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SHANKAR IAS ACADEMY

Door No. 18, Old Plot No 109, New Plot No 259,
AL Block, 4th Avenue, Shanthi Colony,
Anna Nagar, Chennai 600040

www.shankariasacademy.com || www.iasparliament.com



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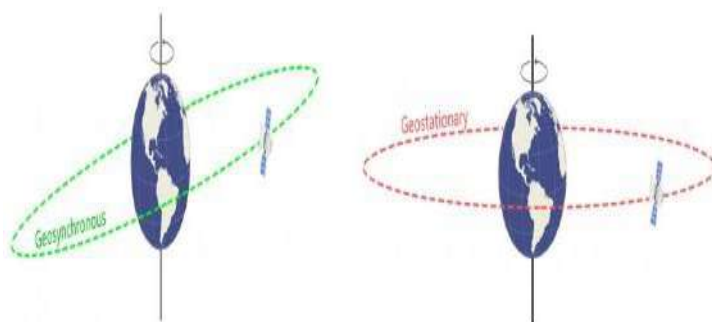
1. SPACE TECHNOLOGY

Introduction

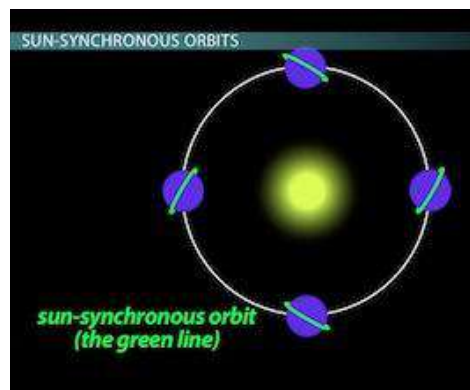
1.1 Types of Orbits

- There are many different satellite orbits that can be used depending upon satellite's functions and area it is to serve.
- The lower the satellites orbit the Earth, the stronger the gravitational pull, and this means that the satellite must travel faster to counteract this pull. Further away the gravitational field is less and the satellite velocities are correspondingly less.
- A satellite orbits 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.
- 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 which the satellite rotates in the same direction as the rotation of the Earth and has an approximate 24 hour period.
- The satellite placed in geostationary orbit remains in the same position relative to the Earth.
- It is used by many applications including **direct broadcast** as well as **communications** or relay systems.
- While geosynchronous satellites can have any inclination, geostationary orbit lie on the same plane as the equator.
- Polar Orbit** –Satellites placed in polar orbits have an inclination of about 90 degrees to the equator and travels north-south over the poles at lower altitudes.

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	



- A satellite in the polar orbit approx. takes 90 minutes for a full rotation. As a result, a satellite can observe the entire surface in the time span of 24 hours.
- They are often used for applications such as **monitoring crops, forests and even global security.**
- **Sun Synchronous Orbit** –It is a special case of Polar Orbit moving from pole to pole allowing satellite to pass over any given point of the planet's surface at roughly the same local time each day.
- Since there are 365 days in a year and 360 degrees in a circle, it means that the satellite has to shift its orbit by approximately one degree per day.
- These orbits are used for satellites that need a constant amount of sunlight and are useful for imaging, spy, and weather satellites.



1.2 Types of Satellites

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

1.3 Launch Vehicles

- Launch Vehicles are used to carry spacecraft to space.
- Following are the various launch vehicles used by ISRO
- **Historic launchers** - Satellite Launch Vehicle - 3 (SLV-3) and Augmented Satellite Launch Vehicle (ASLV).
- SLV was India's first experimental satellite launch vehicle with solid engines in all 4 stages. ASLV has 3 times augmented capacity of SLV-3.



- **Operational launchers** - Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) and Sounding Rockets.
- **Future launchers** – GSLV MK-III, Reusable Launch Vehicle (RLV-TD), Scramjet Engine – TD.

1.4 PSLV

- It is the **3rd generation launch vehicle** and first Indian launch vehicle to be equipped with liquid stages.
- PSLV emerged as the reliable and versatile workhorse launch vehicle of India with consecutively successful missions.
- It successfully launched two spacecraft such as Chandrayaan-1 in 2008 and Mars Orbiter Spacecraft in 2013.
- 3 variations in PSLV - PSLV-G (General), PSLV-XL variants and PSLV-CA (Core Alone).
- It has 4 stages in its operation to provide thrust in launching spacecraft to different orbits.
- **Stage I:** It uses **solid rocket motor** that is augmented by 6 solid strap-on boosters. Strap on boosters are used only in G and XL variation.
- **Stage II:** It uses an Earth storable **liquid rocket engine**, known as the Vikas engine.
- **Stage III:** It uses **solid rocket motor** that provides high thrust after the atmospheric phase of the launch.
- **Stage IV:** It comprises two Earth storable **liquid engines**.
- **Capacity** - 1,750 kg of payload to Sun-Synchronous Polar Orbits of 600 km altitude and to 1,425 kg of payload to Geosynchronous and Geostationary orbits, like satellites from the IRNSS constellation.
- **PSLV launches in 2020/2019**–PSLV-C48/RISAT-2BR1, PSLV-C47 / Cartosat-3, PSLV-C46/RISAT-2B, PSLV-C45/EMISAT MISSION, PSLV - C44/Microsat, Kalamsat

1.5 GSLV

- It is the **4th generation** launch vehicle, a three-stage vehicle with four liquid strap-on boosters.
- GSLV Mk II is the largest launch vehicle developed by India, which is currently in operation.
 1. **Stage I:** It uses **solid rocket** motor with 4 liquid strap-ons.
 2. **Stage II:** It uses **liquid rocket** engine (similar to vikas engine of PSLV stage II).
 3. **Stage III:** It uses India's **first cryogenic engine** (CE-7.5) in the upper stage. It enabled the launching of 2000 kg of communication satellites.
- **Capacity** - It can take up to 5000 kg of pay load to Low Earth Orbits, 2500 kg of payload to Geosynchronous Transfer Orbit (GTO) which are primarily INSAT class of communication satellites.
- **GSLV Launches in 2018** – GSLV – F11/GSAT-7A and GSLV – Fo8/GSAT – 6A mission.
- The next variant of GSLV is GSLV Mk III, with indigenous high thrust cryogenic engine.

1.6 GSLV MK III

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



1.7 Cryogenic Engine

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

1.8 RLV-TD

- Reusable Launch Vehicle – Technology Demonstrator (RLV-TD) is a fully reusable launch vehicle to enable low cost access to space.
- The configuration of RLV-TD is similar to that of an aircraft and combines the complexity of both launch vehicles and aircraft.
- The winged RLV-TD has been configured to act as a flying test bed to evaluate various technologies, namely, hypersonic flight, autonomous landing and powered cruise flight.
- In future, this vehicle will be scaled up to become the first stage of India's reusable two stage orbital launch vehicle.
- **Objectives of RLV-TD** - Hypersonic aero thermodynamic characterisation of wing body, Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes, Integrated flight management and Thermal Protection System Evaluation
- It was successfully flight tested in 2016 from Sriharikota.

1.9 Scramjet Engine - TD

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



- ISRO's Advanced Technology Vehicle (ATV), which is an advanced sounding rocket, was the solid rocket booster used for test of Scramjet engines at supersonic conditions.
- ATV is a two- stage solid launch vehicle capable of carrying Scramjet engines weighed 3277 kg at lift-off.
- India is the fourth country (after USA, Russia and European Space Agency) to demonstrate the flight testing of a Scramjet Engine.

1.10 Small Satellite Launch Vehicle

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

1.11 Vikas Engine

- Vikas is a family of liquid fuelled rocket engines that powers India's launch vehicles PSLV and GSLV.
- It is aimed at improving the payload capability of PSLV, GSLV and GSLV Mk-III launch vehicles.
- It is used in second stage of PSLV which consists of four stages in its operation (Solid-Liquid-Solid-Liquid) and in second stage and four strap-on stages of GSLV.
- GSLV is a three-stage vehicle (Solid-Liquid-Cryogenic Engine) with four liquid strap-on boosters.
- ISRO has recently improved the thrust of the Vikas engine which is expected to boost the rocket engine.
- The main beneficiary of the high-thrust Vikas engine is GSLV-Mark III launcher, which is expected to lift 4,000-kg satellites to space.
- GSLV-Mark III uses twin engine core liquid stage (L110).
- GSLV – Mark III with upgraded Vikas engine would be the third Mk-III and the first working one to be designated MkIII Mission-1 or M1.

1.12 Green Propellants

- ISRO is developing green propellants for use in future rocket & satellite propulsion systems.
- It has made a beginning by developing an eco-friendly solid propellant to eliminate the emission of chlorinated exhaust products from rocket.
- The propellants are based on Glycidyl Azide Polymer (GAP) as fuel and Ammonium Di-Nitramide (ADN) as oxidizer.
- ISRO is also carrying out various technology demonstration projects involving green propellant combinations such as Hydrogen Peroxide (H₂O₂), Kerosene, Liquid Oxygen (LOX), Liquid Methane etc.
- It has successfully developed **ISROSENE**, which is a rocket grade version of kerosene as an alternative to conventional hydrazine rocket fuel.
- It has already used Liquid oxygen and liquid hydrogen combination in cryogenic upper stage of GSLV MK-III.

1.13 Indo-UN Small Satellites Programme

- UNSSP is launched by ISRO to train 90 qualifying engineers from various countries to build and test three small satellites each year.
- ISRO's Bengaluru-based U.R. Rao Satellite Centre (URSC) until recently known as ISAC will train the overseas students.
- Students will be hosted in Bengaluru for two months each year and work in three annual batches of 30.



- This capacity-building programme is in response to a request that the UN Office for Outer Space Affairs had made to space-faring nations last year.
- **UNISPACE+50** - It is an event marking the 50th year of the first UN Conference on the Exploration and Peaceful Uses of Outer Space.

Indian Missions

1.14 GSAT-30

- It is a 3,357-kg satellite launched by Ariane-5 VA-251 vehicle from the Guiana Space Centre in Kourou
- It will replace INSAT-4A which was launched in 2005.
- The mission life is more than 15 years.
- The high-power satellite is equipped with 12 normal C band and 12 Ku band transponders.
- It provides Indian mainland and islands coverage in Ku-band and extended coverage in C-band covering Gulf countries, a large number of Asian countries and Australia.
- It will provide DTH television services, connectivity to VSATs (that support working of banks') ATMs, stock exchange, television up linking and teleport services, digital satellite news gathering and e-governance applications.
- The satellite will also be used for bulk data transfer for a host of emerging telecommunication applications.
- For this operation ISRO hired a foreign launcher as GSAT-30 is much heavier than the 2,000-kg lifting capacity of its geostationary launch vehicle GSLV-MkII.

1.15 PSLV C-48

- PSLV in its 50th flight (PSLV-C48), successfully launched RISAT-2BR1 along with 9 commercial satellites.
- RISAT-2BR1 is a radar imaging earth observation satellite weighing about 628 kg.
- It will provide services in the field of Agriculture, Forestry and Disaster Management. The mission life of RISAT-2BR1 is 5 years.
- The nine commercial satellites were from Israel, Italy, Japan and USA.
- These satellites were launched under a commercial arrangement with NewSpace India Limited (NSIL), the commercial arm of ISRO.
- PSLV-C48 has launch vehicle in 'QL' configuration i.e with 4 solid strap-on motors.

1.16 PSLV C-47

- PSLV C-47 has launched CARTOSAT 3 satellite along with 13 nano satellites from the US.
- Cartosat 3 is a third-generation earth imaging satellite.
- It is an advancement over the previous cartosat series satellites with higher spatial resolution parameter.
- It is deployed for cartography (map-making applications), infrastructure planning, coastal land use and regulation, road-network monitoring and more importantly, change detection in bringing out geographical and man-made features.
- Among the American satellites aboard is a technical demonstration spacecraft from US-based company Analytical Space Inc, which enables users to gain faster access to satellite data.





1.17 PSLV – C46 / RISAT-2B

- PSLV-C46 has launched RISAT-2B into space, which is a radar imaging earth observation satellite.
- The satellite is intended to provide services in the field of Agriculture, Forestry and Disaster Management.
- It has been developed for military and general surveillance purposes.
- RISAT-2B is equipped with synthetic aperture radar that can take pictures of the earth during day and night, and also under cloudy conditions.
- RISAT – 1 was India's first indigenous all-weather Radar Imaging Satellite

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

- GSLV MkIII-M1, successfully launched Chandrayaan-2 spacecraft into its planned orbit but failed to soft-land the lander on the moon.
- **Chandrayaan-1** was designed to just orbit the Moon and make observations, while **Chandrayaan-2** is created to land on the Moon.
- It has three important components — the Orbiter, the Lander 'Vikram', and Rover 'Pragyan'
- The mission aims to explore the unexplored South Pole of the Moon.
- According to ISRO, there is a possibility of the presence of water in permanently shadowed areas around it.
- South Pole region also has craters that are cold traps and contain a fossil record of the early Solar System.
- GSLV MK – III also called as '**Baahubali**', the country's heaviest and most powerful rocket to date.
- ISRO provides four reasons for what made the Chandrayaan-2 mission "special".
- Chandrayaan-2 would be -
 1. the first space mission to conduct a soft landing on the moon's south pole
 2. the first Indian expedition to attempt a landing on lunar surface using home-grown technology
 3. the first Indian mission to explore lunar terrain with home-grown technology
 4. the mission that would make India only the 4th country to soft land on the moon
- **Orbiter** - The Orbiter will 100 km away from the moon, which will observe lunar surface and relay communication between Earth and the Lander.
- The orbiter is equipped with different kinds of camera to take create high-resolution three-dimensional maps of the surface, would remain in orbit for a year.
- **Vikram Lander** - Lander module Vikram was named after Vikram Sarabhai.
- It is the first time that ISRO is attempting to soft-land a module in extra-terrestrial space to mainly study the moon's atmosphere and look out for seismic activity.
- However, it failed in its attempt.
- **Pragyaan Rover** - Rover module Pragyaan means wisdom.
- The 6-wheeled, AI Solar powered rover was designed, developed and build indigenously by ISRO.
- The rover will be landed closer to the Moon's equator to receive more sun light.
- Its primary objective will be to study the composition of the surface near the lunar landing site, and determine its abundance of various elements.
- Both the Lander and Rover are designed to work for only 14 days (1 lunar day).
- This mission will help us to better understand the origin and evolution of the moon.
- Studies of lunar topography, mineralogy, elemental abundance, and signatures of water ice are the prime objectives.
- The orbiter has 8 instruments fitted into it and 7 of them are India's.



- NASA has one payload onboard called the Laser Retroreflector Array (LRA).
- The ‘**Terrain Mapping Camera-2**’(TMC-2) will map the lunar surface and help to prepare 3D maps of it.
- The ‘**Miniature Synthetic Aperture Radar**’(Mini SAR) will also map the surface of water-ice in the South Pole and thickness of the lunar dust on the surface.
- The ‘**Dual Frequency Radio Science**’(DFRS) will study the density of the electrons in the moon’s ionosphere.
- The orbiter has a high-resolution camera (OHRC) that ensures that the lander makes a safe touchdown on the lunar surface by taking 3D images of the landing site.
- The ‘**Solar X-ray Monitor**’(XSM) measures the intensity of the solar rays and the outer most part of the atmosphere or its corona.
- **CLASS** (Chandrayaan 2 Large Area Soft X-ray Spectrometer) measures the light absorbed by the Moon and will check for different metals that are present in its spectrum.
- Thermo-physical property of the lunar surface and seismic activities will also be measured.
- The orbiter will continue to orbit the Moon for a year, at an altitude of 100 kilometres.
- The Rover which is 6-wheeled, AI-powered and the Lander are designed to work for only 14 days (1 lunar day).
- **China’s mission** - China landed a lander and rover on the Moon’s far side (not facing the Earth).
- This was the first time any landing had taken place on that side.
- The Chinese mission, Chang’e 4, was designed to function for three lunar days but has already entered its fifth lunar night.

Geotail and its impact on Chandrayaan-2

- Recently, **ISRO** tweeted that an instrument on Chandrayaan-2, **CLASS**, had detected charged particles during the mission.
- This happened during the orbiter’s passage through the ‘Geotail’.
- The Geotail is a region in space that allows the best observations.
- The region exists as a result of the interactions between the Sun and Earth.
- The Sun emits the solar wind, which is a continuous stream of charged particles.
- These particles are embedded in the extended magnetic field of the Sun.
- Since the Earth has a magnetic field, it obstructs the solar wind plasma.
- This interaction results in the formation of a magnetic envelope around Earth.
- On the Earth side facing the Sun, the envelope is compressed into a region that is approximately 3 to 4 times the Earth radius.
- On the opposite side, the envelope is stretched into a long tail, which extends beyond the orbit of the Moon.
- It is this tail that is called the **Geotail**.
- Once every 29 days, the Moon traverses the geotail for about six days.
- When Chandrayaan-2, which is orbiting the Moon, crosses the geotail, its instruments can study the properties of the geotail.
- It can help to detect the presence of key elements like Na, Ca, Al, Si, Ti and Fe in the lunar soil.



Launch Vehicle	Mission	Application
PSLC C-44	Microsat-R and Kalamsat-V2 satellites	Kalamsat - 10cm cube communication nano-satellite weighing about 1.2kg designed by students First satellite to use PS4 as an orbital platform, thus reducing space debris Microsat-R - 130-kg military imaging satellite
PSLV C-43	HysIS and 30 international co-passenger satellites	HysIS – India's first Hyper spectral Imaging Satellite Aim - Study the earth's surface in the visible, near infrared and shortwave infrared regions of the electromagnetic spectrum
PSLV C-42	Foreign satellites - NovaSAR and S1-4 of UK	Resource Observation Satellite NovaSAR - S-Band Synthetic Aperture Radar satellite S1-4- High-resolution Optical Earth Observation Satellite
PSLV C-41	IRNSS - 1I	8th satellite to join the NavIC navigation satellite constellation
Ariane-5 VA-247	GSAT – 31	40 th communication satellite Provide communication services to Indian mainland and islands
GSLV MK-III D2	GSAT 29	Heaviest satellite launched from India Multi-beam, multibank communication satellite for providing high quality internet services
GSLV Mk-II	GSAT -7A	Heaviest satellite launched by GSLV Mk-II First satellite built primarily for the Indian Air Force
GSLV-F09	GSAT-9	South Asia Satellite is to provide various communication applications in Ku-band with coverage over South Asian countries
	ExseedSAT – 1	A CubeSat mission by the Indian private space company Exseed Space Launched by SpaceX, a private aerospace company, from California satellite launch pad. First Indian Private entity satellite launched by SpaceX, in its Falcon9 rocket

1.19 India's Space Station

- ISRO has announced to launch India's own space station.
- The space station is an artificial satellite placed in orbit and is used as a long-term base for manned operations in space.
- The proposed Indian space station would be similar to the International Space Station but smaller in size weighing about 20 tones and would take another 5 to 7 seven years to construct.
- India would be the fourth country to launch a space station as the US and Russia have already launched their space stations and China is planning to launch its in 2020.
- The International space station (ISS) is currently the only active space station in the earth's orbit.

- ISS is a joint project between five participating space agencies NASA (USA), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).
- The Indian space station would be stationed at an altitude of 400 kilometres from Earth.
- The newly planned Indian space station will conduct microgravity experiments in space where astronauts can stay for 15-20 days.
- This project would be an extension of the Gaganyaan mission, which intends to put two or three Indian astronauts in space for a maximum of a week and is scheduled to be launched by August 2022.

1.20 Bhuvan Panchayat

- Bhuvan Panchayat is a Web portal developed by ISRO.
- The Web Geo portal is developed for the benefit of Gram Panchayat members and other stakeholders, able to perform the following
 1. Database visualization,
 2. Data analytics,
 3. Generation of automatic reports,
 4. Model based products and services
- The targeted audience for this portal is Public, PRIs and different stakeholders belonging to the gram panchayats.
- ISRO National Remote Sensing Centre, which is the national repository of earth imageries, aids rural planners to plan and locate a healthcare unit, water harvesting, and rural communication network.

1.21 SISDP-Update Project

- Satellite imagery-based database of rural natural resources, called SISDP, was launched by ISRO.
- It will be the backbone of planning and decision-making in the country's 2.5 lakh village panchayats, according to its main stakeholders in the departments of Space and Panchayat Raj.
- The recent update to the project is short for Space-based Information Support for Decentralized Planning — uses high-resolution data from recent earth observation satellites and offers detailed information to panchayats about their key assets.

1.22 Vyommitra

- Vyommitra is ISRO's first woman half-humanoid astronaut.
- It will simulate human functions before real astronauts in Gaganyaan crew take off.
- It will be used for an unmanned flight of ISRO's GSLV III rocket (Gaganyaan Mission) in December 2020, which, along with a second unmanned flight in July 2021.
- ISRO will send the human-resembling model in a space capsule around the end of 2020 or early 2021 to study how she and later real astronauts respond to living outside earth in controlled zero gravity conditions.
- She can detect and give out warnings if environmental changes within the cabin get uncomfortable to astronauts and change the air condition.
- She can take up postures suited for launch and tasks and take commands.
- It can also able to perform following functions
 1. Replacing carbon dioxide canisters,
 2. Operating switches,
 3. Monitoring of the crew module,
 4. Receiving voice commands,
 5. Responding via speech (bilingual).

Other Notable Missions

1.23 Gaganyaan

- Gaganyaan is the India's first Human Space Flight Programme set for 2022.
- The programme will make India the fourth nation in the world to launch a Human Spaceflight Mission, only after the USA, Russia and China.
- It is being operating under a newly formed Centre, Human Space Flight Centre (HSFC).
- It aims to send a three-member crew to space for a period of five to seven days.
- Objectives of Gaganyaan Mission-
 1. Enhance of science and technology levels in the country,
 2. Serve as national project involving several institutes,
 3. Inspire youth,
 4. Develop technology for social benefits and
 5. Improve international collaboration
 6. Improve of industrial growth.
- Critical Technologies for Human Space Flight (HSF)-
 1. Orbital Module
 2. Crew Escape System
 3. Integration facility
 4. Crew Module
 5. Deep Space Network
 6. Re-entry and Recovery system
- ISRO has developed some critical technologies through demonstrations like Space Capsule Recovery Experiment (SRE-2007), Crew module Atmospheric Reentry Experiment (CARE-2014) and Pad Abort Test (2018).
- The spacecraft will be placed in a low earth orbit of 300-400km.
- GSLV Mk-III launch vehicle will be used to for the mission. It has the payload capacity of 4000 kg satellites in Geosynchronous Transfer Orbit (GTO) and 8000 kg payload to Low Earth Orbit.
- The crew will be selected by Indian Air Force (IAF) and ISRO jointly after which they will undergo training for two-three years.
- **Re-entry & Recovery tech** - ISRO has already tested the GSLV Mk-III with experimental crew module.
- It came back to Earth after being taken to an altitude of 126 km into space. This this known as Crew module Atmospheric Re-entry Experiment (CARE).
- **Crew Escape System** – It is an emergency escape measure to quickly pull the astronaut crew out to a safe distance from launch vehicle during a launch abort.
- Pad Abort test was conducted earlier to demonstrate this to ascertain the efficiency of crew escape system.
- **Life support** -The Environmental Control & Life Support System (ECLSS) is meant for humans inside to live comfortably.
- It ensures that conditions inside the crew module are suitable for living.
- The ECLSS -
 - i. maintains a steady cabin pressure and air composition
 - ii. removes carbon dioxide and other harmful gases
 - iii. controls temperature and humidity



- iv. manages parameters like fire detection and suppression, emergency support
- v. takes care of food and water management
- The crewed vehicle is planned to be launched on ISRO's GSLV Mk III in December 2021.

1.24 GEMINI system

- GEMINI (GAGAN Enabled Mariner's Instrument for Navigation and Information) is a new marine information dissemination system.
- It is to provide disaster warnings to fishermen by utilizing GAGAN (GPS Aided Geo Augmented Navigation) satellite systems of the AAI and ISRO.
- It is a portable device which receives data from the GAGAN satellites and sends it to the user's cellphone App, which decode the alerts.
- It is developed by INCOIS under Ministry of Earth Sciences and Airport Authority of India.
- INCOIS regularly provides information, advisories, ocean data, weather forecasts, potential fishing zones data to beneficiaries like fishermen, Indian Navy, marine industries, shipping etc.
- But due to the limited range of mobile networks, the disaster warning couldn't reach beyond 10-12km of the coastline which was acutely felt during 2017 Ockhi cyclone.
- The data coverage of GEMINI covers the entire India Ocean full-time, which will help in information transmission to the fishermen far away from coastal areas.

1.25 Human Space Flight Centre

- India's world-class facility for training GAGANYAAN astronauts will be established in three years at Challakere.
- It is a shrubby, arid oilseeds town on the Bengaluru-Pune NH4 in Chitradurga district of Karnataka.
- The 400-acre ISRO land at Challakere will be the single-stop consolidating infrastructure and activities related to space travellers.
- Challakere will also host work related to crew and service modules of the spacecraft that carries the astronauts and up to mission control.
- Challakere, is called the Science City, it houses facilities of the ISRO, the Defence Research & Development Organisation's Advanced Aeronautical Test Range, the Bhabha Atomic Research Centre and the Indian Institute of Science.

1.26 Mission Venus

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

1.27 Aditya-L1 Mission

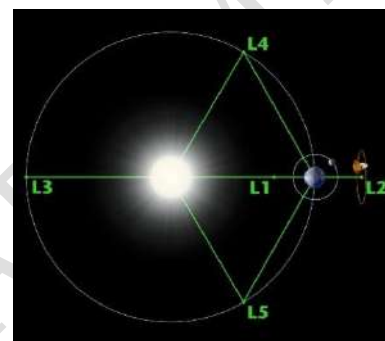
- It is the first Indian mission to study the Sun.
- It is expected to be launched in 2019 by the launch vehicle PSLV-XL with six payloads from Sriharikota.
- The main aim of the solar mission is to do coronal and near UV studies.



- It was meant to observe only the solar corona but with additional experiments, it can provide observations of Sun's Photosphere (soft and hard X-ray), Chromosphere (UV) and corona (Visible and NIR).
- The outer layers of the Sun, extending to thousands of km above the disc (photosphere) is termed as the corona. It has a temperature of more than a million degree Kelvin which is much higher than the solar disc temperature of around 6000K.
- It will be launched into the halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system.
- This orbit has the advantage of allowing continuous monitoring of the sun.

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.



1.28 AstroSat

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

1.29 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.

1.30 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 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 and natural hazards.

Global Missions

NASA

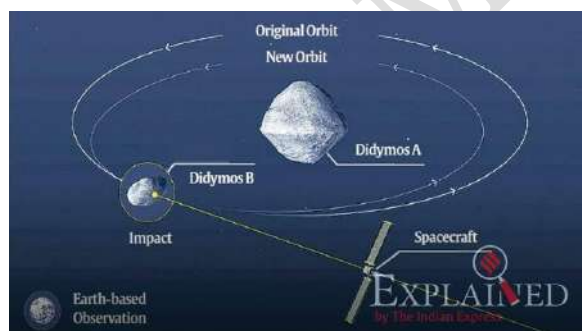
1.31 NASA New Missions

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

1.32 Asteroid Impact Deflection Assessment Mission

- AIDA is a dual-mission concept, involving two independent spacecraft NASA's Double Asteroid Redirection Test (DART), and European Space Agency's Asteroid Impact Mission (AIM).
- It involves Double Asteroid Redirection Test (DART) to avoid potential hit by the asteroids.

- DART is a planetary defence technique developed by NASA.
- Its objective is to save the planet from Asteroid collision by changing its motion in space.
- The spacecraft will cause deliberately crashing itself into the asteroid at a speed of approximately 6 km/s.
- It will be the first demonstration of the kinetic impactor technique to change the motion of an asteroid in space.
- 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.
- It targets binary near-Earth asteroid Didymos, which pose a hazard to earth.
- The target is the smaller of two bodies in the “Double Didymos asteroids” that are in orbit between Earth and Mars.
- It is going to be launched SpaceX Falcon 9 rocket that will hit Didymos in September 2022.
- Flying along with DART will be an Italian-made miniature CubeSat, called **LICIACube**, to record the moment of impact.
- ESA’s contribution is a mission called ‘Hera’, which will perform a close-up survey of the post-impact asteroid.
- **Near -Earth Asteroid (NEA)** - An asteroid 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.



1.33 Artemis Mission

- Artemis is NASA’s next mission to the Moon.
- ARTEMIS stands for Acceleration, Reconnection, Turbulence and Electrodynamics of Moon’s Interaction with the Sun.
- It aims to send astronauts to the Moon by 2024 with the ultimate goal to land humans on Mars.
- The mission consists of spacecraft to measure what happens when the Sun’s radiation hits our rocky moon, where there is no magnetic field to protect it.
- The ARTEMIS mission uses two of the five in-orbit spacecraft from another NASA Heliophysics constellation of satellites (THEMIS) that were launched in 2007 and successfully completed their mission earlier in 2010.
- The ARTEMIS mission allowed NASA to repurpose two in-orbit spacecraft to extend their useful science mission, saving tens of millions of taxpayer dollars instead of building and launching new spacecraft.
- The astronauts will be first sent to the Orion spacecraft using the new Space Launch System (SLS) rocket.
- The spacecraft will take the crew to the lunar orbit and will return them to Earth as well.
- The Orion spacecraft will be docked at the Gateway, from where the astronauts will take expeditions to the surface of the Moon in the human landing system.
- For the mission, NASA announced it will also be accepting proposals from private space corporations to use their technologies for the exploration program.
- Boeing has submitted a proposal to NASA about its integrated Human Lander System (HLS) that will minimise mission complexity with its ‘Fewest Steps to the Moon’ approach.

1.34 Solar Orbiter

- Solar Orbiter is a collaborative mission between the European Space Agency and NASA to study the Sun, took off from Cape Canaveral in Florida.



- The mission, which will take the first pictures of the top and bottom of the sun, was launched on an Atlas V rocket.
- It carries four in situ instruments to measure the space environment immediately around the spacecraft like the sense of touch and Six remote-sensing imagers, which see the sun from afar.
- The Solar Orbiter (called SoLO) will face the sun at approximately 42 million kilometers from its surface.
- The new spacecraft will use the gravity of Venus and Earth to swing itself out of the ecliptic plane, passing inside the orbit of Mercury, and will be able to get a bird's eye view of the sun's poles for the first time.
- In 1990, NASA and ESA had sent the Ulysses mission, which also passed over the sun's poles but at much farther distances, and did not carry a camera.
- Orbiter will take pictures using telescopes through a heat shield that is partly made of baked animal bones, to help it withstand temperatures of up to 600 degree Celsius.
- The Orbiter will help scientists understand the sun's dynamic behavior, and solve mysteries such as the sunspot cycle, or why the star spews out high velocity charged particles through the solar system.
- With more data on the global magnetic field of the star, scientists would be able to forecast space weather events.

1.35 Mars Reconnaissance Orbiter (MRO)

- **MRO is a multipurpose spacecraft of NASA designed to conduct reconnaissance** and exploration of Mars from orbit.
- Launched in 2005, it carried instruments for studying the atmosphere of Mars and to search for signs of water on planet.
- The scientific goals of MRO, according to NASA, are
 1. Search for evidence of past or present life in Mars.
 2. Understand the climate and volatile history of Mars.
 3. To Characterize the geology of Mars.
- To accomplish these goals, MRO carries multiple instruments and it has 3 cameras,
 1. High Resolution Imaging Science Experiment (HiRISE)
 2. Context Camera (CTX)
 3. Mars Color Imager (MARCI)
- MRO has also has,
 1. A spectrometer called 'Compact Reconnaissance Imaging Spectrometer for Mars' (CRISM),
 2. A radiometer called the 'Mars Climate Sounder' (MCS), and
 3. A radar instrument called 'Shallow Radar' (SHARAD).
- It recently captured dust cloud from an avalanche of ice blocks on North Pole of Mars.
- The photo of the avalanche was captured by onboard 'High Resolution Imaging Science Experiment' (HiRISE) camera.
- According to NASA, every spring the sun shines on the side of North Pole of Mars known as the north polar layered deposits.
- This warmth destabilises the ice blocks, break loose which causes Avalanche.
- Avalanches can also be caused by a number of things on Mars surface.
 1. In June 2018, NASA's orbiter was able to spot an avalanche, caused by a meteoroid impact on Mars.
 2. The meteoroid crashed on a slope, it destabilized it and caused an avalanche of dirt and dust.



1.36 Super Cam

- NASA will sending a new laser-toting robot as one of seven instruments aboard the Mars 2020 rover.
- SuperCam, the robot is used for studying mineralogy and chemistry from up to about 7 meters away.
- It might help scientists find signs of fossilized microbial life on Mars.
- It fires a pulsed laser beam out of the rover's mast to vaporize small portions of rock from a distance, providing information that will be essential to the mission's success.
- From more than 7 m away, SuperCam can fire a laser to study rock targets smaller than a pencil point, that lets the rover study spots it can't reach with its arm.
- SuperCam looks at rock textures and chemicals to find those that formed or changed in water on Mars long ago.
- SuperCam looks at different rock and "soil" types to find ones that could preserve signs of past microbial life on Mars — if any ever existed.
- For the benefit of future explorers, SuperCam identifies which elements in the Martian dust may be harmful to humans.
- Scientists can learn about how atmospheric molecules, water ice, and dust absorb or reflect solar radiation, this helps predict Martian weather better.

Other Missions to Mars

- **Mars Missions by NASA**

1. Mariner
2. Mars Resonance Orbiter
3. Phoenix
4. MAVEN
5. In-Sights Lander
6. Curiosity Rover

- **Mars Missions by ISRO**

1. Mangalyaan (Mars Orbiter Mission)

1.37 Insight Mission

- Interior Exploration using Seismic Investigations, Geodesy & Heat Transport, is a Mars lander, launched in 2018.
- 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.
- The lander carries a robotic arm and set of instruments to study the makeup and dimensions of the planet's core, mantle and crust.
- The landing site is Elysium Planitia, a featureless, and hopefully quiet, landscape is well-suited for the mission, to map the interior of the planet.
- Along with the spacecraft, a pair of mini satellites known as Mars Cube One, or MarCO also reached Mars.
- It will be a first test of miniaturized **CubeSat technology** at another planet, which researchers hope can offer new capabilities to future missions.

MarCO Mission

- MarCO stands for Mars Cube One which has twin low-cost cube sats – MarCO A and MarCO B, boarded in Insights lander to Mars.
- The objective of the mission is to find out whether CubeSats could survive the journey to deep space.
- By verifying cubesat as a viable technology for interplanetary mission, it could lead to many other applications to explore and study our solar system.
- It has recently beamed back an image of Mars, visible as a tiny red dot against the dark sky.



- This mission is part of **NASA's Discovery Program** for highly focused science missions that ask critical questions in solar system science.
- 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.

Marsquake

- NASA has recently recorded tremblings in Mars for the first time ever.
- It appears to have come from inside the planet, as opposed to being caused by forces above the surface.
- It was recorded by NASA's Insight lander and its specially designed seismometer picked up the faintest trembles.

1.38 Curiosity

- It is a rover deployed by NASA in its **Mars Exploration Program**, 2011 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.
- 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.
- The rover has recently successfully collected the first rock samples on the red planet in over a year, using a new way to drill rocks and extract powder from the target called "Duluth".

High Methane Levels on Mars

- High amounts of **Methane** in the air on Mars was rediscovered by Curiosity.
- This led to excitement whether this was an indication of life on the Red Planet.
- On Earth, methane (CH₄) is a naturally occurring gas.
- Most of the methane on **Earth** is produced in biological processes.
- However, methane can also be produced by abiotic processes as chemical reactions, found in rocks, springs and aquifers.
- Since many living organisms in Earth release methane, the presence of methane in Mars is considered a potential indicator of life.
- **Curiosity** has an instrument called the **Sample Analysis at Mars** which is a **laser spectrometer** capable of measuring atmospheric composition.
- But it cannot definitively say whether the source of the methane is biological or geological.

1.39 Opportunity Rover

- It was launched in 2003 to land in Mars. It landed in 2004 and began traversing the planet in search of signs of past life.
- It was the first rover to find solid evidence of water on Mars.
- It is still actively exploring the Martian terrain.
- It was originally planned for 90-day mission. But it has far outlasted its planned mission by 55 times longer than originally planned.



- Mars is prone to dust storms due to its thin atmosphere and deserts conditions.
- No response has been received from Opportunity since June 10, 2018amid a planet-encircling dust storm on Mars.
- NASA has declared that the mission is complete.

1.40 NASA Solar Probe

- Parker Solar Probe named as “Eugene Parker”, is the first robotic spacecraft to the Sun, which will travel directly into the sun’s atmosphere about 4 million miles from the star’s surface.
- The mission is to study why the surface of the Sun, called the photosphere, is not as hot as its atmosphere, called the corona.
- It will perform the closest-ever observations of the Sun’s outer atmosphere 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.
- It 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.
- **Recent Development**–It has beamed back the first-light data from each of its four instrument suites.
- It has recently got its revolutionary **heat shield** permanently attached to the spacecraft.
- The shield is made of superheated carbon composite material sprayed with a specifically formulated white coating on the sun facing side to reflect the sun’s energy away from the spacecraft.
- As the spacecraft approach the sun, temperatures on the heat shield will reach nearly 1,300°C but the spacecraft will be kept at about 30°C.
- The shield will help the spacecraft remain safe as it collects data about the inner workings of the corona.

1.41 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.

1.42 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."
- It 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).
- It has found the evidence of penitents which are snow and ice features formed by erosion and characterised by bowl-shaped depressions.
- Until now, Earth is the only planet in the solar system to have Penitentes.



- **Recent developments** - Recently it is reported that the spacecraft will reach icy object nicknamed Ultima Thule (TOO-lee).
- Ultima Thule will be the farthest world ever explored by humankind, no spacecraft has visited anything so primitive.
- Pluto is barely in the Kuiper Belt, the so-called Twilight Zone stretching beyond Neptune, Ultima Thule is in the Twilight Zone's heart.
- The color of Ultima Thule is expected to be darker than coal, burned by eons of cosmic rays, with a reddish hue.

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.

1.43 Juno Spacecraft

- Its mission is to measure Jupiter's composition, gravity field, magnetic field, and polar magnetosphere.
- The objectives of the mission are
 1. Determine how much water is in Jupiter's atmosphere
 2. Look deep into Jupiter's atmosphere to measure composition, temperature, cloud motions and other properties
 3. Map Jupiter's magnetic and gravity fields, revealing the planet's deep structure
 4. Explore and study Jupiter's magnetosphere near the planet's poles, especially the auroras – Jupiter's northern and southern lights.
- It has sent new images of volcanic plume on Jupiter's moon Io, which is the most volcanic body in our solar system.
- Recently, the spacecraft reached "Perijove", the point at which an orbit comes closest to Jupiter's centre and completed a close flyby of Jupiter's Great Red Spot (GRS).
- GRS is a 16,000-km wide storm monitored since 1830 and possibly existing for more than 350 years.
- It has also beamed back an image of a long, brown oval known as a "brown barge", which is an elusive atmospheric feature in Jupiter's South Equatorial Belt.

Cyclones in Jupiter

- When Juno first arrived in Jupiter, it discovered **giant cyclones** encircling the planet's poles (9 in the north and 6 in the south).
- It was discovered using data from Jovian Infrared Auroral Mapper (JIRAM) instrument.
- It has recently discovered a new cyclone on Jupiter's South pole on its 22nd flyby of the planet. Now the South Pole has 7 cyclones.

1.44 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.
- The aim of the mission is to collect a sample of regolith- the loose, soil-like material which covers the surface of the asteroid.
- It was launched in 2016 and it will return a sample to Earth in 2023.

1.45 ICON Satellite

- NASA has recently launched Ionospheric Connection Explorer (ICON) spacecraft from Cape Canaveral Air Force Station.
- It is designed to probe Earth's upper atmosphere (Ionosphere), a massive layer that overlaps with the boundary of space.



- Its measurements will help scientists better understand the link between space weather and terrestrial weather, and how the two interact in the ionosphere.
- It is the region where strange and unique phenomena, such as the auroras and geomagnetic storms are created.

1.46 Voyager 1 & Voyager 2

- It was launched to explore **Jupiter and Saturn** and later extended to other solar bodies.
- The twin voyager probes are the NASA's longest running missions.
- 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.
- Voyager 2 went on to explore Uranus and Neptune, and is still the only spacecraft to have visited those outer planets.
- 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.
- Voyager probes are the first spacecraft to date that humans have sent to this boundary, called the heliopause.
- **Recent developments** - NASA has recently reported that Voyager 2 is nearing heliosphere (Sun's outer border) and could soon enter interstellar space.

1.47 BRUIE

- Buoyant Rover for Under-Ice Exploration (BRUIE) is a robot developed by NASA for underwater exploration in extra-terrestrial, icy waters.
- It will search for life in ocean worlds beyond Earth.
- It could be used to explore Jupiter's moon Europa or Saturn's moon Enceladus.
- As these moons are believed to have liquid water oceans beneath thick crusts of ice, they may be the most promising locations in our solar system to search for evidence of extra-terrestrial life.
- It will be rolling into Antarctica soon to perform driving upside down under sea ice, since they are the closest Earth analog to the seas of an icy moon which makes them an ideal testing ground for it.
- It uses buoyancy to remain anchored against the ice and is impervious to most currents.
- NASA is already constructing the Europa Clipper orbiter, scheduled for launch in 2025 to study Jupiter's moon Europa, laying the groundwork for a future mission that could search for life beneath the ice.

1.48 Terra and Aqua Satellites

- NASA Satellites Terra and Aqua have tracked the movement of cyclone Fani through Infrared, microwave and visible imagery of it.
- Both are Earth Observing satellites, studying the precipitation, evaporation, and cycling of water.
- Both employed MODIS (or Moderate Resolution Imaging Spectroradiometer) as a key instrument, which image the same area on Earth approximately three hours apart.
- Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon.
- Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths.

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.
- 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.



1.49 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.
- It has avoided its head-on collision with phobos, the natural satellite of Mars in 2018.

1.50 Dawn Mission

- It was launched to study the asteroid Vesta and dwarf planet Ceres, which are celestial bodies believed to have accreted early in the history of the solar system.
- 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.
- 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 which the spacecraft will descend to lower altitudes than ever before at the dwarf planet.
- **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.

1.51 TESS

- Transiting Exoplanet Survey Satellite (TESS) is a planet hunter mission. It deploys a space telescope to search for exoplanets (planets outside of our solar system) that could support life.
- The spacecraft will be looking for a phenomenon known as a transit, where a planet passes in front of its star, causing a periodic and regular dip in the star's brightness.
- The principal goal is to detect small planets with bright host stars in the solar neighborhood.
- It will survey 200,000 of the brightest stars near the sun to search for transiting exoplanets.
- It will do an all-sky survey from an orbit between the Earth and the moon

1.52 Magnetospheric Multiscale (MMS) Mission

- MMS, launched in 2015, consists of 4 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.



1.53 CubeSat

- CubeSats are a class of research spacecraft called nanosatellites, which can serve purposes such as Earth observation or amateur radio.
- They are used to demonstrate spacecraft technologies that are targeted for use in small satellites.
- They are built to standard dimensions of 10 cm x 10 cm x 11 cm unit and typically weigh less than 1.33 kg/unit.
- 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 tasks like high-resolution imaging and internet services to disaster response, environmental monitoring and military surveillance.

1.54 Cassini Space Craft

- It is a joint project of NASA, European space agency mission and Italian space agency launched to probe **Saturn**.
- It was launched in 1997 and it arrived in Saturn in 2004.
- It is the fourth space probe to visit Saturn (after pioneer 11, Voyager 1, Voyager 2) and the first to enter orbit.
- Its design includes a Saturn Orbiter and a Lander called "Huygens" for the **moon Titan** (landed in 2005).
- The data collected by lander 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.

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.
- Those carbon chains 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.

1.55 Rosetta

- The mission was launched in 2004 to land a probe on a comet.
- It arrived in the Comet 67P/Churyumov-Gerasimenko in 2014.
- It 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.

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.

Mission	Application
Focusing Optics X-ray Solar Imager (FOXSI) mission	It is a sounding rocket that aims directly at Sun and search for nanoflares using its X-ray vision.
Exploration Mission-1 (EM-1) - Orion Spacecraft	Next-generation vehicle to carry astronauts to the Moon



	and on to Mars
Europa Clipper Mission	To conduct investigation of Jupiter's moon Europa
Lucy and Psyche	To explore Asteroids Lucy - Jupiter's Trojan asteroids Psyche - a giant metal asteroid in the Asteroid belt - 16 Psyche
Neutron star Interior Composition Explorer (NICER)	World's first mission devoted to studying rapidly spinning neutron stars
GOLD & ICON	To explore ionosphere, 96km above Earth's surface
Interstellar Mapping and Acceleration Probe (IMAP)	To understand the boundary of the Heliosphere
VISIONS-2 mission,	Visualizing Ion Outflow via Neutral Atom Sensing-2 To explore how the Earth's atmosphere is slowly leaking in to space
EcAMSat – E.coli Anti-Microbial Satellite Mission	To investigate spaceflight effects on bacterial antibiotic resistance and its genetic basis
ICESat-2	A laser-armed satellite which measures changes in the glaciers, icesheets and sea ice
GRACE FO	Gravity Recovery and Climate Experiment (GRACE) Follow on Mission Keep track changes in mass distribution around the planet, including the massive polar ice sheets, sea level rise and aquifers level

Other Space Agencies

1.56 Lunar Evacuation System Assembly

- It is developed by the European Space Agency.
- It is a pyramid-like structure whose purpose is to rescue an astronaut who suffers an injury on the lunar (moon) surface.
- It can be operated by a single astronaut.
- LESA can be transported like a golf caddy and placed close to the fallen astronaut to provide a lifting mechanism
- It enables an astronaut to lift their crewmate onto a mobile stretcher.
- The astronauts can then safely bring their crewmate to the lander.
- This entire process of deploying and securing their crewmate to the stretcher should take less than 10 minutes.
- This is the second version of LESA.
- An earlier prototype was tested during the NEEMO 22 mission.
- NEEMO is a NASA's mission that sends groups of astronauts to live in Aquarius, the world's only undersea research station, for up to three weeks at a time.
- The Aquarius habitat and its surroundings provide a convincing analog for space exploration.

**1.57 Galileo**

- Galileo is a navigation satellite program being developed by the European Union as a rival to the U.S. Global Positioning System.
- It was commissioned in 2003 and is due for completion by 2020.
- It is a project of the European Commission and European space agency.
- It consists of 24 satellites in which 22 are currently in orbit and it is likely to reach 30 in 2021.
- It promises eventual real-time positioning to accuracy of one metre or less.

1.58 ExoMars

- ExoMars is a joint space venture between European Space Agency and Russian space agency Roscosmos to Mars.
- The ExoMars programme comprises 2 missions.
- The first mission was launched in 2016 and consists of the Trace Gas Orbiter (TGO) and Schiaparelli, an entry, descent and landing demonstrator module.
- The second mission is planned to be launched in 2020 and comprises a rover and surface science platform.
- The rover that will carry a drill and a suite of instruments dedicated to search for possible existence of life beyond earth and geochemistry research.
- It is likely to land on Mars' equator called Oxia Planum, which had housed a massive pool of water in the prehistoric era.

1.59 Hope Spacecraft

- The Hope Mars Mission is also called Emirates Mars Mission.
- It is a planned space exploration probe mission to Mars funded by the United Arab Emirates and built by the Mohammed bin Rashid Space Centre, University of Colorado, Arizona State University, and University of California, Berkeley and set for launch in 2020.
- The probe will study the climate daily and through seasonal cycles, the weather events in the lower atmosphere such as dust storms, as well as the weather on Mars different geographic areas.
- The probe will attempt to answer the scientific community questions of why Mars atmosphere is losing hydrogen and oxygen into space and the reason behind Mars drastic climate changes.
- The probe is scheduled to reach Mars in 2021, which coincides with the 50th anniversary of the United Arab Emirates' formation.

1.60 BepiColombo mission

- It is a first mission of its kind by European Space Agency to Mercury.
- A UK-built spacecraft will determine if the nearest planet to the Sun contains water.
- The mission will send two orbiters to explore the fiery world where the surface temperatures reach about 450°C.
- Till now, only 2 spacecraft have been to Mercury, NASA's Mariner 10 and Messenger.

1.61 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.

1.62 Tiangong-2

- Tiangong-2 (“Heavenly Palace”) is a Chinese Space Laboratory.
- It is an experimental space station which carried out research and human operations in Low Earth Orbit (LEO).
- It was launched on September 2016 and it was has deorbited on July 19, 2019 spent over 1,000 days in orbit.
- It was brought down to Earth in a controlled fashion and burned up over the South Pacific ocean by China.
- It followed the Tiangong-1, China’s first space station, which crashed into the southern Pacific Ocean on 2018.
- It deploys to space the first-ever ‘Cold Atomic Fountain Clock’ which has a higher precision than conventional atomic clocks.
- It detected 55 ‘gamma-ray bursts’ by a device names POLAR installed on the spacecraft.
- It also docked a micro-satellite that took high-resolution pictures of the connected space lab and Shenzhou-11 manned spacecraft.

1.63 Chang’e 4

- Chang’e 4 is a Chinese lunar exploration mission, which incorporates an orbiter, a robotic lander and rover
- It is the world’s mission to land on the dark side of the moon.
- The moon is tidally locked Earth, rotating at the same rate that it orbits our planet, so the far side (Dark side) is never visible from the Earth.
- It will reach the far side of the Moon, not visible from the Earth, a feat no country has ever achieved.
- It will explore the lunar surface in the south pole – Aitken basin, which is one of the largest known impact craters in the solar system.
- The probe has recently entered a planned orbit to prepare for the first ever soft landing on the far side of the moon.
- Chang’e-4 will follow China’s successful Chang’e-3 mission which soft-landed on the visible side of the Moon in 2013.
- The vehicle is similar to **Yutu, China’s first lunar rover** launched in 2013 along with Chang’e 3.

1.64 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.

1.65 MINERVA-II1

- Micro Nano Experimental Robot Vehicle for Asteroid (MINERVA) is the second-generation rover developed by Japanese Space Agency.
- It is the world’s first man-made object to explore movement on an asteroid surface.
- It recently landed on Asteroid Ryugu and the world’s first rover to land on the surface of an Asteroid.
- This is also the first time for autonomous movement and picture capture on an asteroid surface.

- It will collect a sample of the primitive world during its stay at Ryugu, to bring to Earth for laboratory analysis

1.66 Star Link satellites

- SpaceX has launched its third batch of mini-satellites into orbit, consisting of 60 mini-satellites as a part of star link satellite constellation.
- The satellite cluster was launched on-board the Falcon 9 rocket from Cape Canaveral, Florida.
- Star Link is a plan of SpaceX to build a giant constellation of thousands of satellites that form a global broadband Internet system.
- To address the space debris issue Star link is designed in a way to use their propulsion systems to de-orbit over the course of a few months and if they fail, they will burn up naturally in the atmosphere in under five years, when their lifetime is almost up.

1.67 Terminator Tape

- To tackle the problem of space debris, a company called Tethers Unlimited has demonstrated an easy solution to get rid of satellites once they are of no use.
- The Terminator Tape is a small module about the size of a notebook.
- It weighs less than two pounds that will be attached to the exterior of a satellite that deploys the 230-feet long conductive tape through an electric signal from either the satellite or an independent timer unit.
- This tape interacts with the space environment to create a drag force on the satellite that lowers its orbit.
- The company calls the Terminator Tape “an affordable, lightweight solution for removing space debris from an orbit”.
- Tethers Unlimited is currently collaborating with Millennium Space Systems, TriSept, and RocketLab to prepare a scientific method-based low-Earth orbit flight experiment called “DRAGRACER”.
- It will compare deorbit of two identical satellites– one with a Terminator Tape and another without one.
- The experiment will compare the falling speed of the two satellites to analyze the tape’s performance.

Mission	Application
Aeolus Satellite	Part of the Copernicus project (EU + European Space Agency) To track environmental damage and aid disaster relief operation Advanced laser technology to track global winds and improve weather forecasts World's first space mission to gather information on Earth's wind on a global scale.
Gaia Mission	Global Astrometric Interferometer for Astrophysics (Gaia) To chart a 3-D map of the home galaxy
Sentinel-5P satellite	European Satellite to track global air pollution
Queqiao (Magpie Bridge)	China – to set up a communication link between the Earth and a planned Chinese lunar exploration mission to explore the Moon's mysterious far side
HY-1C satellite	China – To improve understanding of maritime waters and climate change
Ibuki – 2	Japan – For Greenhouse Gas observation
Kirameki-2 satellite	Japan – The first military communication satellite
Venus Satellite	Vegetation and Environment Monitoring New Micro-Satellite



	Israel and France Monitor Earth'
Falcon Heavy	Reusable super heavy-lift launch vehicle designed and manufactured by SpaceX, a private American aerospace manufacturer

2. PLANETARY SYSTEMS

2.1 Definition of a Planet

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

2.2 Ploonet

- When the moons of exoplanets break away from their own orbits, went rogue and acts like a planet, it is called "**Ploonet**."
- It gets its name from 'Planet + moon = **Ploonet**'.
- As the exoplanets move inward toward their suns, the orbits of their moons are often disrupted.
- So, the moon may run away from their exoplanets and could become 'Ploonets', according to new study models.
- This is because of the combined gravitational forces of the planet and the star.
- This gravitational force would inject extra energy into the moon's orbit, pushing it farther from its planet until eventually it escapes.
- This process happens in every planetary system composed of a giant planet in a very close-in orbit.
- As for Earth's own Moon, it is a potential ploonet.
- It moves about 4cm farther away from Earth every year.
- Going at this rate, it won't break away from the Earth's orbit for about next 5 billion years.
- However, astronomers not yet confirmed the existence of a single exomoon, it just remains hypothetical in research papers.

2.3 Planet Saturn

- Scientists at International Astronomical Union's Minor Planet Centre have identified 20 new moons around Saturn.
- With this discovery, Saturn has become the planet with the highest number of moons (82) surpassing Jupiter with 79 moons.



- 17 of the new moons orbit the planet in the opposite, or retrograde, direction and 3 moons have prograde orbits, circling in the same direction.

2.4 Goldilocks zone

- A habitable zone, also called the “Goldilocks zone”, is the area around a star where it is not too hot and not too cold for liquid water to exist on the surface of surrounding planets.
- Obviously, our Earth is in the Sun’s Goldilocks zone.
- If Earth were where the dwarf planet Pluto is, all its water would freeze; on the other hand, if Earth were where Mercury is, all its water would boil off.

2.1 Sun’s Atmosphere

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

2.2 Solar Cycles and Sun spots

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



2.3 Asteroid & Comet

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

Naming of an Asteroid

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



- It is located between Mars and Jupiter, and was discovered on November 11, 2006 by the Arizona based telescope.

2.5 Heliosphere, Heliopause and Interstellar Space

- The sun creates heliosphere by sending a constant flow of particles and a magnetic field out into space at over 670,000 miles per hour. This stream is called the 'solar wind.'
- Heliopause marks the end of a region created by our sun that is called the heliosphere.
- It is the boundary between our Solar System and the interstellar medium.
- It is the place where the sun's constant flow of material and magnetic field stop affecting its surroundings.
- Interstellar Space is the part of space that exists between stars with cold particles around it.
- Inside the heliosphere, the solar particles are hot but less concentrated. Outside of the bubble, they are very much colder but more concentrated.
- Once an object arrives in interstellar space, there would be an increase of "cold" particles around it.

2.4 Kuiper Belt

- The Kuiper Belt is a region of the Solar System that exists beyond the eight major planets.
- It is similar to the asteroid belt, in that it contains many small bodies, all remnants from the Solar System's formation.
- But unlike the Asteroid Belt, it is much larger – 20 times as wide and 20 to 200 times as massive.

2.5 Super Blood Blue Moon

- Super Blood Blue Moon = Super moon + Blue moon + Total Lunar Eclipse
- **Super moon** – It occurs 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.

2.6 Super Blood Wolf Moon

- It is a phenomenon wherein the Moon appears particularly large and bright with a reddish glow.
- A supermoon happens when the full moon coincides with the moon's closest approach to Earth in its orbit (perigee).
- It makes the moon appear a little brighter and closer than normal.
- Blood during a total lunar eclipse when the Earth passes in between the Sun and the Moon.



- Earth blocks the Sun's light from falling directly on the Moon so the only light the moon gets is reflected off of Earth.
- Earth's atmosphere scatters blue so only the red light gets reflected onto the Moon's surface and makes it look red.
- Wolf Moon is the name given by Native Americans to a full moon that appears in January.
- So Super Blood Wolf Moon = Full Moon + Perigee + Lunar Eclipse + January
- A lunar eclipse only takes place when there is a full Moon.

2.7 Pink Moon

- The full moon in April is called the 'pink moon' in North America.
- It is to represent ground phlox, which are ground-cover flowering plants and usually bloom around springtime.
- The April moon is also known as the Sprouting Grass moon, the Egg Moon and the Fish Moon.
- These names are all Native American names for the phenomenon.
- Every month's full moons are named by the tribes.
- As the early Native American tribes did not record time using either the Julian or the Gregorian calendars, they used the moons to keep track of seasons.

2.8 Mini-Moon

- Astronomers have observed a small object orbiting Earth, which they have dubbed a "mini-moon" or the planet's "second moon".
- It is actually an asteroid, about the size of a car, with a diameter of about 1.9-3.5 m.
- Unlike our permanent Moon, the mini-moon is temporary, it will eventually break free of Earth's orbit and go off on its own way.
- Dubbed 2020 CD₃, the mini-moon was discovered by NASA-funded Catalina Sky Survey (CSS).
- CSS previously discovered 2006 RH₁₂₀, which orbited Earth for some time that year, before it escaped in 2007.
- The Minor Planet Center of the International Astronomical Union acknowledged the discovery.
- When an asteroid's orbit crosses Earth's orbit, it can sometimes be captured into the latter orbit, this is what happened with 2020 CD₃.
- It is now orbiting at a distance farther from Earth, Such an asteroid is called a Temporarily Captured Object (TCO).
- The orbit of such objects is unstable and they have to contend with the gravitational influence of our permanent Moon as well as that of the Sun.
- Once caught in Earth's orbit, such objects usually remain for a few years before they break free and go into independent orbit around the Sun.

2.6 Europa

- Europa, a frozen moon around Jupiter, is believed to be one of the most habitable worlds in the solar system.
- It was first imaged in detail by the NASA's Voyager 1 probe in 1979, revealing a surface almost devoid of large craters.
- Europa is also criss-crossed with long troughs, folds and ridges, potentially made of icebergs floating around in melt-water or slush.
- In 1990's The Galileo mission found evidence that it had a sub-surface liquid salt water ocean.
- Recent studies show it may well be normal table salt (sodium chloride), just like on Earth.

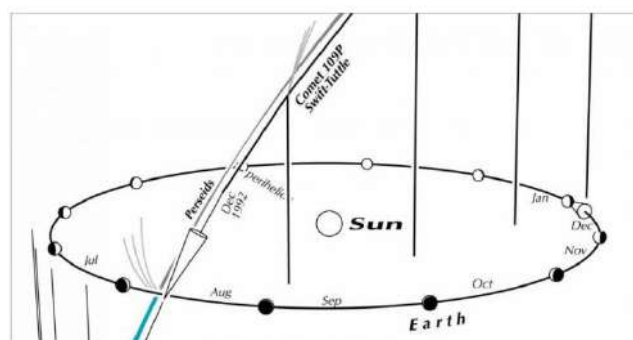
- This has important implications for the potential existence of life in Europa's hidden depths.
- Scientists believe that hydrothermal circulation within the ocean, possibly driven by hydrothermal vents might naturally enrich the ocean in sodium chloride, via chemical reactions between the ocean and rock.
- On Earth, hydrothermal vents are thought to be a source of life, such as bacteria.
- Like our moon and Earth, Europa is tidally locked to Jupiter, meaning that it always presents the same side to the giant planet.
- Salt, specifically the sodium ions in table salt, is also crucial for a whole range of metabolic processes in plant and animal life.

2.7 Artificial Gravity

- A team from the University of Colorado is working on making a device which could create artificial gravity in space
- Artificial gravity is a force that simulates the effect of gravity in a spaceship.
- It is not caused by the attraction to the Earth but is instead caused by **acceleration** or **centrifugal force**.
- **Artificial gravity** or rotational **gravity**, is thus the appearance of a **centrifugal force** in a rotating frame of reference.
- The research centrifuge is called as '**Human Eccentric Rotator Device**' (HERD) and the device is compact enough to fit into a small room.
- A rotating circular space station can create artificial gravity.
- The rate of rotation is necessary to duplicate the Earth's gravity depends on the radius of the circle.
- Future astronauts heading into an **artificial-gravity room** to spend time on a small revolving system.
- It is built with the aim of counteracting the negative effects of weightlessness.

2.8 Perseid Meteor Shower

- The 'Perseids', are a prolific meteor shower which peak during mid-August, are considered the best meteor shower of the year.
- They are also known for their 'Fireballs' and also for their brightest Meteor Shower.
- Fireballs are larger explosions of light and color that can persist longer than an average meteor streak.
- Meteors come from leftover comet particles and bits from broken asteroids.
- When comets come around the sun, they leave a dusty trail behind them.
- Every year, from around July 17 to August 24, Earth crosses the orbital path of Comet Swift-Tuttle, the parent of the Perseid meteor shower.
- Debris from this comet litters the comet's orbit.
- The bits and pieces from Comet Swift-Tuttle slam into the Earth's upper atmosphere at some 210,000 km/hour, lighting up the nighttime with fast-moving Perseid meteors.
- The Perseids currently visible in the night sky are not due to the debris left behind by the comet Swift-Tuttle during its most recent pass, which happened in 1992.
- This particular comet goes around the Sun once in 133 years.
- The meteors now visible were left behind by the pass before the last one or perhaps even earlier.



The Perseids happen every year. Their parent comet – Swift-Tuttle – takes about 130 years to orbit the sun once. It last rounded the sun in the early 1990s and is now far away. But we see the Perseids each year, when Earth intersects the comet's orbit, and debris left behind by Swift-Tuttle enters our atmosphere. Chart via Guy Ottewill.



2.9 K2-18b

- '**K2-18b**' is an 'exoplanet' discovered in 2015 by NASA's 'Kepler spacecraft'.
- Now, scientists have found signatures of 'Water vapour' in the atmosphere of **K2-18b**.
- This makes it the only planet outside Solar system with temperatures and water vapour that can potentially support life.
- It is about 110 light years from Earth, and 8 times the mass of Earth, orbits a star.
- It resides in a habitable zone, the region around a star in which liquid water could potentially pool on surface of a rocky planet.
- **K2-18b** is not 'Earth 2.0' as it is significantly heavier and has a different atmospheric composition.
- The researchers used data from the 'Hubble Space Telescope' and analysed the **K2-18b**'s atmosphere.
- The results revealed the molecular signature of water vapour, indicating, presence of hydrogen and helium in its atmosphere.

2.10 Interstellar objects

- In 2017, The Haleakala Observatory in Hawaii spotted a strange, spaceship-shaped object passing through the Solar System.
- It was named "**Oumuamua**", it became the subject of speculation whether it was really an alien spaceship.
- It was eventually declared by scientists to be an interstellar object, the first such known visitor to the Solar System.
- Now, it appears that a second interstellar object is paying a visit.
- On August, the MARGO observatory in Crimea spotted a comet and is believed to have originated from outside the Solar System,
 - although the official confirmation has not been made yet.
- The comet has been designated "**C/2019 Q4 (Borisov)**".
- It is still inbound toward the Sun. It will remain farther from Earth than the orbit of Mars.
- It was detected by NASA's Jet Propulsion Laboratory (**JPL**), Scout system.
- **JPL** automatically flagged the object as possibly being interstellar.
- The comet's current velocity is about 150,000 kph, which is well above the typical velocities of objects orbiting the Sun.
- The high velocity indicates that the object likely originated from outside our Solar System and head back to interstellar space.

2.11 Sagittarius A

- It is a supermassive black hole sits 26,000 light years away from Earth, near the 'Galactic Centre' or the centre of the 'Milky Way'.
- Since the discovery of **Sagittarius A** 24 years ago, it has been fairly calm.
- This year, however, **Sagittarius A** has shown unusual activity, and the area around it has been much brighter than usual.
- Reason for this unusual activity,
 1. Sagittarius A may become hungrier and has been feeding on nearby matter at a faster rate, it is described as a "**Big feast**".
 2. A black hole does not emit light by itself, but the matter that it consumes can be a source of light.
 3. Sagittarius A could be growing faster than usual in size.
 4. The current model that measures its level of brightness maybe inadequate and is in need of an update.

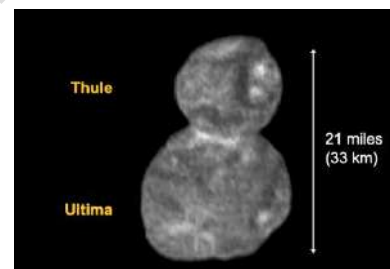
- Another possibility involves a bizarre object known as **G2**.
 1. It is most likely a pair of binary stars, which made its closest approach to the black hole.
 2. It is possible the black hole could have stripped off the outer layer of G2.
 3. This could help explain the increased brightness just outside the black hole.

2.12 Black Hole System

- Indian, British astronomers have recently discovered new details of black hole 10,000 light years away.
- The black hole system 'MAXI J1820+070' was first discovered in 2018.
- Its mass is the equivalent of seven Suns compressed into a region smaller than the city of London.
- The effect of the black hole's strong gravity and the material's own magnetic field can cause rapidly changing levels of radiation, which are emitted from the system as a whole.
- This radiation was detected in visible light by the HiPERCAM instrument on the Gran Telescopio Canarias, Spain and in NASA's NICER observatory aboard the International Space Station.
- This kind of observations are not possible even by the Event Horizon Telescope (EHT) as the distance make them too faint and too small.

2.13 Arrokoth

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



2.14 TOI 700 d

- Recently NASA reported the discovery of an Earth-size planet, named TOI 700 d, orbiting its star in the "habitable zone".
- TOI 700 d measures 20% larger than Earth.
- It orbits its star once every 37 days and receives an amount of energy that is equivalent to 86% of the energy that the Sun provides to Earth.
- The newest such planet was found by NASA's Transiting Exoplanet Survey Satellite (TESS) mission, which it launched in 2018.
- Very few such Earth-size planets have been found so far, including some by NASA's Kepler mission, and this one is the first such discovery by TESS.

2.15 Venus Volcanoes

- New research suggests that the Earth's sister planet Venus has active volcanoes.
- According to the study lava flows on Venus may be only a few years old.
- This suggests that Venus could be volcanically active today, making it the only planet in our solar system, other than Earth, with recent eruptions.



- The Visible Infrared Thermal Imaging Spectrometer (VIRTIS) on the Venus Express orbiter has measured the amount of infrared light emitted from part of Venus' surface during its nighttime, shedding new light on volcanism on the planet.
- This allowed scientists to differentiate the fresh lava flows on the surface of Venus from the older ones.
- Earlier, the ages of lava eruptions and volcanoes on Venus could not be identified because the alteration rate of fresh lava was not well constrained.
- The new research led by Universities Space Research Association (USRA) has used data from the European Space Agency's (ESA's) Venus Express orbiter to confirm that the lava flows are recent and Venus could have currently active volcanoes.

2.16 TRAPPIST-1

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

2.9 Saraswati - Supercluster of Galaxies

- A team of Indian scientists has reported the discovery of a 'supercluster' of galaxies and named it Saraswati.
- It is located four billion light years away from the earth.
- Galaxies are themselves made of billions of stars and planets, and a cluster typically contains several hundreds of these galaxies.
- Superclusters, a group of clusters of galaxies, are the largest structures of stars, planets and other heavenly bodies in the Universe.
- The Milky Way galaxy, of which the Earth is a very small member, is part of the Laniakea supercluster, which was identified only in 2014.

2.17 Ryugu Asteroid

- A Japanese Probe "Hayabusa2" has reached "Ryugu", an asteroid 300 million km away from Earth.
- Japan Aerospace Exploration Agency, JAXA has launched the probe in 2014.
- The aim of the mission is to collect information about the birth of the solar system and the origin of life.
- It identify suitable sites to take samples from once the probe touches down on the asteroid.
- It will deploy a small lander and three rovers.
- It will then blast an artificial crater to analyze material below the asteroid's surface. After that, the probe will head back to Earth, arriving near the end of 2020 with samples in tow.

2.18 Oumuamua

- Oumuamua is the first interstellar object known to enter our solar system.
- It accelerated faster away from the sun than expected. This has created the notion that some kind of artificial sail (force of radiation pressure that runs on sunlight) may have pushed it.
- This artificial sunlight known as “Light sail” may be responsible for the excess acceleration of the object.



2.19 Farout

- Astronomers have reported the discovery of the most distant body ever observed in the Solar System, at 120 astronomical units (AU) from the Sun.
- This has led to the nickname “Farout” for the object, provisionally titled 2018 VG18.
- Farout is also the first known Solar System object that has been detected at a distance that is more than 100 times farther than Earth is from the Sun.
- For context, the second-most distant observed Solar System object is Eris, at about 96 AU. Pluto is currently at about 34 AU.
- 1 AU is defined as the distance between the Earth and the Sun.



3. TELESCOPES & OBSERVATORIES

3.1 Square Kilometre Array

- SKA project is an international effort to build the world's largest radio telescope, with eventually over a square kilometre (one million square metres) of collecting area.
- It will use 1000s of dishes and up to a million low-frequency antennas that will enable astronomers to monitor the sky in unprecedented detail and survey the entire sky much faster than any system currently in existence.
- South Africa's Karoo region and Western Australia's Murchison Shire were chosen as co-hosting locations for this project.
- Karoo will host the core of the high and mid frequency dishes and Murchison will host the low-frequency antennas.
- **Recent Developments - MeerLITCH** is the world's first optical telescope linked to a radio telescope launched in South Africa.
- The device forms part of the SKA project and will be linked to MeerKAT, a radio telescope located 200km away.
- Scientists at Cambridge have finished designing the data processor of SKA's telescopes.

3.2 CHEOPS Satellite

- CHEOPS – CHAracterising ExOplanet Satellite is a new telescope launched by European Space Agency.
- Unlike, NASA's Kepler and TESS mission, it is a follow-up mission for the study of exoplanets rather than a discovery machine.
- Thus, it will help in determining planet sizes and other information.
- It will lift-off as a secondary passenger on a Soyuz-Fregat rocket.



- Its aim is to measure size of known transiting exoplanets and search for transits of exoplanets previously discovered via radial velocity.
- It is the first mission dedicated to searching for exoplanetary transits by performing **ultra-high precision photometry** on bright stars already known to host planets.
- The Mission objectives are,
 - i. Use ultra-high precision photometry to measure accurate sizes of a large sample of Earth to Neptune sized planets,
 - ii. Seeks to measure light curves of hot Jupiters to see how energy is transported in planetary atmospheres,
 - iii. Combine CHEOPS size measurements with existing planet masses to constrain their composition and internal structures.
 - iv. Identify prime targets to search for the fingerprints of key molecules in the planets' atmospheres using future observatories on Earth.
- Ever since its launch CHEOPS satellite has been orbiting the Earth at an altitude of 700 kilometers (435 miles).

3.3 Spitzer Mission

- The Spitzer Space Telescope is a space-borne observatory, one of the elements of NASA's Great Observatories that include the Hubble Space Telescope and the Chandra X-Ray.
- Using different infrared wavelengths, Spitzer was able to see and reveal features of the universe including objects that were too cold to emit visible light.
- Apart from enabling researchers to see distant cold objects, Spitzer could also see through large amounts of gas using infrared wavelengths to find objects that may otherwise have been invisible to human beings.
- These included exoplanets, brown dwarfs and cold matter found in the space between stars.
- NASA's Spitzer Mission, studied the universe in infrared light for more than 16 years.
- It will come to an end since it is low on fuel and has been drifting away from Earth for a few years now.
- Engineers will decommission the Spitzer aircraft, after which it will cease to conduct science operations.

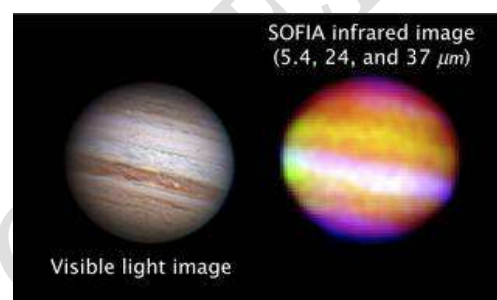
3.4 Gravitational Wave Observatory

- A gravitational wave (GW) is a concept, predicted by Einstein through his theory of general relativity which states that mass distorts both space and time.
- When an object accelerates, it creates ripples in space-time, just like a boat causes ripples in a pond. These space-time ripples are gravitational waves.
- GWs are caused by cataclysmic events that result in high-energy explosions, such as collision of black holes or neutron stars.
- GWs are extremely weak and so are very difficult to detect.
- Strength of the wave depends on the mass of the object and requires extremely sensitive detectors to sense them.
- Missions like **LIGO (Laser Interferometer Gravitational-wave Observatory) in U.S** helps to spot gravitation waves, detecting small changes in the distances between objects at set distances.
- **LIGO:** It is a large-scale physics experiment and observatory with the mission to **directly observe gravitational waves of cosmic origin.**
- A fourth gravitational wave has been detected with help from **Italy-based equipment Virgo detector.**
- The Virgo detector is an underground L-shaped instrument that tracks gravitational waves using the physics of laser light and space.
- The underground stations are known as interferometers, do not rely on light in the sky, but instead sense vibrations in space created by a gravitational wave.

- The Japanese **KAGRA detector** is set to go online in 2019 and LIGO India set to join by 2024.
- Previously, gravitational waves have been found using two U.S.-based detectors known as the Laser Interferometer Gravitational-Wave Observatory (LIGO).
- **LIGO-India**, or INDIGO, is a planned collaborative project between the LIGO Laboratory and the **Indian Initiative in Gravitational-wave Observations (IndIGO)** to create a world-class gravitational-wave detector in India.
- A site in the Hingoli district (Maharashtra) has been selected.
- **Noble Prize for Physics** - Rainer Weiss, Barry C. Barish's and Kip Thorne's were jointly awarded the Nobel Prize for physics for their contribution to the LIGO-VIRGO project and its detection of gravitational waves.

3.5 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.



3.6 Kepler Telescope

- It is an observatory in space dedicated to finding planets outside our solar system.
- It was originally launched in 2009 as part of NASA's Discovery Program.
- It recently ran out of fuel and was retired nearly after 9-year mission.
- It was approved far beyond its original mission length and was operating well until May 2013, when a second of its four reaction wheels or gyroscopes failed.
- It targets particularly alien planets that are around the same size as Earth in the "habitable" regions of their parent star.
- Since 2009, it has discovered extra-solar planets in the range between the size of Earth and Neptune.
- It was the first telescope to find a planet (Kepler-69c) approximately the size of Earth in the habitable region of a star.
- It examined the TRAPPIST-1 system which likely has multiple Earth-sized planets in it between December 2016 and March 2017.

3.7 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.
- The telescope has recently imaged a “stunning spiral galaxy” located about 30 million light-years away from the earth in the constellation of Leo.
 - The spiral galaxy named as NGC 2903 is similar to our own Milky Way galaxy.

Comet 2I/Borisov

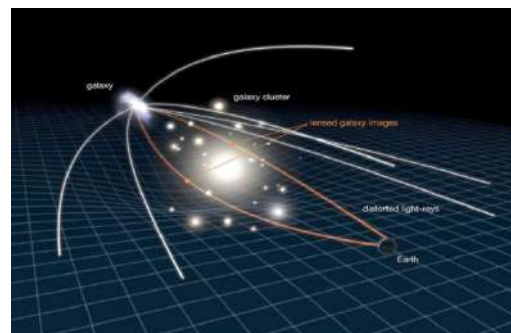
- Recently, NASA’s Hubble space telescope have captured Comet 2I/Borisov to enter the solar system.
- It is the first interstellar comet to enter the solar system and the closest comet to the Sun.
- It speeds past the sun at 160,000 kilometres per hour.
- Borisov is only the second interstellar object ever seen entering the solar system. The first was **Oumuamua** in 2017.
- The mass of ice and dust particles and the comet’s centre is 1 km long.
- The comet will pass Jupiter in mid-2020 before making its way back to interstellar space and remaining there for billions of years.

3.8 James Webb Telescope

- NASA’s James Webb Telescope is the world's **premier infrared space observatory** of the next decade.
- It is developed in coordination among NASA, the European Space Agency, and the Canadian Space Agency.
- It is the most sophisticated and expensive space observatory ever designed.
- It is scheduled for launch in 2021 aboard a European Ariane 5 rocket from French Guiana and to orbit at Earth's second Lagrange point (L2).
- It will study every phase in the history of our universe, ranging from the first luminous glows after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own Solar System.
- It was formerly known as the "Next Generation Space Telescope”.
- It is the successor to the ‘Hubble observatory’ and it won’t just replace Hubble, it will massively expand our ability to observe distant objects.
- Once put in space, the telescope will explore the cosmos, planets and moons within our solar system.
- It will also explore the most ancient and distant galaxies using infrared light.
- It is funded by NASA in conjunction with the European Space Agency (ESA) and the Canadian Space Agency (CSA).
- It will also have the power to analyse the atmospheres of many the new planets, for the potential for life.
- After launch, it will head near the Earth-Sun ‘**L2**’ Lagrange point almost a million miles away (1.5 million kilometers).

3.9 Gravitational Lensing

- Using NASA’s James Webb Space Telescope researchers plan to investigate how new stars are born.
- For this, a natural phenomenon called “Gravitational lensing” is to be used.





- The gravitational field of a massive object will extend far into space, and cause light rays passing close to that object to be bent and refocused somewhere else.
- This phenomenon is 'Gravitational lensing', simply put, 'mass bends light'.
- The effect is analogous to that produced by a lens.
- The more massive the object, the stronger its gravitational field and hence the greater the bending of light rays.
- It is just like using denser materials to make optical lenses results in a greater amount of refraction.
- In effect, these are natural, cosmic telescopes, called gravitational lenses.
- These large celestial objects will magnify the light from distant galaxies that are at or near the peak of star formation.
- The effect allows researchers to study the details of early galaxies too far away.
- Gravitational lensing happens on all scales,
 1. The gravitational field of galaxies and clusters of galaxies can lens light.
 2. On smaller objects such as stars and planets.
 3. Even the mass of our own bodies will lens light passing near us a tiny bit, although the effect is too small to ever measure.
- The Milky Way today forms the equivalent of one Sun every year, but in the past, that rate was up to 100 times greater.
- NASA now plans to look billions of years into the past in order to understand how our Sun formed.
- The programme is called 'Targeting Extremely Magnified Panchromatic Lensed Arcs and Their Extended Star Formation', or **TEMPLATES**.

3.10 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.

3.11 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.



3.12 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.

Hygiea

- Space scientists have discovered a new celestial body Hygiea using Very Large Telescope in Chile.
- It might be the smallest such planet to exist in our solar system, sized at 430 kilometres (267 miles) in diameter.
- According to the criteria which defines celestial bodies as dwarf planets instead of asteroids, is that it needs to have sufficient mass for the gravity to pull it into a shape of a sphere.

3.13 Giant Metrewave Radio Telescope

- GMRT serves as a unique facility for radio astronomical research using the metrewavelengths 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.

3.14 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.

3.15 X-Calibur Telescope

- It is a telescope that has been successfully launched recently by US scientists from the McMurdo Station in Antarctica.
- It was launched on a helium balloon intended to reach an altitude of 130,000 feet i.e at nearly four times the cruising altitude of commercial airliners, and above 99 per cent of the Earth's atmosphere.
- It will analyse X-rays arriving from distant neutron stars, black holes and other exotic celestial bodies.
- The prime observation target will be Vela X-1, a neutron star in binary orbit with a supergiant star.
- Neutron stars are objects of very small radius (typically 30 km) and very high density, composed predominantly of closely packed neutrons.
- Neutron stars are thought to be formed by the gravitational collapse of the remnant of a massive star after a supernova explosion.



- It is the same process by which black holes are formed except that here the star is not massive enough to produce a black hole.
- Supergiant stars are the largest stars in the universe. They can be thousands of times bigger than our Sun and have a mass up to 100 times greater.
- The largest known supergiant star, **VY Canis Majoris**, is up to 2,100 times the size of the Sun.
- Binary stars are two stars orbiting a common center of mass.

3.16 SPHEREx

- NASA will launch a new space telescope in 2023 called SPHEREx.
- It would provide a glimpse of the first moments in the history of the universe, and explore how common are the ingredients for life in our galaxy's planetary system.
- SPHEREx is the Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer.
- NASA plans it as a two-year mission.
- It will survey the sky in optical as well as near-infrared light which serves as a powerful tool for answering cosmic questions.

3.17 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.

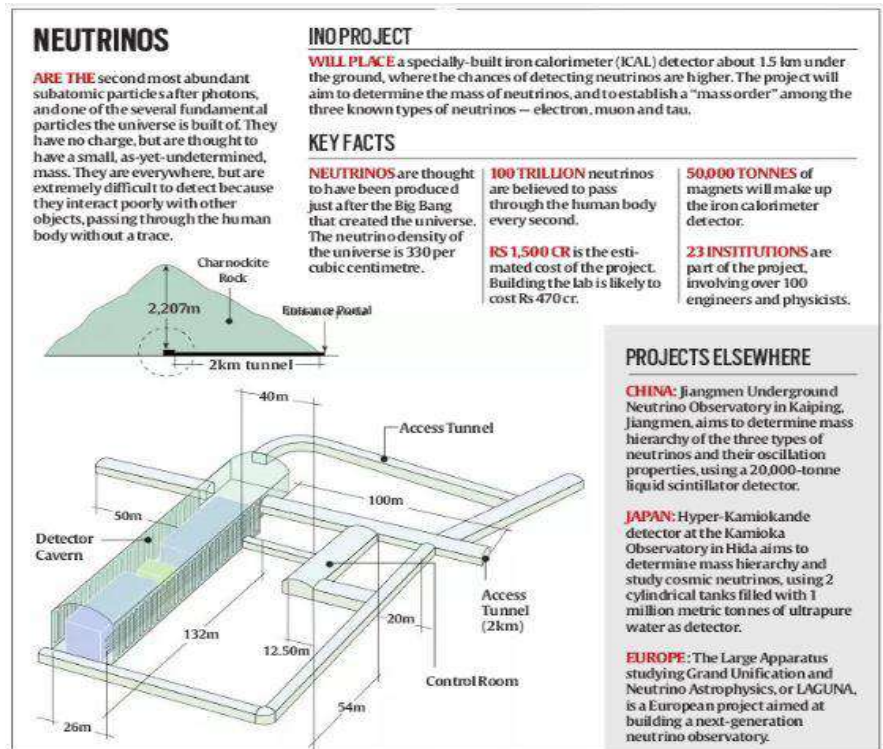
3.18 SPARCS telescope

- 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.

3.19 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.



4. DEFENSE

Artillery

4.1 Pinaka Mark I

- It is an indigenous multi-barrel unguided rocket launch system developed by DRDO for firing of multiple warheads.
- It was used in the 1999 Kargil conflict. Range - 40 km.
- It was later transformed in to a short-range precision guided missile and thus renamed as Guided Pinaka – Mark II.
- It has high accuracy and equipped with a navigation, guidance and control system with a range of 70 to 80 km.
- The missile is currently undergoing trials and expected to be delivered to the Army in 2 years.
- A Multiple rocket launcher is a type of rocket artillery system with multiple warheads and it was launched simultaneously by an unguided system.
- Guided Missile is a self propelled and launched by a precision guided system and it has 4 components such as targeting/missile guidance, flight system, engine and warhead.



4.2 Dhanush Artillery Gun

- It is an indigenously developed gun and upgraded version of the Swedish Bofors gun procured by India.
- It is a 155 mm ammunition system with a range of 36 km.
- It is compatible with all NATO 155mm ammunition systems.
- It has successfully completed final trials and is ready for induction into the Army.

- Artillery is a class of heavy weapons built to fire far beyond the range and power of infantry's small arms.
- Self-propelled artillery is equipped with its own propulsion system to move towards its target.
- They superficially resemble tanks, but they are generally lightly armoured.
- However, they protect their crews against shrapnel and small arms and are therefore usually included as armoured fighting vehicles.

4.3 K9 Vajra-T Gun

- It is an artillery gun produced by South Korea.
- India procured these guns and it will be the first induction of heavy artillery since the Swedish Bofors guns imported in the 1980s.
- It is a 155-mm, 52-calibre self-propelled artillery gun with a maximum range of 40 km, customized from the original K9 Thunder gun.
- The fire control system has also been customized for desert conditions.
- India is also planning to procure **M777 ultra-light howitzers** from the U.S.
- It is a 155-mm, 39-calibre towed artillery gun and weighs just four tonnes, making it transportable under slung from helicopters.



4.4 Advanced Towed Artillery Gun System

- It is a 155mm, 52 calibre gun being developed by the DRDO.
- Indian Army has recently begun finalising the Preliminary Specifications Qualitative Requirements (PSQR) for the gun system.
- The gun is currently weighing about 18 tonnes while the ideal weight is 14-15 tonnes.
- Significant features of the gun system - All-electric drive, high mobility, quick deployability, auxiliary power mode, advanced communications system, automated command and control system.

4.5 Smart Anti-Airfield Weapon

- It is an indigenously developed light weight glide bomb, capable of targeting large enemy infrastructure, like airfields.
- It was recently flight tested from Indian Air Force's Jaguar aircraft successfully.
- It is an accurate bomb and is termed a precision-guided munition (PGM).
- It has "Inertial navigation system" which guides it precisely to its target, typically an enemy airfield up to 100 km away.
- This precisely guided one bomb is more economical than traditional free fall bombs which are less accurate.
- It has another advantage that it can release the bomb at a safer distance to enemy airfield and return without exposing itself to enemy anti-aircraft defences.

4.6 Smerch Multiple Barrel Rocket Launchers

- It is designed to defeat soft and hard-skinned targets, artillery and missile systems.

- It features an automatic rocket preparing and launching system and range of up to 90km.
- It was developed by Russia in the early 1980s and entered service with the Russian Army in 1988.
- In December 2005, India placed an order for an initial 38 systems and deliveries began in May 2007.
- A tender for mobility vehicles to carry this Smerch system and missiles developed by DRDO, was opened by the Indian government earlier in 2015.
- For the first time, an Indian vehicle manufacturer (Ashok Leyland) has acquired the tender and it will deliver heavy duty, high mobility vehicles for the above stated purpose.

Missiles

4.7 Astra Missile

- Air-to-Air missile, **ASTRA**, has been successfully flight tested from Su-30 MKI as a part of User trials.
- It was indigenously designed and developed Beyond Visual Range Air-to-Air Missile (BVRAAM) by the **DRDO**.
- It was successfully test fired from Su-30 aircraft.
- 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.
- It is capable of engaging targets of different ranges and altitudes.
- It is beyond Visual Range Air-to-Air Astra missile with a range of over 70 kms.
- Modifications of the Sukhoi-30 MKI jets to accommodate Astra missiles has been carried out by Hindustan Aeronautics Limited.
- The main purpose of astra is to replace the R77 from IAF.
- Being a 5th Generation missile, it would provide true beyond visual range capability with greater strategic depth.
- It is smoke free, having two way data link, it provides very less chances to enemy to be alert about it.
- The Astra missile is developed as part of the Integrated Guided Missile Development Programme (**IGMDP**).
- DRDO carried out mission analysis, system design, simulation and post-flight analysis of the weapon system.

4.8 Quick Reaction Surface to Air Missile

- Recently 'Quick Reaction Surface-to-Air (QRSAM) Missile' was successfully test-fired.
- The state-of-the-art missile has been developed and tested by the 'Defence Research and Development Organisation' (DRDO).
- It uses solid-fuel propellant and has a range of 25-30 km, with the capability of engaging multiple targets.
- It is equipped with indigenously developed phased array radar, Inertial Navigation System, Data Link and RF seeker.
- It is also equipped with electronic countermeasures against jamming by aircraft radars.
- The entire mission was captured by various Electro Optical Tracking Systems, Radar Systems and Telemetry Systems.
- It is an all-weather missile that will help the Indian Navy in Inertial Navigation System.

4.9 Pinaka Missile

- Pinaka Missile System developed by DRDO was successfully flight-tested from the Integrated Test Range, Chandipur off the Odisha coast recently.

- It is an Artillery Missile System capable of striking into enemy territory up to a range of 75 kilometres with high precision.
- The Pinaka MK-II Rocket is modified as a missile by integrating with the Navigation, Control and Guidance System.
- The Navigation system of the missile is also aided by the Indian Regional Navigation Satellite System (IRNSS).
- It is to improve the end accuracy and enhance the range.
- The mission achieved all the objectives including enhancing the range, accuracy and sub-system functionality.

4.10 Prithvi – II

- India has recently test-fired Prithvi-II missile off the Integrated Test Range at Chandipur, Odisha.
- Prithvi II is an indigenously developed surface-to-surface nuclear-capable missile.
- It is a single-stage liquid fuelled twin engine missile with a short-range of 350km.
- It is capable of carrying 500 to 1000 kg of warheads.
- It was inducted into the Indian Defence in 2003.
- It is the first one to have been developed by the DRDO under the Integrated Guided Missile Development Programme.
- **Prithvi – III** is a short-range, road-mobile, ballistic missile and its model is a departure from Prithvi I, II as it employs a **two-stage, solid propellant motor**.

4.11 Brahmos

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

4.12 Pralay

- It is a newly developed surface-to-surface tactical missile.
- It is a derivative of Prithvi Defence Vehicle (PDV) exo-atmospheric interceptor which can destroy enemy weapons at high altitudes.
- It has a payload of 1 tonne and it has the capacity to strike targets 350 km away.
- It can travel up to 500 km if the payload is halved.
- It is propelled by solid-fuel rocket.
- It can fly faster than the conventional missiles in its class and can evade ballistic missile defence system.
- It will be launched from its own canister-based transport erector launcher.

4.13 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.

4.14 HELINA

- It is an acronym for “Helicopter Launched Nag” missile.
- Nag is a third generation Anti-Tank guided missile indigenously developed under “**Integrated Guided Missile Development Programme (IGMDP)**” of DRDO.
- Anti-Tank Guided Missiles are primarily designed to hit and destroy heavily armored military vehicles.
- Helina is the helicopter launch variant of Nag, that can be fired from Dhruv advanced light helicopter and HAL Rudra attack helicopter.
- It is a heavier and longer-range version of the vehicle mounted Nag missile with a 7-km range.
- Typically, a land version of Nag missile has a range of only 4 km.
- The missile is guided by “infrared imaging seeker”, that homes in on the target’s heat signature.
- IGMDP involves the development of Agni, Akash, Trishul, Prithvi and Nag missiles.

4.15 Akash Missile

- It is an indigenously developed short-range surface-to-air missile (SRSAM) system
- DRDO developed Akash as part of the Integrated Guided Missile Development Programme initiated in 1984.
- It can target aircraft up to 30 km away, at altitudes up to 18,000 m.
- It consists of Rohini radar that detects incoming aircraft with a range of 120 km.
- It can intercept fighter jets, cruise missiles as well as ballistic missiles.
- It soon will get an upgraded variant and Defence Acquisition Council (DAC) gave its procedural approval to the variant.
- Recently, it was test fired with an indigenous radio frequency seeker.
- This is the first surface-to-air missile with indigenous seeker that has been test fired.
- With this success, India has achieved the capability of making any type of surface-to-air missile.

4.16 Agni V

- It was successfully test fired from a canister on a road mobile launcher from Dr. Abdul Kalam Island, off the coast of Odisha.
- It is India’s longest-range ballistic missile which will be inducted into the nuclear arsenal soon.
- It is an Inter-Continental Ballistic Missile (ICBM) with a range of over 5,000 km and can reach most parts of China.
- It is powered by three stage solid fuelled missiles.
- It can carry a payload of 1.5 tonnes.
- It is a part of Integrated Guided Missile Development Program (IGMDP).
- Earlier variants of the Agni family of long-range missiles have already been deployed.

4.17 Barak-8

- It is a missile system jointly developed by DRDO India and M/s Israel Aerospace Industry (IAI).



- 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).

4.18 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.

4.19 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).

4.20 Interceptor Missile Test

- 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 and Advanced Air Defence (AAD)/ Ashwin Ballistic Missile Interceptor.
- India successfully conducted an interceptor missile (Prithvi Defence Vehicle) test off the Abdul Kalam Island in Odisha Coast.
- The Prithvi Defence Vehicle (PDV) is being developed by DRDO which is set to replace the existing PAD.
- PDV mission is for engaging the targets in the exo-atmosphere region at an altitude above 50 km of the earth's atmosphere.
- PDV is guided by high-accuracy Inertial Navigation System (INS).
- AAD mission is for engaging the targets in the endo-atmosphere at an lower altitude of 15-30 km.

4.21 Advanced Air Defence systems in India

- India is deploying a multi-tiered air defence network to fully secure its airspace from incoming fighter aircraft, missiles and UAV.
- An indigenous two tiered defence shield known as "Ballistic Missile Defence (BMD)", to destroy enemy ballistic missiles is being developed.
- The BMD consists of two interceptor missiles,
 - The Prithvi Defence Vehicle (PDV) for exo-atmospheric (high) altitudes of 50–80 km and
 - The Advanced Area Defence (AAD) missile for endo-atmosphere (low) altitudes of 15-30 kilometers.
- India is also in an advanced stage of talks with Russia for the procurement of very long range S-400 air defence systems.

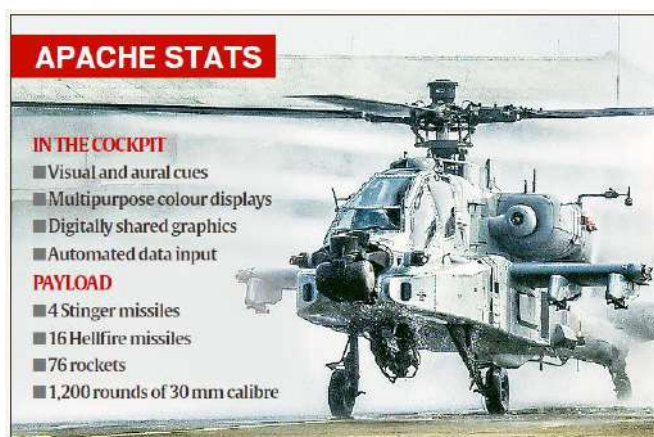
4.22 Advanced Area Defence

- DRDO has recently conducted the successful test of Ballistic missile interceptor - AAD from Abdul Kalam Island, Odisha.
- Ballistic Missile Defence (BMD) is a two tiered defence shield which aims to destroy enemy ballistic missiles.
- The BMD consists of two interceptor missiles, the Prithvi Defence Vehicle (PDV) and the Advanced Area Defence (AAD) missile.
- PDV/Pradyumna Ballistic Missile Interceptor is capable of destroying missiles at exo-atmospheric (high) altitudes of 50–80 km.
- PDV is a two stage supersonic missile fuelled by solid motor in 1st stage and liquid fuelled in 2nd stage.
- AAD/Ashvin Advanced Defense interceptor is capable of destroying missiles at endo-atmosphere (low) altitudes of 15-30 kilometers.
- AAD is a single-stage supersonic solid fuelled interceptor missile.
- BMD shield is expected to be achieved by 2022.

Aircrafts

4.23 Apache Helicopters

- Eight US made Apache AH-64E stealth attack helicopters, has been inducted into IAF.
- The IAF has signed a contract with 'The Boeing' and the US government for 22 Apache attack helicopters.
- Apache is the most advanced multi-role heavy attack helicopter in the world.
- Its modern capabilities includes, fire-and-forget, anti-tank missiles, air-to-air missiles, rockets, and other ammunition.
- Apaches has their ability to operate at much higher altitudes, unlike the aging Russian Mi-24/Mi-35 attack helicopters.
- It also has modern electronic warfare capabilities to provide versatility in network-centric aerial warfare.
- It carries a 30 mm chain gun with 1,200 rounds as part of the area weapon subsystem.
- The helicopter carries the fire control Longbow radar, which has 360-degree coverage.
- It also has a nose-mounted sensor suite for target acquisition and night-vision systems.





- The Radar systems in the helicopter will enhance the capability of the IAF in providing integrated combat aviation cover.
- It is day/night, all weather capable, and have high agility and survivability against battle damage.
- These are easily maintainable even in field conditions, and are capable of prolonged operations in tropical and desert regions.
- **Recent Developments** -The deal for 6 Apache attack helicopters for the Indian Army is likely to be signed early next year.
- These are in addition to 22 Apaches being inducted by the Indian Air Force (IAF) which are expected to be delivered by 2020.
- In 2017, the Defence Acquisition Council approved the purchase of six Apache attack helicopters from the U.S. for the Army.
- It will replace the ageing Russian Mi-35 attack helicopters in service.

4.24 Tejas

- It is an indigenous fighter aircraft inducted into Indian Airforce in the year 2016.
- It has recently commenced its operation.
- It is designed by the Aeronautical Development Agency (ADA) and Hindustan Aeronautics Limited (HAL).
- It is a single-seat, single-jet engine, multirole light fighter.
- It is the smallest and lightest multi-role supersonic fighter aircraft in its class.
- It can fire Air to Air Missiles, carry bombs and Precision Guided ammunition.
- It has its root in the Light Combat Aircraft (LCA) programme, which began in the 1980s to replace the ageing MiG-21 fighters.
- MiG-21 fighters are purchased from Russia in 1961.
- **Recent Developments** - The naval variant of the **LCA Tejas** has made a first successful “Arrested landing” test.
- “Arrested landing” means to rapidly decelerate an aircraft as it lands.
- An “arrested landing” on the deck of an aircraft carrier is a feat achieved by only a handful of fighter jets developed in the US, Russia, the UK, France and China.
- The aircraft has to land on a 100-metre runway on an aircraft carrier (a normal LCA lands on a one-kilometre runway).
- The Tejas will need to replicate this, out at sea when it attempts to land on the deck of India's only operational aircraft carrier, **INS Vikramaditya**.



4.25 MiG-21 Fighter Jets

- MiG is a product of Soviet Union which entered into the service in 1959.
- It is the first supersonic fighter aircraft of the Indian Air Force.
- India inducted the MiG-21 in 1963 and got full technology transfer and rights to license-build the aircraft in the country.
- Russia stopped producing the aircraft in 1985, while India continued operating the upgraded variants.
- In the upcoming India-Russia Bilateral summit, India is likely to gift 3 MiG fighter jets to Russia.
- MiG-21 fighter jets will be phased out of service by 2021-22.
- Tejas, an indigenous fighter aircraft will replace the ageing MiG-21.



4.26 Dhanush Regiment

- It is an indigenously developed gun and upgraded version of the Swedish Bofors gun procured by India.
- It is a 155 mm ammunition system with a range of 36 km.
- It is compatible with all North Atlantic Treaty Organisation (NATO) 155mm ammunition systems.
- It is fitted with an inertial navigation system having GPS based gun recording, an automated gun sighting system equipped with camera, thermal imaging, and laser range finder.
- The Indian Army, will have the first regiment in place by March 2020 and will get all 114 guns by 2022.
- Last year, the Army inducted its first modern artillery guns system which include M-777 Ultra-Light Howitzers (ULH) from the U.S. and K9 Vajra-T self-propelled artillery guns from South Korea.

4.27 Sukhoi Su-30MKI

- Sukhoi Aircraft was developed by Russia. The license for building it was given to Indian Air Force in the past 2 decades.
- It is twin-finned, twin-jet multi-role aircraft capable of attaining speeds of Mach 2 at high altitudes.
- It can carry guns, missiles, bombs, rockets and other weaponry.
- The first indigenously **overhauled** Sukhoi Su-30MKI supersonic aircraft was recently handed over to the Indian Air **Force**.
- During the overhaul, the aircraft was stripped completely and rebuilt from scratch, replacing certain worn out parts/components.

4.28 Mid-Air Refuelling

- Tejas is an indigenously developed light combat aircraft.
- It is a single-seat, single-jet engine, multirole light fighter.
- It is the smallest and lightest multi-role supersonic fighter aircraft in its class.
- It can fire Air to Air Missiles, carry bombs and Precision Guided ammunition.
- The Indian Air Force has successfully carried out the first ever mid-air refuelling of Tejas.
- A Russian-built IL-78 MKI tanker transferred fuel to a Tejas MK I aircraft.
- It is considered as a major milestone in its development cycle.
- The ability to carry out air-to-air refuelling is one of the critical requirements for Tejas to achieve final operational clearance.
- Earlier, Tejas has successfully fired an air-to-air beyond visual (BVR) range missile.

4.29 Advanced Medium Combat Aircraft

- It is India's next indigenous fighter and expected to make its first flight by 2032.
- It is built under India's only **fifth generation aircraft** programme.
- The aircraft will feature geometric stealth which is different from material stealth feature.
- In **material stealth**, radar-absorbing materials are used to **absorb** the radio waves thus reducing the radar footprint.
- Whereas, in **geometric stealth**, the aircraft is designed at such angles to **deflect** away maximum radar waves to minimise radar cross section.
- Thus, the fighter will have low radar cross section, making it difficult for the enemy to spot it.



4.30 Biojet fuel for Aircraft

- IAF flew an An-32 aircraft in 'vic' formation, whose lead plane used a mix of Aviation Turbine Fuel blended with 10% biofuel.
- The biofuel has been extracted from Jatropha plant seeds using a technology patented by the CSIR and the Indian Institute of Petroleum, Dehradun.
- Following the clearance given by the Centre for Military Airworthiness and Certification IAF is expected to use biofuel for its transport fleet and helicopters.
- The 'vic' formation comprises 3 or more aircraft flying in close formation with the leader at the apex and the rest to left and right, the whole resembling the letter 'V'.

4.31 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.

Warning Systems

4.32 NETRA

- It is the first indigenously built Airborne Early Warning and Control System (AEW&CS) developed by DRDO.
- It is light-weight autonomous UAV for long range surveillance and reconnaissance operations.
- This radar system is also 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.

4.33 Swathi

- It is a Weapon Locating Radar, developed by DRDO's Electronics & Radar Development Establishment.
- 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.





4.34 Recce Vehicle

- The NBC Recce Vehicle Mk-I, is developed by Vehicles Research & Development Establishment.
- 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.

Programs

4.35 Mission Shakti

- It was India's successful 'Anti-satellite (ASAT) missile' test.
- An Indian satellite at 300 km in Low Earth Orbit was targeted and destroyed through 'collision' (rather than warheads).
- It made India to join the ranks of the US, Russia and China.
- It gives teeth to India's space programme and military posture.
- It was the prerogative of DRDO.
- The DRDO's Ballistic Missile Defence interceptor was used.
- A BMD, by destroying incoming missiles, provides a strategic umbrella,
- ASAT adopted 'Direct Ascent Kinetic Kill' method.

4.36 Sagar Maitri Mission-2

- It is a unique initiative of **DRDO** which aligns with the objective of "**Safety And Growth for All in the Region(SAGAR)**".
- Marine & Allied Interdisciplinary Training and Research Initiative(**MAITRI**) is the specific scientific component of DRDO.
- It is to promote greater scientific interaction especially in ocean research among 'Indian Ocean Rim' (**IOR**) countries.
- **INS Sagardhwani**, will embark on a two-month long mission.
- The mission commemorates the Golden Jubilee Celebrations of India's lone research ship **INS Kistna**'s mission.
- **INS Sagardhwani** will revisit the selected tracks of INS Kistna.
- The prime objectives of the mission are,
 1. data collection from the entire North Indian Ocean,
 2. focussing on the the Andaman Sea and adjoining seas and
 3. establishing long-term collaboration with IOR countries in the field of ocean research and development.
- It will promote closer co-operation in socio-economic aspects with IOR countries.
- The **IOR** countries, includes Oman, Maldives, Sri Lanka, Thailand, Malaysia, Singapore, Indonesia and Myanmar.

4.37 Bhabha Kavach

- It is the India's lightest and cheapest 'bullet-proof jacket' for the CRPF and the Ministry of Home Affairs personnel.

- It is indigenously developed by the Ordnance Factories Board, a public sector undertaking MIDHANI along with BARC.
- It is named after nuclear physicist Dr. Homi J. Bhabha.
- The jacket weighs just 6.6 kg in comparison to the 17-kg jackets in use.
- It can shield from AK-47 (7.62 mm hard steel bullets), SLR and INSAS (5.56 mm) weaponry.
- It is made using extremely hard boron carbide ceramics, carbon nano-tubes and composite polymer.
- It is available in 3 variants as per the requirement of the armed forces.
- BARC has transferred the technology to Mishra Dhatu Nigam, Hyderabad, for its large-scale production.

4.38 Mission Raksha Gyan Shakti

- It was recently launched with an aim to educate scientists and technologists in defence public sector undertakings and ordnance factories OFs to create more patents.
- A target has been set to train approximately 10,000 persons of OFs and DPSUs on IPR in the financial year 2018-19 under the mission.

4.39 Digital Sky Platform

- The DGCA announced the Civil Aviation Regulations to enable safe flying of Remotely Piloted Aerial Systems (RPAS) popularly referred to as drones in India.
- It specified the obligations of operators, remote pilots/ users and manufacturers/ OEM for safe operations of RPAS and co-operative use of airspace.
- It also announced Digital Sky Platform, a first of its kind that implements 'no permission, no take-off' (NPNT) – a novel system of software based self-enforcement to minimize deviations from the CAR.
- The Digital Sky Platform will register and monitor the drones, pilots, and operators for online permission before the take-off.
- This platform is built to evolve with the needs of the rapidly changing industry with Digital Sky Service Providers (DSPs) by extending the functionality of the platform through Application Program Interfaces (APIs).

4.40 Strategic Partnership Model

- The Defence Ministry has recently approved key guidelines for implementation of Strategic Partnership model.
- The guidelines were approved by the Defence Acquisition Council (DAC), the ministry's highest decision making body.
- Under this model, select private firms will be roped in to build military platforms like submarines and fighter jets in India in partnership with foreign entities.
- It aims to create a vibrant defence manufacturing ecosystem in the country through joint ventures between Indian corporates and global defence majors.
- All procurements under the SP Model would be executed by specially constituted Empowered Project Committees (EPC).
- It is to provide focused attention and ensure timely execution.



Submarines

4.41 Submarines

Class	Type	Boats
Arihant	Ballistic missile submarine (SSBN)	INS Arihant INS Arighat
Chakra (Akula II)	Attack Submarine (SSN)	INS Chakra
Sindhughosh	Attack Submarine	INS Sindhughosh INS Sindhudhvaj INS Sindhuraj INS Sindhuvir INS Sindhuratna INS Sindhukesari INS Sindhukirti INS Sindhuvijay INS Sindhurashtra
Shishumar	Attack Submarine	INS Shishumar INS Shankush INS Shalki INS Shankul
Kalvari	Attack Submarine	INS Kalvari INS Khanderi INS Karanj

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

4.42 Scorpene-class submarine

- The Indian Navy has launched INS Karanj, 3rd of the 6 Scorpene class submarines that are being built under 'Project 75I' of the Indian Navy.
- The submarines of Kalvari class of Project 75 are actually Scorpene class submarines i.e submarines that are propelled by diesel-electric engines and Torpedo is mounted as a primary weapon.
- It will have both anti-surface and anti-submarine warfare.
- The Project 75I-class submarine is a follow-on of the Project 75.
- 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.
- 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.

4.43 Project 28

- It 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.
- Three of the four corvettes, INS Kamorta and INS Kadmat, INS Kiltan were commissioned in 2014, 2016 and 2017 respectively.
- INS Kavaratti is expected to be commissioned by May 2019.

4.44 Project-15B

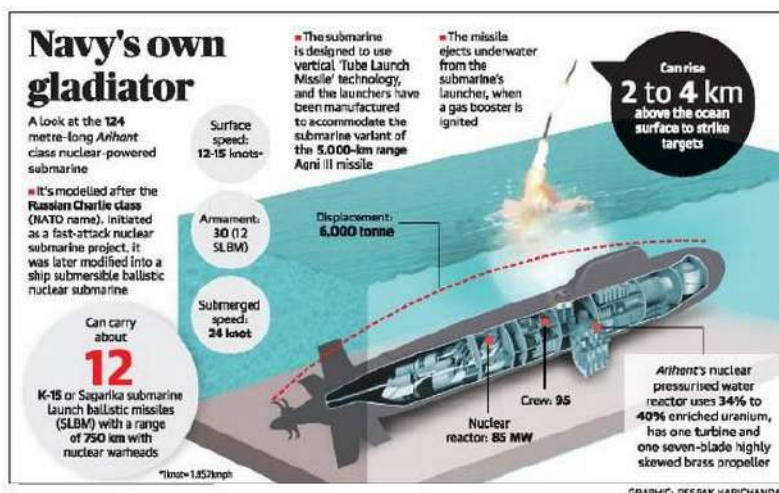
- The Project 15B/ Visakhapatnam Class destroyer is a class of guided missile destroyers.
- It comprises of four ships - Visakhapatnam, Mormugao, Paradip and Porbandar all of which are being built by the Mazagon Dock Limited (MDL), for the Indian Navy.
- Visakhapatnam and Mormugao are already launched.
- Project 15B is an improved variant of the Kolkata-class destroyers (Project 15A), with enhanced stealth characteristics 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.

4.45 INS Chakra

- It belongs to Akula-class nuclear powered Submarine.
- It was taken from Russia on a 10 year lease period.
- 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.

4.46 INS Arihant

- It is an indigenously-built nuclear-propelled submarine.
- It is a Strategic Strike Nuclear Submarine (SSBN), is capable of carrying 12 K-15 submarine-launched ballistic missiles having a range of over 700 km.
- It can dive to 300 metres and is powered with a 83 MW nuclear power reactor.
- It is its most dependable platform for a second-strike as the other options i.e land-based and air-launched, are easier to detect.
- There here are plans to induct INS Arighat (Aridhaman), the second SSBN.
- 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.
- 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.
- Its induction also marked the completion of India's nuclear triad.
- A nuclear triad refers to the nuclear weapons delivery via land, air and sea i.e. land-based intercontinental ballistic missiles (ICBMs), strategic bombers, and submarine-launched ballistic missiles (SLBMs).

4.47 Deep Submergence Rescue Vehicle

- Indian Navy has recently inducted deep submergence rescue vehicle which will be operational from April, 2019.
- Currently India operates conventional submarines of the Sindhughosh, Shishumar, Kalvari classes as well as nuclear powered submarines.
- The traditional methods of search and rescue by these conventional submarines during an eventuality exposes them to high degree of risk.
- To overcome this gap, India has acquired a 3rd generation, advanced submarine rescue system considering of a Non-tethered Deep Submergence Rescue Vehicle (DSRV) and its associated equipment.
- It is capable of undertaking rescue from a disabled submarine up to 650 metres depth.
- The DSRV, operated by a crew of three, can rescue 14 personnel from a disabled submarine at a time.
- The vehicles are developed by Scotland-based JFD.
- With this, India joins a select league of navies with the sovereign capability to search, locate and rescue crew from a disabled submarine.

4.48 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.

4.49 Losharik (AS-12 or AS-31)

- It is a highly advanced **Nuclear powered submarine** of **Russia**.
- This week a fire accident was reported on the submarine within the Russian territorial waters.
- It is a deep-diving special missions ship, operated by the Russian Navy.
- It is capable of withstanding high pressures at great depths, enabling it to survey the ocean floor.
- Its interior hull is built using titanium spheres which makes the vessel dive up to 6000 metres. A regular submarine can go to the depth of only 600 metres.
- It is generally carried under the hull of a larger submarine and is capable of releasing a smaller submarine itself.
- According to Russian military the submarine was carrying out 'bathymetric measurements' or underwater mapping.
- But the US and its allies feared that Russia might be developing new, secretive ways to tap or even cut undersea **Fiber-optic cables** that carry transatlantic Internet traffic.



- In recent years, U.S. and British military officials have warned that Russian submarines have been spotted close to the cables.

Other Naval Ships

4.50 INS Shivalik and INS Sindhukirti

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

4.51 INS Sagardhwani

- It is the Oceanographic research vessel of **DRDO**.
- It is maintained and operated by the Indian Navy.
- It is a 'Marine Acoustic Research Ship' (**MARS**) designed and developed by 'Naval Physical and Oceanographic Laboratory' (**NPOL**), Kochi.
- NPOL is a premier systems laboratory of DRDO.
- The ship is fitted with state-of-the-art equipments like the latest wave height measuring radars, marine radio etc.
- It is exclusively used for the scientific and research programmes of NPOL.

4.52 INS Tarkash

- It is a state-of-the-art stealth frigate of the Indian Navy.
- It is the 5th Talwar-class frigate constructed for the Indian Navy, built at the Yantar shipyard in Kaliningrad, Russia.
- It is equipped with a versatile range of weapons and sensors capable of addressing threats in all three dimensions.

4.53 INS Nilgiri

- It is the first ship of the Project-17A frigates, designed indigenously by the Indian Navy.
- It has a launch weight of 2,650 tonnes with enhanced stealth features, weapons and sensors.
- It was launched at the dockyard of the Mazagon Dock Shipbuilders Limited (MDL) in Mumbai for sea trials.
- Launching is a process when a dockyard releases a warship into the sea for the first time and it undergoes various tests.



- Project-17A is a deviation from the existing Shivalik class of frigates and it incorporate new design concepts for improved survivability, sea keeping, stealth and ship manoeuvrability.

4.54 INS Vikramaditya

- US team members of joint working group 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.

4.55 INS Vishal

- It 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.

Aircraft Carriers of Indian Navy

- **INS Vikrant** - Initially laid down as HMS Hercules for the British Navy, but construction was put on hold. India purchased the incomplete carrier in 1957, and construction was completed in 1961 and inducted as first aircraft carrier of India.
- Decommissioned in 1997, Scrapped in 2014.
- **INS Viraat** - A Centaur-class aircraft carrier commissioned in 1959 as the British Navy's HMS Hermes and later sold to India in 1987.
- Decommissioned in 2017.
- **INS Vikramaditya** - Originally built as Baku for Soviet Navy
- Entered into Indian Navy in 2013.
- **INS Vikrant (2013)** - First domestically built aircraft carrier expected to join service by 2020.

4.56 INS Sahyadri

- It is an indigenously built stealth frigate.
- It participated in trilateral Malabar war games with Japan and the U.S. off the Coast of Guam.
- It recently participated in RIMPAC and has been adjudged **runner-up in an innovation competition**.
- INS Sahyadri presented the 'idea of integrating yoga into our daily life as technology for well-being during extended deployments for ships'.
- The idea was appreciated by representatives of participating countries.

4.57 INS Tarangini

- It is part of the first Training Squadron based at Kochi, under the Southern Naval Command of the Indian Navy.
- The word Tarangini means 'the one that rides the waves'.
- It is the first ship of the Indian Navy to have circumnavigated the globe in the year 2003-04.
- It commenced 'Lokayan-18' from Kochi, to cover a distance of over 20,000 nautical miles to display the Indian flag at 15 ports across 13 countries.
- During its Lokayan voyage, it will participate in the prestigious 'tall ship races - 2018' at Sunderland Port in the UK.
- It has already participated in tall ship races conducted around the world in 2007, 2011 and 2015.



4.58 INS Trikand

- It is a state-of-the-art warship of the Indian Navy equipped with a versatile range of weapons and sensors capable.
- It can address threats in all three dimensions - air, surface and sub-surface.
- It recently visited Sri Lanka in a goodwill visit.

4.59 INSV Tarini Team

- Minister for Women and Child Development presented the prestigious Nari Shakti Puraskar 2017 to the members of the INSV Tarini team.
- The crew of the Indian Navy Sailing Vessel 'Tarini' is a part of the Indian Navy's unique project 'NavikaSagarParikrama'.
- It is an all-women team circumnavigating the globe, promoting ocean sailing activities in the Navy and depicting Government of India's commitment towards women empowerment.
- The Project aims to demonstrate the thrust of Nari Shakti on the world platform.
- The voyage also showcased the 'Make in India's initiative by sailing on-board the indigenously built INSV Tarini.
- All six members of the crew were trained for over three years under Captain DilipDondé, who is also the first Indian to successfully carry out solo-circumnavigation of the globe between 2009 and 2010.

4.60 Sagar Kanya

- It is a ocean research vessel.
- The vessel is a versatile ocean observing platform equipped with technologically advanced scientific equipment and related facilities.
- It is owned and operated by National Centre for Antarctic and Ocean Research.
- The ship has helped in India's studies of the Arabian Sea, the Bay of Bengal, and the Indian Ocean.
- In 1983, under Indo-German collaboration, this multidisciplinary research vessel was built in Germany and delivered in India to Ministry of Earth Sciences (then Department of Ocean Development).

4.61 Operation 'Madad'

- It has been launched by the Southern naval command at Kochi.
- It is for assisting the state administration of Kerala and undertaking disaster relief operations due to the unprecedented flooding experienced in many parts.
- Flooding in many parts is due to incessant rainfall and release of excess water from Idukki and other dams.
- **INHS Sanjivani** has been deployed for rendering medical assistance.

4.62 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.

4.63 Indian Coast Guard Ship Vijaya

- ICGS Vijaya, the second in the series of 98-metre offshore patrol vessels was commissioned recently.
- Ministry of Defence has initiated a project for building 7 offshore patrol vessels with private sector partnership.

- In 2017, the first in the series ICGS Vikram was commissioned.
- It is fitted with advanced technology, navigation and communication equipment, sensor and machinery
- The ship will be based at Paradip, Odisha.
- It will be deployed extensively for Exclusive Economic Zone surveillance and other duties
- It is designed to carry one twin-engine helicopter and four high speed boats.

4.64 Rani Rashmoni

- It is a fast patrol vessel, indigenously built by Hindustan Shipyard.
- It is built under the Fast Patrol Vessel (FPV) project of Indian Coast Guard.
- Under the first phase of the project, 5 FPV's has been built.
- The first four such ships are ICGS Rani Abbakka, ICGS Rani Avanti Bai, ICGS Rani Durgavati and ICGS Rani Gaidinliu.
- They have been commissioned and are in active service at various locations on the eastern seaboard.
- Rani Rashmoni is the last in the first phase and recently commissioned into the ICG.
- It will be based in Visakhapatnam.

4.65 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.

4.66 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.

4.67 INS Kohassa

- Naval Air Station (NAS) Shibpur was established in 2001 in Shibpur of North Andaman.
- It has a 1,000 feet-long airfield that permitted short-range maritime reconnaissance (SRMR) aircrafts.
- Many Indian aircrafts, which participated in the abortive search for the missing Flight 370, operated from NAS Shibpur.
- It is now commissioned as INS Kohassa, a full-fledged naval base.
- It is the fourth military airfield in the Andaman & Nicobar archipelago.
- It has been named after a White-Bellied Sea Eagle, which is a large bird of prey endemic to A&N Islands.
- It is set up as a Forward Operating Air Base (FOAB) for surveillance in North Andaman.
- The station will function as a base for joint operation of both military and civil aircraft in keeping with the UDAN scheme of the government.

4.68 ASRAAM Missile

- Advanced Short Range Air-to-Air Missile (**ASRAAM**) is the next generation **infrared-guided** missile of UK.
- It is also known as 'heat seeking', because infrared is radiated primarily by heat.
- It is designed and built by MBDA, UK to provide enhanced aerial combat capabilities for fighter aircraft.



- It is widely used as a **‘Within Visual Range’**(WVR) air dominance missile with a range of over 25km.
- It can also be fired at targets behind its aircraft.
- The Indian Air Force (IAF) is looking to adopt ASRAAM across its fighter fleet.
- This plan is to bridge the missile gap between the IAF and the Pakistan Air Force (PAF), which displayed an edge during the 27 February dogfight.
- The missile was shortlisted through a tender and MBDA was working with Hindustan Aeronautics Limited (HAL) on the integration.

Exercises

4.69 Varuna

- It is an **Indo-French Joint Naval Exercise**.
- It is held either in the Indian Ocean or Mediterranean sea with the aim of improving Indo-French coordination.
- The Indian Navy is represented by
 - 1) Aircraft carrier INS Vikramaditya,
 - 2) destroyer INS Mumbai,
 - 3) the Teg-class frigate,
 - 4) INS Tarkash,
 - 5) the Shishumar-class submarine INS Shankul, and
 - 6) the Deepak-class fleet tanker INS Deepak.
- It is the largest ever joint exercise undertaken by the two navies.
- The exercise was conducted in two phases with first phase being held in **Goa**.
- The second sea phase is scheduled to be held at the end of May in **Djibouti**, located on the Horn of Africa.
- The exercise underscores the shared interests and commitment of both nations in promoting maritime security.

4.70 Military Exercises

- **Ekuverin** – It is a joint military exercise between Indian and Maldives.
- Its 10th edition will be organised in Maharashtra.
- **Nomadic Elephant** – It is Indo – Mongolian joint military training.
- Its 14th edition will be conducted in Bakloh, Himachal Pradesh.
- **Kazind** – It is an annual military exercise between India and Kazakhstan.
- Its 4th edition commenced in Pithoragarh, Uttarakhand.
- **Maitree – 2019** - It is the joint military exercise between India and Thailand.
- It was recently conducted in Meghalaya.
- Its scope encompassed joint training in various facets of counter terrorism operations in urban and jungle environments.
- **Dharma Guardian – 2019** - It is a joint military exercise between India and Japan.
- It covers joint training on counter terrorism operations in jungle and urban scenario.
- **IMNEX-2019** - It is India Myanmar Naval Exercise going to be held in Visakhapatnam.
- INS Ranvijay, a guided-missile destroyer and INS Kuthar, a missile corvette will participate in the exercise.



- **Shakti-2019** - Exercise Shakti is a series of joint military exercise between India and France.
- It was commenced in the year 2011 and it is a biennial exercise.
- It is conducted alternately in India and France.
- This year exercise is going to be organised in the State of Rajasthan.
- It will focus on Counter Terrorism operations in backdrop of semi-desert terrain under United Nations Mandate.
- **Dustlik-2019** – It is the first ever India-Uzbekistan joint military exercise.
- It will be organised in Tashkent and focus on Counter terrorism.
- **SCOJtEx-2019** – India's NDRF is hosting the Shanghai Cooperation Organization(SCO) Joint Exercise on Urban Earthquake Search and Rescue.
- It is to rehearse the disaster response mechanism, share knowledge, experience and technology for mutual coordination.
- **Samudra Shakti** - It is a bilateral naval exercise between India and Indonesia.
- It is being held in Visakhapatnam.
- INS Kamorta, an Anti-Submarine Warfare Corvette participates in the exercise from Indian Side.
- The joint exercises include manoeuvres, Surface Warfare exercises, Air Defence exercises, Weapon firing drills, Helicopter Operations and Boarding Operations.
- **Ex - Roar of the Sea** –It is conducted between the Indian Navy and Qatari Emiri Naval Forces.
- It would strengthen cooperation and enhance interoperability between the two navies.
- This Bilateral Maritime Exercise between the two navies would strengthen the robust defence co-operation between the two countries.
- **MILAN 2020** - It is a biennial naval exercise held under the command Indian Navy.
- The Last (10th) edition was held in 2018 and the next (2020) is going to be held in Vishakhapatnam.
- In its forthcoming edition, 41 countries have been invited for the participation.
- USA and Russia have been invited while Pakistan and China are not.
- The areas of cooperation include Capacity Building, Marine Domain Awareness, Training, Hydrography, Technical Assistance, Operational Exercise etc.
- **Exercise HIM VIJAY**–It is a routine military exercise conducted to validate operational capabilities of our combat formations.
- It is to test mobility, communication and coordination of such huge body of fast-moving troops in difficult terrain.
- Three Battle Groups, , each comprising around 4000 soldiers, are participating which will include troop mobilisation, mountain assault and air assault.
- Air force and Army helicopters will be transferring troops and equipment at the terrain of upto 15,000 ft.
- This year, it was taken place in Arunachal Pradesh.
- **Ex-SURYA KIRAN**–It is a Joint military exercise between India and Nepal will be conducted in Nepal.
- It is an annual event which is conducted alternatively in Nepal and India.
- The aim of this exercise is to conduct a Battalion level combined training between Indian Army and Nepal Army to increase interoperability in jungle warfare and counter terrorist operations in mountainous terrain, humanitarian assistance and disaster relief, medical and environmental conservation including aviation aspects.
- **Ex- Tiger Triumph** - It is the maiden India US joint Tri services Humanitarian Assistance and Disaster Relief (HADR) Exercise.
- Indian Naval ships Jalashwa, Airavat **and** Sandhayak, would be participating in the exercise.



- The US would be represented by US Navy Ship Germantown.
- The Exercise is aimed at developing interoperability for conducting HADR operations.

5. HEALTH

Government Initiatives and Programmes

5.1 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.

5.2 Intensified Mission Indradhanush

- Mission Indradhanush was launched in 2014 to achieve full immunisation coverage for all children and pregnant women at a rapid pace.
- Intensified Mission Indradhanush (IMI) was launched from Vadnagar in 2017 and its second version (2.0) 2.0 is going to be launched from Dec 2, 2019.
- Through IMI, Government aims to reach each and every child upto 2 years of age and all those pregnant women who have been left uncovered under the routine immunisation programme/Universal Immunisation Programme (UIP).
- It aims to achieve targets of full immunization coverage in 272 districts in 27 States.
- It shall be implemented in the block level (652 blocks) in Uttar Pradesh and Bihar.
- It will focus on urban, underserved population and tribal areas.
- It consists of 4 rounds of immunization that will be conducted in the selected districts and urban cities between December 2019 & March 2020.
- The UIP basket has vaccines for ten diseases i.e
 1. BCG for **TB**, OPV for **poliomyelitis**,
 2. monovalent measles vaccine for **measles**,
 3. Rota Virus vaccine for **Diarrhoea**,



4. JEV for **Japanese Encephalitis**
 5. Pentavalent Vaccine for DPT (**diphtheria, pertussis**, i.e. whooping cough & **tetanus**) and
 6. Vaccine for **Hepatitis B & Pneumonia** due to Hib.
- Measles-rubella vaccine (MR) is also added now to the UIP

5.3 National Animal Disease Control Programme (NADCP)

- **NADCP** was launched recently, aimed at eradicating 'Foot and Mouth disease' (FMD) and 'Brucellosis' in livestock.
- India has the world's largest livestock population of 125-crore plus heads but,
 1. The cattle productivity is low and animal diseases are a major concern.
 2. The diseases have resulted in some overseas markets being shut to Indian dairy and meat products.
 3. It prevented the industry from realising its income potential.
- **NADCP** programme aims to,
 1. Vaccinate over 500 million livestock heads, including cattle, buffalo, sheep, goats and pigs against FMD.
 2. Vaccinate over 36 million female bovine calves annually against Brucellosis.
 3. The programme has received 100% funding from the Centre, for 5 years until 2024.
 4. The NADCP aims to control these 2 diseases by 2025 and to eradicate them by 2030.
- **FMD (Foot and Mouth disease)**
 1. It is a highly infectious viral disease of livestock.
 2. It is generally not fatal in adult animals but leaves them severely weakened.
 3. It results in a drastically reduced production of milk.
 4. Therefore, it financially ruinous for dairy farmers.
 5. Infected animals get a fever, sores in their mouth, on their teats, and between their hooves.
 6. It spreads through excretions and secretions, infected animals also exhale the virus.
 7. It is endemic in several parts of Asia, most of Africa, and the Middle East.
 8. Australia, New Zealand, Indonesia, Central, North and Latin America, continental Western Europe are **FMD-free**.
- **Brucellosis**
 1. This is a zoonotic disease that is endemic in most parts of the country.
 2. It causes early abortions in animals and prevents the addition of new calves to the animal population.
 3. **WHO** recommends the vaccination of cattle and in some cases, testing and culling to control the disease.

5.4 Non-Communicable Diseases (NCDs) In India

- **Indian Council of Medical Research (ICMR)** released the report entitled "**India: Health of the Nation's States**", Contribution of Non-Communicable Diseases (NCDs)
- According to the report total death in the Country due to NCDs was 61.8% in 2016, as compared to 37.9% in 1990.
- Non-communicable diseases (NCDs) are a group of diseases that affect individuals over an extended period of time causing socio-economic burden to the nation.
- The major NCDs has 5 behavioural risk factors -
 1. Unhealthy diet,
 2. Lack of physical activity,
 3. Use of tobacco and alcohol,



4. Ageing,
 5. Rapid unplanned urbanization.
- There are primarily 5 types of Non-communicable diseases -
 1. Cancer,
 2. Chronic respiratory disease,
 3. Stroke
 4. Cardiovascular diseases
 5. Diabetes, which are responsible for a majority of morbidity and mortality in the country.
 - Mental health and injuries also have a considerable burden.
 - NCDs cause 61% of deaths in India states WHO report
 - Cardiovascular diseases are at the top, in 2016 a staggering 28.1% of all deaths in India were caused by heart conditions.
 - Also, India has the highest number of diabetes cases in the world, with 72 million reported in 2017.
 - Punjab, Tamil Nadu and Kerala, all wealthy states, were found to have some of the highest rates of heart disease in the country.
 - **Public health is a State subject,**
 - **National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS)** under the **National Health Mission (NHM)** is an effort by Central Government which supplements State Governments effort.
 - The objectives of the programme include health promotion activities and opportunistic screening for common NCDs including cancer.
 - **Affordable Medicines and Reliable Implants for Treatment (AMRIT)** Deendayal outlets have been opened at 159 Institutions/Hospitals.
 - Its objective is to make available Cancer and Cardiovascular Diseases drugs and implants at discounted prices to the patients.
 - **Jan Aushadhi stores** are set up by Department of Pharmaceuticals to provide generic medicines at affordable prices.
 - Chandigarh hosted the World NCD Congress in November 2017, spotlighting the impact of NCDs both in India and on the global stage.
 - India has shown commitment towards Preventing Non-communicable Diseases as it became the first country to adopt the WHO's Global Monitoring Framework on Non-communicable Diseases.

5.5 Menstrual Hygiene Scheme (MHS)

- It is a scheme for promotion of menstrual hygiene among adolescent girls in the age group of 10-19 year in **rural areas**.
- It comes under Ministry of Health and Family Welfare.
- The major **objectives** of the scheme are,
 - i. To increase awareness among adolescent girls on Menstrual Hygiene
 - ii. To increase access to and use of high quality sanitary napkins to adolescent girls in rural areas.
 - iii. To ensure safe disposal of Sanitary Napkins in an environmentally friendly manner.
- Funds are provided to States/UTs through National Health Mission (**NHM**).
- The funds are for decentralized procurement of sanitary napkins packs primarily to rural adolescent girls at a subsidized rate of Rs 6 for a pack of 6 napkins.
- The **ASHA** will be responsible for distribution of napkins.



- They will receive an incentive of Re 1 per pack sold and a free pack of napkins every month for her own personal use.
- A range of **IEC** (Information Education and Communication) material has been developed around MHS.
- It is a 360-degree approach to create awareness about safe and hygienic menstrual health practices.
- It includes audio, video and reading materials for adolescent girls.
- **MHS** is a part of **Rashtriya Kishor Swasthya Karyakram**, which is to ensure holistic development of adolescent population.

5.6 Jan Jagrukta Abhiyaan

- It is a mega awareness campaign on Dengue and Malaria in Delhi.
- It is organised by the Ministry of Health and Family Welfare in association with all three Delhi Municipal Corporations and New Delhi Municipal Council.

5.7 Medical Devices

- Ministry of Health & Family Welfare has prepared a draft rule to bring all the non-notified Medical Devices under the regulation of the Central Drugs Standard Control Organisation (CDSCO).
- The Ministry has also proposed to notify all the Medical devices under the Drugs and Cosmetics Act, 1940 and Medical Devices Rules, 2017.
- CDSCO is under the Ministry of Health and Family Welfare.
- It regulates the safety, efficacy and quality of notified medical devices under the provisions of Drugs and Cosmetics Act, 1940 and Rules made thereunder.

5.8 Public Health Emergency of International Concern

- A Public Health Emergency of International Concern (PHEIC) is a formal declaration by the World Health Organization (WHO).
- It is declared during an extraordinary event which is determined to constitute a public health risk to other States through the international spread of disease and to potentially require a coordinated international response.
- It is formulated when a situation arises that is "serious, sudden, unusual or unexpected", which "carries implications for public health beyond the affected State's national border" and "may require immediate international action".
- Under the 2005 International Health Regulations (IHR), states have a legal duty to respond promptly to a PHEIC.
- Since 2009, there have been six PHEIC declarations:
 1. In 2009 H1N1 (or swine flu) pandemic,
 2. In 2014 polio declaration,
 3. In 2014 outbreak of Ebola in Western Africa,
 4. In 2015–16 Zika virus epidemic,
 5. In 2015-16 Kivu Ebola epidemic,
 6. In 2020 novel coronavirus outbreak.
- The recommendations are temporary and require reviews every three months.
- SARS, smallpox, wild type poliomyelitis, and any new subtype of human influenza are automatically PHEICs and therefore do not require an IHR decision to declare them as such.
- A PHEIC is not only confined to infectious diseases, and may cover an emergency caused by a chemical agent or a radio nuclear material.
- It is a "call to action" and "last resort" measure.

- Most epidemics and emergencies do not gain public attention or fulfil the criteria to be a PHEIC.

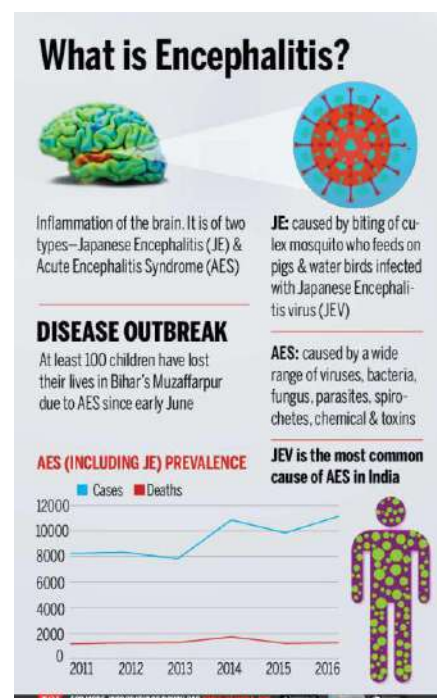
5.9 e-Cigarettes

- The Central government has directed all states and Union Territories to not allow the manufacture, sale and advertisement of e-cigarettes and other Electronic Nicotine Delivery Systems (ENDS).
- Electronic cigarettes or e-cigarettes, are devices that do not burn or use tobacco leaves but instead vaporise a solution, which a user then inhales.
- The main constituents of the solution, in addition to nicotine, are propylene glycol (with or without glycerol and flavouring agents).
- ENDS are devices that heat a solution to create an aerosol, which also frequently contains flavours, usually dissolved into propylene glycol and glycerin.
- A number of metals, including lead, chromium and nickel, and chemicals like formaldehyde have been found in aerosols of some ENDS.
- ENDS are not approved as NRTs (nicotine-replacement therapies) under the Drugs and Cosmetics Act and rules made thereunder.
- According to Global Tobacco Epidemic 2017 report by the WHO, the governments of 30 countries like Mauritius, Australia, Singapore etc have already banned ENDS.

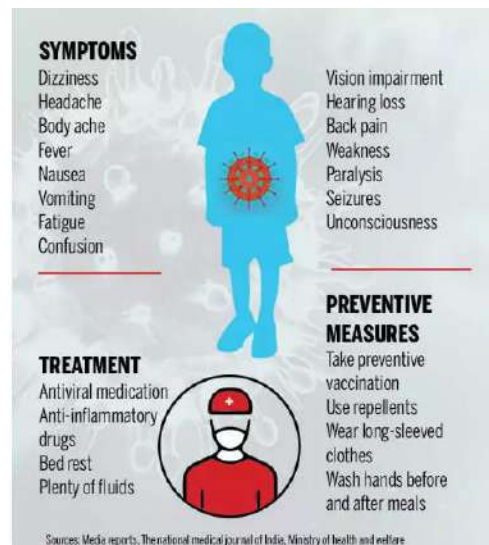
Diseases in News

5.10 Acute Encephalitis Syndrome

- The outbreak of acute encephalitis syndrome (AES) in Bihar has led to around 100 deaths.
- While the causes of AES are still researched, the association with hypoglycaemia and litchi fruit has drawn attention.
- Acute Encephalitis Syndrome is a broad term involving several infections, and it affects young children.
- AES is not a disease; it is a syndrome.
- Under its umbrella comes the hypoglycaemia, Japanese Encephalitis, Herpes meningitis, Rice syndrome, cerebral malaria, scrub typhus, etc.
- All of them are grouped under AES as they have a classical triad of sudden onset of fever, convulsions and loss of consciousness.
- **Causes** - The syndrome can be caused by viruses, bacteria or fungi.
- In India, the most common cause is the virus that causes Japanese encephalitis (JE).
- Health Ministry estimates attribute 5-35% of AES cases to the JE virus.
- In Bihar, the Directorate of Health Services claimed that the JE virus had caused only two of the total 342 AES cases this year.
- The syndrome is also caused by infections such as scrub typhus, dengue, mumps, measles, and even Nipah or Zika virus.
- In the latest outbreak in Muzaffarpur, the cause is yet to be clinically identified in most of the children.
- **Hypoglycaemia and AES** - Hypoglycaemia (low blood sugar) is a commonly seen sign among AES patients, and the link has been the subject of research for long.
- The combination of AES with hypoglycaemia is unique to Muzaffarpur, Vietnam and Bangladesh.
- A 2014 study in Muzaffarpur suggested that hypoglycaemia was the trigger that led to diagnosis of encephalitis.



- So, Hypoglycaemia is not a symptom but a sign of AES.
- With 98% of AES patients in Bihar also suffering hypoglycaemia, doctors are attributing deaths to the latter.
- In Bihar, convulsions in children (which is AES) are found in combination with hypoglycaemia.
- **Litchi Connect** - Methylene cyclopropyl glycine (MCPG), also known as hypoglycin A, is known to be a content of litchi fruit.
- Undernourished children who ate litchi during the day and went to bed on an empty stomach presented with serious illness early the next morning.
- MPCG lowers blood sugar level during night, and these children are found unconscious in the morning.
- Blood glucose falls sharply causing severe brain malfunction (encephalopathy), leading to seizures and coma, and death in many cases.
- However, this remains a subject of debate, and the possible association needs to be documented.
- Malnutrition is high in both states, and malnourished children are prone to infection.
- As per Health Ministry data, UP and Bihar together account for over 35% of child deaths in the country.
- National Family Health Survey-4 data show that in 2015-16, 48% children aged less than 5 in Bihar were stunted, which is the highest in India.
- Also, heat, humidity, unhygienic conditions and malnutrition which are unique to these areas, together contribute to the rise in AES.
- Incidence is higher in litchi fields around which malnourished children live.



5.11 Japanese Encephalitis

- Japanese Encephalitis has been recently reported in Assam.
- It is a **mosquito-borne viral infection**.
- It is a **flavivirus** family related to dengue, yellow fever and West Nile viruses.
- It is the leading cause of viral encephalitis in Asia.
- It will not spread from one person to another.
- There is **no cure** for the disease. Treatment is focused on relieving severe clinical signs and supporting the patient to overcome the infection.
- Most JEV infections have mild (fever and headache) or without apparent symptoms.
- Approximately 1 in 250 infections results in severe clinical illness. The incubation period is between 4-14 days.
- Safe and effective vaccines are available to prevent JE.



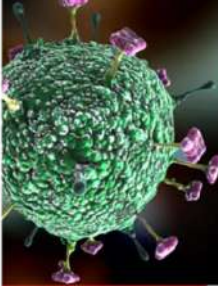
- ‘SA 14-14-2’ vaccine become the most widely used vaccine in endemic countries, and it was prequalified by WHO.
- Since the recent outbreak in Assam, all 27 districts of Assam were covered under the JE vaccination campaign for those aged between 1 to 15 years.
- Migratory birds along with pigs in the community play an important role in the transmission of JE from one area to another.

5.12 Nipah Virus Case in Kerala

- It is a zoonotic virus (transmitted from animals to humans) that causes severe disease in both animals and humans.
- The natural hosts of the Nipah virus are fruit bats of the Pteropodidae family and Pteropus genus, widely found in South and South East Asia.
- However, the actual source of the current infection is not yet known.
- Scientists are currently working on finding the epidemiological link of the outbreak.
- Nipah virus infections were first identified in 1999 in Malaysia.
- From then on infections have been detected quite frequently in Bangladesh.
- It can be transmitted to humans from animals (such as bats or pigs), or contaminated foods and can also be transmitted directly from human-to-human.
- It spreads mainly through bad droppings or bodily remains and then spreads laterally within a species.
- In infected people, it causes a range of illnesses from asymptomatic infection to acute respiratory illness and fatal encephalitis.
- It was first identified during an outbreak of disease that took place in Kampung Sungai Nipah, Malaysia in 1998.
- The classical symptom is acute and rapidly progressive encephalitis (brain inflammation and pain) with or without respiratory involvement.
- It is also capable of causing disease in pigs and other domestic animals.
- There is no vaccine for either humans or animals.
- There is no effective specific treatment for the infection and hospitalisation is only to support our bodily immune systems.
- **Effect** - Nipah virus causes a so far incurable infection in human beings, which can sometimes be fatal.
- Patients either show no symptoms of the infection, thereby making it difficult to detect.
- Otherwise, patients develop acute respiratory problems, or encephalitis that often becomes fatal.
- WHO says the infection has been found to be fatal in 40% to 75% of the infected patients.
- There is **no treatment** available as of now, either for humans or animals, nor any vaccine.
- **Transmission** - The infection is generally transmitted from animals to human beings, mainly from bats and pigs.
- Human-to-human transmission is also possible, and so is transmission from contaminated food.

Previous instances

- **Kerala** - There have been a few incidents of infection in India earlier, apart from the 2018 outbreak in Kerala.
- The 208 outbreaks was confined to two districts of Kerala, Kozhikode and Malappuram.

SYMPTOMS	 <p>After exposure and incubation period of 5-14 days, illness presents with 3-14 of fever and headache followed by other symptoms</p>
<ul style="list-style-type: none"> Fever Headache Drowsiness Disorientation Mental confusion Coma Potentially death 	
TREATMENT	<p>No specific treatment for Nipah Virus</p> <p>Primary treatment is intensive supportive care</p>

Source: WHO & Centers for Disease Control and Prevention, US



- Studies have revealed that a particular kind of fruit bat, *Pteropus* spp, was most likely the source of human infection in 2018.
- Research suggested that this particular strain might have been circulating in the local bat population.
- The newly detected case in Kerala is believed to have actually been a result of intensified preventive and containment efforts after last year's outbreak.
- The increased awareness and vigilance in the community has helped in early detection this time.
- **Elsewhere in India** - The first outbreak was in 2001 in Siliguri, West Bengal.
- More than 30 people were hospitalised with suspected infection then.
- Another outbreak happened in 2007 in Nadia of West Bengal, with over 30 cases of fever with acute respiratory distress and/or neurological symptoms.
- Notably, five of them turned out to be fatal.

5.13 Covid-19

- The World Health Organization (WHO) has named the new coronavirus disease as 'Covid-19'.
- The new name is taken from the words "corona", "virus" and "disease", with 2019 representing the year when it emerged.
- The WHO wanted to avoid stigmatizing a country or particular group, so it chose a name that did not refer to a geographical location, an animal, an individual or a group of people.
- The WHO, in consultation with the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO), has identified best practices for naming new human diseases.
- These best practices apply to a new disease:
 - That is an infection, syndrome, or disease of humans;
 - That has never been recognised before in humans;
 - That has potential public health impact; and
 - Where no disease name is yet established in common usage
- Names that are assigned by the WHO may or may not be approved by the International Classification of Diseases (ICD) at a later stage.
- The ICD, which is also managed by the WHO, provides a final standard name for each human disease according to standard guidelines that are aimed at reducing the negative impact from names while balancing science, communication and policy.
- **Coronavirus** – They are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV).
- A novel coronavirus (nCoV) is a new strain that has not been previously identified in humans.
- Coronaviruses are zoonotic, meaning they are transmitted between animals and people.
- Detailed investigations found that SARS-CoV was transmitted from civet cats to humans and MERS-CoV from dromedary camels to humans.
- Several known coronaviruses are circulating in animals that have not yet infected humans.
- Coronaviruses are named for the crown-like spikes that protrude from their surfaces, resembling the sun's corona.
- Coronaviruses are among a large number of viruses that are common in people and many animals.
- The new virus, first detected in China, is believed to have originated in bats.
- While antibiotics don't work against viruses, researchers are testing drugs that could disrupt viral proteins and stop the infection.



5.14 Severe Acute Respiratory Syndrome

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

SARS vs CORONA

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

5.15 Classical Swine Fever (CSF) Vaccine

- ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar, develops classical Swine Fever Cell culture Vaccine.
- CSF is one of the most important diseases of pigs causing high mortality.
- A lapinized CSF vaccine (Weybridge strain, UK) is being used in India since 1964 for controlling the disease.
- IVRI recently developed a new CSF Cell Culture Vaccine by attenuating an indigenous virulent CSF virus in cell culture.
- The vaccine virus has a very high titre, lakhs of doses can be produced very easily in cell culture, and the country's requirement can be easily fulfilled using this new vaccine.
- The new vaccine is ready for release and commercial production will be completed in less than a year.
- The vaccine would be the best choice for use in the CSF Control Programme (CSF-CP) already launched by Department of Animal Husbandry and Dairying (DAHD)

5.16 Diphtheria

- Diphtheria is an **infectious disease** caused by the **bacterium Corynebacterium diphtheria**.
- It primarily infects the throat and upper airways and produces a toxin affecting other organs.
- The bacteria produce a toxin because they themselves are infected by a certain type of virus called a phage.
- The toxin causes a membrane of dead tissue to build up over the throat and tonsils, making breathing and swallowing difficult.



- Diphtheria infection spread only among humans.
- The primary infection is in the throat and upper airways.
- It is spread by direct physical contact.
- Specific signs and symptoms of diphtheria are low fever, swollen glands on the neck, Swelling of soft tissue in the neck, fast heart rate.
- It particularly affects children aged 1 to 5 years.
- It can be fatal if left untreated but has become increasingly rare in recent decades due to high rates of vaccination.
- In 1978, India launched the '**Expanded Programme on Immunisation**' which covers BCG (against TB), DPT (diphtheria, pertussis, tetanus) and cholera.
- In 1985, the programme was converted to the '**Universal Immunisation Programme**' (UIP).
- As per data from the National Family Health Survey 4, the coverage of diphtheria vaccine is 78.4%.
- This has reduced the mortality and morbidity of diphtheria dramatically. However, Vaccine hesitancy is a growing all over the world.
- So, cases of Diphtheria have been going up in the last few years.

5.17 Rotavirus Vaccine

- 'Ministry of Health and Family Welfare' plans to expand Rotavirus vaccine coverage to all states.
- Rotavirus is a viral infection that causes severe diarrhea in children, particularly in youngsters less than 2 years old.
- In India, every year 37 out of every 1000 children born are unable to celebrate their 5th birthday and one of the major reasons for this is diarrheal deaths.
- It is very contagious and the virus is found in the stool of a person during and after the time, the person has diarrhea.
- Not washing a child's hands can lead to the virus contaminating other objects, such as toys.
- Other children can then become infected, if they also touch these contaminated objects.
- The virus easily spreads and causes inflammation in the stomach and intestines.
- Two brands of vaccine are available to protect against rotavirus.
- Antibiotics will not help because they fight bacteria not viruses.
- Since rotavirus disease can cause severe vomiting and diarrhea, it can lead to dehydration.
- The best way to protect against dehydration is to drink plenty of liquids.
- Rotavirus vaccine along with proper sanitation, hand wash practices and zinc supplementation will help in reducing the mortality and morbidity due to diarrhoea in children.
- National Technical Advisory Group on Immunization (NTAGI), recommended introduction of rotavirus vaccine (RVV) in the Universal Immunization Programme (UIP).
- Government is committed to ending morbidity and mortality in children due to diarrhoea by 2022.

National Technical Advisory Group on Immunization

- NTAGI is the highest advisory body on immunization in the country.
- It consists of independent experts who provide recommendations on vaccines after reviewing data on disease burden, efficacy and cost-effectiveness of vaccines.
- The Immunization Technical Support Unit (ITSU) was established to support MoHFW for evidence-based planning.
- One of the functions of ITSU was to host the NTAGI Secretariat to facilitate the secretarial work of NTAGI.



Rotavac 5D Vaccine

- Hyderabad based Bharat Bio-Tech, an international biotechnology company, has recently unveiled advanced version of rotavirus vaccine Rotavac 5D.
- It is the oral rotavirus vaccine to tackle **viral diarrhoea**.
- It has been developed with close coordination with the Department of Biotechnology.
- The current Rotavac vaccine, also manufactured by Bharat Biotech, requires to be stored at -20-degreeCelsius same as oral polio vaccine.
- The newer Rotavac 5D will, however require between two to eight degrees celsius storage temperature, which is the normal refrigeration temperature.
- Rotavac 5D will have reduction in dosage from 2.5 to 0.5ml.
- The vaccine is waiting for prequalification from WHO to supply across the world.

5.18 Hepatitis B Control

- Bangladesh, Bhutan, Nepal and Thailand became the first four countries in the WHO's South-east Asia region to have successfully controlled hepatitis B.
- Hepatitis B is a viral infection that attacks the liver and can cause both acute and chronic disease.
- The virus is most commonly transmitted from mother to child during birth and delivery, as well as through contact with blood or other body fluids.
- WHO estimates that in 2015, 257 million people were living with chronic hepatitis B infection (defined as hepatitis B surface antigenpositive)
- Hepatitis B can be prevented by vaccines that are safe, available and effective.
- The virus is said to be controlled when the disease prevalence is reduced to less than 1% among children less than 5 years of age.
- India introduced hepatitis B vaccine in the Universal Immunization Programme in 2002 and scaled-up nationwide in 2011.
- Despite the above, about 1 million people in India become chronically infected with the virus every year.
- Hepatitis B infection at a young age turns chronic, causing over 1,00,000 premature deaths annually from liver cirrhosis or liver cancer.
- One of the reasons for this is the sub-optimal coverage of birth dose in all infants within 24 hours of birth.
- Hepatitis B birth dose, given in the first 24 hours, helps prevent vertical transmission from the mother to child.

5.19 Hepatitis C

- WHO has listed viral hepatitis as a major public health problem throughout the world and particularly in India
- 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.
- It has the same mode of transmission as HIV, spreading through blood, injecting drugs, blood transfusion and sexual activity, and from mother to child during pregnancy.
- Hepatitis A is closely associated with unsafe water or food, inadequate sanitation and poor personal hygiene.
- Unlike hepatitis B and C, hepatitis A infection does not cause chronic liver disease and is rarely fatal.
- Hepatitis C virus (HCV) is mostly transmitted through exposure to infective blood and it can cause both acute and chronic hepatitis.
- Acute HCV infection is usually asymptomatic (persons do not exhibit symptoms) and is only very rarely associated with life-threatening disease.



- HCV can also be transmitted sexually and can be passed from an infected mother to her baby, but it is not spread through breast milk, food, water or by casual contact.
- Hepatitis A & E virus are responsible for sporadic infections and the epidemics of acute viral hepatitis.
- Hepatitis B & C virus predominantly spread through the parental route and are notorious for causing chronic hepatitis.
- According to WHO Hepatitis is preventable and treatable but remains an acute public health challenge globally and in the Southeast Asia region.
- 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).
- HCV is an important public health issue in India.
- In Uttar Pradesh, Bijnor district, Pahuli village has emerged as a hotspot of hepatitis C infection.
- Union Health Ministry's National Programme for Control of Viral Hepatitis for 2018-19, for the next three years, hopes to screen the vulnerable population and provide free treatment where needed.
- The National Hepatitis Policy will translate into better surveillance and detection of water and blood-borne hepatitis viral infections in various regions.

5.20 Diarrhea Vaccine

- The University of Gothenburg in Sweden have recently developed a potential Diarrhea vaccine named "ETVAX".
- The treatment aims to prevent enterotoxigenic E. coli (ETEC) diarrhea.
- It is common among children and is passed through food and water contaminated with feces.
- The infections typically come with symptoms ranging from chills and vomiting to cramps and fever.
- There is currently no vaccine in the market and the doctors typically prescribe antibiotics to infected patients.
- In adults, the doctors allow the illness to run its course and with strong immune systems, it typically fades after three weeks.
- It is a common illness among citizens of developing countries and those who travel there.

5.21 Measles

- Measles is a highly contagious viral disease.
- It remains an important cause of death among young children globally, despite the availability of a safe and effective vaccine.
- Also called German Measles, Rubella is a contagious, generally mild viral infection that occurs most often in children and young adults
- Measles is transmitted via droplets from the nose, mouth or throat of infected persons.
- Severe measles is more likely among poorly nourished young children, especially those with insufficient vitamin A, or whose immune systems have been weakened by HIV/AIDS or other diseases.
- The most serious complications include blindness, encephalitis (an infection that causes brain swelling), severe diarrhea and related dehydration, and severe respiratory infections such as pneumonia.
- Under the Global Vaccine Action Plan, measles and rubella are targeted for elimination in five WHO Regions by 2020.
- India, as part of the global initiative, has targeted elimination of measles and control of rubella by 2020.
- Recently India has stepped in to help the Maldives tackle a recent outbreak of measles.
- The Indian government's initiative comes even as the two countries implement the Memorandum of Understanding on Health cooperation — signed during PM Narendra Modi's visit to Male in June 2019.



5.22 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.
- The vaccine being given in the MR campaign is produced in India and is WHO prequalified.
- MR vaccine is safe and effective, and in use for over 40 years across 150 countries.
- It is being given in the routine immunisation programme of India and in neighbouring countries like Bangladesh, Sri Lanka, Nepal and Myanmar.
- Private practitioners in India have been giving measles-rubella (MR) or measles-mumps-rubella (MMR) vaccine to children for many years.

5.23 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.
- There are 3 strains of wild poliovirus (type 1, type 2, and type 3).
- P2 was **eradicated** globally in 1999. The last case due to type-2 wild poliovirus globally was reported from Aligarh in India in 1999.
- India attained a polio-free status in 2014 after successfully eliminating the wild P1 and P3 strains.
- India **eliminated** the type-2 strain in 2016, and the type-2 containing poliovirus vaccine (ToPV) was phased out in April 2016.
- Thus, Children born after April 2016 in India have no immunity to type-2 polio virus.
- Recently, Traces of polio type-2 virus were found in some batches of oral polio vaccine (OPV) manufactured by a Ghaziabad-based pharmaceutical company.
- No case of type 3 has been found since the last reported case in Nigeria in November 2012.
- Today, only 3 countries in the world have never stopped

Elimination and Eradication

- Elimination means stopping the transmission of a disease in a specific geographic area or country, but not worldwide.
- Disease eradication is the permanent reduction of a disease to zero cases through deliberate measures such as vaccines.
- Once a disease has been eradicated, intervention measures are no longer needed.



transmission of polio (Pakistan, Afghanistan and Nigeria).

- The vaccine used by the World Health Organisation (WHO) in the global eradication effort is a trivalent preparation comprising all three serotypes.
- India completed a full 5 years as a “polio-free nation” on January 13, 2016.
- India’s last reported polio case was from Howrah, West Bengal in the year 2011.

5.24 Pulse Polio Campaign

- It 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.
- **Oral Polio Vaccine (OPV)** contains weakened but live polio virus, which can cause paralytic polio.
- OPV reduced the outbreak caused by wild polio virus by 99.9% since 1988.
- 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.
- Vaccine Derived Polio Virus (VDPV), like imported wild polio, can cause outbreaks in under-immunised population.
- According to The Lancet, vaccination (using OPV) has become the main source of polio paralysis in the world.
- It is for this reason that the eradication of polio worldwide requires OPV to be stopped and replaced with the **Inactivated Polio Vaccine (IPV)**.
- It consists of killed poliovirus strains of all three poliovirus types and it produces antibodies in the blood to all three types of poliovirus.
- In the event of infection, these antibodies prevent the spread of the virus to the central nervous system and protect against paralysis.
- It is 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.
- 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.

5.25 Rising dengue cases in Mumbai

- Mumbai registered its first dengue death this year and already 71 dengue cases have been confirmed by the BMC.
- Dengue is the fast emerging ‘mosquito-borne viral infection’.
- It flourishes in urban poor areas, suburbs mostly in tropical and subtropical countries.
- The dengue virus (DEN) comprises four distinct serotypes, which belong to the genus Flavivirus, family Flaviviridae.
- The ‘Aedes aegypti’ mosquito is the main vector.
- ‘Aedes aegypti’ mosquito breeds in freshwater. (unlike Malaria mosquito (Anopheles) breeds in any water accumulating in open areas).
- The breeding sites can be domestic atmosphere, under refrigerator plates, water containers, ACs in households.
- The mosquito mainly acquires the virus while feeding on the blood of an infected person.



- It develops severe flu-like symptoms which includes,
 1. Severe headache
 2. Pain behind the eyes
 3. Nausea, Vomiting
 4. Swollen glands
 5. Muscle and joint pains
 6. Rashes
- In India it peaks from Monsoon every year.
- It is prevalent in Maharashtra, Gujarat, Rajasthan, Delhi, Harayana, Punjab, West Bengal and most of southern India.
- There is no specific treatment for dengue fever and the patients are advised to drink plenty of fluids.
- Maintenance of the patient's circulating fluid volume is the central feature of such care.
- The only current method of controlling dengue is to effectively combat the vector mosquitoes.
- It is implemented using 'Integrated Vector Management' (IVM) approach.
- IVM is a rational decision-making process for the optimal use of resources for vector control.
- Dengue cases have been recorded by the 'National Vector Borne Disease Control Programme' (NVBDCP).

5.26 Kyasanur Forest Disease

- Kyasanur Forest disease (KFD) or Monkey Fever is a re-emerging zoonotic disease caused by virus.
- The KFD virus belongs to the family Flaviviridae, which also includes yellow fever and dengue fever.
- It was first identified in 1957 from Kyasanur forest area in Shivamogga district of Karnataka.
- It causes viral hemorrhagic fever i.e the overall vascular system is damaged, and the body's ability to regulate itself is impaired.
- Hard ticks (*Hemaphysalis spinigera*) are the carriers of KFD virus and are known to thrive in western ghats.
- Rodents, shrews, and monkeys are common hosts for KFDV after being bitten by an infected tick.
- It has high fatality in primates.
- 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.
- It is a re-emerging zoonotic disease endemic in Karnataka.
- It has been detected in monkeys in parts of Bandipur National Park, Karnataka and re-emerging source has been found in cashew plantations in Goa.

5.27 Influenza classification

- Recently, India was again declared free of H5N1 virus, which causes 'avian influenza' or 'Bird flu' (earlier declaration in 2017).
- **WHO** defines influenza as a contagious, acute respiratory illness caused by influenza viruses.
- The many kinds of viruses causing influenza are identified by a standard nomenclature issued by the WHO in 1980.
 1. It is of four types, A, B, C, and D.
- According to the US Centers for Disease Control and Prevention (CDC), only 'influenza A and B viruses' are known to cause '**epidemics**'.
 1. The 'C type' virus usually causes mild respiratory illness.
 2. The 'D type' virus typically affects cattle and is not known to infect humans.



- Influenza is known to kill 6.5 lakh people every year, especially young children, elderly, pregnant women or those with vulnerable immune systems.
- Only the 'Influenza A virus' is divided into subtypes, based on two proteins on the surface of the virus,
 1. Hemagglutinin (**H**) and Neuraminidase (**N**)
 2. Hemagglutinin has **18** further subtypes while
 3. Neuraminidase has **11**.
 4. They are named from H1 to H18 and N1 to N11 in a sequential system.
- Humans can be infected with avian, swine and other zoonotic influenza viruses.
 1. Avian influenza subtypes - A(H5N1), A(H7N9) and A(H9N2).
 2. Swine influenza subtypes- A(H1N1), A(H1N2) and A(H3N2).
- Novel strains of the **H1N1** virus have appeared in 1918, 1957, 1968 and most recently in 2009.
- **WHO** designated global 'bird flu' outbreak in 2009 as '**Pandemic**'

Epidemiological Terms to know

- **Endemic** - A disease that exists permanently in a particular geographical region or population.
- **Epidemic** - An infectious disease spreads rapidly to many people at about the same time.
- **Pandemic** - An epidemic spread throughout the world.
- **Outbreak** - Refers to the number of cases (disease) that exceeds what would be expected.

5.28 H9N2 virus

- Indian scientists have detected the country's first case of infection with a rare variant of the virus that causes avian influenza, or bird flu.
- In the December 2019 issue of the Emerging Infectious Diseases journal of the US Centers for Disease Control and Prevention (CDC), scientists of the National Institute of Virology (NIV), Pune, have reported avian influenza A(H9N2) virus infection in a 17-month-old boy in Maharashtra.
- H9N2 is a subtype of the influenza A virus, which causes human influenza as well as bird flu.
- The H9N2 subtype was isolated for the first time in Wisconsin, US in 1966 from turkey flocks.
- According to the US National Centre for Biotechnology Information (NCBI), H9N2 viruses are found worldwide in wild birds and are endemic in poultry in many areas.
- H9N2 virus infections in humans are rare, but likely under-reported due to typically mild symptoms of the infections.

5.29 African Swine Fever (ASF)

- An **ASF** outbreak has been sweeping through swine populations in **China**, leading to massive mass cullings.
- This subsequently increased the price of the country's favourite protein.
- **ASF** is a highly contagious and fatal animal disease that infects domestic and wild pigs.
- It is a severe 'viral disease' of pigs that can spread very rapidly in pig herds.
- The disease occurs in many African countries, outbreaks have also occurred in Central and Eastern Europe, Eurasia and China.
- **ASF** virus infects the herds in a number of ways,
 1. Often through the feeding of uncooked/undercooked contaminated food.
 2. Through the bites of soft-bodied ticks, lice and flies.
 3. Through inoculation with contaminated syringes and use of contaminated surgical equipment.
- The virus is then easily spread between pigs by,
 1. Direct contact with an infected animal,
 2. From its body fluids (nasal, oral, feces, blood) or



3. Indirectly from contact with contaminated objects.
 4. Some species of 'ticks' (vector) can transmit the virus.
 5. Blood sucking flies or insects may possibly spread the virus between pigs.
- The fever has **no cure, no approved vaccine**, the only way to stop it spreading is by culling the animals.
 1. So over 5 million animals have been culled in China since August 2018.
 2. Philippines, world's 7th largest pork importer and 10th largest pork consumer culled more than 7,000 pigs.
 - **ASF** is not a threat to human beings since it only spreads from animals to other animals.
 - According to **FAO** of **UN**, **ASF** affected countries includes China, Vietnam, Mongolia, Cambodia, North Korea, Laos, and Myanmar, The Philippines.
 - It affected small farmers in China who do not have the resources to protect their pigs from the disease.

5.30 Eradicating Malaria by 2050

- A report in 'The Lancet' concludes that it is possible to eradicate malaria as early as 2050 or within a generation.
- It is a life-threatening disease caused by **Plasmodium parasites**.
- It is transmitted to people through the bites of infected female *Anopheles* mosquitoes.
- The mosquito transmits the parasite in to bloodstream and after it gets matured it begin to infect red blood cells.
- There are 5 parasite species that cause malaria in humans, and 2 of these species *P. falciparum* and *P. vivax* pose the greatest threat.
- It is preventable and curable.
- An infected mother can also pass the disease to her baby at birth. This is known as congenital malaria.
- Malaria is transmitted by blood, so it can also be transmitted through:
 1. an organ transplant
 2. a transfusion
 3. use of shared needles or syringes
- Since 2000, global malaria incidence and death rates declined by 36% and 60%, respectively.
- Today, more than half of the world's countries are malaria-free.
- However, Malaria cases are rising in 55 countries in Africa, Asia and Latin America.

Malaria Detection Chromatography

- Paper chromatography is an analytical method used to separate colored chemicals or substances.
- Indian researchers has found simple malaria detection method that uses an instrument when in the lab or a piece of chromatographic paper when in the field.
- The kit can be used to detect *Plasmodium* parasite, which causes malaria and also specifically detect *Plasmodium falciparum*, a notorious species.
- This kit has high stability in hot and humid conditions and the paper-based method offers the result rapidly.

5.31 New anti-tuberculosis drug

- TB is caused by bacteria (*Mycobacterium tuberculosis*) that most often affect the lungs.
- It is curable and preventable.
- It is spread from person to person through the air.
- About 1/4th of the world's population has latent TB, which means people have been infected by TB bacteria but are not (yet) ill with the disease and cannot transmit the disease.



- It mostly affects adults in their most productive years. However, all age groups are at risk.
- People who are infected with HIV are 20 to 30 times more likely to develop active TB
- 8 countries accounted for two thirds of the new TB cases: India, China, Indonesia, the Philippines, Pakistan, Nigeria, Bangladesh and South Africa.
- India has set its own target of eliminating TB by 2025.
- Multidrug-resistant tuberculosis (MDR-TB) is a form of TB caused by bacteria that do not respond to the most powerful first-line anti-TB drugs (isoniazid and rifampicin).
- MDR-TB is treatable and curable by using second-line drugs (bedaquiline and delamanid).
- **Latent TB Infection** - Persons with LTBI are those who harbor the TB-causing bacteria within, where it can lie dormant.
- In other words, it is a state of persistent immune response to stimulation by Mycobacterium tuberculosis antigens without evidence of clinically manifested active TB.
- The WHO lays emphasis on a specific strategy to tackle latent TB but only in high- and upper middle-income countries with a low incidence of the disease.
- According to a WHO report, approximately 10% of people with LTBI will develop TB, with the majority of them getting it within the first five years of infection.
- LTBI can often be tackled by maintaining good health and observing coughing and sneezing etiquette.
- **Recent Developments** - The anti-tuberculosis drug **Pretomanid** was recently approved by the U.S. Food and Drug Administration (FDA).
- This will be a game changer for treating people with extensively drug-resistant TB (XDR-TB) and multidrug-resistant TB (MDR-TB) drugs.
- Pretomanid is only the third drug in the last 4 decades to get FDA approval.
- The all-oral, three-drug regimen of bedaquiline, pretomanid, and linezolid (**BPaL**) had a **90% cure rate** in a phase III trial in South Africa involving 109 participants.
- In contrast, the current treatment success rate for XDR-TB and MDR-TB is about 34% and 55%, respectively.

5.32 NIKSHAY

- It is a web enabled application, which facilitates monitoring of universal access to TB patient's data by all concerned stakeholders.
- It has been developed jointly by the Central TB Division of the Ministry of Health and Family Welfare and National Informatics Centre (NIC).
- Two objectives –
 - i. To create database of all TB patients including Multi-Drug Resistant cases across the country,
 - ii. To use this database for monitoring and research purposes at all levels so that TB can be eradicated from India in an effective manner.
- The government launched the NikshayPoshan Yojana, a direct benefit transfer scheme, to provide nutritional support to TB patients.
- Under the scheme, TB patients receive ₹ 500 per month for the entire duration of treatment.
- According to the recent Tuberculosis India Report 2019 released by the Govt of India, the estimated TB incidence in India stands at 27 lakh.
- **Report Highlights** - TB burden in India is highest in Uttar Pradesh, followed by Maharashtra and Rajasthan, Gujarat and MP.
- The number of HIV-infected people who go on to develop Tuberculosis (TB) is increasing in India.
- TB is the leading cause of morbidity and mortality among People Living with HIV (PLHIV).



- In 2018, the Revised National Tuberculosis Programme (RNTBP) was able to achieve notification by 21.5 lakh persons, which is an increase of 16% as compared to 2017.

5.33 **Salmonella**

- Indian **MDH** sambar masala were recalled from retail stores in **US** after tests by the **US-FDA** showed positive for 'Salmonella'.
- **MDH** is a top Indian cooking brand which is selling various spice mixes that are key to Indian cooking.
- **Salmonella** is a group of '**bacteria**' that can cause food-borne illnesses known as **Salmonellosis**.
- It is commonly found in the intestines of humans and animals.
- It can also be found on raw meats, poultry, eggs and in unpasteurised milk.
- It causes an illness if 'live Salmonella bacteria' enters the body.
- The bacteria can attach to the cells lining the intestines where they produce toxins and attack the intestinal cells.
- According to estimates by the **US** 'Centers for Disease Control and Prevention' (**CDC**),
 1. Salmonella causes 1.2 million illnesses and about 450 deaths in the US every year.
 2. In a majority of these cases, food is the source of the illness.
- Individuals who develop salmonellosis may show symptoms such as nausea, diarrhoea, fever and abdominal cramps.
- Usually, the illness lasts for 4-7 days, and most people recover without treatment.
- In some cases the diarrhoea is severe and there is risk of it spreading from the intestines to other parts of the body.
- **WHO** identifies 'Salmonella' as one of four key global causes of diarrhoeal diseases.
- 'Salmonella bacteria' are widely distributed in domestic and wild animals.
- They are prevalent in food animals such as poultry, pigs, and cattle, as well as in pets, including cats, dogs and birds.
- 'Salmonellosis' in humans is generally contracted through the consumption of contaminated food of animal origin.
- It also pass through other foods, including green vegetables contaminated by manure.
- Person-to-person transmission can also occur through the faecal-oral route

5.34 **Bluetongue**

- It is a non-contagious, viral disease affecting domestic and wild ruminants primarily sheep and including cattle, goats, buffalo, antelope, deer, elk and camels.
- It is transmitted by insects, particularly biting midges of the Culicoides species.
- The virus which causes this disease belongs to the member of the Reoviridae family.
- It is a disease listed under the OIE Terrestrial Animal Health Code and it must be reported to the World Organisation for Animal Health.
- It has significant distribution in Africa, Asia, Australia, Europe, North America and several islands in the tropics and subtropics, where culicoides species is present.
- Without the insect vector, the disease cannot spread from animal to animal.
- Indian Council of Agricultural Research (ICAR) has released diagnostic kits Bluetongue sandwich ELISA (sELISA) and the Japanese Encephalitis IgM ELISA for the control of Swine and Detection of Antigen.



5.35 Lymphatic Filariasis

- National Symposium on the theme 'United to Eliminate Lymphatic Filariasis' was organised recently by the Ministry of Health and Family Welfare.
- Call to Action to eliminate Lymphatic Filariasis by 2021 was signed.
- Lymphatic filariasis, commonly known as elephantiasis, is a painful and profoundly disfiguring disease.
- It is caused by three species of thread-like nematode (roundworms) of the family Filariodidea. *Wuchereriabancrofti* is responsible for 90% of the cases.
- Infection occurs when filarial parasites are transmitted to humans through mosquitoes.
- It is one of the Neglected Tropical Diseases.
- It impairs the lymphatic system and can lead to the abnormal enlargement of body parts, causing pain, severe disability and social stigma.
- It can be eliminated by stopping the spread of infection through preventive chemotherapy with safe medicine combinations repeated annually.
- Global Program to Eliminate Lymphatic Filariasis (GPELF) was organised by the WHO in 2000.

5.36 EEHV

- Elephant Endotheliotropic Herpesvirus (EEHV) is a rare viral disease that causes fatal disease in young Asian Elephants.
- When it is triggered, the elephant dies of massive internal bleeding and symptoms which are hardly visible.
- Some elephants show symptoms such as reduced appetite, nasal discharge and swollen glands.
- The disease is usually fatal, with a short course of 28-35 hours.
- It is lethal for young elephants between the ages of 1 and 12.
- There is no true cure for herpesviruses in animals or in humans.
- If a young elephant dies before reproducing, it affects the population of the species in the concerned geography.
- It has killed five elephants in Nandan Kanan Zoo & Chandaka forest in Odisha.

5.37 EVALI Disease

- Recently the number of deaths in the US caused due to the mysterious respiratory illness linked to vaping and e-cigarettes rose to 55.
- As of December 2019, the Centers for Disease Control and Prevention (CDC), a US federal agency, has reported 2,561 cases across the country who have suffered from the illness.
- The CDC is tentatively referring to the disease as EVALI (e-cigarette, or vaping, product use associated lung injury).
- E-cigarettes, also called 'vapes' or 'electronic nicotine delivery systems (ENDS)', are battery-run devices that were originally marketed as a safer alternative to smoking traditional cigarettes.
- The disease 'EVALI' is unknown to doctors, and a link between vaping and the lung illness is yet to be concretely established.
- Symptoms, according to the CDC, are those in common with other respiratory illnesses, including coughing, chest tightness, and shortness of breath, extreme fever or fatigue.

5.38 Yada Yada virus

- Researchers have reported the discovery of a new virus called Yada Yada.
- Yada Yada is an alphavirus, a group of viruses that are as "small, single-stranded positive-sense RNA viruses (that) include species important to human and animal health, such as Chikungunya virus and Eastern equine

encephalitis virus... (and which) are transmitted primarily by mosquitoes and (are) pathogenic in their vertebrate hosts”.

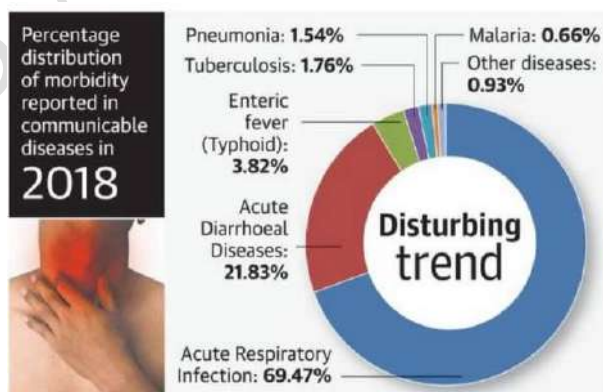
- Unlike some other alphaviruses, Yada Yada does not pose a threat to human beings.
- The virus was detected in mosquitoes trapped as part of the Victorian Arbovirus Disease Control Programme in Encephalitis Virus Surveillance traps set up overnight in three locations in Victoria, Australia, for seven weeks in late 2016, the researchers reported.

5.39 Sahana (hemorrhagic septicemia)

- Around 40 buffaloes have died within four days due to suspected Sahana disease (hemorrhagic septicemia) in a number of villages located in the Garadapur block of Odisha's Kendrapara.
- Hemorrhagic septicemia is a severe bacterial disease.
- It spread through contact with infected animals, contaminated clothes, equipment and ingestion or inhalation of the bacteria.
- The main symptoms of the disease include undigested food in faeces, swishing tail, reduced cuddling reduced milk yield.
- Burring the carcasses of infected animals in deep pits will prevent the spread of the disease.

5.40 Alzheimer's Disease

- China has approved the first home-grown drug “Oligomannate (GV-971)” for the treatment of "mild to moderate Alzheimer's disease (AD).
- It is the first drug to be approved for Alzheimer's disease globally since 2003.
- AD is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills, and, eventually, the ability to carry out the simplest tasks.
- It is the most common cause of dementia – loss of cognitive thinking among older adults.
- It often starts with mild symptoms and ends with severe brain damage.
- The plaques and tangles in the brain are still considered some of the main features of Alzheimer's disease.
- Another feature is the loss of connections between nerve cells (neurons) in the brain.



5.41 Acute Respiratory Infections

- ARI is a serious ailment that prevents normal breathing function and kills an estimated 2.6 million children annually every year worldwide.
- Indians face the double burden of heavy air pollution in addition to the high rate of ARI which hits children the hardest.
- National Health Profile – 2019 says that Acute Respiratory Infections (ARI) accounted for 69.47% of morbidity (poor health) in the communicable disease category leading to 27.21% mortality (Loss of Life).
- ARI is highest in the Andhra Pradesh, Gujarat, Karnataka, Kerala, Tamil Nadu, Uttar Pradesh and West Bengal.
- **Implications** – Polluted air penetrate and inflame the linings of bronchial tubes and lungs.
- This leads to respiratory illness such as chronic bronchitis, emphysema, heart disease, asthma, wheezing, coughing and difficulty in breathing.
- It poses a high risk to pregnant women and the baby. The foetus receiving polluted air from mother can increase health risk of unborn babies.



- In pregnant women, it can cause a medical condition called intrauterine inflammation.

5.42 Avian Botulism

- Over 17,000 birds were found dead in the past few days in the Sambhar Lake in Rajasthan.
- It is not the first time that where deaths due to botulism have been recorded. It is reported in Lake Michigan in 2007 and 2008 and in Hawaii in 2008.
- The Indian Veterinary Research Institute (IVRI), Bareilly, states that climatic conditions were ultimately responsible for having triggered the mass die-off.
- It is occurred due to avian botulism, a disease caused by a bacteria that affects nerves.
- Botulinum is a natural toxin produced by a bacteria known as ***Clostridium botulin***.
- It produces the toxin when it starts reproducing and attack the neurons which leads to muscle paralysis.
- It is commonly found in the soil, river, and sea water
- There are around eight types — A, B, C₁, C₂, D, E, F, and G — of botulinum toxin and they are distinguishable when diagnosed.
- Botulinum affects both humans and animals, but the type of the toxin varies — botulinum C in birds and A, B and E in humans.

Climate Change and Botulism

- It has been recognised as a major cause of mortality in wild birds since the 1900s.
- It needs anaerobic (absence of oxygen) conditions and does not grow in acidic conditions.
- It also requires a nutrient-rich substrate, like areas with large amounts of decaying plant or animal materials.
- Water levels in the lake were fluctuating throughout the year.
- Due to a good monsoon this year, the water level reached the lakebed after a gap of 20 years which provided a favourable environment for the bacteria to spread.
- The monsoon brought with it a large population of crustaceans (like shrimps, crabs, and prawns), invertebrates (snails) and plankton (like algae).
- These living organisms are capable of hosting the bacteria for a long period of time.
- It reproduces through spores and these spores remain dormant for years.
- Botulism outbreaks are likely to become more frequent as climate change alters wetland conditions to favour bacteria and pathogens.

5.43 Wooden Breast Syndrome

- Researchers have recently found that the Wooden Breast Syndrome affects broiler chickens by making the meat hard and chewy.
- It is a metabolic disorder characterised by abnormal fat accumulation in the breast muscle tissue.
- It involves inflammation of the veins in the breast tissue and accumulation of lipid around the affected veins.
- It is followed by muscle cell death and replacement by fibrous and fatty tissue.
- An enzyme called lipoprotein lipase is behind the syndrome and it is crucial for fat metabolism.
- At the onset of wooden breast syndrome, lipoprotein lipase was higher in affected chickens, leading to more fat accumulating in the breast muscles.
- This is an irregularity because breast muscle fibres in chicken typically rely on sugar molecules for fuel, not fat molecules.
- It can render the birds unmarketable and cause losses for growers.



5.44 Bombay Blood Group

- Recently, the 'Bombay blood group', a rare blood type, has been at the centre of attention in Mumbai's healthcare scene.
- Demand for the blood type has coincidentally spiked at hospitals, but supply has been scarce.
- The 4 most common blood groups are **A**, **B**, **AB** and **O**.
- The rare, 'Bombay blood group' was first discovered in Mumbai in 1952 by Dr Y M Bhende.
- Each red blood cell has antigen over its surface, which helps determine which group it belongs to.
- The Bombay blood group, also called "**hh**", is deficient in expressing antigen H, meaning the RBC has no antigen H.
- For instance, in the **AB** blood group, both antigens A and B are found.
 - A** will have A antigens, **B** will have B antigens.
 - In **hh**, there are no A or B antigens.
- Globally, the **hh** blood type has an incidence of 1 in 4 million.
- It has a higher incidence in South Asia, in India, 1 in 7,600 to 10,000 are born with this type.
- This blood type is more common in South Asia than anywhere else because of inbreeding and close community marriages.
- It is genetically passed and shared common ancestry among Indians, Sri Lankans, Pakistanis and Bangladeshis.
 - This led to more cases of **hh** blood phenotype in this region.
- Often the **hh** blood group is confused with the **O** group.
- The difference is that the **O** group has **Antigen H**, while the **hh** group does not.
- The individuals with 'Bombay blood group' (**hh**) can only get blood from individuals of Bombay hh phenotype.
- In contrast, **hh** blood group can donate their blood to **A, B, O** blood types.

5.45 Leprosy

- Leprosy, also known as Hansen's disease, is a bacterial disease.
- It affects skin and nerves which can lead to physical deformity and disability if left untreated.
- It is not hereditary and completely curable, as opposite to general public views on leprosy.
- It is only mildly infectious (i.e) more than 85% of cases are non-infectious and over 95% of the population has a natural immunity to the disease.
- Leprosy colonies in the country still faces stigma and government's attention towards it is also going down.
- This is mainly because of WHO declaration of the elimination of leprosy as a public-health concern in India in 2005.
- This has diluted the international funding and reduced attention and made life difficult for the people living in the colonies.

5.46 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

5.47 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.

5.48 Avian Influenza A(H7N9)

- 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.

5.49 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.



5.50 Diabetes

- Diabetes mellitus (DM) - Commonly referred to as diabetes, is a group of metabolic disorders in which there are high blood sugar levels over a prolonged period.
- Most common types of Diabetes Mellitus are as follows
- **Type 2 diabetes** - A chronic condition that affects the way the body processes blood sugar (glucose).
- **Type 1 diabetes** - A chronic condition in which the pancreas produces little or no insulin.
- **Prediabetes** - A condition in which blood sugar is high, but not high enough to be type 2 diabetes.
- **Gestational diabetes** - A form of high blood sugar affecting pregnant women.
- **Diabetes insipidus** - It occurs when the body can't regulate how it handles fluids.
- The condition is caused by a hormonal abnormality and isn't related to diabetes.
- In addition to extreme thirst and heavy urination, other symptoms may include getting up at night to urinate, or bed-wetting.
- Depending on the form of the disorder, treatments might include hormone therapy, a low-salt diet and drinking more water.

5.51 Fluorosis

- It 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.

5.52 West Nile Virus

- They are typically spread by culexmosquitoes and can cause neurological disease and death in people.
- It is a member of the flavivirus genus and belongs to the same family of Japanese encephalitis - Flaviviridae.
- Its transmission cycle, by nature, revolves between birds and mosquitoes. Humans, horses and other mammals can be infected.
- Mosquitoes become infected when they feed on infected birds, which circulate the virus in their blood for a few days.
- Human infection is most often the result of bites from infected mosquitoes.
- Unlike other mosquito-borne diseases, it does not cause symptoms in everybody that contracts the virus.
- To date, no human-to-human transmission of WNV through casual contact has been documented.
- It may be transmitted through contact with other infected animals, their blood or other tissues.
- No vaccine is available for humans.
- It is commonly found in Africa, Europe, the Middle East, North America and West Asia.
- It was first isolated in a woman in the West Nile district of Uganda in 1937. In India, it was first noticed in 1956 and it had its presence in Kerala in 1973.



- It has been recently reported in Kerala from Kozhikode district.

5.53 Human Papilloma Virus

- 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.

5.54 Noro Virus

- The 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 diahorrea.
- It infects people across all age groups and is highly contagious.
- It is primarily transmitted through oral-faecal, also through contaminated food, water and surface.
- The symptoms are Sudden onset of vomiting and/or diarrhea, Nausea and abdominal pain headaches, Body aches and fever. In Extreme cases, loss of fluids could lead to dehydration.
- At present, vaccines are not available.

5.55 Yara Virus

- Researchers have discovered an unusually small virus in a lake in Brazil.
- The virus has been named Yaravirus after 'Yara', a water-queen figure in Brazilian mythology.
- The Yaravirus infects amoeba and has genes that have not been described before, something that could challenge how Deoxyribonucleic Acid (DNA) viruses are classified.
- DNA viruses are classified based on the protein that makes up their shell, or capsid. The Yaravirus' capsid doesn't resemble any previously known protein.
- The Yaravirus does not infect human cells.

5.56 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**.

5.57 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.

5.58 Deworming

- Ministry of Health and Family Welfare (MoHFW) conducts deworming drive twice a year.
- Deworming is a process to kill worms commonly tape, round and hook worm, that infest bodies of children below 18 years of age.
- As per the guidelines, children aged below two years are given 200 gm of Albendazole tablet, a drug to treat parasitic worm infestation, and school-going children are administered 400 mg tablets.
- The Albendazole tablet paralyses the muscles of these worms, the worm loses its grip of intestinal tract and is flushed out of the human body.
- A worm takes six months to mature and start sucking, therefore the exercise is carried out biannually.
- Deworming has no serious side effects, but it can cause nausea and vomiting if a child has worms.
- The medicine disrupts the worms which leads to uneasiness in the stomach.
- **Significance** - Parasitic worms and their larvae are generally found in contaminated food and water.
- In slums children walk bare feet and they frequently contract worms.
- The worm first enters the blood circulation system and its larvae land up in the larynx, from where it finally reaches the gastrointestinal tract.
- The hook, round and tapeworm grow by sucking blood from its host in this case the human body.
- Loss of blood leads to a drop-in haemoglobin level and causes anaemia, thus deworming kills these worms and helps prevent anaemia.
- The National Family Health Survey-3 data suggests anaemia is widely prevalent in all age groups.
- Its prevalence is 56% among adolescent girls (aged 15-19) and 70 per cent among children below five years.



5.59 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 immunization programmes.
- This will help reduce the burden of typhoid disease, especially among the vulnerable populations.

5.60 Global Syndemic

- A syndemic is defined as “the presence of two or more disease states that adversely interact with each other”.
- A Lancet Report states that the pandemics of obesity, under nutrition, and climate change are interlinked.
- It terms it as “global syndemic”.
- They represent as the paramount challenge for humans, the environment and our planet that presses the need for urgent action.
- Until now, undernutrition and obesity have been seen as polar opposites.
- But the report states that they are both driven by the same unhealthy, inequitable food systems, underpinned by the same political economy that is focused on economic growth.
- Few instances are-
 - i. Climate change > extreme weather events > increased food insecurity > under nutrition
 - ii. Climate change > increased prices of fruit and vegetables > increasing consumption of processed foods > obesity
 - iii. Foetal and infant under nutrition > risk of adult obesity.
- Not a single country has reversed the obesity epidemic across the world.

5.61 Ban on FDC Drugs

- The Drug Technical Advisory Board has recommended banning 343 “irrational” fixed-dose combination (FDC) drugs
- An FDC drug is one that contains two or more active ingredients combined in a fixed dose to form a single drug.
- Several cough syrups, painkillers and dermatological drugs in India are FDCs.
- Some are marketed with licenses approved only by state regulatory agencies instead of the Drug Controller General of India.
- These FDCs could be irrational and unsafe for consumption, with potential health risks.
- Rampant use of FDCs has allowed antibiotic resistance to assume threatening proportions in India.
- However, not all FDCs are unsafe as some are crucial to treat chronic illnesses like diabetes and HIV.
- **Ban** - In 2016, the Ministry of Health and Family Welfare had implemented a ban on 349 FDCs.
- It included popular brands like Saridon, Corex, D Cold Total, and Vicks Action 500 Extra, etc.
- The government says there are enough single drug alternatives that are safer and effective.
- **Committee** - The ban was based on recommendations of the Chandrakant Kokate committee.

Drugs Technical Advisory Board

- DTAB is the apex body to decide on technical matters related to drugs in the country.
- It is constituted as per the Drugs and Cosmetics Act, 1940.
- It functions as part of the Central Drugs Standard Control Organization (CDSCO) in the Ministry of Health and Family Welfare.



- It said FDCs are "unsafe" and "irrational" for consumption, posing health risks.
- **Court** - On pharma companies challenging the ban, the matter was taken to the Supreme Court.
- Drug makers argued that the statutory bodies on drug regulations were not consulted before the ban.
- Eventually, the Supreme Court referred the matter to the Drug Technical Advisory Board (DTAB).
- It directed the DTAB to make a fresh review of the issue with fixed-dose combination drugs.

5.62 Oxytocin Ban

- Oxytocin is a hormone secreted by the pituitary gland in human also called as Love Hormone.
- It plays a role in reproduction, child birth and lactation, apart from social interaction in humans.
- It also has physical and psychological effects, including influencing social behavior and emotion.
- Oxytocin is used both for humans and animals, to accelerate normal labour.
- Worryingly, it is also used in illegal and unsafe abortions to induce labour.
- It is being misused in the livestock industry to stimulate the mammary gland and induce milk production in farm animals.
- The drug's abuse in animals shortens their lives and makes them barren sooner.
- Vegetables and fruit, too, are injected with Oxytocin, to increase their sizes.
- The Ministry of Health and Family Welfare has restricted the manufacture of Oxytocin formulations for domestic use to public sector only from 1st July 2018.
- It has also banned the import of Oxytocin and its formulations.
- From 1st July 2018, no private manufacturer will be allowed to manufacture the drug for domestic use.
- Karnataka Antibiotics & Pharmaceuticals Ltd (KAPL) is the only public sector company, authorised for manufacturing this drug for domestic use.

5.63 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.

5.64 Global Classification of Diseases

- The World Health Organization (WHO) has released its new International Classification of Diseases (ICD-11).



- ICD is a unique code for diseases, injuries that helps health professionals to share health information across the globe.
- It is also used by national health programme managers, health insurers whose reimbursements depend on ICD coding.
- The latest edition ICD – 11 provides significant improvements on previous versions in coding structure and electronic tooling.
- This will allow health care professionals to more easily and completely record conditions.
- ICD-11 will be presented at the World Health Assembly in May 2019 for adoption by Member States.
- It will come into effect on 1 January 2022.
- **New Additions in ICD-11** – It includes new separate chapters including traditional medicine and sexual health which was previously categorized in mental health conditions.
- Gaming disorder has been added to the section on addictive disorders
- The codes relating to antimicrobial resistance are more closely in line with the Global Antimicrobial Resistance Surveillance System (GLASS).

5.65 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.

5.66 Lorcaserin

- Lorcaserin (brandname Belviq or Belviq XR) is a weight-loss drug.
- Lorcaserin has been withdrawn from the U.S. market after caution by the U.S. Food and Drug Administration because of cancer risk.
- The agency also said that health care professionals should stop prescribing and dispensing the drug to patients.
- Following this Indian doctors have also cautioned against the use of the drug.

Reports

5.67 Health Index 2019 - NITI Aayog

The second edition of NITI Aayog's Health Index was recently released in its report titled 'Healthy States, Progressive India: Report on Rank of States and UTs'.

- The Index ranks the States and Union Territories based on 23 health-related indicators which include –
 - i. neonatal mortality rate
 - ii. under-five mortality rate
 - iii. proportion of low birth weight among new-borns
 - iv. progress in treating tuberculosis and HIV
 - v. full immunisation coverage
 - vi. improvements to administrative capability and public health infrastructure
 - vii. proportion of districts with functional Cardiac Care Units
 - viii. proportion of specialist positions vacant at district hospitals
- The report has ranking in three categories - larger States, smaller States and Union Territories, to ensure comparison among similar entities.
- The Health Index does not capture other related dimensions, such as non-communicable diseases, infectious diseases and mental health.
- It also does not get uniformly reliable data, especially from the growing private sector.
- **Highlights** - Kerala continued to top the list for the best performing State in the health sector among the 21 large States.
- Kerala was followed by Andhra Pradesh, Maharashtra, Gujarat and Punjab, Himachal Pradesh, Jammu and Kashmir, Karnataka and Tamil Nadu.
- Andhra Pradesh and Maharashtra have had the additional distinction of making incremental progress from the base year.
- Uttar Pradesh retains the worst performer tag in the index.
- Uttar Pradesh continued to be at the bottom of the list with its score falling to 28.61; Kerala got a score of 74.01.
- Other States at the bottom of the list are Bihar (32.11), Odisha (35.97) and Madhya Pradesh (38.39).
- Among the UTs, Chandigarh jumped one spot to top the list with a score of (63.62).
- It is followed by Dadra and Nagar Haveli, Lakshadweep, Puducherry, Delhi, Andaman and Nicobar and Daman and Diu (41.66).
- Overall, only about half the States and UTs showed an improvement in the overall score between 2015-16 (base year) and 2017-18 (reference year).
- Among the 8 Empowered Action Group States, only 3 States (Rajasthan, Jharkhand and Chhattisgarh) showed improvement in the overall performance.

**Top 5 and bottom 5 states in overall performance in 2018 and 2017**

Top states (2018)	Top states (2017)	Bottom states (2018)	Bottom states (2017)
Kerala	Kerala	Uttar Pradesh	Uttar Pradesh
Andhra Pradesh	Punjab	Bihar	Rajasthan
Maharashtra	Tamil Nadu	Odisha	Bihar
Gujarat	Gujarat	Madhya Pradesh	Odisha
Punjab	Himachal Pradesh	Uttarakhand	Madhya Pradesh

NOTE: Health index-2018 has the base year of 2015-16 and reference year of 2017-18; while health index-2017 has the base year of 2014-15 and reference year of 2015-16

Source: NITI Aayog

5.68 World Vision Report

- The first-ever world vision report was released by WHO.
- It highlighted that, more than a quarter of the world's population (2.2 billion people), suffer from vision impairment out of which 1 billion cases could have been prevented or have been left unaddressed.
- It warned that population ageing would lead to a dramatic increase in the number of people with vision impairment and blindness.
- **Presbyopia**, a condition in which it is difficult to see nearby objects, affects 1.8 billion people. This condition occurs with advancing age.
- **Myopia**, a condition in which it is difficult to see objects at a distance affects 2.6 billion, with 312 million being under the age of 19 years.
- Cataract, age-related macular degeneration, glaucoma, corneal opacities, diabetic retinopathy, trachoma are other common vision impairments listed in the report.
- Trachoma is caused due to bacterial infection in the eye. Many countries have eliminated it, including India.
- **Region wise** - The prevalence of vision impairment in low- and middle-income regions is to be four times higher than in high-income regions.
- South Asia, East Asia and South-East Asia with 51% of the total population of the world, accounted for 62% of the total vision impairment.
- Myopia is the highest in high-income countries of the Asia-Pacific region.
- Glaucoma has hit Africa the most, followed by Latin America and the Caribbean.
- Incidence of a rural-urban divide does exist.
- The report said that accessibility to eye care services and high costs involved in accessing them, particularly for rural populations were major drivers of vision impairment.
- There was praise for India in the report for its National Programme for Control of Blindness (NPCB).
- NPCB provided cataract surgery to a total 6.5 million people in India, achieving a cataract surgical rate of over 6,000 per million population.

5.69 National Health Profile

- National Health Profile (NHP) 2019 has been released by the Central Bureau of Health Intelligence.
- It covers demographic, socio-economic, health status and health finance indicators, human resources in the health sector and health infrastructure.
- It is also an important source of information on various communicable and non-communicable diseases that are not covered under any other major programmes.



- **Key Findings** - India has registered an improved sex ratio from 933 in 2001 to 943 in 2011.
- In rural areas the sex ratio has increased from 946 to 949 and in urban areas from 900 to 929.
- Kerala has recorded the highest sex ratio in respect of total population (1,084), rural population (1,078) and urban (1,091).
- The lowest sex ratio in rural areas has been recorded in Chandigarh (690).
- India also shows a decline in birth and death rates.
- Non-communicable diseases dominating over communicable in the total disease burden of the country.
- The estimated birth rate reduced from 25.8 in 2000 to 20.4 in 2016 while the death rate declined from 8.5 to 6.4 per 1,000 population over the same period.
- The total fertility rate (average number of children that will be born to a woman during her lifetime) in 12 States has fallen below two children per woman and 9 States have reached replacement levels of 2.1 and above.
- Delhi, Tamil Nadu and West Bengal have the lowest fertility rate among other States.

5.70 India State-Level Disease Burden Initiative

- India State-Level Disease Burden Initiative prepared the first comprehensive estimates of disease burden attributable to mental health from 1990.
- It states that Tamil Nadu, Kerala, Telangana, Karnataka and Andhra Pradesh account for a higher prevalence of mental disorders.
- It manifests primarily during adulthood in depression and anxiety.
- It finds that roughly one in seven Indians, or 197 million persons, suffered from mental disorders of varying severity in 2017.
- These include depression, anxiety disorders, schizophrenia, bipolar disorders, idiopathic developmental intellectual disability, conduct disorders, and autism.
- The contribution of mental disorders to the Disability Adjusted Life Year (DALY) has doubled between 1990 and 2017 increasing from 2.5% to 4.7%.
- In accordance with socio-demographic index (SDI), prevalence of depressive disorders was highest in,
 - i. Tamil Nadu (loss of 836 years per 1 lakh population), Kerala (loss of 641 years) in the high SDI state group and
 - ii. Andhra Pradesh (loss of 793 years) in the middle SDI State group.
- **DALY** - the sum of total years of life lost and years lived with disability
- **SDI** - It is a composite measure of per-capita income, mean education, and fertility rate in women younger than 25 years and is calculated on a scale of one.

6. BIO-TECHNOLOGY

6.1 Stem Cells

- Stem cells differ from other kinds of cells in the body.
- They have the remarkable potential to develop into different cell types in the body during early life and growth.
- They have three unique properties.
 1. They are capable of dividing and renewing themselves for long periods;
 2. They are unspecialized; and
 3. They can give rise to specialized cell types.
- Commonly, stem cells come from **two main sources**:



1. **Embryonic Stem Cell** - Embryos formed during the blastocyst phase of embryological development.
 2. **Adult stem cells** – Exist throughout the body after embryonic development and are found inside of different types of tissue such as the brain, bone marrow, blood, blood vessels, skeletal muscles, skin, and the liver
- The capacity to differentiate into specialized cell types and be able to give rise to any mature cell type is referred to as potency.
 - When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell.
 - **Totipotent stem cells** can differentiate into embryonic and extra embryonic cell types. These cells are produced from the fusion of an egg and sperm cell and can construct a complete, viable organism.
 - The only totipotent cells are the fertilized egg and the cells produced by the first few divisions of the fertilized egg are also totipotent.
 - **Pluripotent stem cells** are the descendants of totipotent cells and can differentiate into nearly all cells, i.e. cells derived from any of the three germ layers.
 - These are true stem cells, with the potential to make any differentiated cell in the body. **Embryonic Stem Cells** come under this category.
 - **Multipotent stem cells** can differentiate into a number of cells, but only those of a closely related family of cells (i.e) it can only differentiate into a limited number of types.
 - Eg. The bone marrow contains multipotent stem cells that give rise to all the cells of the blood but not to other types of cells.
 - **Oligopotent stem cells** can differentiate into only a few cells, such as lymphoid or myeloid stem cells.
 - **Unipotent cells** can produce only one cell type, their own, but have the property of self-renewal, which distinguishes them from non-stem cells.
 - Such Unipotent cells include muscle stem cells.

6.2 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.

6.3 Earth BioGenome Project

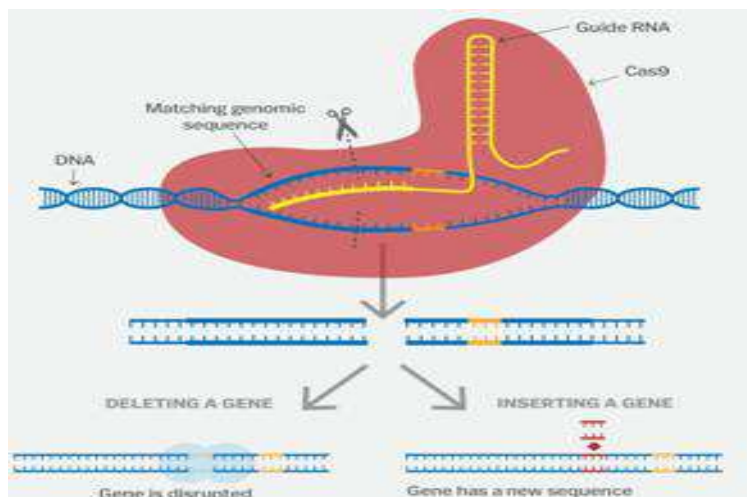
- The Earth BioGenome Project aims to sequence the genomes of the roughly 1.5 million known animal, plant, protozoan and fungal species collectively known as eukaryotes.
- The project will characterize the genomes of all of Earth's eukaryotic biodiversity over a period of 10 years.
- It was officially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

6.4 Gene Editing

- Genetic modification involves the introduction of foreign DNA into an organism. On the other hand, gene editing involves editing of the organism's native genome.
- CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a gene editing technology.
- It allows researchers to permanently modify genes in living cells and organisms by targeting specific stretches of genetic code to edit DNA at precise locations.
- This is done by introducing a protein (Cas9) containing the code of a defective gene.
- The protein then seeks out parts of the defective DNA that match this code.
- It then attaches itself to it, cuts it out, and then the DNA is allowed to repair itself by getting rid of the defect.
- It can be used to target multiple genes simultaneously and can also activate gene expression instead of cutting the DNA.
- This can be used to correct mutations at precise locations in the human genome to treat genetic causes of diseases.
- Correcting the mutation in an embryo ensures that the child is born healthy and the defective gene is not passed on to future generations.
- Apart from being used as a gene-editing tool, CRISPR CAS-9 can also function as a diagnostic tool.
- It can recognise target DNA very quickly and identify viruses such as Zika and dengue very efficiently.
- When an alien bacteria or virus invades the body, CRISPR is "programmed" to recognise the alien material. It then uses CAS-9, an enzyme produced by the CRISPR system to bond with the alien DNA and excise it.

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.
- **Kinome** 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.

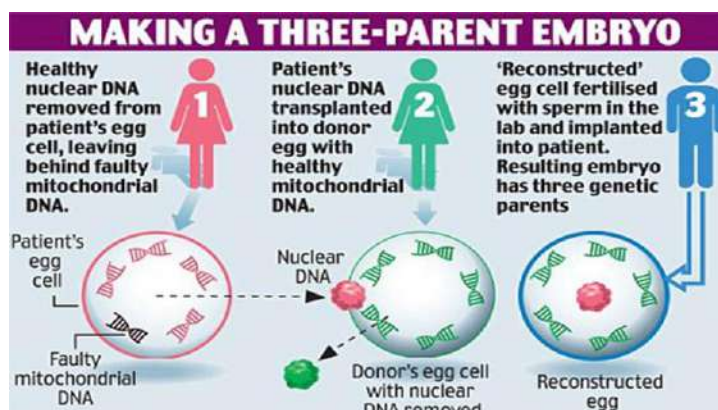


6.5 Gene Silencing

- It is a technique that aims to reduce or eliminate the production of a protein from its corresponding gene.
- It generally describes 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).
- Researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad have 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**.
- 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.

6.6 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.

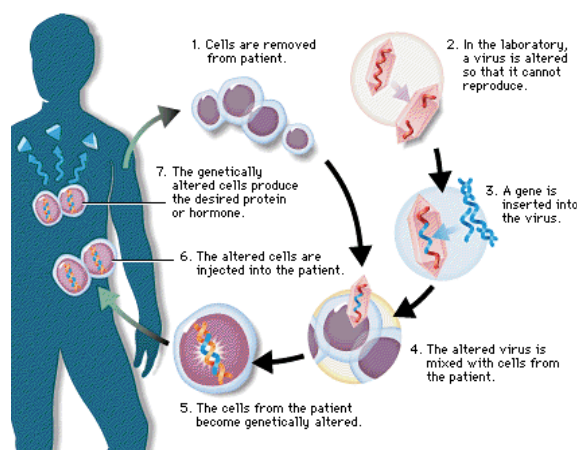
- The resulting embryo now has DNA from both parents, as usual, plus mitochondrial DNA from the donor.
- **Concerns** - The procedure has been seen as controversial because any offspring from such a procedure will then have DNA from three parents.
- However, mitochondrial DNA is separate from core DNA 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.

6.7 Genetically Modified Mosquitoes

- A new initiative aims at reducing the population of *Aedes aegypti* mosquito by introducing genetically modified version of mosquitoes.
- *Aedes aegypti* mosquito is the carrier of diseases such as Zika, dengue and chikungunya.
- These diseases are transmitted when an infected, pregnant female mosquito bite somebody.
- Males do not bite and are, therefore, harmless.
- Genetically modified mosquitoes involve producing *transgenic male Aedes aegypti* mosquito, which carries a new gene fatal only to female mosquitoes.
- GM male mosquitoes will then breed with normal females in the wild.
- In the next generation, only the males would survive, and these would breed again, with normal females.
- After a few generations, the female population will be drastically reduced.
- Eventually this cycle will result in a reduction of the entire mosquito population.
- Transgenic males do not bite and the modified genes are said to be harmless to humans.

6.8 Gene Therapy for Cancer

- US 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.
- Leukemia - cancer of the blood cells. Most blood cells form in the bone marrow.
- In leukemia, immature blood cells become cancer.

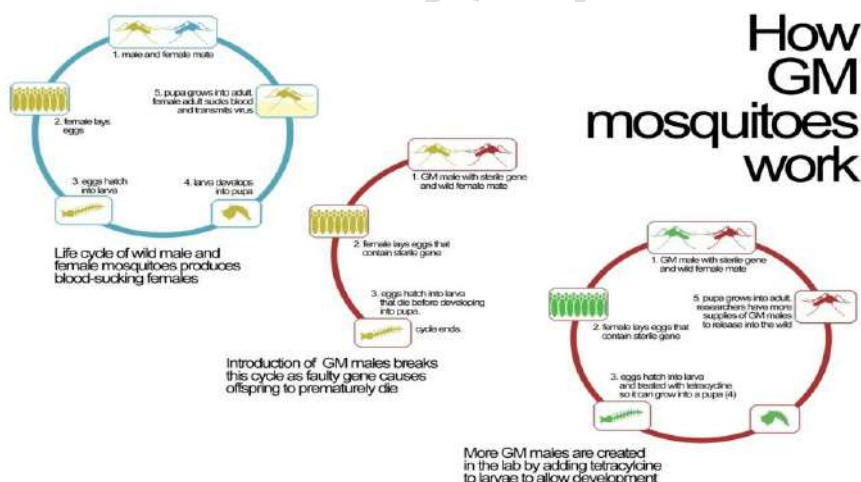


- These cells do not work the way they should and they crowd out the healthy blood cells in the bone marrow.

6.9 Status of GM Mosquitoes in India

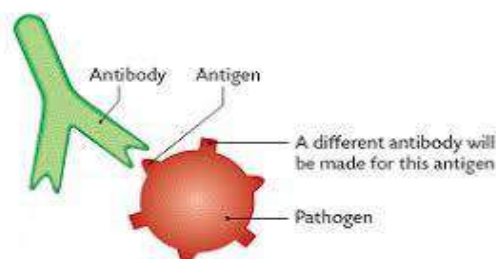
- The Department of Biotechnology (DBT) is hesitant to permit field trials to release GM mosquitoes to tackle certain diseases.
- The so-called “Friendly Aedes” project launched “closed cage” trials at the Oxitec facility in Maharashtra.
- But, DBT scientists fear that there may be unknown hazards associated with large scale trials.
- It is thus feared that it could result in harmful consequences to the environment or ecology.
- Notably, the Aedes aegypti is part of the food chain.
- During its life cycle, it is consumed by fishes.
- Also, during its early aquatic phase, it is consumed by frogs and then by birds, lizards and spiders.
- A drastic reduction in the mosquito population could thus impact prey species.
- This could also potentially result in ecological collapse.
- There is also a possibility that the engineered genes could directly harm the species that consume mosquitoes.
- More research may be required to ensure that there are no unforeseen consequences.

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.



6.10 Human Antibodies in Lab

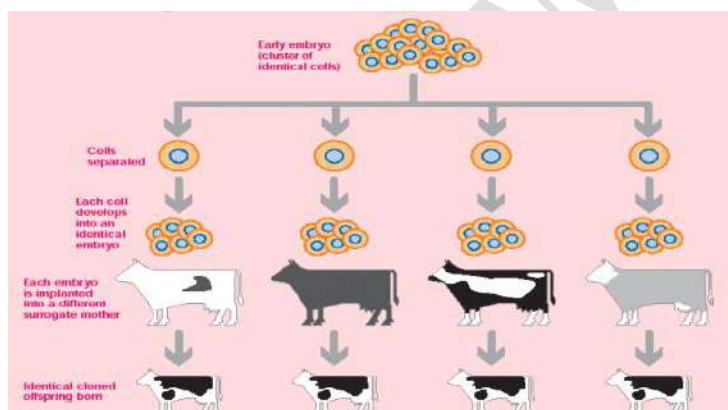
- Scientists have recently produced human antibodies in the laboratory for the first time. It could usher the rapid development of new vaccines to treat a wide range of infectious diseases.
- **Antibodies**, also called immunoglobulins, are proteins manufactured by the body that help fight against foreign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



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

6.11 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 Rashtriya Gokul 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.

6.12 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.

6.13 Restricted Use of Pesticides for Basmati

- Punjab has over 40% of the total Basmati export of India.
- There is a huge demand of Punjab Basmati across the globe.
- So to meet the demand, farmers use the pesticide on the recommendation of pesticide dealers.
- It is against the instructions of the agricultural experts and are not recommended by Agriculture Department.



- In the past, Punjab Basmati has faced rejection due to detection of residue of such pesticides which are not permissible in Europe, US and other countries.
- So, the Punjab government restricted 9 pesticides, which are,
- Acephate, Carboendazim, Thiamethoxam, Triazofos, Tricyclazole, Buprofezin, Carbofuron, Propiconazole and Thiophanate Methyl.
- The use of these restricted pesticides makes the input cost go up Rs 2000 to Rs 4000 per season, with pesticide companies making a huge profit.
- Basmati is grown during a period (in July) when naturally there is no pest attack on the crop during the initial stage.
- But farmers in Punjab are known to use pesticides as a preventive measure which is not recommended.

6.14 Dangers of Artificial Ripening

- Fruits are a good source of vitamins and minerals, and play an important role in preventing Vitamin C and A deficiencies.
- **WHO** recommends 5 servings of fruits and vegetables every day for a healthy living.
- However, health benefits of fruits depend on how they are ripened.
- The best course will be to allow them to ripen on the plant itself.
- The fruits become soft, change in colour and develop aroma with increase in sugar level and reduction in acid content.
- Many factors influence the process of ripening including temperature and relative humidity.
- It is not always possible to wait for the fruit to ripen naturally.
- More often than not, they need to be transported over long distances.
- If they had been harvested in a ripe stage, they get spoilt before reaching their destination.
- For such situations, farmers harvest them much before they get ripe.
- The traders then ripen them artificially at the destination using certain chemicals.
- Most fruits produce a gaseous compound called '**ethylene**' that starts the ripening process.
- Its level in under-ripe fruit is very low, but as the fruits develop, they produce larger amounts of the chemical that speeds up the ripening process.
- These enzymes convert complex polysaccharides into simple sugars and make the skin of the fruits soft.
- In artificial ripening, this process is mimicked using chemicals.
- The most commonly used chemical is called '**ethephon**' (2-chloroethylphosphonic acid).
- It penetrates into the fruit and decomposes ethylene.
- Another chemical that is regularly used is '**Calcium carbide**', which produces 'acetylene', which is an analogue of 'ethylene'.
- It is, however, fraught with several problems.
- Studies have shown that it breaks down the organic composition of vitamins and other micronutrients.
- Besides, it changes only the skin colour, the fruit remains raw inside.
- Industrial grade calcium carbide is often found contaminated with traces of arsenic and phosphorus which are toxic chemicals.
- The symptoms of arsenic and phosphorous poisoning include,
 1. Vomiting, diarrhoea with/without blood, weakness, burning sensation in the chest and abdomen, eye damage, ulcers.
- According to studies, Calcium carbide can also affect the neurological system.



- **FSSAI** has banned calcium carbide under the “Prevention of Food Adulteration (**PFA**) Act, 1954”.
- To distinguish the artificially ripened fruit,
 1. They will have uniform skin colour in fruits like tomato, mango, papaya, and in the case of banana,
 2. The fruit will be yellow while the stem will be dark green.
 3. If the fruits are available before season, it could mean they are artificially ripened.
- Washing and peeling the fruits before eating can minimise the risks of calcium carbide.

6.15 LRRK2

- Leucine-rich repeat kinase 2 (**LRRK2**) is a kinase enzyme that protects the body against viral and bacterial infections by triggering inflammation like swelling, redness, heat and pain.
- According to a recent study, this enhanced inflammation can lead to collateral damage to the body.
- Inflammation caused by mutation in a gene can raise the risk of Parkinson’s and Crohn’s diseases as well as leprosy.
- Leprosy caused by infections characterised by lesions in the nerve endings of the skin.
- **LRRK2**, which causes excessive inflammation to defend body against a type of mycobacterium infects peripheral nerves, is thought to be behind leprosy.
- The findings are also important for ongoing clinical trials of Parkinson’s drugs that can reduce excessive **LRRK2** activity.
- However, total absence of **LRRK2** function can make people more prone to infections.

6.16 IndiGen

- It is a programme managed by the CSIR for a free mapping of whole genomes of a person.
- CSIR-Institute of Genomics and Integrative Biology (IGIB) and the CSIR-Centre for Cellular and Molecular Biology (CCMB) are part of this.
- The objectives of this programme are,
 - i. To test if it’s possible to rapidly and reliably scan several genomes and advise people on health risks that are manifest in their gene and,
 - ii. Understand the variation and frequency of certain genes that are known to be linked to disease.
- A genetic test usually involves analysing only a portion of the genome that’s known to contain aberrant genes linked to disease.
- A whole genome sequencing is more involved, expensive and generally attempted only for research purposes.
- The human genome has about 3.2 billion base pairs.

6.17 Global Bio-India 2019

- The Global Bio-India 2019 is one of the largest biotechnology stakeholders conglomerate will be held for the first time in India at New Delhi.
- Ministry of Science & Technology along with its Public Sector Undertaking, Biotechnology Industry Research Assistance Council (BIRAC) is organizing this event.
- It is to bring together stakeholders to strengthen the indigenous research capabilities, bio-entrepreneurship, investments and last-mile-delivery of technology across rural India and tier-2, 3 cities.

6.18 Golden Rice

- In the late 1990s, German scientists developed a genetically modified variety of rice called Golden Rice.
- It was claimed to be able to fight Vitamin A deficiency, which is the leading cause of blindness among children and can also lead to death due to infectious diseases such as measles.



- Rice is naturally low in the pigment beta-carotene, which the body uses to make Vitamin A.
- Golden rice contains this, which is the reason for its golden colour.
- Now, Bangladesh could be on the verge of becoming the first country to approve plantation of this variety.
- In Bangladesh, over 21 per cent of the children have vitamin A deficiency.
- The Golden Rice that is being reviewed in Bangladesh is developed by the Philippines-based International Rice Research Institute.

6.19 Indian Cobra Genome Decoded

An international team of researchers have sequenced the genome of the Indian cobra, in the process identifying the genes that define its venom.

- This genome sequence can provide a blueprint for developing more effective anti-venom.
- The cobra genome sequence is of really high quality.
- Sequence information of the genes that code for venom proteins is very important for the production of recombinant anti-venoms.
- Their **efficacy varies**, besides producing side effects.
- In India, the challenge has been producing anti-venom for the species known collectively as the “big four”,
 1. The Indian cobra (*Naja naja*),
 2. Common krait (*Bungarus caeruleus*),
 3. Russell’s viper (*Daboia russelii*), and
 4. Saw-scaled viper (*Echis carinatus*).
- **Common anti-venom** is marketed for the treatment of bites from the “big four”, but its effectiveness came under question in a recent study.
- The common anti-venom worked against the saw-scaled viper and the common cobra.
- But this anti-venom fell short against some neglected species and also against one of the “big four” - the common krait.
- **Facts** - Accidental contacts with snakes lead to over 100,000 deaths across the world every year.
- India alone accounts for about 50,000 deaths annually, and these are primarily attributed to the “big four”.
- Venom is a **complex mixture** of an estimated 140-odd protein or peptides.
- Only some of these constituents are toxins that cause the physiological symptoms seen after snakebite.
- But anti-venom available today does not target these toxins specifically.
- Anti-venom is currently produced by a century-old process.
- In this process, a small amount of venom is injected into a horse or sheep, which produces antibodies that are then collected and developed into anti-venom.
- **Horse technique** - This is expensive, cumbersome technique and comes with complications.
- Some of the antibodies raised from the horse may be completely irrelevant.
- The horse also has a lot of antibodies floating in its blood that have nothing to do with the venom toxins.
- One more problem with horse antibodies is that our immune system recognises it as foreign and when anti-venom is given our body mounts an antibody response. This leads to what is called **serum sickness**.
- In the Indian cobra genome, the researchers have identified 19 key toxin genes, the only ones that should matter in snakebite treatment.
- They stress the need to leverage this knowledge for creation of safe and effective anti-venom using synthetic human antibodies.



- The next step would be obtaining the genomes and the venom gland genes from the other three of the “big four” and the deadly African species.
- However, there is a very long way to go from genomes to effective anti-snake venoms.

6.20 POLYCRACK

- POLYCRACK is world’s first patented heterogeneous catalytic process, which converts multiple feedstock into hydrocarbon liquid fuels, gas, carbon and water.
- Polycrack Plant can be fed with all types of Plastic, Petroleum sludge, Un-segregated MSW (Municipal Solid Waste) with moisture up to 50%, E–Waste, Automobile fluff, Organic waste including bamboo, garden waste etc., and Jatropha fruit and palm bunch.
- The process is a closed loop system and does not emit any hazardous pollutants into the atmosphere.
- The combustible, non-condensed gases are re-used for providing energy to the entire system and thus, the only emission comes from the combustion of gaseous fuels.
- Pre-segregation of waste is not required to reform the waste, It has high tolerance to moisture hence drying of waste is not required.
- This process will produce energy in the form of Light Diesel Oil which is used to light furnaces.
- Indian Railways commissions first Waste to Energy Plant based on POLYCRACK technology in Bhubaneswar.
- The capacity of this Waste to Energy Plant is 500 Kg waste per day.
- All types of waste including plastic and e-waste will be converted to Light Diesel Oil, which is used to light furnaces.

6.21 Food Irradiation Centers

- 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.
- Irradiation is a process in which 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.
- Unique advantages of radiation processing of products (including fruits, vegetables, cereals, pulses, spices, sea foods and meat products) are:
 1. Cold (no temperature increase) and clean process (no chemical residue)
 2. Effective elimination of harmful bacteria and insects/pests
 3. Treatment after final packaging to avoid recontamination
 4. Significant increase in shelf life.

6.22 Milk Adulteration

- National Milk Safety and Quality Survey 2018 was conducted by a third party across all States and UTs and recently released by FSSAI.
- According to the survey, Telangana, Madhya Pradesh and Kerala accounted for the highest number of cases of adulteration.
- 37% of the total samples tested failed to meet the prescribed quality and 10% of the processed milk samples were non-complaint.
- The adulterants like aflatoxin-M1, antibiotics and pesticides such as urea, hydrogen peroxide, detergent were found in the milk.



- The adulteration was mainly on account of low fat or low SNF (Solid Non-Fat) or both.
- Aflatoxin-M1 is more dominant in processed milk than raw milk, which is life threatening, usually through damage to liver.
- It comes in the milk through feed and fodder that are currently not regulated in the country
- Tamil Nadu, Delhi and Kerala were top three States where Aflatoxin residue was found the most.
- India is the world's largest producer of milk with the total estimated milk production in the country was 176.35 million tonnes during 2017-18.

6.23 Bharatiya Poshan Krishi Kosh

- Ministry of Women and Child Development is going to launch Bharatiya Poshan Krishi Kosh.
- It is a repository of diverse crops across 128 agro-climatic zones in India.
- Its aim is to provide better nutritional outcomes and to fight malnutrition.
- Harvard Chan School of Public Health and the Bill and Melinda Gates Foundation will be a part of this initiative.
- They will document and evaluate promising regional dietary practices and the messaging around them and develop a food atlas on regional agro-food systems.
- It will select around 12 high focus states, which are representative of the geographical, social, economic, cultural and structural diversities of India.

6.24 Muktoshrī Rice

- Researchers from West Bengal's have developed a rice variety called Muktoshrī (IET 21845), that is resistant to arsenic.
- The variety yields 5.5 metric tons per hectare in the Boro (Winter) season and 4.5 to 5 metric tons per hectare in the Kharif season, respectively.
- The rice was long and thin, and aromatic.
- Notification for the commercial use of Muktoshrī was made by West Bengal last year.

6.25 Genome Mapping of Basmati Rice

- Gene mapping describes the methods used to identify the locus of a gene and the distances between genes.
- Genome mapping is used to identify and record the location of genes and the distances between genes on a chromosome.
- The essence of all genome mapping is to place a collection of molecular markers onto their respective positions on the genome.
- Molecular markers come in all forms.
- Recently Scientists have mapped the complete genome of two basmati rice varieties, including one that is drought-tolerant and resistant to bacterial disease.
- Basmati 334 from Pakistan, known to be drought tolerant and resistant to rice-killing bacterial blight, and Dom Sufid from Iran, an aromatic long-grain rice that is one of the most expensive on the market are two basmati rice varieties used by scientists.

6.26 MicroRNAs

- Researchers from National Centre for Biological Sciences, Bengaluru, have discovered how small molecules called microRNAs are made in plants.
- This finding makes it much easier for studying processes in plants.
- MicroRNAs are small molecules, about 21 nucleotides long, and help in controlling the levels of proteins in the cell.



- All growth and development in plants are regulated at various levels in the cell, and mediated by proteins
- In order to decrease the level of a particular protein in specific cells, the microRNAs destroy the messenger RNA molecules that help with the production of that specific protein in the cell.
- The microRNA molecules do this by cutting down that particular messenger RNA thereby destroying it.
- This process is called the silencing of the messenger RNA.
- The microRNA that achieve this silencing are evolutionarily conserved – that is, they are found in all flowering plants, whether they are mosses or roses.
- Similarly, the best way to study the effect of a gene in the DNA is to silence or “knockout” the gene.
- Knocking out a gene does not mean removing the entire gene.
- In knocking out processes, those RNA that induce the gene to produce proteins are destroyed or their levels are reduced by the microRNA as described earlier.

7. NUCLEAR TECHNOLOGY

7.1 Thorium-Based Nuclear Reactors

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



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

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

7.2 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).

7.3 Russian-built Floating Nuclear Plant

- “Akademik Lomonosov”, the first floating nuclear plant to be built in the world completed its 5000-km journey.
- It causes an excitement in the energy sector, but sparking fears among environmentalists over the safety of the Arctic region.
- The floating plant contains two nuclear reactors of 35 MW each.
- It is a small plant compared to conventional land-based nuclear projects.
- The plant will supply electricity to the Chukotka region, where important Russian national assets such as oil, gold, and coal reserves are located.
- Environmental groups such as Greenpeace Russia have criticised the project as a “Chernobyl on Ice” and a “Nuclear Titanic”.
- Activists fear that any accident aboard the plant could cause great damage to the fragile Arctic region.
- A recent nuclear accident in Russia after which there was a brief spike in radiation levels has added to the fears.
- The radiation fallout from the Fukushima nuclear disaster in Japan is also cited as a reason to not rush into such projects.

7.4 Cyber Attacks on Kudankulam Nuclear Unit

- The Nuclear Power Corporation of India (NPCIL) admitted to a malware attack on one of the computers in Kudankulam nuclear power plant, Tamil Nadu.



- The NPCIL admitted that computer systems at the Kudankulam nuclear power station had been infected with malware since early September 2019.
- The NPCIL infection is said to be caused by Dtrack.
- Dtrack is a Trojan virus that creates backdoors into computer networks.
- This was originally developed and commonly used by North Korean hackers with state backing.
- However, there are many variations of Dtrack, and the code may have been adapted by another group.
- Kudankulam is high on the list of such targets because it is both part of the nuclear programme, as well as the power grid.
- The Indian Computer Emergency Response Team (CERT-In) claims to be aware of these vulnerabilities.
- It is also reported to have issued advisories in many instances.
- However, its scope is limited as it is the responsibility of the organisation owning the asset to protect it.
- The linking of all the regional grids to the national grid makes it easier to supply power to any region on demand.
- However, it also makes the entire infrastructure more vulnerable to contagion from cyber-attacks.
- The government has been trying to set up a system for cyber-protection of infrastructure.
- The National Critical Information Infrastructure Protection Centre (NCIIPC) is proposed to be the coordinator.
- Dedicated sectoral CERTs, such as CERT-Thermal-NTPC and CERT-Transmission-POWERGRID would be responsible for guarding power assets.
- However, the government has to address the bureaucratic hassles in assigning the responsibility.

7.5 Nuclear Command Authority

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

7.6 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.



7.7 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).

7.8 Nuclear Plant in M.P

- Activist and villagers in Madhya Pradesh raised their concerns over the proposed nuclear plant in Chutka.
- In 2009, Nuclear Power Corporation of India Ltd. (NPCIL) has decided to set up the atomic station in Mandla district of Madhya Pradesh to generate 1,400 MW power.
- At present, there are 9 nuclear power reactors at various stages of construction.
- Kakrapar (2 reactors) in Gujarat, Rawatbhata (2 reactors) in Rajasthan, Kudankulam (2 reactors) and Kalpakkam (1 reactor) in Tamil Nadu and Gorakhpur (1 reactor) in Haryana.
- There are few nuclear power reactors accorded administrative approval and financial sanction. Each site has 2 reactors.
- Gorakhpur in Haryana, Mahi-Banswara in Rajasthan, Kaiga in Karnataka, Chutka in Madhya Pradesh, Kudankulam in Tamil Nadu.

8. INNOVATIONS

8.1 Optoelectronics

- Optoelectronics is the study and application of electronic devices and systems that source, detect and control light, usually considered a sub-field of photonics.
- In this context, light often includes invisible forms of radiation such as gamma rays, X-rays, ultraviolet and infrared, in addition to visible light.
- Materials such as tungsten diselenide (WSe₂) and molybdenum diselenide are being studied keenly for their opto-electronic properties.
- A key property of these materials is photoluminescence, in which the material absorbs light and re-emits it as a spectrum.
- Photoluminescence properties can be used in various devices such as quantum LEDs which can be used in communication and computation.

8.2 Shortwave Radio Transmissions

- Shortwave radio is radio transmission using shortwave radio frequencies, the range always includes all of the high frequency band (HF), and generally extends from 3-30 MHz (10 to 100 meters), above the medium frequency band (MF), to the end of the HF band.
- Radio waves in the shortwave band can be reflected or refracted from a layer of electrically charged atoms in the atmosphere called the ionosphere.
- Therefore, short waves directed at an angle into the sky can be reflected back to Earth at great distances, beyond the horizon.
- This is called skywave or "skip" propagation, thus shortwave radio can be used for very long-distance communication, in contrast to radio waves of higher frequency which travel in straight lines (line-of-sight propagation) and are limited by the visual horizon, about 64 km (40 miles).
- Shortwave radio is used for broadcasting of voice and music to shortwave listeners over very large areas, sometimes entire continents or beyond.
- It is also used for military over-the-horizon radar, diplomatic communication, and two-way international communication by amateur radio enthusiasts.

8.3 Data Localization

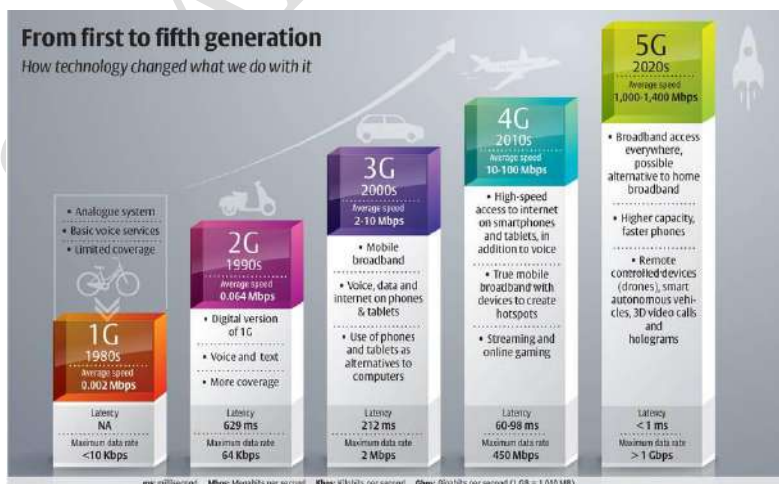
- Data localization is the act of storing data on any device that is physically present within the borders of a specific country where the data was generated.
- For securing citizen's data, data privacy, data sovereignty, national security, and economic development of the country.
- Recommendations by the RBI, the committee of experts led by Justice BN Srikrishna, the draft ecommerce policy and the draft report of the cloud policy panel show signs of data localization.
- The extensive data collection by technology companies, has allowed them to process and monetize Indian users' data outside the country.
- Therefore, to curtail the perils of unregulated and arbitrary use of personal data, data localization is necessary.

8.4 Artificial Gravity

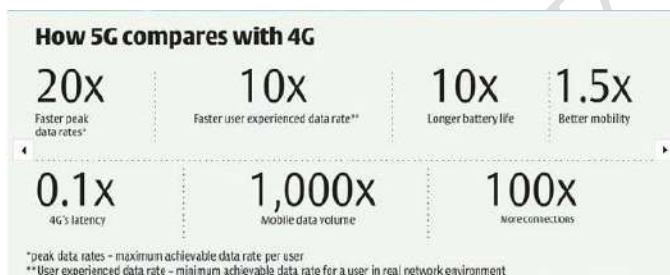
- A team from the University of Colorado is working on making a device which could create artificial gravity in space
- Artificial gravity is a force that simulates the effect of gravity in a spaceship.
- It is not caused by the attraction to the Earth but is instead caused by **acceleration** or **centrifugal force**.
- **Artificial gravity** or **rotational gravity**, is thus the appearance of a **centrifugal force** in a rotating frame of reference.
- The research centrifuge is called as '**Human Eccentric Rotator Device**' (HERD) and the device is compact enough to fit into a small room.
- A rotating circular space station can create artificial gravity.
- The rate of rotation is necessary to duplicate the Earth's gravity depends on the radius of the circle.
- Future astronauts heading into an **artificial-gravity room** to spend time on a small revolving system.
- It is built with the aim of counteracting the negative effects of weightlessness.

8.5 5G Technology

- Essentially, 5G is a set of technical ground rules.
- They define the workings of a cellular network, including the radio frequencies used and how various components like computer chips and antennas handle radio signals and exchange data.
- **Speed** - The speed depends on where one is, and which wireless services is used.
- Qualcomm, the wireless chipmaker, said it had demonstrated peak 5G download speeds of 4.5 gigabits a second.
- However, it predicts initial median speeds of about 1.4 gigabits.

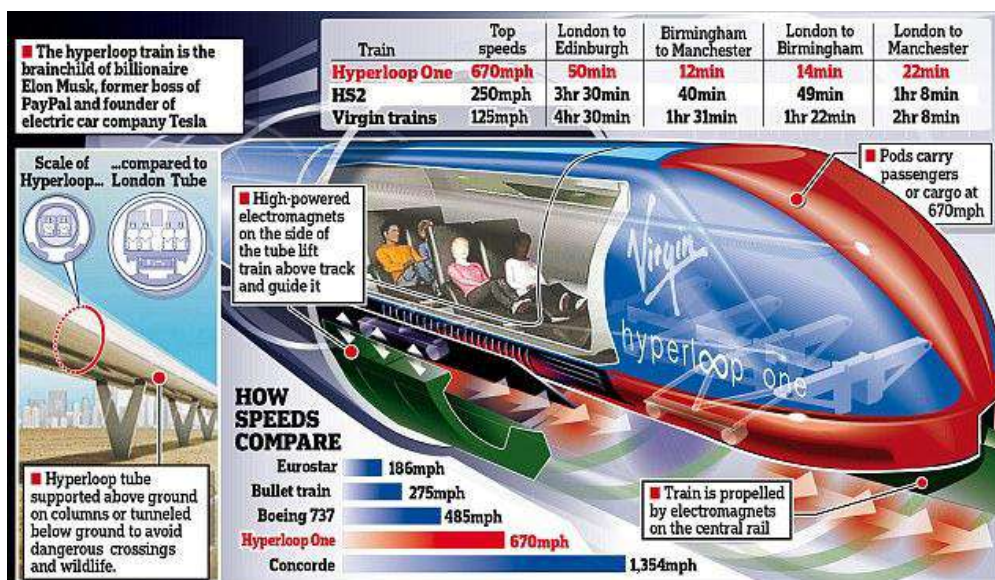


- In other words, it would be roughly 20 times faster than the current 4G experience.
- E.g. downloading a typical movie at the median speeds cited by Qualcomm would take 17 seconds with 5G, compared with 6 minutes for 4G
- The speeds will be particularly noticeable in higher-quality streaming video.
- **Latency** - There is another kind of speed, a lag known as latency, that may become even more important with 5G.
- The response is not exactly immediate when issuing a command now on a smartphone, such as starting a web search.
- A lag of 50 to several hundred milliseconds is common, partly because signals often must pass between different carrier switching centers.
- 5G, which uses newer networking technology, was designed to reduce this latency down to a few milliseconds.
- **Reliability** - 5G is also designed to deliver signals more reliably than earlier cellular networks.
- [Networks now frequently drop bits of data that are not essential for tasks like watching movies on a phone.]
- This change could bring many benefits, notably in fields such as virtual reality.
- The highest-quality VR applications now typically require bulky headsets that are connected by wire to nearby personal computers that generate 3-D images.
- With 5G, that would be off-loaded wirelessly to other machines, freeing users to move and making it easier to develop goggles the size of eyeglasses.
- In the related field of augmented reality, a smartphone camera could be pointed at a football game to see both live video on the display and superimposed player statistics or other data.
- **Besides** these, 5G's impact extends to medicine and other fields that increasingly rely on high-speed connections.
- Officials in the United States and China see 5G networks as a competitive edge.
- The faster networks could help spread the use of artificial intelligence and other cutting-edge technologies too.



8.6 Hyperloop

- It is the futuristic transportation system concept, proposed by Elon Musk.
- It envisages pods or capsules travelling at high speeds through low-pressure tubes erected on columns or tunnelled underground.
- The system is fully autonomous and sealed, so no driver-related error is anticipated.
- In a sealed environment with almost no air resistance, the pods are expected to reach very high speeds.
- It uses magnetic levitation, and is propelled by a proprietary electric propulsion system.
- Its motion will not involve contact, so the vehicle will be virtually noiseless.
- It is so far only a concept with no resemblance to any public transport system known to man.
- 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.

8.7 Hydrogen-powered vehicles over Electric vehicles

- China, Japan and South Korea have set ambitious targets to put millions of hydrogen-powered vehicles on their roads.
- But, Hydrogen fuel cell vehicles (FCVs) have been upstaged by electric vehicles (EVs).
- It becomes a mainstream option due to the success of Tesla Inc's luxury cars as well as sales and production quotas set by China.
- Critics argue FCVs may never amount to more than a niche technology.
- But proponents counter hydrogen is the cleanest energy source for autos available and with time, it will gain acceptance.
- China, far and away the world's biggest auto market is aiming for more than 1 million FCVs in service by 2030.
- Japan, a market of more than 5 million vehicles annually, wants to have 800,000 FCVs sold by that time.
- Resource-poor Japan sees hydrogen as a way to greater energy security.
- Driving ranges and refuelling times for FCVs are comparable to gasoline cars,
 - whereas EVs require hours to recharge and provide only a few hundred kilometres of range.
- In general, hydrogen is seen as the more efficient choice for heavier vehicles that drive longer distances.
- However, lack of refuelling stations which are costly to build, is usually cited as the biggest obstacle to widespread adoption of FCVs.
 - Consumer worries about the risk of explosions are also a big hurdle.
 - Residents in Japan and South Korea have protested against the construction of hydrogen stations.
 - This year, a hydrogen tank explosion in South Korea killed 2 people, followed by a blast at a Norway hydrogen station.
- Heavy subsidies are needed to bring prices down to levels of gasoline-powered cars.
- Automakers contend that once sales volumes increase, economies of scale will make subsidies unnecessary.

8.8 Indigenous Fuel Cell System

- Council of Scientific and Industrial Research (CSIR) has unveiled the first indigenous high temperature fuel cell system.



- It was launched in partnership with Indian industries under the flagship programme “New Millennium Indian Technology Leadership Initiative (NMITLI)”.
- A fuel cell is an electrochemical device which directly converts the chemical energy of a fuel into electrical energy.
- In a fuel cell, the fuel and the oxidant, which is usually oxygen or air, are supplied continuously from an external source and power is also drawn continuously.
- In a conventional battery, on the other hand, the fuel and the oxidant are contained within and when these reactants are consumed the battery must be replaced or recharged.
- A high temperature fuel cell using a solid oxide electrolyte, and operated at temperatures above 700°C , is a highly efficient energy conversion device utilizing primarily gaseous fuels like H_2 and CO .
- It can also be operated in the reverse manner as a high temperature steam electrolyser to produce hydrogen.
- It would replace Diesel Generating (DG) sets and help reduce India's dependence on crude oil.

8.9 Dark Fiber

- Dark Fiber also known as unlit Fiber is an unused optical fiber that has been laid but is not currently being used in fiber-optic communications.
- Since fibre-optic cable transmits information in the form of light pulses, a "dark" cable refers to one through which light pulses are not being transmitted.
- Companies lay extra optical fibres in order to avoid cost repetition when more bandwidth is needed.
- Recently major telecom service providers in India, have approached the state-run Bharat Broadband Network Limited (BBNL) to use its dark fiber.
- It will help the telecom service providers to cut down on their capital expenditure.

8.10 Elastocaloric Effect

- When rubbers bands are twisted and untwisted, it produces a cooling effect which is called the “elastocaloric” effect.
- When a rubber band is stretched, it absorbs heat from its environment, and when it is released, it gradually cools down.
- Researchers have suggested that if it is harnessed, the need of fluid refrigerants used in fridges and air-conditioners can be done away.
- These fluids are susceptible to leakages and can contribute to global warming.
- In the elastocaloric effect, the transfer of heat works much the same way as when fluid refrigerants are compressed and expanded.
- In order to figure out how the twisting mechanism might be able to enable a fridge, the researchers compared the cooling power of rubber fibres, nylon and polyethylene fishing lines and nickel-titanium wires.
- They observed high cooling from twist changes in twisted, coiled and supercoiled fibres.

8.11 Synthesis of New Ink

- A novel security ink has been synthesised by researchers from the Delhi-based National Physical Laboratory (CSIR-NPL).
- The ink emits that emits intense red colour when exposed to 254 nm wavelength UV due to florescence.
- It emits green colour soon after the UV source is turned off due to phosphorescence phenomenon.
- Both red and green can be clearly seen with the naked eye under ambient conditions.
- This is the first report that the ink emit different colours at different wavelengths when exposed to UV light of a particular wavelength.
- The ink has the potential to be used as a security feature on currency notes and passports.



Fluorescence and Phosphorescence

- Phosphorescence is an emission of light from a substance exposed to radiation and persisting as an afterglow after the exciting radiation has been removed.
- In Fluorescence, the absorbed light is spontaneously emitted about 10^{-8} second after excitation,
- Phosphorescence requires additional excitation to produce radiation and may last from about 10^{-3} second to days or years, depending on the circumstances.

8.12 Tech Sagar

- TechSagar is a dynamic national repository of India's cyber tech capabilities.
- It is launched by National Cyber Security Coordinator's office in partnership with Data Security Council (DSCI) of India.
- It will list business and research entities from the IT industry, startups, academia, and individual researchers.
- It provides actionable insights about capabilities of the Indian Industry, academia and research across technology areas.
- It covers 25 areas like internet of things (IoT), Artificial Intelligence (AI), Machine Learning (ML), blockchain, cloud & virtualisation, robotics & automation, Augmented/Virtual reality, wireless & networking, and more.
- DSCI is a not-for-profit, industry body on data protection in India, setup by NASSCOM.

8.13 Tyre Pyrolysis

- It refers to a technique of breaking down used tyres at temperatures between 250°C and 500°C , in the absence of oxygen.
- This process produces liquid oil and gases.
- It leaves fine carbon matter, pyro-gas, oil as residue, thereby inadequate management of these by-products poses health risks.
- However, this is considered a safer technique than burning tyres in open spaces.
- The National Green Tribunal in 2014 prohibited used tyres from being burnt in the open or being used as fuel in brick kilns, because of the toxic emissions.
- Subsequently, Maharashtra Pollution Control Board issued a set of guidelines in which pyrolysis was recommended as an acceptable mode.
- **Recent Developments** – The Central Pollution Control Board (CPCB) has pulled tyre pyrolysis units in 19 States for employing technology that is polluting and harmful to the health of workers employed.
- It orders States to close all pyrolysis units that are not compliant and to strictly regulate import of used tyres.
- India is also a recipient of used tyres from Australia and the U.K., which are sent for recycling and disposal.

8.14 Bio-Rock

- Bio rock is the name given to the substance formed by electro accumulation of minerals dissolved in seawater on steel structures that are lowered onto the sea bed.
- The technology works by passing a small amount of electrical current through electrodes in the water.
- When a positively charged anode and negatively charged cathode are placed on the sea floor, with an electric current flowing between them, calcium ions combine with carbonate ions and adhere to the structure (cathode).
- This results in calcium carbonate formation; Coral larvae adhere to the CaCO_3 and grow quickly.
- Fragments of broken corals are tied to the bio rock structure, where they are able to grow at least four to six times faster than their actual growth as they need not spend their energy in building their own calcium carbonate skeletons.

- The Zoological Survey of India (ZSI), with help from Gujarat's forest department, is attempting for the first time a process to restore coral reefs.
- Under the plan a biorock structure or mineral accretion technology was installed one nautical mile off the Mithapur coast in the Gulf of Kachchh, it will use solar panels that float on the surface as a power source.

8.15 NEON

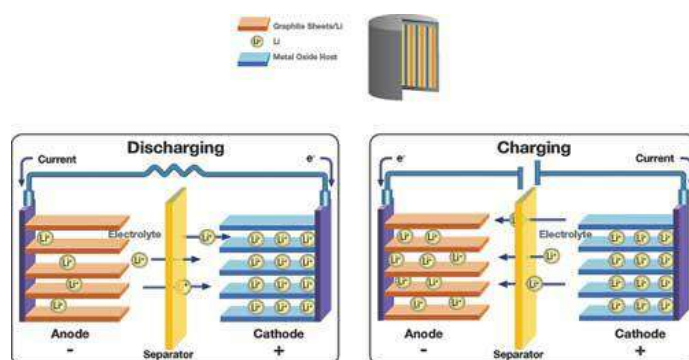
- Among the most-discussed new concepts at the annual Consumer Electronics Show (CES) in Las Vegas this year was NEON.
- The first project of Samsung's Star Labs, NEONs are being called the world's first artificial humans.
- They look and behave like real humans, and could one day develop memories and emotions though from behind a 4K display.
- NEONs are computationally created virtual humans — the word derives from NEO (new) + human.
- For now the virtual humans can show emotions when manually controlled by their creators.
- But the idea is for NEONs to become intelligent enough to be fully autonomous, showing emotions, learning skills, creating memories, and being intelligent on their own

8.16 Lithium Sulfur (Li-S) Battery

- Researchers from Australia have claimed that they have developed the world's most efficient lithium-sulfur (Li-S) battery.
- It is capable of powering a smartphone for five continuous days, the equivalent of an electric car being able to drive a distance of over 1,000 km.
- Li-S battery has an "ultra-high capacity" and has better performance and less environmental impact.
- This means that they may be able to outperform the Li-ion batteries by more than four times.
- With Li-ion batteries, some disadvantages include their susceptibility to overheating and their being prone to damage at high voltages.
- Such batteries also start losing their capacity over time — for instance, a laptop battery in use for a few years does not function as well as a new one.
- While the materials used in the Li-S batteries are not different from those in Li-ion batteries, the researchers have reconfigured the design of the sulfur cathodes (a type of electrical conductor through which electrons move) to accommodate higher stress without a drop in overall capacity
- Li-S batteries are considered as the successors of the Lithium-ion (Li-ion) batteries because of their lower cost of production, energy efficiency and improved safety.
- Their cost of production is lower because sulfur is abundantly available.

8.17 Lithium-ion Battery

- Central Electro Chemical Research Institute (CECRI), Karaikudi, Tamil Nadu and RAASI Solar Power Pvt Ltd have signed a Memorandum of Agreement for transfer of technology for India's first Lithium Ion (Li-ion) Battery project.
- 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.

8.18 Thermal Battery Plant

- World's first-ever thermal battery plant was recently inaugurated in Andhra Pradesh.
- It aims to create a new energy storage form with commercial applications, maintaining a low carbon footprint and less dependent on external factors like weather.
- Conventional battery technology is based on the system of charging/discharging cycles that are driven by electricity. Eg. Lithium ion battery used in electronic devices.
- Thermal batteries use thermal energy to operate, i.e. the energy created by temperature differences.
- The energy transfer in thermal batteries helps store heat when heat travels from one part of the battery setup to the other.
- **Working of Thermal Battery** - It consists of two parts such as a cool zone known as sink, and a hot source called source.
- When the sink of a thermal battery receives heat, it transforms physically or chemically, thereby storing energy, while the source cools down.
- During operation, the sink is cooled down, so it releases the stored energy, while the source heats up.
- **Applications** - Electric vehicles, Telecom infrastructures, Power intensive industries.

8.19 Quantum Supremacy

- It was reported that a draft research paper claimed that Google researchers had achieved a long-sought-after goal in physics called "quantum supremacy".
- A quantum computer differs from a traditional computer in the way it stores information.
- A traditional computer stores information in the form of bits that can take only two values - zero or one.
- A quantum computer stores it in the form of quantum bits (qubits) that can take on various combinations of zero and one.
- **Quantum supremacy** refers to a quantum computer solving a problem that cannot be expected of a classical computer in a normal lifetime.
- This relates to the speed at which a quantum computer performs.
- The quantum processor referred in the paper took 200 seconds to perform a calculation.
- The world's fastest supercomputer, Summit, would have taken 10,000 years to accomplish this.



8.20 Quantum Computing and Dots

- 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.
- **Quantum Dots** - 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 which will pave the way for brighter, lighter and more energy efficient TVs and smart devices.

8.21 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.

8.22 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.

8.23 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.

8.24 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.
- Facebook announced its plans to launch “**Libra**” a digital currency, in 2020
- For Libra, Facebook announced a dedicated wallet app called “Calibra.”
- “**Calibra**” will be built into WhatsApp and Messenger as well, to let users store and use “Libra” coins.

8.25 Kalam Centre for Science and Technology

- A Memorandum of Understanding (MoU) was signed between Ministry of Defence and Central University of Jammu for the establishment of Kalam Centre for Science and Technology.
- It will be equipped with state-of-the-art facilities and equipment leading to increase scholars in computational system security and sensors.

8.26 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.

8.27 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

8.28 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.

8.29 National Supercomputing Mission

- India has recently granted contract to French technology firm to build 70 supercomputers under the National Supercomputing Mission.
- The mission aims to connect national academic and R&D institutions with a supercomputing grid of over 70 high-performance computing facilities.
- Supercomputers will be installed across the country and will be networked on the National Supercomputing grid over the National Knowledge Network (NKN).
- It will be implemented by the Department of Science and Technology and Department of Electronics and Information Technology (DeitY) through Centre for Development of Advanced Computing (C-DAC) and IISc, Bangalore.
- The Mission also includes development of highly professional High Performance Computing (HPC) aware human resource for meeting challenges of development of these applications.
- The NKN is another programme of the government which connects academic institutions and R&D labs over a high speed network.

8.30 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.



8.31 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.

8.32 Free Space Optical Communications

- AP 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.

8.33 4D Printing

- Scientists have successfully developed the world's first 4D printing for ceramics.
- It can be used to create complex, shape-changing objects.
- 4D printing is conventional 3D printing combined with the additional element of **time as the 4th dimension**.
- The 4D printed objects can re-shape or self-assemble themselves over time with external stimuli, such as mechanical force, temperature, or a magnetic field.
- The existing 3D-printed ceramic productions are usually difficult to deform and hinder the production of ceramics with complex shapes.
- A novel ceramic ink was developed to stretch the ceramic products beyond its initial length and allow complex shapes with heat treatment.

8.34 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.
- This makes the communication signal more effective and secure.

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

8.35 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.

8.36 Change in the definition of 'Kilogram'

- The Definition of the Kilogram is about to change by redefining the International system of units (SI).
- There are seven fundamental units and every other unit of measurement can be derived from one or more of these seven units.
- Three of the seven fundamental units are already based on unchanging properties of nature.
- These are the second (time), the metre (distance), and the candela (luminous intensity, a measure for light's brightness).
- The first kilogram was by the measure of mass of one cubic decimetre of distilled water at 4°C (the temperature at which water has its highest density under standard conditions).

THE SEVEN FUNDAMENTAL UNITS		
UNIT	QUANTITY	HOW IT IS/WILL BE DEFINED
Meter*	Distance	Based on speed of light
Kilogram**	Mass	To be based on Planck constant
Second*	Time	Based on radiation of caesium-133 atom
Ampere**	Current	To be based on an electron's charge
Kelvin**	Temperature	To be based on Boltzmann constant
Mole**	Amount of substance	To be based on Avogadro constant
Candela*	Luminous intensity	From efficacy of light of specific frequency

*Current definition stands **Being redefined



- This had the advantage in that most properly equipped labs would be able to reproduce this standard.
- These variable measurements were finally replaced with the international prototype kilogram (IPK), used today, which is a **metal** cast from a mixture of platinum and iridium to make it very hard and prevent it reacting with oxygen.
- Although this metal is stored in a highly controlled environment, its weight can change by tiny amounts as wear and tear causes it to lose mass and dirt causes it to increase.
- Hence, even the modern IPK to measure the kilogram can gradually change in mass.
- To address this problem, scientists decided that instead of measuring the kilogram against a block stored in a vault, it should be based on precise values of constants of nature.
- Thus the kilogram's definition is set to change and the new definition of the kilogram uses a measurement from another fixed value from nature, Planck's constant (h).
- Planck's constant will be defined as $6.62607015 \times 10^{-34}$ joule seconds and can be found by dividing the electromagnetic frequency of a particle of light or "photon" by the amount of energy it carries.
- The constant is usually measured in joule seconds but this can also be expressed as kilogram square metres per second.
- Since 1967, the second has been defined as the time it takes for a certain amount of energy to be released as radiation from atoms of Caesium-133.
- This became the basis of all measures of time, and is used in atomic clocks.
- The SI unit of the metre is also based on another universal constant, namely the speed of light.
- The metre is defined as the distance travelled by light in vacuum in $1/299,792,458$ of a second (which is already defined).
- Thus, since definition of a second and a metre have already adjusted to universal constants, by adding these measurements, along with an exact knowledge of Planck's constant, a very precise definition of the kilogram can be reached easily.

8.37 Purifies Terephthalic Acid (PTA)

- Union government recently removed the antidumping duty on Purified Terephthalic Acid.
- Purified Terephthalic Acid (PTA) is a crucial raw material used to make various products, including polyester fabrics.
- PTA makes up for around 70-80% of a polyester product and is, therefore, important to those involved in the manufacture of man-made fabrics or their components, according to industry executives.
- This includes products like polyester staple fiber and spun yarn.
- The duty had meant importers were paying an extra \$27-\$160 for every 1,000 kg of PTA that they wanted to import from countries like China, Taiwan, Malaysia, Indonesia, Iran, Korea and Thailand.
- Removing the duty will allow PTA users to source from international markets and may make it as much as \$30 per 1,000 kg cheaper than now, according to industry executives.
- Mono Ethylene Glycol (MEG), another raw material used in the manufacturing of polyester, is currently the subject of another anti-dumping duty investigation initiated by Director General Of Trade Remedies (DGTR) recently.

8.38 Indian Science Congress

- The Indian Science Congress Association (ISCA) owes its origin to the foresight and initiative of two British Chemists, namely, Professor J. L. Simonsen and Professor P.S. MacMahon.
- The first meeting of the Congress was held from January 15-17, 1914 at the premises of the Asiatic Society, Calcutta.
- 107th Indian Science Congress is scheduled to take place between January 3-7, at the University of Agricultural Sciences (UAS) in Bengaluru, Karnataka.



- “Science & Technology: Rural Development” is the theme for the congress.
- Indian Science Congress is a major focal point for scientists, researchers and academicians interested in various aspects of scientific discoveries and technologies.

Women Science Congress

- The 9th Women Science Congress (WSC) is organized as part of the Indian Science Congress (ISC) at the University of Agricultural Sciences, Bangalore.
- The event highlighted opportunities that can help women overcome the hurdles they face because of their gender in the pursuit of Science.
- Indian Science Congress Association is a premier scientific organisation of India with headquarters at Kolkata, West Bengal.
- The association started in the year 1914 in Kolkata and it meets annually in the first week of January.
- The first meeting of the Congress was held in January 1914 at the premises of the Asiatic Society, Calcutta.

9. INTELLECTUAL PROPERTY RIGHTS

9.1 Different Categories of IPR

PATENT

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

TRADE MARK

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

INDUSTRIAL DESIGN

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

COPYRIGHT

- Copyright is given to authors of literary and artistic works for their artistic creations such as books and other writings, musical composition, paintings, sculptures, films, computer programmes.

- It is protected under Copyright act 1957
- Time period
 - Literary, dramatic, musical and other artistic works – lifetime of author + 60 years
 - Government work, sound records, photography.. – 60 years
- Copyright does not cover - Names, titles or short phrases, Ideas, Facts and works lacking originality.

TRADE SECRET

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

GEOGRAPHICAL INDICATORS (GI)

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

9.2 Patent Prosecution Highway Programme

- It is a pilot programme between Indian Patent Office (IPO) and Japan Patent Office (JPO).
- Under the programme, Indian Patent Office may receive patent applications in certain specified technical fields only while JPO may receive applications in all fields of technology.
- The technical fields include Electrical, Electronics, Computer Science, Information Technology, Physics, Civil, Mechanical, Textiles, Automobiles and Metallurgy.
- It will be operative for 3 years.
- IPO works under the Controller General of Patents, Designs & Trademarks (CGPDTM), Ministry of Commerce and Industry with patent offices of various other interest countries or regions.

9.3 Technology and Innovation Support Centre

- 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.

9.4 Traditional Knowledge Digital Library

- 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.

9.5 Odisha's Rasagola - GI Tag

- Odisha gets GI tag for its version of Rasagola
- The name of the geographical indication will be read as "Odisha Rasagola".
- West Bengal got GI tag for its 'Banglora Rasagola' which has been existing since 1863.
- Now both Odisha and West Bengal has GI Tag for their own version of Rasagola.
- The mention of the word 'rasagola' was found in the 15th Century Odia Dandi Ramayan written by the medieval poet 'Balaram Das'.
- It is made with chhena (cottage cheese) cooked in sugar syrup, which is very soft, juicy and non- chewy and can be swallowed without teeth pressure.
- In its 'Ajodhya Kanda', there is an elaborate descriptions of chhena and chhena- based products including rasagola.
- Odisha is celebrating the 'Rasagola Dibasa' every year on the day of 'Niladri Bije' (Return of Lord Jagannath from Rath Yatra into the temple).
- The deities are offered Rasagola by servitors before entering the temple.

9.6 Erode Turmeric

- Recently Erode's unique slender turmeric received a GI tag for its distinctive fragrance and color.
- Erode's turmeric is smaller and more slender when compared with other varieties, and it has a high curcumin content of around 3.9%.
- The loamy red and black soil of the Erode region is believed to be the reason behind the distinctive brilliant yellow color, as well as its characteristic sweet taste and aroma.
- Due this distinctive features erode turmeric is preferred choice of commercial curry powder manufacturers in India and abroad.

9.7 Kandhamal Haldi

- Odisha's KandhamalHaldi (turmeric) has recently received GI tag.
- The spice, named after the district where it is produced, has been cultivated since time immemorial and is known for its medicinal value, cosmetic and domestic purposes.
- Turmeric is the main cash crop of tribal people in Kandhamal.



- About 50% of Kandhamal population are engaged in growing the variety.
- Few other important GI items of Odisha are Kotpad's handloom fabric, Konark stone work, Sambalpur Bandhasaree.

9.8 Stone Sculptures of Mamallapuram

- 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 Narasimhavarmapallava, 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.

9.9 Etikoppaka Toys

1. **Etikoppaka Toys** are made from the soft wood of AnkudiKarra (Wrightiatinctoria) 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.
 - The other products that have received this tag this year include
 - i. Pochampally Ikat of Telangana;
 - ii. Gobindobhog Rice of West Bengal;
 - iii. Durgi Stone Carvings and
 - iv. Chakshesang Shawl of Nagaland

9.10 Shahi Litchi

- Shahi Litchi is mostly grown in Muzaffarpur and neighbouring districts in Bihar.
- It has recently got Geographical Indication Tag.
- It is known for its sweet, juicy, unique flavour and aroma.
- Other known GI from Bihar - Katrani rice, Jardalu mango and Magahi paan (betel vine).

9.11 Alphonso Mango

- The government has recently granted Geographical Indication (GI) tag to the Alphonso Mango from Ratnagiri, Sindhudurg and other adjoining areas in Maharashtra.
- Alphonso, the king of Mangoes, better known as 'Hapus' in Maharashtra, is in demand in domestic and international markets for its taste, pleasant fragrance and vibrant colour.
- A GI is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin.
- 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.

9.12 Some of the registered GIs- State Wise

- Assam - Muga Silk, Joha Rice, Tezpur Litchi.
- Bihar - Madhubani Paintings, Bhagalpur Silk, Sikki Grass Work
- Himachal Pradesh - Kangra Paintings, Kullu Shawl, ChambaRumal
- Jammu & Kashmir – Pashmina Hand-Knotted Carpet, Papier Mache, Walnut Wood Carving
- Karnataka - Channapatna Toys & Dolls
- Kerala - Aranmula Kannadi, Palakkadan Matta Rice, Balaramapuram Saris and Fine Cotton Fabrics
- Maharashtra - PuneriPagadi, Nashik Valley Wine, Mahabaleshwar Strawberry, Warli Painting
- Manipur - ShapheeLanphee, WangkheiPhee, MoirangPhee and Kachai Lemon.
- Nagaland - Chakshesang Shawl
- Puducherry - Villianur Terracotta Works
- Rajasthan - Blue Pottery of Jaipur, Kathputlis, Sangneri Hand-Block Printing
- Sikkim - Large Cardamom
- Telangana - Silver Filigree of Karimnagar, Hyderabad Haleem, Narayanpet Handloom Sarees
- Tiripura- Tripura Queen Pineapple

Geographical Indications	States
From April 2018- March 2019	
Araku Valley Arabica Coffee	Andhra Pradesh & Odisha
Boka Chaul (Rice)	Assam
Shahi Litchi	Bihar
Silao Khaja (Food)	Bihar
Jeeraphool (Rice)	Chhattisgarh
Pethapur Printing Blocks	Gujarat
RajKot Patola	Gujarat
Himachali Kala Zeera	Himachal Pradesh
Himachalic Chulli Oil	Himachal Pradesh
Bababudangiris Arabica Coffee	Karnataka
Chikmagalur Arabica Coffee	Karnataka
Coorg Arabica Coffee	Karnataka
Sirsi Supari	Karnataka



Kolhapuri Chappal	Karnataka and Maharashtra
Marayoor Jaggery	Kerala
Wayanaad Robusta Coffee	Kerala
Alphonso	Maharashtra
Sangli Turmeric	Maharashtra
Jhabua Kadaknath Black Chicken Meat	Madhya Pradesh
Erode Manjal (Turmeric)	Tamil Nadu
Thirubuvanam Silk Sarees	Tamil Nadu
Chunar Balua Patthar (Sandstone)	Uttar Pradesh
From April 2019 - March 2020	
Idu Mishmi Textiles	Arunachal Pradesh
Kaji Nemu (Lemon)	Assam
Khola Chilli	Goa
Gulbarga Tur Dal	Karnataka
Tirur Betel Leaf	Kerala
Hmaram (Handicraft)	Mizoram
Mizo Puanchei (Handicraft)	Mizoram
Ngotekherh (Handicraft)	Mizoram
Pawndum (Handicraft)	Mizoram
Tawlhlohpuan (Handicraft)	Mizoram
Kandhamal Haladi	Odisha
Odisha Rasagola	Odisha
Dindigul Locks	Tamil Nadu
Kandangi Saree	Tamil Nadu
Kodaikanal Malai Poondur	Tamil Nadu
Palani Panchamirtham	Tamil Nadu
Srivilliputtur Palkova	Tamil Nadu



- Chunar Balua Patthar of U.P is the second item to get the GI tag under natural goods category after Makrana marble of Rajasthan.
- Karnataka has the highest number of Geographical Indications.