
 - Up to **ten-year battery life** for low power, machine-type devices

7.6 Li-Fi

- Light-fidelity (LiFi) is a technology used for free-space communication using visible and near-visible light.
- It is similar to Wireless Fidelity (WiFi), a technology for wireless local area network communication using microwaves.
- Microwaves can pass through walls while transmitting signals whereas visible and near-visible light cannot pass through walls.
- Microwaves are used in WiFi technology to transmit signals which can pass through walls.
- Li-Fi, on the other hand, uses visible and near-visible light that carry the LiFi signal. Hence it cannot pass through walls.
- Thus it makes LiFi signal network more secure.
- Scientists have recently added a new layer of security to LiFi.
- Light bounces off from walls and falls on the receiver.
- So wall boundaries can be used effectively for reflecting signals so that communication is maintained even without line-of-sight communication between the signal source and receiver.
- Receiving detectors can receive both direct and reflected signals.
- Walls painted with fluorescent and phosphorescent paints absorb and then emit light with marginal loss.
- The paints continue to emit light even several hours after the original source of light has been switched off.

| Parameter | Li-Fi | Wi-Fi |
|------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Medium through which data transfer | Light medium | Radio waves |
| Privacy | In Li-Fi, light is blocked by the walls and hence will provide more secure data transfer | In Wi-Fi, RF signal can not be blocked by the walls and hence need to employ techniques to achieve secure data transfer. |
| Data Transfer Speed | About 1Gbps | 150Mbps |
| Frequency of operation | 100THz | 2.4GHz, 4.9GHz and 5GHz |
| Coverage distance | About 10 meters | About 32 meters (WLAN 802.11b/11g), vary based on transmit power and antenna type |

- This makes the communication signal more effective and secure.

7.7 Quantum Dots

- Quantum dots are tiny particles or nanocrystals of a semiconducting material with diameters in the range of 2-10 nanometres.
- Quantum dots display unique electronic properties, intermediate between those of bulk semiconductors and discrete molecules.
- They can be made to emit or absorb specific wavelengths of light by controlling their size.
- It can lead to a new generation of high definition technology.
- It can be used as a display platform in televisions, for enhanced medical imaging as well as in solar cells.
- The Science Advances journal says, when quantum dots are clustered together they are more fluorescent, providing a wide variety of colours.
- It will pave the way for brighter, lighter and more energy efficient TVs and smart devices.

7.8 Quantum Mechanics

- Quantum mechanics deals with the behaviour of matter and light on the atomic and subatomic scale.
- It attempts to describe and account for the properties of molecules and atoms and their constituents such as electrons, protons, neutrons.
- It is considered as the dark arts of physics since it deals with the invisible world of subatomic particles.
- Through quantum mechanics, subatomic particles can be manipulated for purposes that benefit the visible world such as making integrated circuit chips and fibre-optic lines for global, instantaneous communication.
- Recently, China has combined satellite technology and quantum mechanics to demonstrate how secret information can be transmitted over a thousand kilometres.
- It has transmitted the information with the guarantee that any unauthorised attempt to decipher it would be immediately discernible.

7.9 Quantum Computing

- A quantum computer, still largely a theoretical entity, employs the principles of quantum mechanics to store information in 'qubits' instead of the typical 'bits' of 1 and 0.
- Qubits work faster because of the way such circuits are designed, and their promise is that they can do intensive number-crunching tasks much more efficiently than the fastest comparable computers.
- The existing systems use principles of quantum computing to solve very limited problems.
- Internationally, Canada's D-Wave Systems, is a pioneer in developing quantum computers.
- India has joined the Quantum Computing race by funding development of quantum machines by Department of Science and Technology.

7.10 Virtual Reality

- The school children in United States experience exotic field trips through the virtual reality headsets.
- The definition of 'virtual' is near and reality is what we experience as human beings. So the term 'virtual reality' basically means 'near-reality'.
- Virtual reality is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person.

7.11 Microsoft HoloLens-Augmented Reality

- Augmented reality headsets -HoloLens can help doctors 'see through' organs and tissues in the operating theatre.
- The advancement improves the outcome of reconstructive surgery for patients.
- The approach can help surgeons locate and reconnect key blood vessels during reconstructive surgery, which could improve outcomes for patients
- Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated perceptual information.

- Other Fields of applications are: Archaeology, Architecture, Education, commerce.

7.12 Raman Effect

- Raman Effect deals with the change in the wavelength of light that occurs when a light beam is deflected by molecules.
- The method can provide key information easily and quickly by characterizing the chemical composition and structure of a sample.
- Raman Effect has a wide range of application in fields such as geology, material science, forensic science, nuclear science and pharmacology.
- The effect is named after the Indian Physicist Sir C.V.Raman who observed the same.
- He was awarded Nobel Prize in Physics in 1930.
- To mark the discovery of Raman Effect, February 28 is celebrated as the National Science Day in the country.

7.13 Humanoid Robot- Sophia

- Sophia is the world's first AI powered humanoid robot
- It was a part of the World Congress on Information Technology (WCIT), 2018, held in Telegana, India.
- A Humanoid may be defined as something that resembles or looks like a human and having their characteristics like opposing thumb etc,
- A Humanoid robot is fully automated as it can adapt to its surroundings and continue with its goals, as the case with Sophia.
- Sophia with her incredible human likeness and expressiveness is an evolving genius machine.
- Sophia, with a perfect skin and soft facial muscles, can give as many as 66 facial expressions.

7.14 Largest prime number

- A very big number over 23 million digits long has discovered to be the "largest known prime number".
- This number was discovered using software called GIMPS.
- A prime number is a number that can only be divided by itself and by 1. For example: 2, 3, 5, 7, 11, and so on.
- Prime number are used in Cryptography (the study of secret messaging, involves sharing information via secret codes), credit cards, cell phones, all depend on cryptography.

7.15 Pratyush

- Pratyush is an array of computers recently unveiled in India.
- It can deliver a peak power of 6.8 petaflops.
- One petaflop is a million billion floating point operations per second and is a reflection of the computing capacity of a system.
- The machines will be installed at two government institutes: 4.0 petaflops HPC facility at Indian Institute of Tropical Meteorology (IITM), Pune & 2.8 petaflops facility at the National Centre for Medium Range Weather Forecast, Noida
- Pratyush is also the fourth fastest supercomputer in the world dedicated for weather and climate research.
- It follows machines in Japan, USA and the United Kingdom.
- A key function of the machine's computing power would be monsoon forecasting using a dynamical model.
- With the new system, it would be possible to map regions in India at a resolution of 3 km and the globe at 12 km.

| Rank | Site | Rpeak (TFlop/s) | Power (kW) |
|------|-------------------------------------------------------------|-----------------|------------|
| 1 | National Supercomputing Center in Wuxi, China | 1,25,435.9 | 15,371 |
| 2 | National Super Computer Centre in Guangzhou, China | 54,902.4 | 17,808 |
| 3 | Swiss National Supercomputing Centre, Switzerland | 25,326.3 | 2,272 |
| 4 | Japan Agency for Marine Earth Science and Technology, Japan | 28,192 | 1,350 |
| 5 | DOE/SC/Oak Ridge National Laboratory, United States | 27,112.5 | 8,209 |

7.16 Mihir

- Mihir' (meaning 'Sun') a High Performance Computer (HPC) System has been installed at the National Centre for Medium Range Weather Forecasting (NCMRWF).
- This HPC facility will be India's largest HPC facility in terms of peak capacity and performance.
- The new HPC facility is expected to improve the following services:
 1. Weather forecasts for predicting extreme weather events.
 2. High resolution seasonal/extended range forecasts of active/break spells of Monsoon.
 3. Very high resolution prediction of cyclones with more accuracy and lead time.
 4. Ocean state forecasts like marine water quality forecasts and Tsunami forecasts.
 5. Air quality forecasts for various cities.

7.17 Jatan and Darshak

- Centre for Development for Advanced Computing (C-DAC), has developed software named "Jatan" that is set to revolutionize museum experience.
- The latest technology will help online visitors get a 3-Dimensional (3D) view of hundreds of artifacts displayed at the museums.
- The software will enable virtual tours to museums.
- The group has developed "Darshak", a mobile-based application, aimed at improving the museum visit experience among the differently-abled.
- It allows real-time museum visitors gather all details about objects or artifacts simply by scanning a QR code placed near the object.
- C-DAC is the premier R&D organization of the Ministry of Electronics and Information Technology (MeitY) for carrying out R&D in IT, Electronics and associated areas.

7.18 High-Tech Public Transport

- The ministry of road transport and highways sought the approval of Niti Aayog to experiment and introduce six latest mass rapid transportation technologies.
- These technologies include metrino, stadler buses, hyperloop, pod taxis, hybrid buses and freight rail road.

7.19 Pod Taxi Project

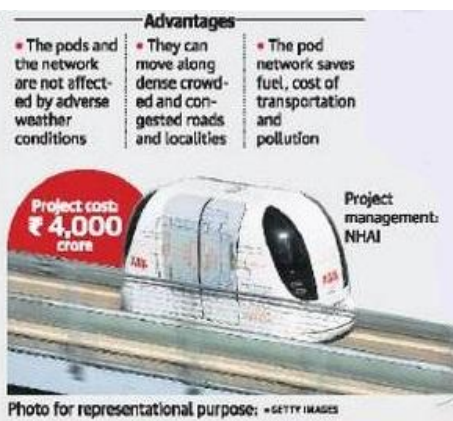
- A high-level panel has recommended inviting fresh bids for India's first pod taxi project.
- The projected Rs. 4,000-crore scheme, also known as Personal Rapid Transit (PRT), is to start off with the 12.3 km Delhi-Gurugram pilot corridor on public-private partnership basis.
- PRT is an advanced public transport using automated electric pod cars to provide a taxi-like demand responsive feeder and shuttle services.
- It is for small groups of travellers and is a green mode of uninterrupted journey.
- The automated people mover (APM) standards in the US constitute the minimum requirements for an acceptable level of safety and performance for the PRT.

The future of travel

A look at the next generation mode of travel in India, the pod-taxi, which is estimated to be operationally cheaper than the Metro rail.

- Pods can carry upto 5 passengers at a time, and are fully automatic, driverless and travel independently over an overhead network which is usually about 5-10 meters above the ground

- Pods are equipped with military grade wireless technology and sensors, which are monitored at a command base and on the ground for extra security and safety



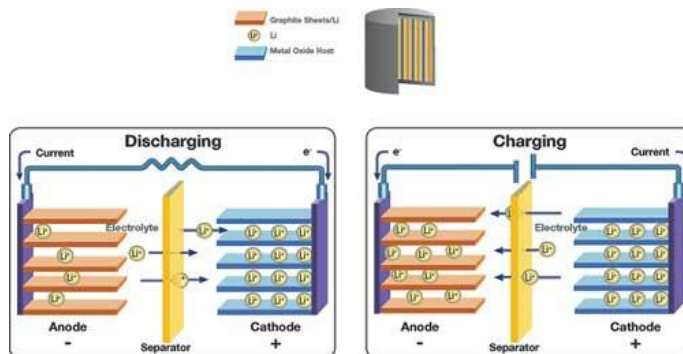
METRINO: fully automatic, driverless small pods travel independently suspended over an overhead network

POD TAXIS: small automated vehicles – cable cars or pod cars – equipped to carry a small group of passengers

HYPERLOOP: a pod-like vehicle is propelled through a near-vacuum tube connecting cities at speeds matching that of an aircraft

7.20 Lithium-ion Battery

- ISRO has approved commercial use of lithium-ion battery technology and the battery makers will be required to pay Rs 1 crore as a one-time technology transfer fee to ISRO for every e-vehicle.
- It is expected to save 10-15 per cent of the cost of e-vehicles.
- The process of remodelling the battery made by ISRO to be used in e-vehicles, will take time to scale up production.
- At present, lithium-ion batteries are not manufactured in India and therefore the country has to depend on imports from Japan or China.
- But there is a concern about the property of flammability of lithium-ion battery.
- Lithium-ion batteries are all about the movement of lithium ions.
- The ions move one way when the battery charges (when it's absorbing power); they move the opposite way when the battery discharges (when it's supplying power).
- Lithium ion batteries are more reliable than older technologies such as nickel-cadmium.
- Nickel batteries appear to become harder to charge unless they're discharged fully first, it is not the case with lithium ion batteries.
- Lithium-ion batteries don't contain cadmium, a toxic, heavy metal.
- It has high energy density i.e. it store more energy per unit of weight when compare to other kind of batteries.
- But it still stores a hundred times less energy dense than gasoline (which contains 12,700 Wh/kg by mass or 8760 Wh/L volume).
- It has a much lower energy density i.e it store less energy per unit of weight.
- It is used in every modern cellphone, laptop, tablet, and most other rechargeable gadgets.



7.21 Free Space Optical Communications

- The Andhra and Telangana government is keen to use Free Space Optical Communications (FSOC) technology by GoogleX to provide internet access to people in parts of the state.
- FSOC technology uses beams of light to deliver high-speed, high-capacity connectivity over long distances.
- Most frequently, laser beams are used, although non-lasing sources such as light-emitting diodes (LED s) or IR-emitting diodes (IREDs) will serve the purpose.
- The theory of FSO is essentially the same as that for fiber optic transmission.
- The difference is that the energy beam is sent through clear air or space from the source to the destination, rather than guided through an optical fiber.
- As long as there is a clear line of sight between the source and the destination, communication is theoretically possible.
- Even if there is no direct line of sight, strategically positioned mirrors can be used to reflect the energy.

7.22 Fiber Optics

- Fiber optics is the science of transmitting data, voice, and images by the passage of light through thin, transparent fibres.
- The basic medium of fibre optics is a hair-thin fibre that is most often made up of glass and sometimes plastics.
- Through a process known as **total internal reflection**, light rays beamed into the fibre can propagate within the core for great distances with remarkably little attenuation, or reduction in intensity.
- In telecommunications, fibre optic technology has virtually replaced copper wire in long-distance telephone lines, and it is used to link computers within local area networks.

7.23 Triboelectric Nanogenerators - Wireless Transmission of Electrical Energy

- For the first time wireless transmission of electrical energy has been achieved using triboelectric nanogenerator.
- Also, for the first, a triboelectric nanogenerator has been directly 3D printed from biodegradable materials.
- A nanogenerator in simple terms is a small electronic chip that harvests mechanical energy and converts it into electrical energy.
- The key components inside a nanogenerator are nanowires.
- Notably, hundreds of nanowires can be packed side by side in a space less than the width of a human hair.
- Given this scale and the flexibility of the nanogenerator's components, even the slightest movement can generate current.
- Triboelectric nanogenerator is one of the 3 types of nanogenerators.
- The other two are piezoelectric and pyroelectric.
- Piezoelectric and triboelectric nanogenerators convert mechanical energy into electricity.
- On the other hand, pyroelectric nanogenerators harvest thermal energy from a time-dependent temperature fluctuation.
- The **triboelectric effect** is a type of **contact electrification**.
- It is where certain materials become electrically charged after coming into frictional contact with another different material.

Applications

- Nanogenerators can be used to light up homes, control doors and even set burglar alarms.
- It can be installed at airports, sidewalks and battery can be placed on the nearby walls to store the energy.
- The electric field can also be made use as an actuated remote.
- E.g. Tapping the W-TENG and using its electric field as a „button“ to open a door or activate a security system, all without a battery.
- There are no wires involved and thus there is no need of power outlets.
- The wireless feature extends its application into resource-limited settings such as in outer space, in middle of the ocean, etc.

7.24 Bitcoins

- Crypto-currency is a digital currency that allows transacting parties to remain anonymous while confirming the transaction is valid.
- Bitcoins are cryptocurrencies introduced in 2008.
- It is the most commonly used crypto currency across the globe.
- It does not belong to any nation, so that there is no regulatory authority for bitcoins.
- It is underpinned by a peer-to-peer computer network made up of its users' machines called block chain.
- Bitcoins are mathematically generated as the computers in this network solve various mathematical tasks.
- This procedure is known as **Bitcoin “mining”**.
- The mathematics of the Bitcoin system is set up in such a way that it becomes progressively more difficult to “mine” Bitcoins over time.
- The total number that can ever be mined is limited to around 21 million.
- When more people accept bitcoin or other cryptocurrencies for goods and services, their value increases.
- There is therefore no way for a central bank to issue a flood of new Bitcoins and devalue those already in circulation.
- Bitcoin transactions done globally can be completed in a few seconds with minimal costs compared to traditional financial systems.

- It can be bought from various international exchanges using credit cards or other electronic means.
- The provision of anonymity is widely misused especially in making cross-border transactions and used as a means for money-laundering, terror funding and drug trafficking, and other illegal activities.
- **Status of Bitcoins** - Since 2014, the American tax authorities have treated cryptocurrencies as 'property' subject to appropriate capital gains tax rate.
- Japan and Australia deemed bitcoin as a legitimate payment method in 2017.
- Chinese authorities have aggressively stepped in to ensure cryptocurrency exchanges function well.
- Indian Finance Ministry and the RBI had issued warning against investing in crypto-currencies (CC) and have likened them to 'Ponzi schemes'.

Block Chain Technology

- Blockchain is the basis of bitcoins, it is a digital public ledger that records every transaction.
- Once a transaction is entered in the blockchain, it cannot be erased or modified.
- Blockchain removes the need for using a trusted third party such as a bank to make a transaction by directly connecting the customers and suppliers.
- Each transaction is recorded to the ledger after verification by the network participants, mainly a chain of computers, called nodes.
- Bitcoin is just one of the applications for the technology, whose use is being tested across industries.
- It is an advantage, when there is a lot of data that is shared across multiple parties with no trust mechanism among the participants.
- Non-financial players like retail, travel, health care, telecom and public sector industries are also working on this technology.

Other Cryptocurrencies

- **Ripple** is a technology that acts as both a cryptocurrency and a digital payment network for financial transactions.
- It was released in 2012 and its coin is labeled as XRP.
- Ripple operates on an open source and peer-to-peer decentralized platform that allows for a seamless transfer of money in any form, whether USD, Yen, bitcoin, or bitcoin.
- It is the fourth-largest cryptocurrency in the world by market capital, which now stands at around \$43 billion.
- **Petro** is a cryptocurrency launched by Venezuela backed by oil reserves.
- It is mainly to shore the collapsed oil economy.
- Venezuela's real currency "**Bolivar**" is in freefall, and the country is sorely lacking in basic needs like food and medicine.

7.25 Artificial Leaf

- CSIR Scientists have developed an artificial leaf that absorbs sunlight to generate hydrogen fuel from water.
- It may provide clean energy for powering eco-friendly cars in the future.
- The artificial leaf is produced through ultra-thin wireless device which mimics plant leaves to produce energy using water and sunlight.
- The device consists of semiconductors stacked in a manner to simulate the natural leaf system.
- When visible light strikes the semiconductors, electrons move in one direction, producing electric current.
- The current almost instantaneously splits water into hydrogen, one of the cleanest forms of fuel.
- When exposed to sunlight for 25 hours, the device retained its efficiency.
- The cell does not need any external voltage and performs better than existing solar cells.
- At present, hydrogen is produced from fossil fuels by steam reforming and in this process emits a large amount of GHG carbon dioxide (CO₂).

7.26 Speed Breeding Technique - Wheat Production

- Recent NASA experiments used continuous light on wheat, triggering early reproduction to grow wheat in space.
- Inspired by this, Australian scientists have developed the new “DS Faraday” wheat variety with speed breeding” technique.
- Speed breeding is an artificial method to produce healthy crops at a faster pace.
- The plants are placed in a simulated growth environment, a specially modified glasshouse.
- It uses enhanced LED lights in simulated conditions to boost crop production. Here, LED lights are optimised for photosynthesis.
- The light induces growth in them 22 hours a day.
- Plants are thus grown under controlled climate and extended daylight conditions.
- The Australian team has achieved wheat generation from seed to seed in just 8 weeks.
- It was thus possible to grow as many as 6 generations of wheat every year which is a threefold increase from the current two or three generations grown in a regular glasshouse or a single generation in the field.
- The quality and yield of the plants grown in modified glasshouses was as good, or sometimes better, than those grown in regular glasshouses.
- The new technology could also have some applications in future vertical farming systems, and some horticultural crops.

7.27 JIGYASA

- It is a student- scientist connect programme by Ministry of HRD and Ministry of Science and Technology.
- It focuses on connecting school students and scientists so as to extend student’s classroom learning to research laboratory based learning by visiting CSIR laboratories and by participating in mini-science projects.
- CSIR and Kendriya Vidyalaya Sangathan (KVS) are collaborating to implement this programme.

7.28 OpenGovDataHack

- Ministry for Electronics and Information Technology has recently launched a nationwide hackathon ‘OpenGovDataHack’.
- It was conducted by the National Informatics Centre (NIC) and the Internet and Mobile Association of India (IAMAI) in 7 cities.
- The seven cities are Surat, Patna, Jaipur, Chennai, Bhubaneswar, Hyderabad and Noida.
- It aims to enable participants develop their ideas into apps/infographics primarily by the use of open government data.
- The sectors selected for the Hackathon are Drinking Water & Sanitation, Transport, Education, Crime and Health.
- The Open Government Data (OGD) Platform India has been set up by the National Informatics Centre (NIC) in compliance with National Data Sharing and Accessibility Policy (NDSAP) 2012.
- The objective of the policy is to provide proactive access to government owned sharable data along with its usage information.

7.29 Global conference on functional materials

- Global conference on functional materials was recently held at Telangana, which was attended by delegates from 10 different countries.
- The conference was aimed to address the application aspect of the functional materials in areas of societal relevance.
- The term functional materials cover different material classes ranging from semiconductors over polymers and molecular crystals to nanoparticles.
- It is their special electrical, optical and magnetic properties which make functional materials so important.

- Technologies such as Computation, Communication, Sensors, storage and displaying of information use functional materials.

7.30 World Congress on Information and Technology (WCIT)

- The World Congress on Information Technology (WCIT) 2018 was concluded recently in Hyderabad, India.
- The First edition held in 1978 and is conducted by WITSA (World Information Technology & Services Alliance).
- India hosted the congress for the first time.
- The theme of the conference was 'Future Enterprises.'
- The congress is held every two years, during which senior global business, government and academic leaders discuss emerging markets, legal and policy issues, political and economic trends.



8. GEOGRAPHY

8.1 Lightning - Powerful over the ocean than land

- A new study validates for the first time through independent measurement that lightning strikes over sea water tended to be more powerful than on land.
- In fractions of a second, charged particles in thunderclouds form into downward channels of electricity.
- This "attach" to electrical, charge-carrying channels rising from land or water to form the familiar zigzag bolt, lightning.
- Analysing the duration and effectiveness of these on land and sea has revealed that lightning with peak currents over 50 kilo amperes is twice as likely to occur in oceanic thunderstorms.
- The findings suggest that people living on or near the ocean may be at greater risk for lightning damage if storms develop over oceans and move on-shore.
- The finding could also inform how off-shore infrastructure and vessels are to be built to minimise the risk of super-powerful lightning bolts.

8.2 Mercury in Arctic Permafrost

- Permafrost in the northern hemisphere is found to store massive amounts of natural mercury.
- Northern permafrost soils are the largest reservoir of mercury on the planet. They store nearly twice as much mercury as all other soils, the ocean and the atmosphere combined.
- There would be no environmental problem if everything remained frozen. But a warming climate could release large amounts of this dangerous toxin.
- Mercury accumulates (Bio accumulation) in aquatic and terrestrial food chains.
- This could potentially cause neurological effects in humans and animals, ranging from motor impairment to birth defects.



8.3 Sagar Vani

- Sagar Vani is an app developed by Ministry of Science & Technology, Earth Sciences and Environment, Forests & Climate Change, on the occasion of Foundation Day of Ministry of Earth Sciences.
- It is an integrated information dissemination system **serving fishermen community** with the advisories and alerts towards their livelihood as well as their safety at Sea.
- The information to be disseminated is given by ESSO -INCOIS under Ministry of Earth Sciences (MoES).
- The system also has facility to provide access to various stakeholders NGOs, State Fishery Departments, Disaster Management Authorities; they will further disseminate these ocean information and alerts to the user community

ESSO – INCOIS

- Indian National Centre for Ocean Information Services (INCOIS) was established as an autonomous body in 1999 under the Ministry of Earth Sciences (MoES) and is a unit of Earth System Science Organization (ESSO).
- It is mandated to provide the best possible ocean information and advisory services through sustained ocean observations and constant improvements through systematic and focussed research.
- It provides potential fishing zone advisory service, ocean state forecast service and tsunami warning service.
- It is a permanent member of the Indian delegation to Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), which is the only competent organization for marine science within the UN system.
- It is a founding member of the Indian Ocean Global Ocean Observing System (IOGOOS).
- Through the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), ESSO-INCOIS provides ocean information and forecasts to member countries.

Ocean Forecasting System

- Recently, INCOIS unveiled Ocean Forecasting System for Comoros, Madagascar, and Mozambique at the third Ministerial Meeting of Regional Integrated Multi-Hazard Early Warning System for Asia and Africa (RIMES).
- The INCOIS has already been providing these operational services to the Maldives, Sri Lanka and Seychelles.

RIMES

- Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) is an intergovernmental institution for the generation and application of early warning information.
- It was established in 2009, evolved from the efforts of countries in Africa and Asia, in the aftermath of the 2004 Indian Ocean tsunami.
- It works with a multi-hazard framework for the generation and communication of early warning information and capacity building for preparedness and response to trans-boundary hazards.
- It operates from its regional early warning center in Thailand.
- Recently, at the 3rd ministerial meeting of RIMES was held at Port Moresby, Papua New Guinea.

8.4 International Training Centre for Operational Oceanography (ITCOcean)

- Recently, cabinet approves UNESCO Agreement to be signed for establishing International Training Centre for Operational Oceanography (ITCOcean).
- It will be hosted at ESSO-INCOIS campus in Hyderabad.
- It will be established as **Category-2 Centre (C2C)**.
- The field of operational oceanography involves systematic ocean studies aimed at supporting day-to-day operations and providing information services to various sectors of the blue economy.
- It provides information for fishing, disaster management, shipping and ports, coastal management, environmental management, offshore industries and defense forces i.e. navy, coast guard.
- It will provide an opportunity for India to emerge as a leader in the Indian Ocean, forging cooperation among South Asian and African countries.

Category-2 Centre

- UNESCO has designated 94 International and Regional Institutes and Centres as Category 2.
- Though not legally part of UNESCO, these Institutes and Centres are associated with UNESCO through formal arrangements approved by the General Conference.
- They are selected upon proposal by Member State(s), based on the strength of their specialization in one of UNESCO's fields of competence.
- They provide a valuable and unique contribution to the implementation of UNESCO's strategic programme objectives for the benefits of Member States.
- The strategic programmes covers Education, Natural Sciences, Social and Human Sciences ,Culture and Communication and Information

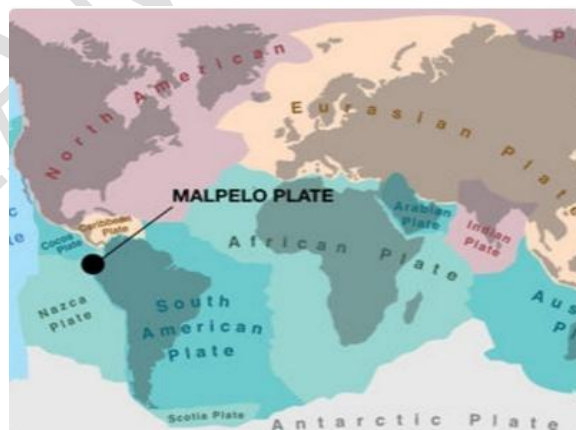
8.5 Zealandia

- Scientists have recently attempted to solve the mysteries of Zealandia by setting sail on an expedition to South Pacific.
- Zealandia, an underwater landmass, was once part of the Gondwana super-continent but broke away some 75 million years ago.
- It is submerged beneath South Pacific, extending from south of New Zealand to north of New Caledonia, covering 5 million square kilometres.
- A piece of seafloor called the Cato Trough still separates Zealandia and Australia.
- It meets all the criteria that are satisfied by the existing seven continents. These are as follows:
 1. it is elevated above the area that surrounds it.
 2. it has its own distinctive geology.
 3. the area that it takes up is well defined.
 4. it has a crust thicker & lighter continental crust than the regular ocean floor with dark volcanic rocks.



8.6 Malpelo Plate

- A microplate called “Malpelo Plate” was recently discovered off the west coast of Ecuador.
- The plate is named for Colombian island and an underwater ridge it contains.
- It is the 57th plate to be discovered and the first in nearly a decade.
- Geologists studied the movements of other plates and their evolving relationships to one another as the plates move at a rate of millimeters to centimeters per year.
- The Pacific lithospheric plate that roughly defines the volcanic Ring of Fire is one of about 10 **major rigid tectonic plates** and it meets two smaller plates, the **Cocos and Nazca**, west of the Galapagos Islands.



List of Tectonic Plates

Major plate - It is any plate with an area greater than 20 million km².

- African Plate
- Antarctic Plate
- Eurasian Plate
- Indo-Australian Plate
- North American Plate
- Pacific Plate
- South American Plate

Minor plate – It is any plate with an area less than 20 million km² but greater than 1 million km².

- Somali Plate
- Nazca Plate
- Philippine Plate
- Arabian Plate
- Caribbean Plate
- Cocos Plate
- Caroline Plate
- Scotia Plate
- Burma Plate
- New Hebrides Plate



List of Tectonic Plates

Micro plate – It is any plate with an area less than 1 million km². For Example,

- Madagascar Plate
- Adriatic Plate
- Sunda Plate
- Greenland Plate
- Galapagos Microplate
- Philippine Microplate
- Mariana Plate

8.7 Geological Stresses in Indian Ocean

- A Geological stresses is building along the Indo-Australian tectonic plate boundary in the Southern Indian Ocean.
- It has the potential to cause a powerful earthquake, triggering a tsunami across much of South India.
- This development is mainly due to the presence of diffuse deformation zone between Indian and Australian tectonic plates.
- Diffuse zones of deformation are in general characterized by complex morphological expressions and scattered seismicity of up to several 100Km width.
- The zones are capable of generating undersea earthquakes up to a magnitude of 8.
- Studies have to be conducted to understand how the event will unfold.
- The largest **strike-slip earthquake** on record had happened along the Indo-Australian boundary in 2012.
- Strike-slip earthquake occurs when tectonic plates slips horizontally along a fault line, unlike most large earthquakes which are caused when two plates collided at their boundaries and one plate slid beneath the other.

8.8 Largest Volcanic Region on Earth

- Researchers have recently discovered the largest volcanic region on Earth with nearly 100 volcanoes, two km below the surface of the vast ice sheet in west Antarctica.
- This huge region is likely to dwarf east Africa's volcanic ridge currently rated as the densest concentration of volcanoes in the world.

8.9 Antarctica Glacier

- An iceberg over 250 square kilometres in size, has broken off from an enormous Pine Island glacier in Antarctica.
- It is second such incident in the last two years.
- The Pine Island Glacier is one of the largest in West Antarctica.
- The glacier loses 45 billion tonnes of ice to the ocean each year equivalent to one millimeter of global sea level rise every eight years.
- This may be due to warmer ocean waters reaching the base of the glacier and weakening it.

8.10 Pacific Shadow zone

- The shadow zone is an area of almost stagnant water sitting between rising currents caused by the rough topography and geothermal heat sources.
- It is located at around **2km below the surface** of the Indian and Pacific Oceans with barely any vertical movement that suspends ocean water in an area, leaving the region directly above isolated for centuries.
- The oldest water in the ocean in the North Pacific has remained trapped in it.
- It traps millennia old ocean water, nutrients and carbon which have a direct impact on the capacity of the ocean to modify climate over centennial time scales.

8.11 Bomb Cyclone

- It's a weather term that applies to a massive winter storm that struck off the U.S. Southeast, the storm has dumped freak snow in this region.
- This storm will usually stay out to sea and blow with high winds gusts exceeding 100 kmph.
- Bomb cyclones draw air from Polar Regions after they leave it means extra cold Arctic air this is based on polar vortex.
- Storm intensity is measured by central pressure the lower the pressure, the stronger.
- A storm is considered a "bomb" when the pressure drops rapidly at least 24 millibars in 24 hours, Millibar is the unit of atmospheric air pressure.

8.12 Polar Vortex

- The polar vortex is a large area of low pressure and cold air surrounding both of the Earth's poles.
- It always exists near the poles, but weakens in summer and strengthens in winter.
- The term "vortex" refers to the counter-clockwise flow of air that helps keep the colder air near the Poles.
- Many times during winter in the northern hemisphere, the polar vortex will expand, sending cold air southward with the jet stream.
- This occurs fairly regularly during wintertime and is often associated with large outbreaks of Arctic air in the United States.
- Polar vortex is not a feature that exists at the Earth's surface and it is not confined to the U.S.
- Portions of Europe and Asia also experience cold surges connected to the polar vortex.

8.13 Earthquake

- The Richter Scale measures the magnitude, which is the amount of energy released during an earthquake.
- The magnitude is derived from a formula involving a logarithm, which makes the scale exponential rather than linear.
- For e.g. an earthquake of magnitude 8.1 is 10 times larger than magnitude 7.1, and 100 times larger than magnitude 6.1.
- But in terms of energy released, magnitude 8.1 is 31.623 times stronger than magnitude 7.1, and 1,000 times (31.623 times 31.623) stronger than magnitude 6.1.
- The Mercalli Scale measures the intensity, which measures the effects of an earthquake.
- These readings are based on factors such as how people perceive the shaking. The same earthquake will have different intensity readings at different places.
- The effects will depend upon the distance (i.e) the farther one moves away from the epicentre, the less intense the shaking.

8.14 World's largest floating solar plant

- China switched on the world's largest floating solar plant, offshore from the city of Huainan in the eastern Anhui province.

8.15 Hywind

- It is the world's first full-scale floating wind farm being built in Scotland.
- The project has a capacity of 30 megawatts
- It has turbines taller than Britain's wind farm "Big Ben".
- The technology will allow wind power to be harvested even in waters that are too deep for the existing bottom-standing turbines.

8.16 High Altitude Cloud Observatory

- A high altitude cloud physics observatory has been established at Munnar, in Western Ghats.
- It is used to observe cloud and rain processes over that region, with state of the art observations.
- The observatory will enable better understanding of rainfall distribution and characterization of rainfall processes in the numerical models used for prediction of monsoon rainfall.



- Another high altitude cloud physics observatory is functional at Mahabaleshwar in Maharashtra.

MAJOR DEFENCE EXERCISES

Joint Exercises conducted by Army

| S. No. | Country | Exercise |
|--------|------------|-------------------------------|
| 1. | Australia | Ex AUSTRAL HIND |
| 2. | Bangladesh | Ex SAMPRITI |
| 3. | China | Ex HAND IN HAND |
| 4. | France | Ex SHAKTI |
| 5. | Indonesia | Ex GARUDA SHAKTI |
| 6. | Kazakhstan | Ex PRABAL DOSTYK |
| 7. | Kyrgyzstan | Ex KHANJAR |
| 8. | Maldives | Ex EKVURIN |
| 9. | Mongolia | Ex NOMADIC ELEPHANT |
| | | Ex KHAN QUEST |
| 10. | Nepal | Ex SURYA KIRAN (BIENNIAL) |
| 11. | Oman | AL NAGAH (SUCCESS) |
| 12. | Russia | Ex INDRA |
| 13. | Seychelles | Ex LAMITIYE |
| 14. | Singapore | Ex AGNI WARRIOR |
| | | Ex BOLD KURUKHESTRA |
| 15. | Sri Lanka | Ex MITRA SHAKTI |
| 16. | Thailand | Ex MAITREE |
| | | Ex COBRA GOLD (Observer Plus) |
| 17. | UK | Ex AJEYA WARRIOR |
| 18. | USA | Ex YUDHABHAYAS |
| | | Ex VAJRA PRAHAR |



Joint Exercises conducted by Navy

| S. No. | Country | Exercise |
|--------|-----------------------|---------------------------------|
| 1. | Australia | AUSINDEX |
| | | KAKADU |
| 2. | Brazil & South Africa | IBSAMAR |
| 3. | Brunei | ADMM+ Exercise (Multilateral) |
| 4. | France | VARUNA |
| 5. | Indonesia | IND-INDO CORPAT (Bi-annual) |
| | | IND-INDO BILAT |
| | | Ex KOMODO (HADR) (Multilateral) |
| 6. | Malaysia | ARF DIREx |
| 7. | Myanmar | IMCOR |
| 8. | Oman | Naseem-al-Bahr |
| 9. | Russia | INDRA NAVY |
| 10. | Singapore | SIMBEX |
| 11. | Sri Lanka | SLINEX |
| | | IN-SLN SF Exercise |
| 12. | Thailand | INDO-THAI CORPAT (Bi-annual) |
| 13. | UK | KONKAN |
| 14. | USA | MALABAR |
| | | RIMPAC (Multilateral) |

Joint Exercises conducted by Air Force

| S. No. | Country | Exercise |
|--------|-----------|-------------------------|
| 1. | France | Ex GARUDA-V |
| 2. | Oman | Ex EASTERN BRIDGE-IV |
| 3. | Russia | Ex AVIAINDRA-14 |
| 4. | Singapore | JOINT MILITARY TRAINING |
| 5. | Thailand | SIAM BHARAT |
| 6. | UAE | Ex DESERT EAGLE-II |
| 7. | UK | Ex INDRADHANUSH-IV |
| 8. | USA | Ex RED FLAG |