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A Shankar IAS Academy Initiative

MAINSTORMING 2019

SCIENCE & TECHNOLOGY II

Shankar IAS AcademyTM

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INDEX

1. DEVELOPMENTS AND THEIR APPLICATIONS AND EFFECTS IN EVERYDAY LIFE 3

- 1.1 Change in the definition of 'Kilogram' 3
- 1.2 Solution to Reduce Wastage of Pesticides 4
- 1.3 Fake Drugs and Block Chain technology 5
- 1.4 Science Based Targets - Transition to Low Carbon Economy 6
- 1.5 Fingerprint, Face Recognition data in CCTNS.... 7
- 1.6 Green Propellants 8
- 1.7 Upgrade to Large Hadron Collider - CERN 8
- 1.8 LIGO to Publish Paper on Analysis Techniques 10
- 1.9 Discovery of Fast Radio Burst 11

2. ACHIEVEMENTS OF INDIANS AND INDIGENISATION OF TECHNOLOGY 12

- 2.1 India in Exo-planetary Research 12
- 2.2 INO Observatory 13
- 2.3 India's Manned Mission to Space 14
- 2.4 Mission Shakti - Anti-Satellite Missile Test 16
- 2.5 Research on CMB Radiation 18
- 2.6 National Supercomputing Mission 18
- 2.7 Supercomputer 19
- 2.8 Param Shivay 19
- 2.9 Pratyush 19
- 2.10 Mihir 20

3. SPACE 20

- 3.1 GSAT-29 Launch - GSLV Mk III D2 20
- 3.2 GSAT-7A Launch - GSLV-F11 21
- 3.3 ISRO - Chandrayaan-2 Mission 22
- 3.4 PSLV-C45 - EMISAT and 28 Customer Satellites 24
- 3.5 RISAT-2B Launch 26
- 3.6 First Hyper Spectral Imaging Satellite 27
- 3.7 Draft Space Activities Bill, 2017 27
- 3.8 Vikas Engine 28
- 3.9 Defining Pluto and a 'Planet' 29
- 3.10 Oumuamua Comet Discovery 30
- 3.11 Liquid Water Lake in Mars 31
- 3.12 Probing for Water on Moon 31
- 3.13 NASA's Mars InSight Probe 33
- 3.14 Chang'e-4 Spacecraft 34
- 3.15 Discovery of Fast Radio Burst 34
- 3.16 Manned Space Mission - Russian Rocket Launch Failure 35
- 3.17 BepiColombo Spacecraft - ESA and JAXA Joint Mission to Mercury 37
- 3.18 Space Debris 38

- 3.19 Sunspots 39
- 3.20 Solar Tsunami 40
- 3.21 Square Kilometre Array 40

4. IT AND COMPUTERS 41

- 4.1 Net Neutrality Rules in India 41
- 4.2 Indigenising India's Cyber Space 42
- 4.3 Blockchains for Internet of Things 43
- 4.4 Banning of Blockchain 45
- 4.5 Facebook's Cryptocurrency - "Libra" 46
- 4.6 5G Technology 47
- 4.7 Internet of Things 48
- 4.8 National Common Mobility Card 50
- 4.9 Free Space Optical Communications 50
- 4.10 LiFi 51
- 4.11 Dark Net 51
- 4.12 DDOS Attack 51
- 4.13 Augmented & Virtual Reality 52

5. ROBOTICS 52

- 5.1 Significance of Artificial Intelligence 52
- 5.2 Need for a Legal Framework for AI in India 54
- 5.3 The Potential of Artificial Intelligence 55
- 5.4 Cyber-Physical Systems 56

6. NANO TECHNOLOGY AND BIO TECHNOLOGY 57

- 6.1 EU Ruling on Gene Editing 57
- 6.2 Genetically Modified Mosquitoes 58
- 6.3 Potentials of Genetic Modification 59
- 6.4 Gene editing in a human embryo 60
- 6.5 Significance of MediPix Technology 61
- 6.6 DNA Technology (Use and Application) Regulation Bill 62
- 6.7 Draft Guidelines for Stem Cell Research 63
- 6.8 Bacteria to degrade Toluene 63
- 6.9 Earth BioGenome Project 64
- 6.10 3D Printed Skin 64
- 6.11 Triboelectric Nanogenerators - Wireless Transmission of Electrical Energy 65

7. Electronics 65

- 7.1 National Policy on Electronics 2019 65
- 7.2 Lithium-ion Battery 67
- 7.3 Thermal Battery Plant 68
- 7.4 Optical Tweezers 68
- 7.5 Hyperloop Technology 69
- 7.6 The Dilemma with e-cigarettes 70
- 7.7 e-waste menace in India 71



8. Issues Related to IPR 72

8.1 EU's New Copyright Law..... 72
8.2 PepsiCo and Potato Farmers Case 73
8.3 Common Geographical Indication Logo 75
8.4 Secondary Patents..... 76
8.5 Draft Pharma Policy 77
8.6 USTR Watch List 78
8.7 Global Trade Mark System Agreements..... 78
8.8 TKDL 78

9. Defence..... 79

9.1 Mid-Air Refuelling..... 79
9.2 Agni V..... 79
9.3 Advanced Air Defence systems in India..... 79
9.4 NETRA 79
9.5 Digital Sky Platform 80

9.6 INS Arihant 80
9.7 BOLD-QIT..... 81
9.8 Air Independent Propulsion 81

10. Miscellaneous 81

10.1 Blocking Mobile Apps 81
10.2 Formalin: A Banned Preservative 82
10.3 Internet shutdowns in India..... 83
10.4 Rising Game revolution in India..... 85
10.5 APSARA - U 86
10.6 International Thermonuclear Experimental Reactor (ITER) 86
10.7 PM-STIAC..... 86
10.8 YUVIKA..... 87
10.9 UNNATI..... 87

MAINSTORMING 2019

SCIENCE & TECHNOLOGY (JUNE 2018 TO JULY 2019)

1. DEVELOPMENTS AND THEIR APPLICATIONS AND EFFECTS IN EVERYDAY LIFE

1.1 Change in the definition of 'Kilogram'

Why in news?

The Definition of the Kilogram is about to change by redefining the International system of units(SI).

How does the measurement of kilogram evolve?

- 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).
- Hence, scientists want to create a measurement system that is based entirely on unchanging fundamental properties of nature.

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

- The first kilogram (originally called a grave) was defined in 1793 by a commission of the French Academy of Sciences, who wanted a better standard than the fixed amounts of grain that had traditionally been used.
- The commission decided that the new measure would be the mass of one cubic decimetre of distilled water at 4°C (the temperature at which water has its highest density under standard conditions).
- This had the advantage in that most properly equipped labs would be able to reproduce this standard.
- Subsequently, a prototype of this mass was cast in brass.
- Unfortunately, this definition/calculation of mass depended upon another variable measurement, the metre.
- At this point, the metre was only provisionally defined as part of the distance from the North Pole to the equator.
- However, once the value of the metre and the temperature of water at its densest were more accurately defined, a new prototype was cast in platinum to represent this mass(kilogram).
- 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.
- Since 1889, countries who are members of the General Conference on Weights and Measures have agreed to use this standard block of metal kept near Paris to define the kilogram.
- This made the kilogram to be the only base unit in the SI still defined by a physical object.
- Six Copies of the IPK are transported across the world to ensure all participating countries use the same standard.
- But 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.

What is the proposed measure?

- To address this problem, scientists around the world have spent nearly two decades discussing how the kilogram could instead be defined in relation to constant measurements of nature.



- So they 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.

Does this redefining really help science?

- The change in definition of the second, previously, has helped ease communication across the world via technologies like GPS and the Internet.
- In the same way, the change in the kilogram will be better for technology, retail and health.
- For most people, everyday life will carry on as normal despite the redefinitions.
- One standard bag of sugar will contain as much sugar as it ever did.
- But some of these changes will mean practical advantages for scientists making very precise measurements.
- Thus, to answer the question how much is a kilogram, we will no longer have to compare blocks of platinum or worry about scratching them.

1.2 Solution to Reduce Wastage of Pesticides

Why in news?

CSIR has found a lipid compound to reduce the wastage of pesticides by slippage.

What is CSIR?

- The Council of Scientific & Industrial Research (CSIR) is India's contemporary R&D organization.
- It is known for its cutting edge R&D knowledgebase in diverse S&T areas.
- CSIR's R&D expertise and experience is embodied in about 4600 active scientists supported by about 8000 scientific and technical personnel.
- It provides significant technological intervention in many areas with regard to societal efforts which include environment, health, drinking water, food, housing, energy, Farm and non-farm sectors.

How CSIR's recent innovation will reduce pesticide wastage?

- The CSIR has identified a lipid compound known as Glycerol-Mono-Oleate (GMO), a natural wax-like solid extracted from sunflower oil.
- The structure of this compound is that its one end is hydrophilic (water-attracting) and the other end is hydrophobic (water-repelling).
- When this compound is mixed with pesticides, the liquid sticks to the leaves and doesn't fall off to the ground.
- When the solution was sprayed the lipid GMO nanoparticles rush to the leaf surface and quickly spread out to make a thin film on the leaves.

- This thin film is hydrophilic on the outside and hydrophobic on the inside resulting in the water-pesticide mix sticking strongly on the leaves.

What is the significance of this innovation?

- The pesticides are sprayed on to the crops which increases its slippage into the ground.
- This residue of pesticides then leeches to the ground, mixes with the water cycle and the food chain which has long term consequences for man.
- From economical point, large of amount of pesticides have to be sprayed to keep the plants away from insects and pests.
- Since, the pesticides don't stick to the leaf, farmers locally mix pesticides with soap water which is not a viable solution.
- This forced the scientists to work on finding a solution for this small yet significant problem and found an innovative solution which is safe for the whole ecosystem.

1.3 Fake Drugs and Block Chain technology

Why in news?

Recently the drug regulator of Rajasthan found certain medicines to be fake which is a part of the counterfeit drugs industry in the country.

What are the problems that arise due to Fake drugs?

- According to the World Health Organization (WHO), around 35 % of the fake drugs sold globally come from India.
- In low and middle income countries like India, one in 10 medical products (pills, vaccines, injectables) in circulation are either substandard or fake.
- The substandard or fake drugs promote **anti-microbial resistance** in people.
- Spurious drugs make pharma companies incur **huge revenue losses**.
- According to industry body Assocham, in 2015, the value of the counterfeit drug industry in India was pegged at around Rs 150 billion
- It was almost 25 % of the total worth of the global pharma industry.

What are the ways to check the fake drugs?

- So far the efforts to combat the proliferation of fake drugs have been through traditional means – via tip-offs and surprise raids.
- The current methods of weeding out counterfeit drugs are quite archaic.
- Still the method of sampling is only used to verify the genuineness of drugs.

What is the latest development?

- Niti Aayog, in collaboration with Oracle Technologies and Apollo Hospitals, is working on a technology.
- The technology will leverage blockchain technology to overcome the counterfeit drug problem.
- Oracle is developing the app through which the consumer will be able to scan the bar code of a medicine
- By scanning we will know about its manufacturer, the date of production, its path of transport and the date it reached the retailer.
- Hence, the consumer can check if the medicine is genuine or not before buying it.
- The technology will work all long the entire supply chain so as to ensure that no fake drugs enter the system.

How does it work?

- The **tracing and tracking of pharmaceutical products** is done with the help of new age technologies like blockchain and Internet of Things (IoT).
- Fake drugs enter into the supply chain as Pharma sector is heavily dependent on logistics.



- Consignments of drugs will be tracked remotely through the use of IoT to check the entry of fake drugs.
- The data captured through IoT will be sent to the cloud server that will then be entered into the block chain ledger.
- The block chain digital ledger system records the transactions and tracking of consignments.
- It becomes easy for all stakeholders -drug manufacturers, controllers and hospitals to monitor the ledger.
- This eliminates the possibility of mixing fake drugs with original drugs.
- In addition block chain process is hack proof because it does not use a centralized system to store data.
- Any revision on the chain requires retrograde action on all associated blocks.
- This process allows users to see transactions in real time.
- The real time monitoring of data across the pharmaceutical supply chain will act as a third eye on fake drug dealers.

What are the other initiatives in this regard?

- Gujarat has implemented an online drug **SMS alert system** for retailers for 'unsafe' drugs.
- The state drug control authority worked with National Informatics Centre to develop the software.
- Abbott has introduced an **SMS authentication** scheme for customers.
- **QR codes** are also used to store product information on packs which will do away with the need to print leaflets.
- These QR codes can be an effective tracking mechanism.
- It allows the manufacturer to keep tabs on the drug's circulation in the market.
- Companies are also planning to print a **hologram** on the packaging and **mirco-emboss the product name** on cartons.

What is the way forward?

- As block chain technology evolves, India's efforts to root out counterfeit drugs will definitely make headway.
- It will surely lead to a much safer public health system in the country.

1.4 Science Based Targets - Transition to Low Carbon Economy

What is the issue?

Science Based Targets, an environmental initiative, could go a long way in driving companies to contribute to tackling climate change.

What is 'Science Based Targets'?

- Science Based Targets is a joint initiative of CDP, the UN Global Compact (UNGC), the World Resources Institute (WRI) and WWF.
- It is an initiative to drive corporate climate actions globally.
- It sets emissions reduction targets to ensure that the transformational action is aligned with current climate science.
- It is 'science-based' as it is in line with the scale required to keep global temperature increase below 2°C compared to pre-industrial temperatures.
- 'Science-based target setting' is a way of boosting companies' competitive advantage in transition to a low-carbon economy.

What is the rationale?

- In 2015 Climate Conference, 195 countries signed the Paris Agreement.
- The goal is to limit global temperature rise to below two degrees Celsius.
- This signalled an acceleration in the transition to a low carbon economy.



- However, the private sector needs to take the lead towards this transition.
- Science Based Targets is an effort at this front.

What is the significance?

- India - India has committed to generate at least 40% of its electricity from non-fossil fuel sources.
- A decrease in carbon emission intensity of GDP by 33 to 35% by 2030 has also been committed.
- Indian companies and multinationals operating in India have a major role in this.
- Sixteen Indian companies have committed to set science-based targets.
- They have secured themselves competitive advantage in the transition.
- Some of the world's biggest companies with significant supply chains in India have also committed.
- These include Kering, Walmart and others.
- Global - Unique to the initiative is the criterion that companies need to commit to setting supply chain or 'scope 3' targets.
- If more than 40% of a company's emissions occur in its supply chain, then it has to commit to reducing those emissions as well as its direct emissions.
- Notably all companies operate within a value chain.
- This has the potential to rapidly escalate the impact of science-based target setting on global emissions.

1.5 Fingerprint, Face Recognition data in CCTNS

Why in news?

Home Affairs Ministry is planning to link fingerprint, face recognition data to the Crime and Criminal Tracking Network System (CCTNS).

What is CCTNS?

- **Aim** - CCTNS aims at creating a comprehensive and integrated system for effective policing through e-Governance.
- It is envisaged as a countrywide integrated database on crime incidents and criminals.
- It aims to connect all police stations, with their crime and criminal data, with a central database.
- It was conceived as a response to the Mumbai attacks of 2008 and approved in 2009.
- **Implementation** - The system is already in operation in many states but with a limited coverage.
- The first phase of CCTNS is nearing completion.
- 14,500 of 15,500 police stations across the country have been connected.
- Only Bihar, for various administrative reasons, is lagging behind.

What is the current proposal?

- As part of Phase II of CCTNS, MHA is planning to scale up fingerprint collection from all police stations and link it to CCTNS.
- It also plans to connect the Railway Protection Force's stations and their data, apart from the *revenue police stations of Uttarakhand*.
- The proposal has provisions for integrating face recognition system and iris scans as well with the CCTNS.
- Integration of these data will boost police department's crime investigation capabilities.
- It will also help civilian verification when needed.
- Also, lakhs of motor vehicle offences, registered by the transport department, has no central database.
- Now, this too would be connected to the CCTNS.
- This would help in ascertaining the history of criminal offences that a vehicle is involved in.

What is the need?

- The Central Finger Print Bureau (CFPB) now stores the fingerprint database.
- It currently uses Automated Fingerprint Identification System (AFIS), also called FACTS, for matching fingerprints.
- However, this technology is an outdated one when compared to Federal Bureau of Investigation's technology (FBI of the US).
- Also, while FBI has over 4 crore fingerprints in its database, the CFPB currently has a database of just over 10 lakh fingerprints.
- Hence, scaling up data collection is an essential prerequisite for better criminal investigations.

1.6 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.

1.7 Upgrade to Large Hadron Collider - CERN

What is the issue?

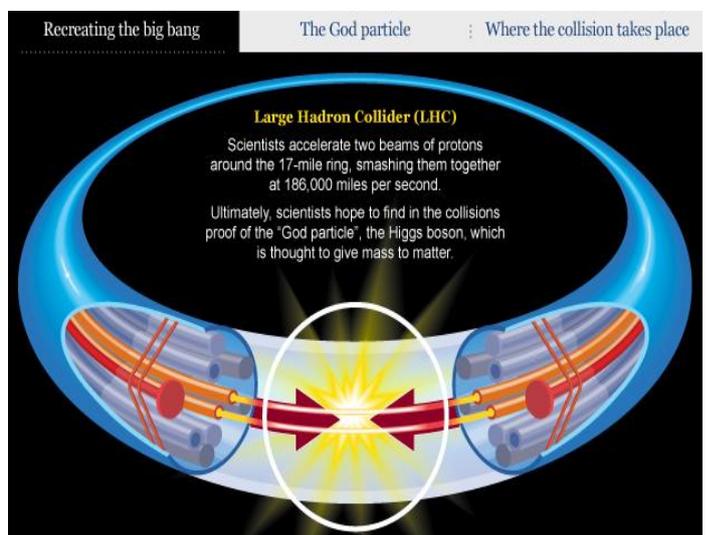
- CERN (the European Organization for Nuclear Research) recently found that Higgs boson decays to fundamental particles known as bottom quarks.
- Testing this and understanding more particles, require an upgradation to the Large Hadron Collider.

Why to study particles?

- Particle physics probes nature at extreme scales, to understand the fundamental constituents of matter.
- Particles communicate with each other in accordance with certain rules.
- These are embedded in what are known as the 'four fundamental interactions'.
- The particles and three of these interactions are successfully described by a unified approach known as the Standard Model (SM).
- The SM is a framework that required the existence of a particle called the Higgs boson.
- The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator.
- One of the major aims of the Large Hadron Collider (LHC) was to search for the Higgs boson.

How are such tiny particles studied?

- Protons are collected in bunches.
- They are then accelerated to nearly the speed of light and made to collide.





- Many particles emerge from such a collision, termed as an event.
- The emergent particles exhibit an apparently random pattern.
- But they follow the underlying laws that govern part of their behaviour.
- Studying the patterns in the emission of these particles help understand the properties and structure of particles.

What is CERN's proposal?

- Higgs boson was discovered at the CERN Large Hadron Collider (LHC).
- The Higgs boson was detected by studying collisions of particles at different energies.
- But they last only for one zeptosecond which is 0.00000000000000000001 seconds.
- So, detecting and studying their properties requires an incredible amount of energy and advanced detectors.
- CERN has thus announced earlier this year that it is getting a massive upgrade to the LHC.
- This will be completed by 2026.

Why an upgrade?

- *Luminosity* is a measure of the number of protons crossing per unit area per unit time.
- Initially, the LHC provided collisions at unprecedented energies.
- This allowed scientists to focus on studying new territories.
- But, it is now time to increase the discovery potential of the LHC by recording a larger number of events.
- So upgrading (increasing the luminosity) will increase the rate of collisions.
- Eventually, the probability of most rare events will also increase.
- This offers scope for studying the properties of newly discovered particle and its effect on all other particles.
- In addition, understanding the properties of the Higgs boson will require their abundant supply.
- But the SM has its shortcomings, and there are alternative models that fill these gaps.
- It thus necessitates a High Luminosity LHC (HL-LHC).

How will it help?

- The beam in the LHC has about 2,800 bunches, each of which contains about 115 billion protons.
- The HL-LHC will have about 170 billion protons in each bunch, contributing to an increase in luminosity.
- After the upgrade, the total number of Higgs bosons produced in one year may be about 5 times the number produced currently.
- The experiments will be able to record about 25 times more data in the same period as for LHC running.

How will it be upgraded?

- The protons are kept together in the bunch using strong magnetic fields of special kinds.
- These are formed using quadrupole magnets.
- Focusing the bunch into a smaller size requires stronger fields.
- Therefore greater currents are employed, necessitating the use of superconducting cables.
- Newer technologies and new material (Niobium-tin) will be used to produce the required strong magnetic fields.
- The creation of long coils for such fields is being tested.
- New equipment will be installed over 1.2 km of the 27-km LHC ring.
- This will help in focusing and squeezing the bunches just before they cross.
- The LHC gets the protons from an accelerator chain.

- This will also need to be upgraded to meet the requirements of the high luminosity.
- Moreover, the length of each bunch is just a few cm.
- So, to increase the number of collisions a slight tilt is being produced in the bunches just before the collisions.
- This is to increase the effective area of overlap.

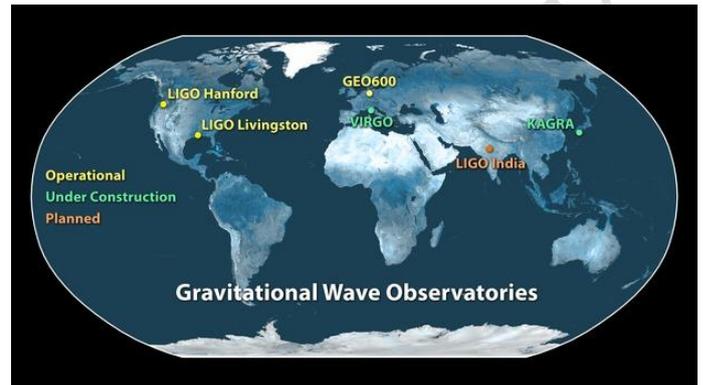
1.8 LIGO to Publish Paper on Analysis Techniques

Why in news?

- The LIGO (Laser Interferometer Gravitational-Wave Observatory) Scientific Collaboration detected gravitational waves in 2015.
- It has recently announced that it would publish a detailed explanation of how it analyses the noise in its detectors.

What was the 2015 discovery?

- Gravitational waves are ripples in the fabric of space-time, arising from the merger of a pair of black holes in distant space.
- LIGO's 2015 announcement of the discovery of gravitational waves was an exciting finding in physics for decades.
- The discovery confirmed a prediction made by Einstein.
- It stated that space-time itself can squeeze and stretch in rhythmic waves, when deformed by cataclysmic events like collision of black holes.
- The collaboration's founders were awarded the Nobel prize in physics in 2017.



What were the further observations?

- Since detecting the binary black hole (BBH) merger, the LIGO Scientific Collaboration (LSC) has made six such observations.
- Five of these were mergers of black holes in very different locations in space and with very different characteristics such as mass.
- Another was the merger of a pair of so-called neutron stars (binary neutron stars).
- The last few detections have been done in conjunction with another detector, Virgo (Italy-based).

What is the need for LIGO's explanation now?

- **Challenge** - LIGO's detectors aim to measure a shortening of space equivalent to about a thousandth of the width of a proton.
- This sort of measurement is swamped by natural thermal vibrations, known as noise.
- This makes picking out the signal from a gravitational wave tricky and challenging.
- The collaboration thus used sophisticated analysis techniques to remove this noise.
- Also, after the first discovery, the LSC made public its data on these techniques.

WHAT IS LIGO?

The advanced Laser Interferometer Gravitational Wave Observatory (or LIGO) is at the centre of the path-breaking find:

The LIGO experiment is an example of extreme engineering chasing an impossible dream

The twin LIGO installations – one in Livingston, Louisiana, and the other in Hanford, Washington – are located 3,000km apart

Two "blind" L-shaped detectors with 4km long vacuum chambers that can accommodate 11 Boeing 747-400 commercial airliners

When a gravitational wave comes through, it stretches space in one direction, and squeezes space in the other direction

By measuring the interference of the laser as they bounce between the different point, physicists can measure very precisely whether the space in between has stretched or compressed

► Built 3,000km apart, operating in unison
► To make the smallest measurement ever attempted by science – a motion 10,000 times smaller than an atomic nucleus
► Caused by the most violent and cataclysmic events in the Universe occurring millions of light years away
► Can detect gravitational waves in a volume of 1 billion cubic light years – covering about 1 million Milky Way type galaxies

► To detect a gravitational wave we should be able to tell when something changes in length by a few parts in 10 to the power 23
► LIGO makes the smallest measurement ever attempted – a motion 10,000 times smaller than an atomic nucleus
► It's like trying to hear a song being hummed in a very, very noisy party

Source: TNN, pndcomics.com, LIGO, Scientific American, phys.org, aps.org, symmetrymagazine.org

- **Dispute** - Analysing the data, in 2017, a group of scientists questioned the validity of the first detection.
- Weeding out noise from the signal is crucial in any such experiment.
- Some claimed that this had not been done properly by the LSC.
- They argued that the two detectors belonging to LIGO were correlated and that this led to a correlation in the noise factor.
- Other scientific investigations also uncovered a number of irregularities in the data.
- **LSC** - After a long silence, recently, the LSC has thus put up a clarification on its website.
- The LIGO collaboration is learnt to be in the process of preparing their paper clarifying their approach and explaining the analysis techniques.

1.9 Discovery of Fast Radio Burst

Why in news?

Canadian Hydrogen Intensity Mapping Experiment (CHIME) has reported the sighting of a repeating fast radio burst from a distant galaxy.

What are Fast Radio Bursts?

- Fast Radio Bursts are brief (few millisecond) bursts of radio waves coming from far beyond our Milky Way galaxy.
- The phenomenon was first reported in 2007 and as of mid-2017, roughly two dozen have been reported and their origin is unknown.
- However, they are ubiquitous: current best estimates suggest these events are arriving at Earth roughly a thousand times per day over the entire sky.
- Of the known detected FRBs, one, FRB 121102, has been observed to repeat and has been shown to come from a small dwarf galaxy at redshift 0.2.
- Whether all FRBs repeat and/or are in dwarf galaxies is yet unknown.

What is CHIME?

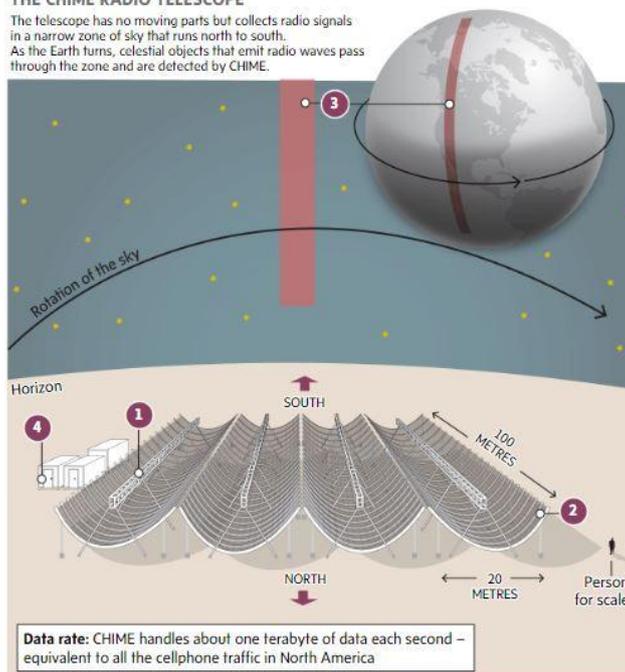
- The CHIME Telescope is located at the Dominion Radio Astrophysical Observatory (DRAO), a national facility for astronomy operated by the National Research Council of Canada.
- The DRAO site is protected against man-made radio-frequency interference by municipal, provincial and federal regulation.
- The CHIME telescope's large collecting area, wide bandwidth and enormous field-of-view make it a superb detector of FRBs.
- The CHIME FRB event rate is predicted to be between 2 and 50 FRBs per day.
- So high an event rate promises major progress on this puzzling new astrophysical phenomenon.
- Bright CHIME-discovered FRBs will be found in real time and reported immediately to the worldwide astrophysical community for multi-wavelength follow up.

What are the recent reporting of the CHIME?

- A mysterious radio signal emanating from a galaxy far, far away has been detected by CHIME.

THE CHIME RADIO TELESCOPE

The telescope has no moving parts but collects radio signals in a narrow zone of sky that runs north to south. As the Earth turns, celestial objects that emit radio waves pass through the zone and are detected by CHIME.



- 1 **Focal line:** each line consists of 256 individual receivers spaced 30 cm apart
- 2 **Reflectors:** made of steel mesh parabolic "half-pipes" aligned north-south
- 3 **Field of view:** nearly the entire sky that can be seen from the telescope's latitude rotates through its field of view every 24 hours
- 4 **Processors:** on-site computer system cross-compares inputs from 1,024 receivers to work out incoming direction of signals and map the radio sky overhead



- The discovery is significant because it's only the second time ever a repeating signal has been observed by scientists.
- In addition to the second repeater, the researchers were able to shed new light on FRBs because they detected them at a much lower frequency than previously recorded finds.
- The radio bursts were observed by CHIME at frequencies between 400 megahertz (MHz) and 800 MHz.
- The majority of previously detected FRBs were found at frequencies near 1400 MHz.

2. ACHIEVEMENTS OF INDIANS AND INDIGENISATION OF TECHNOLOGY

2.1 India in Exo-planetary Research

What is the issue?

- In a feat that is critical for India and science, Ahmadabad based lab discovered a planet orbiting a star 600 light years away.
- This is a 1st for Indian scientists and is a vindication of India's space potency.

What the metrics of Exo-planet studies?

- **Why** - Exo-planets are those celestial bodies that orbit stars outside our solar system in clearly defined elliptical paths.
- We need to understand how planets form around stars, to understand our solar system better, for which study of exo-planets are key.
- Habitability of exo-planets is a keenly studied area, which is mainly based on its distance from its star (the planet should be neither too hot nor too cold).
- Indian scientists have been trying to track exo-planets since 2012, but it was only recently that PRL, Ahmadabad became the 1st to achieve the feat.
- **What** - The 1st thing is to understand about exo-planets are their characteristics and fundamental parameters - mass, radius, and atmosphere.
- With mass and radius, it is easy to get the density, which will help in making a rough estimate of the planet's composition.
- **The challenge** - Detecting an exo-planet is very difficult as it is a dull object that will invariably be roaming around the bright spot of its star.
- Direct imaging of exo-planets is almost impossible, although new techniques are being evolved by NASA and others.
- There are only 5-6 spectrographs around the world that can measure the mass of exo-planets at high precision (radial velocity less than 2 m/s).
- India counts itself as one of the few countries that has the instruments to discover and analyse such difficult worlds.

Then, how are exo-planets studied?

- **How** - The presence of a planet will make its star wobble, which can be measured using a precise spectrograph.
- This spectrographic reading will help in measuring the mass of the planet.
- When the planet passes between its star and Earth, the intensity of light from that star (which reaches the earth) gets minutely dim.
- This dip in star's flux is measured, and this is subsequently employed to estimate the radius of the planet.

What are the observed results of the newly detected exo-planet?

- A suspected planet (now been coded as "K2-236b"), was under the observation of the Ahmadabad based lab over 1½ years.

- In Jan 2018, scientists conclusively stated that their object of observation was a planet, which was then confirmed by “Mount Abu Space Observatory”.
- The planet is said to be composed of 70% iron, ice or silicates and 30% is gas, with about 27 Earth-masses and 6 Earth-radii.
- In terms of mass and radius, the planet is akin to Neptune, and it is just one-seventh of the distance away from its star as compared to ‘Sun-Earth distance’.
- One year on that planet is about 19.5 Earth-days and surface temperatures average to about 600°C, which thereby makes it uninhabitable.

How does the future of exo-planetary studies in India look?

- Indian space scientists have set out with the ultimate aim of detecting planets of close-to-Earth mass (2 to 10 Earth masses).
- A new 2.5-m telescope at “Mount Abu Observatory” with a bigger spectrograph is likely to be installed by 2020, and it will be called “PARAS-2”.
- PARAS-2 is slated to have the capacity to even measure smaller exo-planets that are just about 2 or 4 times Earth’s mass.
- It is also hoped that ISRO will launch some space missions relating to exo-planet studies.

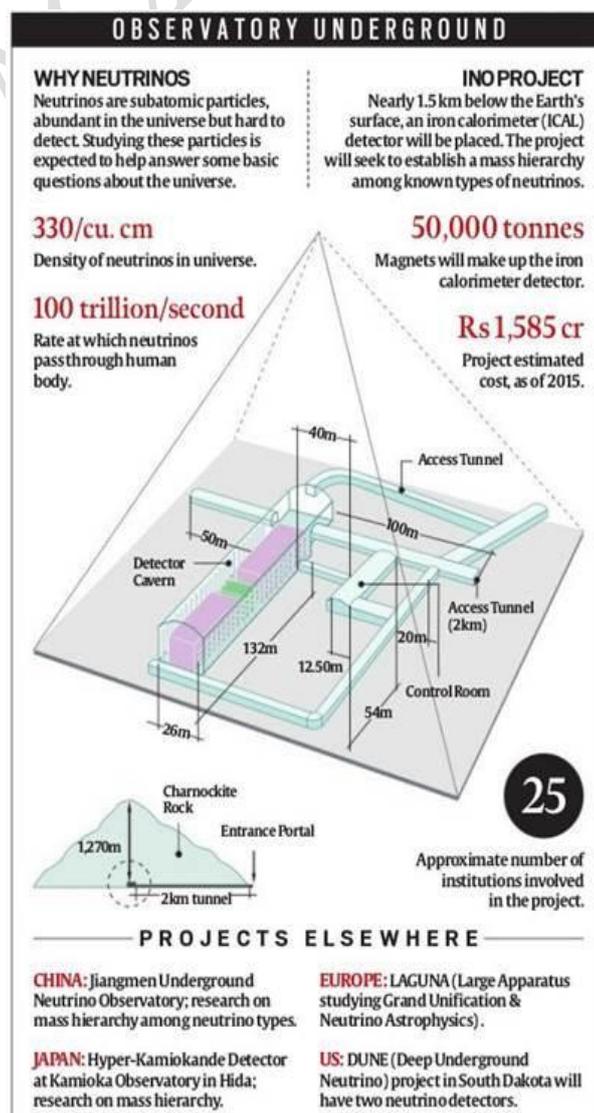
2.2 INO Observatory

What is the issue?

- India-based Neutrino Observatory (INO) is proposed to be established in the Tamil Nadu section of the Western Ghats for furthering research.
- As the site is being mapped in an eco-sensitive, environmental clearances and other compliances are to be strictly adhered to.

What is the INO project?

- It is a particle physics research project to primarily study the elusive sub-atomic particles called neutrinos.
- Neutrinos are extremely tiny elementary particles that are omnipresent in universe which carries no electric charge.
- It is considered to be the second most abundant particle in the universe after the photon, or light particle.
- Yet, they are very difficult to detect because they pass seamlessly through all kinds of matter, unimpeded and undetected.
- Its rest mass is almost zero (1 millionth of an electron).
- It interacts only via weak short range subatomic forces and gravity.
- Hence its detection needs high-end instruments and an environment that is effectively shielded from other radiant interference.
- Hence, a cavern is being carved out at the depth of 1,300 meters (4,300 feet) below the Western Ghats stretch in Bodi West Hills in Theni district for establishing the research site.
- An underground laboratory will be located there, nearly 1.5 km below the Earth’s surface, where a giant neutrino detector is to be placed.



- The overhead rock will effectively shield it from natural cosmic radiation from outside.
- Many countries are carrying out research on neutrinos, believing that it holds important clues to some basic questions on the universe.

When will it operationalize?

- The original timeline had envisaged experimental work starting from 2017, later advanced to 2020.
- It is now unlikely to begin before 2025, even if construction starts next year.
- Construction of the underground facility would take at least 5 years and hence the project cost too is likely to escalate.

What are the challenges?

- **Environment** - It has had to move from its initially proposed location, because the nearby Mudhumalai National Park had been declared a tiger reserve during the same time.
- Hence this second site was selected.
- **Litigations** - The project has been mired in all kinds of trouble such as litigation, public protests, opposition from NGOs and political parties, including the recently ended litigation with NGT.
- **Red Tapes** - Bigger uncertainties in terms of government approvals, meanwhile, are still to come.
- The application for environmental clearance was referred to Environmental Appraisal Committee (EAC) by the State Environment Impact Assessment Authority of Tamil Nadu as it preferred the centre to assess a project of this nature.
- Environment ministry gave the clearance under **category B**, even though it is about to be located near an eco-sensitive national park.
- But it was challenged in NGT by Pooulagin Nanbargal objecting to the category under which the project was cleared. However, the NGT held that the environment ministry has the legal and technical competence to assess the INO project and upheld the environmental clearance.
- The judgment states that it was correct on the part of the EAC and the ministry to appraise the project at their level.
- However, the court reiterated that the INO must also obtain approval from National Board for Wildlife.
- This is because the proposed site is about 4.9 km from Mathikettan Shola bird sanctuary bordering Kerala.
- Any major activity within 5km from any wildlife sanctuary requires a specific approval by the National Board for Wild Life.
- Also, NGT ruled that specific or general condition or recommendation made by the committees and expert groups on Western Ghats will be mandatorily made applicable in the current project of INO.
- **Cost** - The Union government had, in 2015, approved a budget of Rs 1,583 crore for the project.
- That budget was based on cost assessments done in 2012.
- It is estimated the project would now cost at least 25% more than that amount.

Categories under EIA

- The EIA Notification, 2006, broadly divides all projects into two categories, Category A and Category B, based on potential impacts over an area and on human health and natural and man-made resources.
- Accordingly, all Category A projects required to undertake EIA and a public hearing and its clearance are granted by the Union environment ministry.
- On the other hand, Category B projects are given a clearance by state level authorities.
- Category B projects are further classified as B1 and B2.
- While projects under Category B1 also require an EIA and public consultation, those falling under B2 are exempted from requirements of both EIA and public consultation.

2.3 India's Manned Mission to Space

Why in news?

Indian Space Research Organisation (ISRO) has announced the definitive timeline for Gaganyaan mission.



What is ISRO's plan?

- ISRO has announced its first manned mission which is set to be a reality by 2022.
- By this, an Indian astronaut will go on a space odyssey by 2022 on board 'Gaganyaan'.
- ISRO has roped in Indian Air Force pilots to identify the first set of astronauts for a human space flight.
- It will make India the fourth nation in the world to launch a Human Spaceflight Mission after USA, Russia and China.

What are the works in progress?

- **Launch vehicle** - The launch vehicle for this mission is planned to carry heavy payloads into space.
- The spacecraft carrying human beings, called crew module, is likely to weigh in excess of 5 to 6 tonnes.
- For this purpose, GSLV Mk-III (or) Launch Vehicle Mark-3 (LVM-3) is being developed.
- This comes with cryogenic engine, with capabilities to deliver much heavier payloads much deeper into space.
- It has the payload capacity of 4000 kg satellites in Geosynchronous Transfer Orbit (GTO) and 8000 kg payload to Low Earth Orbit.
- 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).
- **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 is known as Crew module Atmospheric Re-entry Experiment (CARE).
- **Crew Escape System (CES)** –It is an emergency escape measure to quickly pull the astronaut crew out to a safe distance from launch vehicle during a launch abort.
- ISRO had tested the Crew Escape System, a mechanism for an advance warning.
- System warns the crew module of anything going wrong with the rocket and pulls it away to a safe distance.
- After this, it can be landed either on sea or on land with the help of attached parachutes.
- 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
- **Astronaut training** - ISRO still plans to set up a permanent facility like a foreign facility, to train candidates for the first manned mission.
- Candidates would be trained for at least two years in living in zero gravity.
- It would also include dealing with a variety of unexpected experiences of living in space.

What are the challenges?

- For a manned mission, the key distinguishing capabilities that ISRO has had to develop include the ability
 - i. to bring the spacecraft back to Earth after flight
 - ii. to build a spacecraft in which astronauts can live in Earth-like conditions in space

- The problem of weight is the fundamental challenge.
- As, a crewed module weighs two or three times more than the communication satellites and remote sensing payloads that ISRO usually launches.
- The only hardware which remains untested is the crew capsule, suitable for keeping two or three astronauts in good health for over a week.
- Elements include systems to maintain the environment, provide food and process waste, and deal with emergencies, these are still on the drawing board.
- An astronaut training centre was scheduled to be set up by 2012 in Bengaluru, but it appears that the first batch of astronauts will have to be trained overseas.
- It would take years to accustom them to life in zero gravity, which has impacts on a myriad behaviours, from moving around to even eating and drinking.

What is the way forward?

- It is true that human space flight no longer signals national prestige, as it did during the Cold War.
- But the project would bump up the entire space industry, forcing it to meet challenges beyond the low-cost launch of payloads, a sector in which it has already excelled.
- Besides, certain missions are better performed by humans than by robots.
- These remain far in the future, but the development of human capabilities in space would prime the industry well in advance.
- The technical knowledge generated in the process would be of use much later, in ways that may not be obvious today.

2.4 Mission Shakti - Anti-Satellite Missile Test

Why in news?

Indian PM announced that India had carried out a successful anti-satellite missile test (ASAT), Mission Shakti.

What is an anti-satellite missile test?

- ASAT is the technological capability to hit and destroy satellites in space through missiles launched from the ground.
- The first anti-satellite test (ASAT) was carried out by the US military way back in 1959. The then Soviet Union followed a year later.
- Thereafter, the two countries carried out a series of such tests up till early 1980s.
- After that there was a lull, broken only by the Chinese test in 2007.
- India became only the fourth country to carry out an anti-satellite missile test.
- Other countries which could have the capability, like Israel, have not shown an intention to test.

What is the objective of ASATs?

- The technology is aimed at destroying, if necessary, satellites owned by enemy countries.
- With large number of crucial applications being satellite-based, satellites are extremely critical infrastructure of any country these days.
- Some of them include navigation systems, communication networks, banking systems, weather forecasting, disaster management, and military applications.
- Destroying a satellite would render these applications useless.
- It can thus cripple enemy infrastructure without causing any threat to human lives.
- As per the norms, the test, however, can be carried out only on one's own satellite.



What is Mission Shakti?

- There are a large number of satellites currently in space, many of which have outlived their utility and orbiting aimlessly.
- One such satellite was chosen for India's present test.
- A missile was launched from the Dr A P J Abdul Kalam Island launch complex near Balasore in Odisha.
- It struck a predetermined target which was a redundant Indian satellite that was orbiting at a distance of 300 km from the Earth's surface.
- As per official sources, the satellite that had been knocked out was Microsat R, a micro-satellite launched by ISRO in January, 2019.

What is the significance?

- The mission has given India a unique and critical strategic capability that only three other countries in the world currently possess.
- India has shown that it is capable of bringing down a satellite, and disrupting communication.
- Much like in the case of nuclear weapons, the effectiveness of anti-satellite missiles depends on the deterrence it brings.
- But unlike the 1998 nuclear test of India, the anti-satellite missile test is not prohibited by any international law or treaty.

What are the other ways of destroying satellites?

- In the last few years, countries have explored alternative options of making enemy satellites dysfunctional.
- These do not involve direct destruction of the target or creation of the debris.
- E.g. technologies have been developed to jam the communication from the satellites by interfering with its radio signals
- Another option is sending satellites that just approach a target close enough to deviate it from its selected orbit, without destroying it.
- China, Japan, Russia and the European Space Agency are learnt to be working on developing these „close proximity“ anti-satellite technologies.
- There is also a possibility of using of ground-based lasers to „dazzle“ the sensors of the satellites.
- This could make them at least “partially blind” so that they are unable to work efficiently.
- But none of these technologies is mature enough to be deployed or tested.

Why is ASAT not widely used?

- ASAT requires very advanced capabilities in both space and missile technologies that not many countries possess.
- But more than that, destroying space infrastructure like satellites is also taboo in the international community, at least till now.
- Almost every country agrees that space must not be used for wars and has spoken against weaponisation of space.
- There are also international treaties governing the use of space, mandating that, it must only be exploited for peaceful purposes.

Why is Mission Shakti safe?

- None of the international treaty or agreements technically prohibits the kind of test that India presently carried.
- By government statement, the Indian test was done in the lower atmosphere to ensure that there was no space debris.
- So whatever debris that is generated will decay and fall back on to the earth within weeks.



2.5 Research on CMB Radiation

Why in news?

Indian space scientists are conducting experiments on Cosmic Microwave Background (CMB) radiation in Timbaktu village.

What are CMB radiation?

- Indian scientists are conducting experiments to confirm occurrence of unusual space signals in the spectrum of Cosmic Microwave Background (CMB) radiation.
- CMB is an all-pervasive but weak electromagnetic radiation from the early universe when matter was still to be formed.
- This radiation does not come from any of the objects that are observed in the universe, like stars or galaxies, it comes from things that are not formed yet.
- CMB is a relic from an early universe when matter and radiation were still in thermodynamic equilibrium.
- Thus when it is observed it is similar to looking at the period in universe after the big bang and before the present objects were formed.

What is the significance of this research?

- Ever since its discovery, CMB has been an invaluable source of information on the early universe.
- From its properties, scientists have inferred that the early universe was filled with hot, dense and extremely uniform gas, mostly hydrogen.
- The first stars were formed when blobs of these gases fused under the influence of gravity emanating visible light commonly referred as cosmic dawn.
- The present theory of origin of universe has the probability of being proved practically with the findings derived by observing CMB radiation.

Why the scientists chose Timbaktu for their tests?

- Timbaktu is a small hamlet in Anantpur district of Andhra Pradesh, It is surrounded by hills with unusual rock formations.
- Its location has least contact with the outside world and minimal footprints of modern digital technology.
- Air present in this place is clean and the sky is clear, making it one of the very few places which practically has no noise.
- Due to these properties, this place is described as Radio Quiet by space scientists hunting for faint electromagnetic signals from the sky.

2.6 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.

2.7 Supercomputer

- The world's largest supercomputer designed to work in the same way as the human brain has been switched on for the first time.
- **SpiNNaker machine** – Spiking Neural Network Architecture is capable of completing more than 200 million million actions per second, with each of its chips having 100 million transistors.
- It is designed and built in The University of Manchester in the UK.
- In real time, it can model more biological neurons (basic brain cells in the nervous system that communicate by pure electro-chemical energy) than any other machine on the planet.
- **SpiNNaker Vs Traditional computers** - Traditional computers communicate by sending large amounts of information from point A to B via a standard network.
- Whereas SpiNNaker mimics the massively parallel communication architecture of the brain, sending billions of small amounts of information simultaneously to thousands of different destinations.
- **Uses** – It will help neuroscientists better understand how our own brain works.
- It also has simulated a region of the brain called the Basal Ganglia - an area affected in Parkinson's disease.
- Thus it has massive potential for neurological breakthroughs in science such as pharmaceutical testing.
- Its power has recently been used to control a robot the spOmnibot, which uses the SpiNNaker system to interpret real-time visual information and navigate towards certain objects while ignoring others.

2.8 Param Shivay

- It is a supercomputer of 833 teraflop capacity.
- It was built at the cost of Rs 32.5 crore under the National Super Computing Mission at the Indian Institute of Technology (IIT), Banaras Hindu University (BHU).
- It will include 1 peta byte secondary storage and appropriate open source system.
- This supercomputer centre will help deal with social issues faced by common people.
- India's first supercomputer called PARAM 8000 was launched in 1991.
- The other super computers in the country are as follows,
 1. Indian Institute of Tropical Meteorology – **Pratyush**
 2. National Centre for Medium-Range Weather Forecasting- **Mihir**
 3. IISc - **SERC-Cray**

2.9 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.

2.10 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.

3. SPACE

3.1 GSAT-29 Launch - GSLV Mk III D2

Why in news?

ISRO successfully launched GSAT-29 communication satellite on board GSLV-Mk III D2 from the Satish Dhawan Space Centre at Sriharikota.

What are the key features of GSAT-29?

- With a mission life of 10 years, GSAT-29 is the 33rd communication satellite built by ISRO.
- GSAT-29 is a multi-beam, multiband communication satellite.
- Its payloads are designed to mainly focus on connectivity to the users in the hilly and geographically inaccessible areas.
- Weighing 3,423 kg at lift-off, GSAT-29 is the heaviest satellite to be launched from India.
- It will be placed in a geostationary transfer orbit.
- At its closest point it will be 190 km above the Earth, and at its farthest it will be close to 36,000 km above the Earth.
- GSAT-29 also carries a Geo High-Resolution Camera to aid in high-resolution imaging.
- For the first time, an optical communication payload will be utilised for data transmission at a very high rate.
- ISRO's Master Control facility at Hassan, Karnataka takes over the command and control of GSAT-29 soon after its separation from GSLV Mk III - D2.
- It will be manoeuvred into a geostationary orbit, its final destination, in days.
- Once placed, the satellite's solar panels and antennae will unfold and work will begin.
- **GSLV MK III** - The Geosynchronous Satellite Launch Vehicle Mark III is a three-stage heavy lift launch vehicle, weighing 640 tonnes.
- The first stage has two boosters with solid propellant, and the second is the core with liquid propellant.
- The cryogenic engine forms the final stage.
- The GSLV Mk III is the heaviest launch vehicle made in India.





What is the significance?

- The GSLV-GSAT launch enhances India's capacity to meet its communication needs.
- Both launcher and satellite have certain characteristics that make them unique.
- The launcher can carry payloads up to 4 tonnes to the geosynchronous transfer orbit and up to 10 tonnes to a low-earth orbit.
- The launch shows that ISRO has developed the capability to lift four-tonne payloads using its new GSLV Mark-III rocket.
- The GSLV-III is also likely to be used in the Chandrayaan-II mission in the early months of 2019.
- The multi-band, multi-beam satellite can cater to the communication needs of people in Jammu and Kashmir and the Northeast.
- **GSLV MK III** - The first successful experimental flight of the GSLV Mk III was in 2014 when it carried a dummy crew module as a payload.
- Its first developmental flight was on June 5, 2017, when it launched GSAT19, weighing 3,136 kg.
- The present launch marked the second developmental flight (D2) of the Mk III.
- With these two successes, the developmental phase of the GSLV Mk III vehicle programme will be complete.
- The launcher is declared 'operational' and joins the ranks of the working vehicles, the PSLV and the GSLV.
- This is far fewer than the number of developmental flights the older launch vehicles were subjected to.
- It sets the stage for trying out variations such as other types of engines, different fuel combinations and higher launch capacities.
- The GSLV Mk III has also restored morale at ISRO, which had been dented by the GSAT 6A setback.

3.2 GSAT-7A Launch - GSLV-F11

Why in news?

ISRO launched the communication satellite, GSAT-7A with GSLV-F11 (Geosynchronous Satellite Launch Vehicles).

What is GSAT-7A?

- GSLV-F11 injected GSAT-7A into a Geosynchronous Transfer Orbit (GTO) very close to the intended orbit.
- GSAT-7A is an advanced communication satellite with a Gregorian Antenna and other new technologies.
- GSAT-7A is the 39th Indian communication satellite of ISRO to provide services to users in Ku-band over the Indian region.
- The satellite operating in the Ku band will service communication needs for network-centric operations of the Indian Air Force and the military.
- Most of the functional requirements of the communication payloads and other systems have been derived from ISRO's earlier geostationary INSAT/GSAT satellites.

What is the key feature?

- At 2,250 kg, GSAT-7A is the heaviest satellite launched by GSLV-Mk-II since it began using the indigenous cryogenic engine.
- The cryogenic stage of this vehicle has been modified to increase the thrust rate.
- The rocket was pushing the limits of its capabilities in launching satellites of the two-tonne class for the seventh time.
- This is a standout factor with this launch and 12 other successful flights carried out so far by ISRO's GSLV-Mk-II rocket.
- They include six successive flights since 2014 with an indigenous cryogenic fuel upper stage.

What is ISRO's GSLV programme?

- GSLV-Mk-II is ISRO's fourth generation rocket with three stages.



- The first stage has four liquid strap-ons and a solid rocket motor.
- The second has a high thrust engine using liquid fuel, and the third is the cryogenic upper stage.
- The indigenous cryogenic engine was tested successfully for the first time in 2014.
- The cryogenic stage uses liquid hydrogen as fuel and liquid oxygen as an oxidiser.
- Compared to solid and earth-storable liquid propellant stages, it is a highly efficient rocket stage that provides more thrust for every kg of propellant it burns.
- ISRO initially used 7 cryogenic engines sold by Russia for the early phase of its GSLV programme that began in 2001.
- GSLV launches with Russian engines have had mixed success, with only two flights performing well.
- ISRO is developing a more powerful, fifth-generation GSLV-Mk-III rocket to launch satellites in the 4-6-tonne category.
- GSLV-Mk-III had a successful development flight recently when it launched the 3,423-kg GSAT-29 communication satellite.
- GSLV-Mk-III is the designated launch vehicle for India's upcoming second moon mission and the first human space flight scheduled for 2022.

3.3 ISRO - Chandrayaan-2 Mission

Why in news?

ISRO recently announced the launch date (July 15, 2019) of Chandrayaan-2 mission, after the long delay from the scheduled launch.

Why was the delay?

- Chandrayaan-2's predecessor, Chandrayaan-1, was an Orbiter mission which was sent way back in 2008.
- Following this, according to the original schedule, Chandrayaan-2 was to be launched in 2012 itself.
- But at that time, it was supposed to be a collaborative mission with the Russian space agency, Roskosmos, which was to provide the lander module.
- The Russians, however, withdrew from the missions.
- [This was after Russia's similarly-designed lander for another mission developed problems in 2011.]
- This left ISRO to design, develop and build the lander on its own.
- As this was new to ISRO, it had led to considerable delay from the original schedule.

What was Chandrayaan-1 mission?

- The Chandrayaan-1 mission was ISRO's first exploratory mission to the moon, in fact to any heavenly body in the space.
- It was designed to just orbit around the moon and make observations with the help of the instruments on board.
- The closest that Chandrayaan-1 spacecraft came to the moon was in an orbit 100 km from its surface.
- For largely symbolic reasons, though, the Chandrayaan-1 mission made one of its instruments crash-land on the moon's surface.
- It was the Moon Impact Probe, or MIP, a 35-kg cube-shaped module with the Indian tricolour on all its sides.
- MIP left an Indian imprint on the moon's surface.
- Besides, ISRO also claims that while on its way, MIP had sent data that showed evidence for the presence of water on the moon.
- But unfortunately, those findings could not be published because of anomalies in calibration of the data.
- [The confirmation for water had come through another onboard instrument, the M3 or Moon Mineralogy Mapper, that had been put by NASA.]



- Given the above, Chandrayaan-2 is a logical progression on Chandrayaan-1 and a more sophisticated mission with various objectives.

What are Chandrayaan-2's features?

- Chandrayaan-2 is India's first lander mission.
- It consists of an Orbiter, Lander and Rover, all equipped with scientific instruments to study the moon.
- The Lander and Rover modules will separate from the orbiter and make a soft-landing on moon's surface (either on September 5 or 6, 2019).
- The lander and rover are designed to work for only 14 days (1 lunar day) while the orbiter would remain in orbit for a year.
- **Orbiter** - The Orbiter would once again watch the moon from a 100-km orbit.
- The Orbiter is a 2379-kg spacecraft with 7 instruments on board.
- It is equipped with different kinds of cameras to take high-resolution three-dimensional maps of the surface.
- It also has instruments to study the mineral composition on the moon and the lunar atmosphere, and to assess the abundance of water.
- The Orbiter will observe lunar surface and relay communication between Earth and the Lander.
- **Lander** - ISRO has named the Lander module as Vikram, after Vikram Sarabhai, the pioneer of India's space programme.
- The 1471-kg lander will remain stationary after touching down on the moon's surface.
- It will carry three instruments that will mainly study the moon's atmosphere.
- One of the instruments will also look out for seismic activity on lunar surface.
- **Rover** - The Rover is a 6-wheeled, Artificial Intelligence-powered and solar-powered vehicle named Pragyan, meaning wisdom.
- Once on the moon, the rover will detach itself from the lander.
- Equipped with two instruments, it would slowly crawl on the surface, making observations and collecting data.
- Its primary objective is to study the composition of the moon's surface near the landing site.
- It would also determine the abundance of different elements on the moon's surface.

What are the challenges?

- The Lander is the distinguishing feature as this is the first time that ISRO is attempting to soft-land a module in extra-terrestrial space.
- Once the Lander and the Rover, enter the Moon's gravity, they would be in a state of free fall.
- That could end in crash-landing and destruction of instrument.
- The main challenge is thus in controlling its speed as it approaches the surface.
- To enable a smooth landing, the speed of the Lander just ahead of touchdown should be 1 m/s (3.6 km/h) or less.
- Due to lack of air to provide drag, these instruments cannot make use of parachute-like technologies.
- So instead, the Lander fires thrusters in the opposite direction to slow down.

What is the significance?

- With Chandrayaan-2, India will become only the 4th country in the world to land a spacecraft on the moon.
- So far, all landings, human as well as non-human, on the moon have been in areas close to its equator.
- This was mainly because this area receives more sunlight that is required by the solar-powered instruments to function.
- Chandrayaan-2 will make a landing at a site where no earlier mission has gone, near the South pole of the moon.



- It is a completely unexplored territory and therefore offers great scientific opportunity for the mission to discover something new.
- [Incidentally, the crash-landing of the MIP from the Chandrayaan-1 mission had also happened in the same region.]
- **South pole** - The south pole of the moon holds the possibility of the presence of water.
- This is one aspect that would be probed meticulously by Chandrayaan-2.
- In addition, this area is also supposed to have ancient rocks and craters.
- It can thus offer indications of history of moon, and also contain clues to the fossil records of early solar system.

3.4 PSLV-C45 - EMISAT and 28 Customer Satellites

Why in news?

The Indian Space Research Organisation (ISRO) recently launched the PSLV-C45 rocket carrying one Indian (EMISAT) and 28 international satellites.

What is the mission for?

- ISRO launched the country's first electronic surveillance satellite, EMISAT, from Sriharikota in coastal Andhra Pradesh.
- EMISAT was built by the Defence Research Development Organisation (DRDO).
- It will gather information on enemy radar positions from a sun-synchronous orbit at an altitude of about 750km.
- EMISAT will achieve this through electromagnetic spectrum measurement.
- So the spacecraft carries a payload of DRDO's prestigious Kautilya system for electromagnetic intelligence (ELINT) gathering.
- Space-based electronic intelligence (ELINT) will add to the situational awareness of the Armed Forces.
- This will provide location and information of hostile radars placed at the borders.
- This will be another dimension to the current land or aircraft-based ELINT.
- Besides this, as many as 28 small satellites of international customers were also put in space as secondary riders.
- These include 24 satellites from the US, two from Lithuania, and one each from Switzerland and Spain.

What are the unique features of PSLV-C45?

- **Orbits** - ISRO holds the world record for carrying a number of satellites on a single launch vehicle.
- It carried 104 satellites on PSLV C-37 in 2017.
- However, so far, these satellites have been ejected in two different orbits at the most.
- PSLV-C45 is the first time that ISRO has launched a rocket that injected satellites in three different orbits.
- **Satellites** - The fourth and last stage of the rocket will function as a satellite itself for some time.
- The fourth stage is what remains of the rocket after most of it is discarded in the three stages after ejecting the payloads.
- **Strap-on motors** - This flight marked the first mission of PSLV-QL, a new variant of PSLV with four strap-on motors.
- [Strap-ons are booster rockets attached externally to the main rocket.
- They provide additional thrust, or energy, by firing themselves midway during the flight.]
- In earlier flights, ISRO has used two or six strap-on motors.
- The four extra-large strap-ons used this time reduced the overall weight while still delivering the power equivalent to six motors.



What was the earlier procedure?

- On most previous occasions, the primary satellite of the rocket was taken to its orbit.
- Meanwhile, the others were ejected, or sprayed in quick succession either before or after that into different trajectories.
- There used to be only a marginal difference in the vertical distances between the satellites.
- Also, the entire operation used to be over in a few minutes.

How is PSLV C-45 different from this?

- EMISAT is the primary satellite in PSLV C-45, which is a piece of surveillance equipment to be used by the DRDO.
- PSLV C-45 placed this primary satellite to the 748 km sun-synchronous polar orbit.
- It then made one complete revolution around Earth, over the poles, while lowering its orbit to 504 km height.
- After this, it deposited the 28 international customer satellites.
- It then made a further round of Earth while attaining an even lower orbit of 485 km.
- At this level, the fourth stage of the rocket will continue for some time.
- The entire operation took a little over three hours.
- For enabling each of the two revolutions around Earth, the fourth-stage engines were reignited, which is a unique feature of PSLV C45.
- Earlier missions used to be “single-shot” operations in which the engines used to fire just once.

What is the significance?

- **Orbit** - Reaching three different orbits gives ISRO a new technological edge.
- The mission will help ISRO pack its future rockets with multiple satellites even if they have to be placed in diverse but precise orbits.
- Earlier, this could be done only in multiple missions.
- It also showed that the guidance and navigation systems aboard the rocket could be used for much longer times than in earlier missions
- **Fourth stage as satellite** - The rocket, or the launch vehicle, is only a carrier.
- Once it places its passenger, or satellite, to its designated orbit in space, it becomes practically useless, adding to the space debris.
- But for the last few years, ISRO had been planning to give some life to the rocket.
- It was planning this at least to the uppermost part, or the last stage, which remains with the satellite till the ejection.
- So significantly, in PSLV-C45, ISRO demonstrated its capability to reuse the fourth-stage engines multiple times.

What purpose will the fourth stage serve?

- The fourth stage is carrying three kinds of equipment to carry out some measurements and experiments; each of them to be used -
 1. to capture messages transmitted from ships
 2. by amateur radio operators' use for tracking and monitoring position data
 3. to study the structure and composition of the ionosphere
- It also carries a solar panel to provide power to these equipment and enable communication with ground stations.
- The fourth stage will not have the usual life of a satellite as it can remain alive only for a few weeks or a few months.



- As, it is not equipped with a lot of other things that enable a satellite to exist for longer duration in outer space, like a radiation shield.
- However, this is still good enough time to carry out shorter duration experiments and data collection.
- In future, such an “orbital platform”, as it is being described, can also be used to inject smaller satellites into orbits.

3.5 RISAT-2B Launch

Why in news?

The RISAT-2B satellite was launched with the PSLV-C46 by the Indian Space Research Organisation (ISRO).

What is the RISAT?

- Two satellites in RISAT (radar imaging satellite) series have earlier been launched by ISRO.
- RISAT-2 was the first one to be launched, in 2009, while RISAT-1, which had got delayed, was launched only in 2012.
- RISAT-1 is no longer operational.
- After a very long time, ISRO’s PSLV rocket was used to launch just one satellite into space.
- In recent times, ISRO has been launching multiple satellites at one go.

What are the key features?

- The RISAT, or radar imaging satellite, is equipped with a sensor known as ‘**synthetic aperture radar**’, to take "radar images".
- It works much like the flashlights of a camera, which release visible light to illuminate an object and then use the reflected light to create an image.
- The synthetic aperture radar transmits hundreds of radio signals (**microwave pulses**) every second towards the ground.
- It then captures the signals reflected back by the objects, to create a radio image, which can then be used by computers to build a real image.
- The moisture and texture of the object will determine the strength of the microwave signal that gets reflected.
- The strength of the reflected signal will help determine different targets.
- Likewise, the time between the transmitted and reflected signals will help determine the distance to the object.
- Unlike visible light, microwaves have longer wavelength and so will not be susceptible to atmospheric scattering.
- In other words, the very large wavelength radio waves are not obstructed by clouds, dust or other such obstacles in the atmosphere.
- So they produce reliable images during day and night and all seasons.
- The RISAT-2B satellite uses **X-band synthetic aperture radar** for the first time, which was developed indigenously.
- Unlike the C-band that was used by RISAT-1, the X-band allows for higher resolution imagery for target identification and discrimination.
- [C-band and X-band are the designations for a band of frequencies in the microwave radio region of the electromagnetic spectrum.]
- Since it has high resolution, the satellite will be able to detect objects with dimensions of as little as a metre.
- This capacity to study small objects and also movement could be useful for surveillance.

What is the significance?

- RISAT-2B adds to India’s capability to observe the earth in all weathers and all conditions.
- It will enhance India’s monitoring capabilities for civil and military purposes, which include -



- i. crop monitoring during the monsoon season
 - ii. forestry mapping for forest fires and deforestation
 - iii. flood mapping as part of the national disaster management programme
- Given that overcast skies are a constant during monsoon season and times of flood, the ability to penetrate the cloud cover is essential.
 - While optical remote sensing that relies on visible light for imaging gets obstructed by clouds, RISAT-2B will not.
 - Services of such satellites are in great demand from national security agencies as well.

3.6 First Hyper Spectral Imaging Satellite

- PSLV-C43 is the Core Alone version of PSLV, has successfully launched India's first Hyper spectral Imaging Satellite (HysIS) and 30 international co-passenger satellites.
- **HysIS** is an earth observation satellite, weighing about 380 kg and configured around ISRO's Mini Satellite-2 (IMS-2) bus.
- The goal is to study the earth's surface in the visible, near infrared and shortwave infrared regions of the electromagnetic spectrum.
- It has a mission life of about 5 years.
- A Hyperspectral imaging camera in space can provide well-defined images that can help to identify objects on Earth far more clearly than regular optical or remote sensing cameras.
- The technology will be an added advantage of watching over India from space for a variety of purposes such as defense, agriculture, land use, minerals and so on.
- It enables distinct identification of objects on earth by reading the spectrum for each pixel of a scene from space.
- The satellite has the Hyperspectral imager which can identify 55 spectral or colour bands from 630 km above ground.
- It can be used for monitoring of environment, finding oil and minerals apart from military surveillance.
- Hypspx was first tried out in Chandrayaan-1 mission which mapped the lunar mineral resources.

3.7 Draft Space Activities Bill, 2017

Why in news?

The Department of Space has released a draft Space Activities Bill, 2017.

What are the key provisions?

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



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

What does the bill aim for?

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

3.8 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.



3.9 Defining Pluto and a 'Planet'

What is the issue?

- In 2006, the International Astronomical Union (IAU) voted to remove Pluto's planetary status.
- Some researchers are now challenging this decision.

What was the 2006 IAU's decision?

- The IAU, in 2006, designated Pluto a 'dwarf planet' along with Ceres in the asteroid belt and Xena.
- Xena is an object in the Kuiper belt which is an icy ring of frozen objects that circle the solar system beyond Neptune's orbit.
- The designation was a bid to overcome sentiment and go by scientific rationale.
- The meeting accordingly defined three conditions for a celestial object to be called a 'planet' -
 - i. it must orbit the Sun
 - ii. it should be massive enough to acquire an approximately spherical shape
 - iii. it has to 'clear its orbit' i.e. be the object that exerts the maximum gravitational pull within its orbit
- 'Dwarf planets', on the other hand, need to only satisfy the first two conditions.

Why is Pluto not a Planet?

- As per the third condition, if an object ventures close to a planet's orbit, it will either collide with it and be accreted, or be ejected out.
- But, in case of Pluto, it is affected by Neptune's gravity.
- It also shares its orbit with the frozen objects in the Kuiper belt.
- Based on this, the IAU deemed that Pluto did not 'clear its orbit' (the third rule).
- Hence, it was designated a dwarf planet.

What is the contention here?

- **Third rule** - The above rationale has been questioned by some who put forth several exceptions to the third rule.
- They cite the manner in which scientific tradition has dealt with the taxonomy of planets.
- The only work in history that used the third rule to classify planets was an article by William Herschel in 1802.
- It is also argued that this work was based on reasoning and observations that have since been disproved.
- However, the argument is not a strong enough case to give up what is, in fact, a sensible rule.
- Evidently, physics has many examples where an idea once discarded for being incorrect, later emerged in a different form and gained acceptance.
- **Planet** - Given these, even if Pluto were to be re-designated a planet, many more complications would arise.
 - Charon, Pluto's moon, is much too large to be called a satellite.
 - Judging by this, the Charon-Pluto system should then rightly be called a binary planet system.
 - This would then lead to classifying several other sets of bodies as binary planets.
 - Also, both the Kuiper Belt and the Oort cloud contain objects that can then be called planets, thereby complicating the issue.
 - Oort cloud is a shell of icy objects that surrounds the entire solar system far beyond the Kuiper belt.

International Astronomical Union (IAU)

- The International Astronomical Union (IAU) was founded in 1919.
- Its mission is to promote and safeguard the science of astronomy in all its aspects through international cooperation.
- It serves as the internationally recognized authority for assigning designations to celestial bodies and surface features on them.



- Denying planetary status to Pluto is the easy way out of the debate at this stage.
- Hence, Pluto remains a dwarf planet, although an exceptional one.

3.10 Oumuamua Comet Discovery

Why in news?

Scientists solved the mystery of the small, dark red cigar-shaped object that shot across cosmic neighbourhood late last year.

What is Oumuamua?

- Oumuamua - Hawaiian for “a messenger from afar arriving first”, was first spotted on October, 2017.
- When it was spotted near the Solar System, astronomers were puzzled to classify the object in space, recently scientists discovered that this object is to be a comet.
- When it was discovered, the oddly-shaped, about 800-m-long ‘Oumuamua was racing through space.
- It was dark and faint, with no visible ‘coma’ (atmosphere of dust and gas around a comet’s core) or ‘tail’ (elongated cloud that points away from the Sun) signature identifiers of comets as they approach the inner Solar System.



How astronomers found the object to be a comet?

- Comets are icy chunks of frozen gases, space rock, and dust, It has fascinated humankind for over 2,000 years.
- The absence of a visible tail in the case of ‘Oumuamua had initially led to its being classified as an asteroid.
- Scientists discovered the object last year, has shown that comets do not necessarily vaporise and light up as they get close to the Sun.
- The object’s spectrum (i.e. the colour of the light it reflects) is very similar to the Solar System comets, This supports its identification as a comet.

How Oumuamua differs from other comets?

- Oumuamua’s nucleus is probably similar to comets of our Solar System, although some aspects have to be different.
- The dust grains have to be larger than typical for other Comets, which could be a reason for the absence of the characteristic cometary tail.
- The tail we see in comets is typically made of fine dust lifted off the nucleus and dragged away by the emitted gas.
- In the case of ‘Oumuamua, the dust is not visible because it’s made of larger grains, that are too heavy to be lifted off by the gas.
- The gas itself is actually very difficult to detect, because the specific molecules composing it (water, CO and CO₂) are difficult to see in optical images.

What are the insights from this findings?

- There isn’t a lot of information about ‘Oumuamua, but the discovery provides exciting insights into the chemistry of objects born in other solar systems.
- The lack of visible tail and activity makes objects harder to see, because they appear less bright.
- If an object is active, the dust around it contributes to the overall brightness, making the object also easier to discover.
- It has happened a few times that an object that looked asteroidal at the time of discovery was then noticed to have a coma or a tail, and therefore reclassified as a comet.
- But once it has been discovered, the indirect method used to identify comets would prevent faulty classifications.

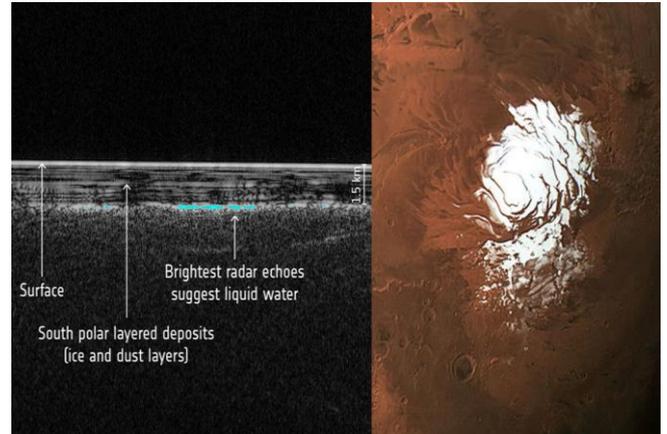
3.11 Liquid Water Lake in Mars

What is the issue?

- Scientists have recently discovered a liquid water 'lake' in Mars.
- This is expected to facilitate a better understanding on the likely presence of life on Mars.

What is the recent finding?

- **Mission** - An 11-member Italian team of researchers surveyed the Planum Australe region, or the southern polar plains of Mars.
- They used the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) instrument.
- This is low-frequency radar on board the European Space Agency's Mars Express Orbiter.
- The instrument beams radar pulses down to the planet's surface and measures how the waves reflect back to the spacecraft.
- This would give information on the kind of materials, even below the surface.
- **Findings** - The team had discovered a lake stretching for 20-km.
- It is found 1.5 km under the southern polar ice cap of Mars.
- Despite temperatures at about -68°C , the water remains in a liquid form.
- The radar profile of the lake closely matches those of subglacial lakes on Earth, beneath the ice sheets of Greenland and Antarctica.



How in liquid form?

- Atmospheric pressure on the Martian surface is almost a hundred times less than on Earth.
- This ensures that water would not be in liquid form, but rather, as ice or vapour.
- So the presence of water is much beneath the surface.
- The liquid form could be due to the heavy presence of sodium, magnesium and calcium salts.
- This may reduce the temperature and help it retain liquid form.
- This, along with the immense pressure of the ice from above, lowers the freezing point.

What is the significance?

- The majority of modern Mars is dry and barren.
- But plenty of evidence has been found that the Red Planet used to be a much wetter place.
- However, any liquid water was believed to be transitional, in short-lived pools or flowing down hillsides in the Martian summer.
- So the discovery of a large, stable, stagnant lake on Mars is significant.
- It offers new potential targets for future missions and places, to search for signs of past or present microbial life.
- However, the sheer saltiness of the spot raises doubts to this belief.

3.12 Probing for Water on Moon

What is the issue?

- NASA recently reconfirmed its 2009 assertion on the presence of water on Moon's surface by using new data from the M3 (Moon Mineralogy Mapper).



- Notably, the instrument had been sent to space on India's Chandrayan –I and has thus far provided ample evidence of water on Moon.

What is the recent news?

- M3 was sent to space through India's Chandrayaan-1 spacecraft in 2008 and data from it has been subjected to rigorous study worldwide.
- Recently, NASA had stated that new data from its M3 instrument has reconfirmed presence of water (solid ice) in moon without any ambiguity.
- NASA's M3's could differentiate between solid, liquid and vapour ice, and its data indicated that solid ice was patchily deposited on the moon's surface.
- It collected data that not only picked up the reflective properties of water molecules but also the distinctiveness in reflections by different water states.
- Most of the newfound water ice lies in the shadows of craters near the poles, where the warmest temperatures never reach above -250°F (-150°C).
- Notably, because of the very small tilt of the Moon's rotation axis, sunlight never reaches these regions.

What are the other studies that confirmed water on moon?

- **Confirmation** - In September 2009, an analytical study of data from NASA's "M3 instrument" on board ISRO's Chandrayan - I spacecraft was published.
- This announced the "unambiguous evidence" of presence of water across the lunar surface, which was done after reconfirmation by NASA's EXPOXI craft.
- Notably, NASA's EPOXI spacecraft passed by the Moon on its way to comet Hartley 2, and its data was corroborated with M3's.
- This was further verified by reassessing the data produced by a spectrometer aboard Cassini spacecraft in 1999.
- The data from ISRO's hyper-spectral imager, an instrument used for mapping minerals, also aboard Chandrayaan-1, supplemented the evidence.
- This is the final confirmation of water on Moon, something that had been hypothesised since the first lunar missions in the 1960s.
- **Subsequently** - Another of ISRO's instruments on Chandrayaan-1, the Moon Impact Probe (MIP), had produced compelling evidence of water on the Moon.
- Notably, MIP, a 35-kg cube-shaped instrument with the Tricolour on all sides, is the first Indian object to land on the Moon.
- After 2009, several studies have pointed to the presence of water, in different forms although most of these have used the same data sets as used in 2009.
- In August 2013, scientists looked at the same M3 data and detected magmatic water (that originates within the Moon's interior), on the lunar surface.

How is water distributed on the lunar surface?

- While water molecules were found mostly in the polar regions of the Moon, a 2017 study showed that water was present across the lunar surface.
- Interestingly, the 2017 study also produced the first map of water distribution on the lunar surface using the M3 data set.
- In February 2018, NASA reported data from two lunar missions that presented fresh evidence of water being "widely distributed" across the surface.
- It said the water appeared to be present on the lunar surface abundantly, although it is not necessarily easily accessible.



3.13 NASA's Mars InSight Probe

Why in news?

NASA's Mars InSight probe has reached its destination and touched down near the red planet's equator.

What is the objective?

- InSight marks the 21st US-launched Mars mission.
- InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) is on a 24-month mission.
- It will not be looking for life on Mars.
- It will study its insides as to what it is made of, how that material is layered and how much heat seeps out of it.

Why Mars?

- Earth and Mars used to be similar - warm, wet and shrouded in thick atmospheres.
- But this was before they took different paths 3.4 billion years ago.
- After the event, Mars stopped changing, while Earth continued to evolve.
- They turned out so different - Mars cold and dry, Venus and Mercury burning hot, and Earth hospitable to life.
- With InSight, Earth would thus be compared to Mars, to better understand how a planet's starting materials make it more or less likely to support life.
- It is thus expected to study how Mars and other rocky worlds formed at the dawn of the solar system 4.6bn years ago.
- But notably, sending a probe to Mars, whether to land, orbit or fly past, is risky; only 40% of missions have succeeded so far.

How does it work?

- **Landing site** - The landing site is Elysium Planitia, where InSight can stay still and quiet all through.
- It is a vast, smooth lava plain that NASA calls "the biggest parking lot on Mars".
- This featureless, and hopefully quiet, landscape is well-suited for the mission, to map the interior of the planet.
- **Lander** - The lander (6m × 1.56m, deck height 83-108 cm) carries a robotic arm 1.8 m long.
- The lander will use a set of instruments to study the makeup and dimensions of the planet's core, mantle and crust.
- It is powered by two solar panels, and carries a seismometer, heat probe and a radio science experiment.
- Two complementary engineering cameras help with navigation and hazard avoidance.
- **Satellites** - Along with the spacecraft, a pair of mini satellites known as Mars Cube One, or MarCO also reached Mars.
- The satellites provided real-time updates of the spacecraft's supersonic descent.
- **Observation** - From Earth, NASA team will be monitoring radio signals using a variety of spacecraft and even radio telescopes on Earth.
- Signals will come from various sources -
 - i. the lander during descent
 - ii. two experimental briefcase-sized spacecraft called MarCOs that is flying behind InSight
 - iii. InSight itself after landing
 - iv. the Mars Reconnaissance Orbiter (MRO) spacecraft during descent
 - v. the 2001 Mars Odyssey (Mars orbiter) after InSight's touchdown



3.14 Chang'e-4 Spacecraft

Why in news?

China recently launched Chang'e-4 spacecraft, which has landed on the dark side of the moon.

What is the mission all about?

- The moon, though has two sides, is tidally locked with Earth.
- It rotates exactly once every time it circles our planet, thus keeping the same hemisphere pointing toward Earth at all times.
- Astronomers refer to the side we always see from Earth as the “near side” and the side we can never see as the “far side (dark side).”
- A Chinese lunar probe named Chang'e-4 made the first-ever landing on the far side of the moon.
- It carries a rover, which carries out low-frequency radio astronomical observations and probing of structure and mineral composition of the terrain.
- The instruments include cameras, low-frequency radio spectrum analyser, lunar neutron and radiation dose detectors.
- With its Chang'e 4 mission, China has possibly become the first country to make a soft landing, which is a landing of a spacecraft during which no serious damage is incurred.
- Thus, the pioneering landing demonstrates China's growing ambitions as a space power.

What is the importance of the launch?

- **Exploration of moon** - The mission could answer fundamental questions about Earth's only natural satellite, the moon.
- It could reveal formation and early evolution of moon, which could guide astronomers in planetary studies and help in understanding exoplanets.
- **Radio Astronomy** - Communication devices and satellites have made it too noisy for radio astronomers to easily and accurately interpret signals.
- The near side of the moon also suffers from this problem of noise.
- However, the moon's far side is shielded from all the radio waves emanating from earth.
- Hence, it is an ideal place to set up a radio telescope that could reveal astronomical mysteries, such as the structure of the universe shortly after the Big Bang.
- Also, the difference in the thickness of the crust between the near side and the far side would be studied.
- **Human spaceflights** - The probe is the first mini-greenhouse to land on another world in the solar system.
- The investigations will reveal whether plants can grow on the moon, which is a crucial step toward long-term human missions beyond Earth.
- Thus, the mission is a step forward in preparing people to return to the moon for longer than a brief visit.

3.15 Discovery of Fast Radio Burst

Why in news?

Canadian Hydrogen Intensity Mapping Experiment (CHIME) has reported the sighting of a repeating fast radio burst from a distant galaxy.

What are Fast Radio Bursts?

- Fast Radio Bursts are brief (few millisecond) bursts of radio waves coming from far beyond our Milky Way galaxy.
- The phenomenon was first reported in 2007 and as of mid-2017, roughly two dozen have been reported and their origin is unknown.
- However, they are ubiquitous: current best estimates suggest these events are arriving at Earth roughly a thousand times per day over the entire sky.

- Of the known detected FRBs, one, FRB 121102, has been observed to repeat and has been shown to come from a small dwarf galaxy at redshift 0.2.
- Whether all FRBs repeat and/or are in dwarf galaxies is yet unknown.

What is CHIME?

- The CHIME Telescope is located at the Dominion Radio Astrophysical Observatory (DRAO), a national facility for astronomy operated by the National Research Council of Canada.
- The DRAO site is protected against man-made radio-frequency interference by municipal, provincial and federal regulation.
- The CHIME telescope's large collecting area, wide bandwidth and enormous field-of-view make it a superb detector of FRBs.
- The CHIME FRB event rate is predicted to be between 2 and 50 FRBs per day.
- So high an event rate promises major progress on this puzzling new astrophysical phenomenon.
- Bright CHIME-discovered FRBs will be found in real time and reported immediately to the worldwide astrophysical community for multi-wavelength follow up.

What are the recent reporting of the CHIME?

- A mysterious radio signal emanating from a galaxy far, far away has been detected by CHIME.
- The discovery is significant because it's only the second time ever a repeating signal has been observed by scientists.
- In addition to the second repeater, the researchers were able to shed new light on FRBs because they detected them at a much lower frequency than previously recorded finds.
- The radio bursts were observed by CHIME at frequencies between 400 megahertz (MHz) and 800 MHz.
- The majority of previously detected FRBs were found at frequencies near 1400 MHz.

3.16 Manned Space Mission - Russian Rocket Launch Failure

What is the issue?

- A Russian rocket launch recently failed but both astronauts on board survived the failure.
- With its preparations for a manned space mission, India must look into the measures on astronaut safety.

What happened?

- The Russian rocket Soyuz FG was on an expedition to the International Space Station.
- The failure of the rocket led to the abortion of this Expedition.
- On board the Soyuz MS 10 mission were Alexey Ovchinin of Roscosmos and Nick Hague of NASA.
- The failure was detected at an altitude of 50 km.
- So an emergency operation was carried out to separate the crew module.
- The astronauts landed on Earth some 402 km from the launch site at the Russian Baikonur cosmodrome.
- It was the first mid-flight failure of a Soyuz rocket since 1975.
- In 1975, a mission was aborted after the second stage failed to fire while it was climbing to leave Earth's atmosphere, with crew on board.

What is the significance?

- The first successful human space flight in 1961 was by Yuri Gagarin.
- Since then, 18 astronauts (13 Americans, 4 Russians, 1 Israeli) have lost their lives on space missions.
- The rocket, the crew module and all systems involved require a "human ratings certification" before they can be used to send a human into space.



- The failure of Russian rocket launch has come as a reminder of the perils and technological challenges involved in every space flight.
- The survival of the astronauts on board has been hailed as an example that underlines the safety measures that were in place.
- **India** - The ISRO is preparing to become the 4th country to launch a human into space (after Russia, the US and China).
- In this line, ISRO's Gaganyaan mission is given the 2022 deadline.
- The focus is now moving from a mission-critical nature to a safety-critical launch nature of rockets.

What are the NASA safety guidelines?

- A NASA manual on human ratings of space systems is available in the public domain.
- It underlines the difference between the development of systems for human space flights and missions with robotic payloads.
- A human-rated system -
 - i. accommodates human needs
 - ii. effectively utilizes human capabilities
 - iii. controls hazards and manages safety risk associated with human spaceflight
 - iv. provides, to the maximum extent practical, the capability to safely recover the crew from hazardous situations
- While designing a rocket to launch any mechanical payload, scientists do not have to consider factors like -
 - i. the amount of heat generated
 - ii. vibration caused
 - iii. metallic changes in the payload capsule
- But for rockets meant to carry humans, all these factors will have to be brought within human tolerance levels.
- The rocket has to be designed to 25% above the worst case of the expected load in the case of a satellite launcher.
- For a human-rated launcher, it has to be designed 40% above the worst-case loads.
- This is difficult and challenging to do without making the rocket really heavy.

How is GSLV in this regard?

- ISRO's GSLV Mk III has undergone one experimental and one developmental flight.
- It is expected to make 10 flights, including two in the form of an unmanned human space launch vehicle.
- It is set to finally launch humans in 2022.
- The GSLV Mk III was designed in the 2000-2002 time-frame, to ultimately become a vehicle that takes a human to space.
- So it was designed keeping in mind human flight in the future and may not need any major tweaking.
- The design conditions were kept in such a way that acceleration, reliability, safety, vibration and other aspects are all addressed right at the design stage.
- But, instrumentation and processing required to abort a mission without causing damage to the crew are being looked into.

What should India do?

- India needs to build safety critical features into rockets.
- The crew escape system is crucial to the human space mission.
- The principle here is that there can be a less reliable rocket but a highly reliable crew escape system.

- The most important part of a human space flight is the ability to detect an imminent danger and take action to abort the mission.
- India needs to have systems for this and onboard intelligence required, to see what is happening around and take action if anomalies develop.

3.17 BepiColombo Spacecraft - ESA and JAXA Joint Mission to Mercury

Why in news?

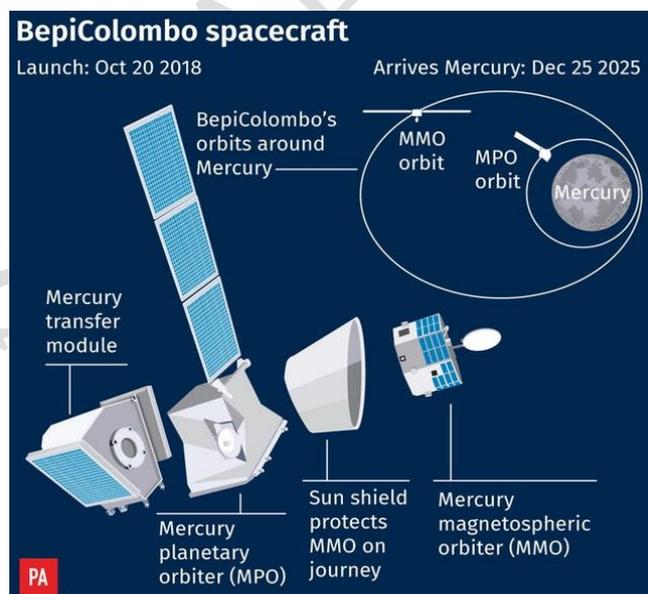
The European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) successfully sent two probes on a joint mission to Mercury.

What is the mission on?

- It is the first European mission to Mercury.
- It is also the first to send two spacecraft to make complementary measurements of mercury and its environment at the same time.
- An Ariane 5 rocket was launched from French Guyana.
- It lifted an unmanned spacecraft, BepiColombo, which is carrying the two probes.
- The spacecraft separated and went into orbit for the 7-year trip to Mercury.

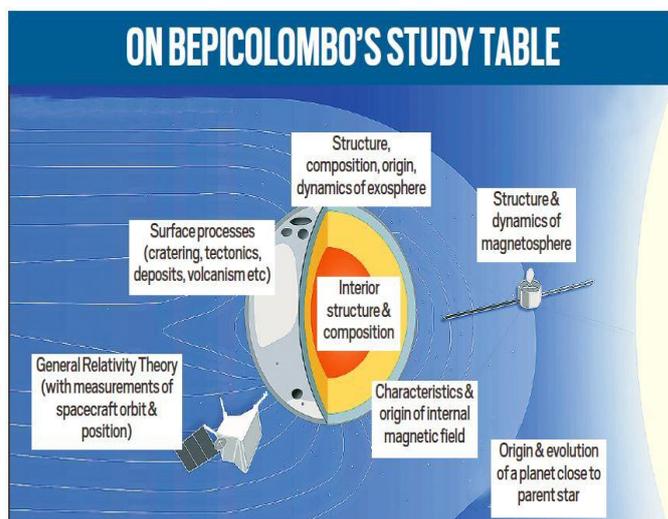
What are the components?

- The orbiters are ESA's Mercury Planetary Orbiter (MPO) and JAXA's Mercury Magnetospheric Orbiter (MMO, or 'Mio').
- A third component is the ESA-built Mercury Transfer Module (MTM).
- MTM will support the duo during the long cruise to the solar system's innermost planet.
- BepiColombo is scheduled to slip into orbit around Mercury in December 2025, after nine different planetary flybys (one of Earth, two of Venus and six of Mercury).
- It uses a combination of solar electric propulsion and the gravity assist flybys.
- Gravity assists flybys are precision maneuvers that involves the harnessing and using the gravity of a planet to accelerate and direct a spacecraft to its destination.
- Flybys are essentially used to increase the energy of a spacecraft's solar orbit beyond the velocity afforded by its launch vehicle.



What are the objectives?

- **Venus en route** - The two orbiters will be able to operate some of their instruments during the cruise phase, to try and collect data at Venus.
- Also, some of the instruments designed to study Mercury in a particular way can be used in a completely different way at Venus (has a thicker atmosphere).
- **Mercury** - A few months before reaching Mercury, the transfer module will be abandoned.
- This will leave the two science orbiters to be captured by Mercury's gravity.





- MPO will separate and descend to its own orbit, and together the orbiters will make measurements.
- The diverse data gathered by the duo will offer a comprehensive picture of the rocky planet.
- It would shed light on its composition, structure, magnetic field, formation and evolution, among other characteristics.
- **Challenges** - The Sun's enormous gravity makes it difficult to place a spacecraft into a stable orbit around Mercury.
- Thus the mission will have to ensure a controlled fall.
- Also, the spacecraft has hence been specially designed for extreme temperatures.

3.18 Space Debris

What is space debris?

- Anything launched into the space remains in space, almost forever, unless it is specifically brought down or it slowly disintegrates over decades or centuries.
- Satellites that are past their life and are no longer required also remain in space, orbiting aimlessly in some orbit.
- As per the recent Orbital Debris Quarterly News, published by NASA, there were 19,137 man-made objects in space that were large enough to be tracked.
- These included active and inactive satellites, rockets and their parts, and other small fragments.
- Besides these, there are millions of other smaller objects that have disintegrated from these and keep floating around in space.
- According to the European Space Agency, there were an estimated 7,50,000 objects of size one cm or above in space.
- In this context, a satellite that is destroyed by a missile disintegrates into small pieces, and adds to the space debris.



How is space debris a threat?

- Space debris is one of the principal threats to satellites as they could collide with the operational satellites and render them dysfunctional.
- E.g. China carried out its first anti-satellite missile test in 2007, destroying its Fengyun-1C weather satellite.
- This created more than 2,300 large pieces of space debris, and an estimated 1.5 lakh pieces of objects that were larger than 1 cm in size.
- Each of them could render a satellite useless on collision, and the debris damaged a functional Russian satellite.
- Debris also came close to hitting the International Space Station.
- Countries are launching more and more satellites, with each of them being a strategic or commercial asset.
- So avoiding collisions could become a challenge in the future for all.

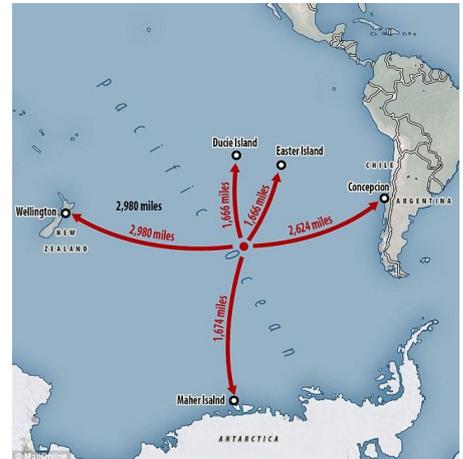
What are the international agreements in place?

- The Outer Space Treaty of 1967 prohibits countries from placing into orbit around the Earth any objects carrying nuclear weapons or other weapons of mass destruction.
- India is a signatory to the Outer Space Treaty.
- The treaty also prohibits the stationing of such weapons on celestial bodies, like the moon, or in outer space.
- It mandates that outer space, and celestial bodies like the Moon, must only be used for peaceful purposes.
- There are at least four more multilateral treaties that deal with specific concepts agreed to in the Outer Space Treaty.

- But besides these, the problem of space debris is a key reason why countries resist from destroying each other's satellites.

What is a spacecraft graveyard?

- There are larger space objects that may not entirely burn up before reaching the ground.
- Spacecraft operators can thus plan for the final destination of their old satellites to make sure that any debris falls into a remote area.
- A 1,500 sq km area in Southern Pacific Ocean is said to be the spacecraft graveyard or spacecraft cemetery.
- This is suitably far from any coast and human habitations thereby.
- Notably, more than 260 satellites were brought down there so far.



What could be done?

- **Passivation** - Satellite explosions are reduced by deactivating various systems.
- **Design for demise** - Designing with material that burn up on re-entry.
- **Deorbiting systems** - Under international guidelines, satellites are brought down within 25 years after mission life.
- **Design for servicing** - Grips or handles can be caught by a robotic arm or astronauts for repairs.
- **RemoveDEBRIS** - An innovation led by University of Surrey's Space Centre, UK.
 - It was launched on a SpaceX flight to International Space Station recently.
 - It will be released into low-earth orbit, where it will release a smaller satellite that will recapture space junk with a harpoon.
- **ISRO** - ISRO is looking to develop reusable launch vehicles.
 - It had notably conducted a space capsule recovery experiment in 2007.

United Nations Office for Outer Space Affairs (UNOOSA)

- The UNOOSA works to promote international cooperation in the peaceful use and exploration of space.
- The Office assists any United Nations Member States to establish legal and regulatory frameworks to govern space activities.
- It also strengthens the capacity of developing countries to use space science technology and applications for economic and social development.
- It does this by helping to integrate space capabilities into national development programmes.

Inter-Agency Space Debris Coordination Committee (IADC)

- The IADC is an international governmental forum.
- It works for worldwide coordination of activities related to the issues of man-made and natural debris in space.
- The primary purposes of the IADC are to -
 - i. exchange information on space debris research activities between member space agencies
 - ii. facilitate opportunities for cooperation in space debris research
 - iii. review the progress of ongoing cooperative activities
 - iv. identify debris mitigation options

3.19 Sunspots

- Sunspots are temporary phenomena on the Sun's photosphere that appear as spots darker than the surrounding areas.



- They are regions of reduced surface temperature caused by concentrations of magnetic field flux that inhibit convection.
- Sunspots usually appear in pairs of opposite magnetic polarity, their number varies according to the approximately 11-year solar cycle.
- Individual sunspots or groups of sunspots may last anywhere from a few days to a few months, but eventually decay.
- The larger variety are visible from Earth without the aid of a telescope.
- Similar phenomena indirectly observed on stars other than the Sun are commonly called star spots.

3.20 Solar Tsunami

- Recently a group of solar physicists suggests that a “solar tsunami” is at work that triggers the new sunspot cycle, after the old one ends.
- Sun has toroidal magnetic field, from which sunspots get generated.
- Holding these fields in their place requires extra mass (plasma mass) from higher latitudes for storing a big mass of plasma a magnetic dam is formed.
- At the end of a solar cycle, this magnetic dam can break, releasing huge amounts of plasma cascading like a tsunami towards the poles.
- These tsunami waves travel at high speeds of about 1,000 km per hour carrying excess plasma to the mid-latitudes.
- There they give rise to magnetic flux eruptions and these are seen as the bright patches that signal the start of the next cycle of sunspots.

3.21 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.
- The project has been six years in the making by a joint-team of South African, Dutch and British scientists.
- **India and SKA** - The National Centre for Radio Astrophysics (NCRA) and the Raman Research Institute (RRI) were, among the 8 institutions from 6 countries that signed an agreement in 1997 to work on a technology study for a very large radio telescope.
- India, has, however, remained an associate member while Australia, Canada, China, Germany, Italy, the Netherlands, New Zealand, South Africa, Sweden and the U.K. became full members of the SKA Organisation with voting rights.



4. IT AND COMPUTERS

4.1 Net Neutrality Rules in India

Why in news?

Telecom commission of India has approved the net neutrality rules under new telecom policy.

What is move on Net neutrality?

- The Telecom Commission is the highest decision-making body in the Department of Telecommunications.
- Recently the commission has approved the net neutrality rules implying internet will remain open to everybody in the country.
- Apart from net neutrality rules, the commission has also approved the new telecom policy, National Digital Communications Policy (NDCP) 2018.
- It is aimed at promoting investments, ease of doing business, and emerging technologies like 5G.
- This decision, which comes within a month of the US nullifying its own net neutrality rules, reiterates India's firm commitment to a non-discriminatory net regime.

What is the significance of the recent move?

- The move on net neutrality is in sync with the recommendations of the Telecom Regulatory Authority of India (Trai).
- It is meant to ensure no service provider can restrict or discriminate in the treatment of content by blocking, slowing down or granting preferential speeds while providing internet access.
- A net-neutral regime allows smaller businesses and individuals to create and disseminate content without fear that their offerings will be swamped by larger competitors, or throttled by ISPs.
- It will remain an open platform and internet service providers (ISPs) will be prohibited from practices such as blocking content, degrading speeds, slowing specific content, or granting differential speeds or treatment.
- In that sense, net neutrality helps to promote innovation across the entire digital ecosystem.

What are the concerns with the move?

- Given India's hyper-competitive market, where telecom service providers have been struggling to generate enough revenues to service debts, tight net neutrality could be considered a restrictive approach.
- For example, under net neutrality, telecom service providers cannot offer "zero-rating" services where they charge surfers less to access specific websites or content run by partners.
- It does certainly restrict the freedom of telecom service providers to offer favourable terms to specific content providers, and does cut down the potential for creating new revenue streams.
- In technical terms new rules require both monitoring of compliance as well as a willingness to accept consumer complaints and penalise operators who violate the rules.

What measures needs to be taken?

- Key element about the net neutrality regime is that certain critical services may be exempt from it.
- It is up to the government now to decide on services that deserve exceptional treatment by regulators.
- For example, emergency remote diagnostic and telemedical services may need to be fast-tracked.
- The same may also be necessary for disaster management or during crowd management situations such as pilgrimages.
- Critical high-tech services like the management of smart power grids could also require priority, and there may be new applications such as autonomous car communications or drone operations, which might merit priority.
- On the whole, this policy should boost innovation by helping to maintain a level-playing field across the digital landscape.
- That will enable everyone from small businesses to artists to create and offer content without fear of being stifled.

4.2 Indigenising India's Cyber Space

What is the issue?

With emerging cyber threats and national security challenges, it is crucial for India to indigenise the IT infrastructure of its military.

What are India's aims in this regard?

- The following were spelt out at different instances as priorities in the cyber space -
 - i. a Digital Armed Force and the increasing importance of dominating the cyber space
 - ii. preparing for rivalries in cyber space
 - iii. the role of the services in encouraging the development of domestic capabilities
- The first vision is on its way to realisation as the government has sanctioned recently the raising of a cyber agency.
- This will steer the planning and conduct of cyber warfare in the military.
- Hopefully, once the doctrine has matured, the cyber agency will be expanded to a much-needed cyber command.
- But the goal of building domestic capability remains largely unfulfilled.

What is the emerging global threat?

- Under the PRISM programme, the US National Security Agency (NSA) collected data from internet communications.
- Leaked documents showed the close involvement of US technology companies like Microsoft, Google, Yahoo, Facebook and Apple.
- The NSA was collecting data directly from the servers of US service providers.
- Microsoft had actively helped the NSA to avoid its own encryption of web chats on Outlook.com.
- It also permitted PRISM to access its cloud storage service SkyDrive, and monitor Skype chats.
- Microsoft denied these allegations, but the evidence was overwhelming.
- Likewise, a recent Bloomberg report highlighted China's intelligence services' similar moves.
- It ordered subcontractors in China to plant malicious chips in Supermicro server motherboards bound for the US.
- Faced with these dangers, countries have moved to restrict foreign products from use in critical networks.
- E.g. in 2014, China banned government offices from buying Microsoft Windows
- Recently, US President Trump signed a bill banning the use of Chinese Huawei and ZTE technology by the US government.
- This followed a 2017 ban on the Moscow-based Kaspersky Lab.

What is the case with India?

- India seems to be largely unaware of the vulnerabilities that exist in the critical networks due to foreign hardware and software.
- **BSNL** - Over 60% of software and hardware being used by BSNL is sourced from Chinese Huawei or ZTE.
- This is despite Huawei being probed for hacking a BSNL network in 2014.
- In 2017, BSNL signed a memorandum of understanding with ZTE for research and commercialisation of future 5G technology.
- Notably, Australia has banned Huawei from supplying equipment for 5G mobile network, citing national security risks.
- **AFNET** - The Air Force Network (AFNET) was launched in 2010.
- Cisco (US network equipment maker) was a major supplier of equipment for AFNET.

- The army's latest communication backbone, Network for Spectrum (NFS), also uses Cisco equipment.
- Rather than looking at indigenous equipment, the request for proposal for NFS equipment had been manipulated to favour Cisco.
- **Software** - The Indian Army mostly uses the Microsoft Windows operating system on its official computers.
- Windows is an outstanding system but is a closed-source software owned by a company that is bound by US laws.
- It is historically tied to the American intelligence community.
- Notably, India is a prime target for American spying as India stood at the 5th place in the overall list of countries targeted by PRISM.

What is the proposal in this regard?

- In 2015, the Northern Command of the army decided to adopt the Bharat Operating System Solutions (BOSS) for all its official computers.
- BOSS is an indigenously developed open-source system by the Centre for Development of Advanced Computing.
- [It is an R&D organisation of the Ministry of Electronics and Information Technology.]
- **Concerns** - Replicating the user-friendliness of Windows and re-training of a generation that had grown up with Windows were key challenges.
- But three years later, the army is still debating the merits of BOSS.
- The arguments are still centered on simplicity of usage, and not on security of networks.
- There is even a push to return to Windows, instead of supporting BOSS.

What lies ahead?

- Building domestic capability for the manufacture of sophisticated weapons and equipment is indeed a major challenge.
- But the same cannot be said for the hardware and software being used in the military information technology (IT) infrastructure.
- Despite Indian products being available, a concerted effort to use indigenous solutions is conspicuously absent.
- But with clear dangers in cyber space, India needs to move towards making changes that are essential to protect national interests.
- A key task is for the Indian military to take the lead in indigenising its IT infrastructure.

4.3 Blockchains for Internet of Things

What is the issue?

- The Internet of Things is gaining momentum as the much deployed technology in the world across sectors.
- In this backdrop, here is how the blockchain architecture could satisfy the key demands of IoT.

What is IoT?

- The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people.
- These are provided with unique identifiers (UIDs) and the ability to transfer data over a network.
- The transfer happens without requiring human-to-human or human-to-computer interaction.

How significant is this becoming?

- Estimatedly, the number of connected devices in the world could grow 2.4-fold, from 6.1 billion in 2017 to 14.6 billion by 2022.
- Traffic from these connected devices is expected to grow seven-fold over the same period.

- With this, there will be an exponential increase in both the number of devices and amount of data transmitted.

What are the challenges?

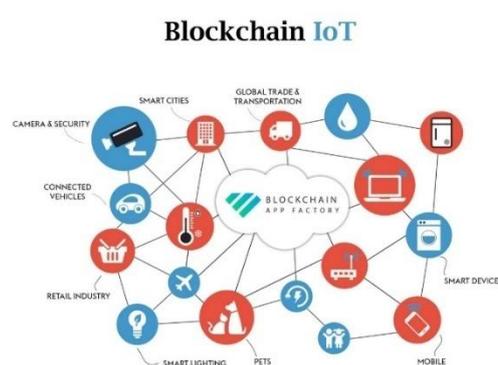
- With IoT, a large amount of data is being captured from all around people by millions of devices.
- So there are reasonable concerns with respect to scalability, reliability and security, when considering the creation of large IoT networks.
- So it is essential to provide for an acceptable level of confidence in the platforms that will power the Internet of Things.
- Besides, a key question is if optimum economic value could be derived from the vast amount of data generated.
- The answer is not that encouraging as the quality and adequacy of the back-office systems and technologies are not adequate yet.
- Globally, only about 30% of IoT projects survive beyond the pilot phase.
- This is a powerful indicator that much needs to be done to effectively tap this new technology.

How does blockchain help here?

- The blockchain or multi-ledger technology provides the possible solution in handling the large amount of data.
- Blockchain was designed specifically as a back-end for Bitcoin, a crypto-currency.
- [It is a digital public ledger that records every transaction. Once a transaction is entered in the blockchain, it cannot be erased or modified.]
- But the conceptual architecture of blockchain, being versatile, has evolved and found theoretical application in nearly every industry.
- It can work as a distributed network, and safely execute on a wide variety of requirements.
- This makes it an ideal candidate to support the level of innovation and adoption required for IoT to succeed.
- The key issues of scalability, identity management, autonomy, reliability, security and marketing can all be addressed.
- But the IoT - Blockchain combination rarely gets the attention it deserves.

What are the key features of IoT-Blockchain use?

- **Decentralisation** - The current centralised architectures of IoT networks is problematic when it comes to citywide networks.
- Decentralisation is a core feature of blockchains; the expected points of failure and scalability bottlenecks in IoT can be adequately addressed.
- If implemented appropriately it could allow for a shift to peer to peer network designs, greater fault tolerance and expedited scalability.
- **Managing identities** - A massive IoT network would also be required to manage identities - of both users and things.
 - With blockchain, all identity records can be contained within a single network, thus facilitating their discovery and management.
- **Autonomy** - The very nature of IoT mandates a certain level of autonomy in the functioning of enabling platforms.
 - The reliance on server farms is expected to be significant for any large scale IoT implementation.
 - With blockchain, devices would be able to communicate without the need for large server farms.
- **Security** - In IoT, authenticity and verification of data are critical, especially in the case of digitised citywide networks.



- The tamper-proof nature of the blockchain provides the much-needed security to IoT platforms.
- Powered by smart contracts, the blockchain could enable secure communications between devices, with scope for radical innovation.

How could large scale adoption be ensured?

- The blockchain possesses the ability to increase market access for deployed services.
- Transactions between peers can be simplified to a significant degree, and without the need for authorities or third parties.
- The blockchains' trustless environment ironically offers unprecedented levels of distributed security.
- This is ideal for the deployment of micro services and for the simplified execution of micro transactions.

4.4 Banning of Blockchain

Why in news?

The Banning of Cryptocurrency and Regulation of Official Digital Currency Bill, 2019 has been leaked recently.

Why is there support for the ban?

- There are high chances of cryptocurrencies being misused in money laundering.
- Various government bodies such as IT, CBDT, and the customs departments are supporting its ban.
- The bill has proposed stringent penalties, including 10 years of imprisonment for holding, selling or dealing in cryptocurrencies.

What is a blockchain?

- It is an **accounting ledger** which can store data on any real-world transaction of any kind.
- The unique feature of this ledger is the **decentralised style**.
- Every computer connected to a blockchain network helps validate and record transactions.
- People who connect their computers to a network are known as validators and receive transaction fees in the form of tokens.
- It also has **data encryption**, which makes it highly resistant to tampering.
- It can perform on **public basis** (such as Bitcoin) **or private**, with a single entity operating a closed blockchain system.

What is the potential of blockchain?

- Blockchain technology has the **potential to create new industries** and transform existing ones.
- Some **new companies are investing millions** in research and development.
- Venture capitalists invested \$2.4 billion in blockchain and cryptocurrency start-ups in 2018.
- **Even big technology companies** have started to take blockchain seriously. E.g Facebook's cryptocurrency Libra.

Why shouldn't there be a ban?

- A law to ban cryptocurrency would **prevent Indians from reaping economic benefits** by participating in blockchain networks as validators and earning transaction fees.
- The ban also will **stifle any innovation related** to this disruptive emerging technology.

What India can learn from Europe?

- The European Parliament and European Council are working on an **anti-money laundering directive** known as AMLD5.
- All crypto exchanges and wallet custodians operating in Europe will have to **implement strict know-your-customer (KYC)** onboarding procedures and need to **register with local authorities**.
- They will be required to **report suspicious activities** to relevant bodies.

- The EU Commission is also proposing
 1. self-declaration by virtual currency owners,
 2. the maintenance of central databases registering users' identities and wallet addresses, and
 3. norms while using virtual currencies as payment or investment means by 2022.
- This is a more reasonable approach, and the Indian government could follow suit.

4.5 Facebook's Cryptocurrency – “Libra”

Why in news?

Facebook announced its plans to launch “Libra” a digital currency, in 2020.

What is Libra?

- Libra is a virtual currency, which users buy and store in a digital wallet.
- It can be used for transactions on a decentralized network that is not controlled by one bank or a government.
- It is powered by a technology called ‘Blockchain’, which functions like an open ledger that gets updated in real time.
- 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.

How it works?

- Once launched, users will be able to buy Libra and add it to their digital wallet.
- Libra will be built into Facebook Messenger and WhatsApp, allowing users to send and receive money via messages.
- People will be able to send money at “low to no cost”
- Libra will also be used for offline payments, such as paying bills, buying coffee, or paying for public transport.

Is Libra different from other Cryptocurrencies?

- The values of most cryptocurrencies, such as Bitcoin, tend to fluctuate against real currencies.
- The plan is to ensure Libra is stable and give users confidence.
- Libra will be backed by a reserve of assets designed to “give it intrinsic value” and ensure stability.
- These assets include securities and fiat currencies (like the dollar, pound).
- The Libra reserve will include bank deposits and government bonds in several international currencies.
- However, the value of the one Libra in any local currency may fluctuate.
- Libra is planned as a “global currency” for use anywhere in the world without transaction fees.
- It will target those who are left out in the formal banking sector.

Who is involved?

- Facebook is also launching its Subsidiary Company, called “**Calibra**” which will handle its crypto dealings.
- “**Calibra**” is a digital wallet, which will store Libras.
- Libra will be controlled by the ‘**Libra Association**’, a non-profit based in Geneva.
- The currency has been backed by Visa and Mastercard, as well as tech firms like Uber, Lyft, Spotify, ebay, Paypal and PayU from India.

Is ‘Libra’ a privacy concern?

- Libra will be built on its own blockchain, a decentralised database that records the history of transactions over time.
- Facebook has said that account details will not be shared with Facebook or third parties for advertising purposes, except for cases of data sharing “to keep people safe, comply with the law.”

- Also Facebook stated that, If someone loses their Libra coins from Calibra wallet, they will get a refund.
- For Libra, a new programming language called 'Move' is being built, which the organization claims is more secure and private.

What about Indian Crypto law?

- Current regulations do not permit use of the banking network for blockchain currency transactions.
- The Ministry of Corporate Affairs Investor Education and Protection Fund (IEPF) Authority favours a ban on cryptocurrencies,
- Any such ban would hugely restrict the reach of Libra.

4.6 5G Technology

What is the issue?

The transition to fifth-generation cellular networks (known as 5G for short) is soon to happen.

What is the change in the making?

- The transition to 5G is an upgrade to wireless systems that will start reaching mobile phone users in a matter of months from now (Aug, 2019).
- But this is not just about faster smartphones.
- This will affect many other kinds of devices, including industrial robots, security cameras, drones and cars that send traffic data to one another.
- This new era will leap ahead of current wireless technology, known as 4G.
- This would offer mobile internet speeds that will let people download movies within seconds and bring big changes to video games, sports and shopping.
- To get the benefits of 5G, users will have to buy new phones, while carriers will need to install new transmission equipment to offer the faster service.

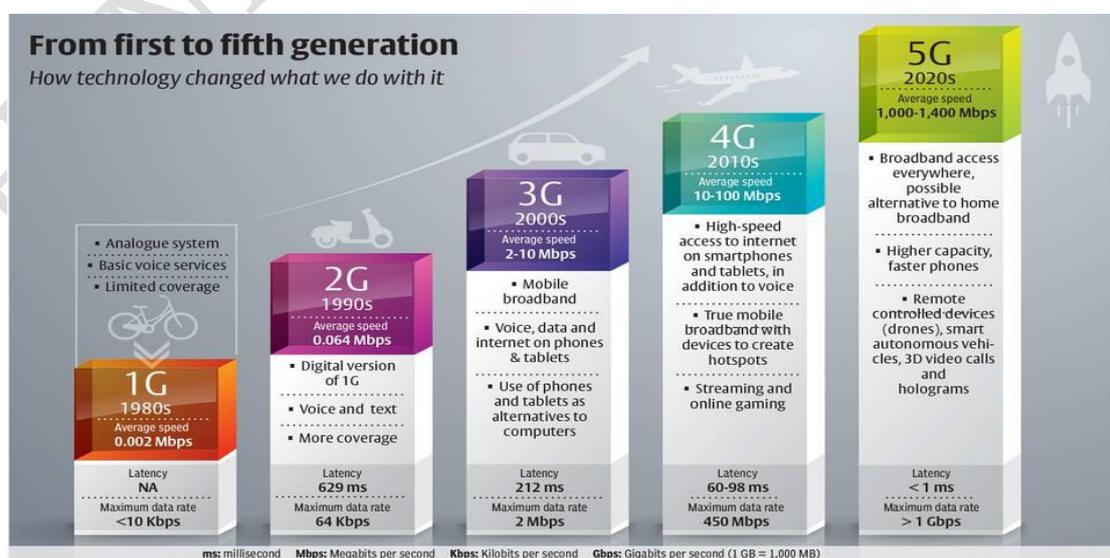
What exactly is 5G?

- 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.



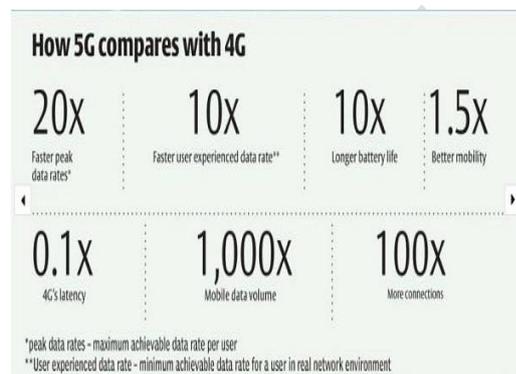
Where 5G technology can be applied

- Healthcare**
 - Reduce pharmaceutical R&D costs
 - Video/3D video appointments for non-life-threatening ailments
 - Development of robotics in surgery
 - More efficient health and fitness monitors
- Smart cities and homes**
 - 3D video calls and holograms
 - Innovative augmented and virtual reality applications
 - Improved public safety with more efficient trackers
 - Remote device control
- Transport**
 - Connected vehicles which allow data collection from traffic signals and road-side sensors will lead to
 - Reduced congestion
 - Intelligent fleet and logistics management
 - Autonomous cars with little or no help from humans can
 - Improve road safety
 - Increase mobility



What are the key benefits?

- **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.



4.7 Internet of Things

What is the issue?

Though Internet of Things throws up several data privacy challenges, India must push ahead.

What is the Internet of Things?

- The Internet of things (IoT) is the network of devices, vehicles, and home appliances that contain electronics, software, actuators, and connectivity which allows these things to connect, interact and exchange data.
- IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets to everyday objects.
- These objects may be anything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices.
- It can also be components of machines, for example a jet engine of an airplane or the drill of an oil rig.
- Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

- Thus, it is all about connecting devices over the internet and letting them ‘talk’ to us, applications and each other.
- However, Internet of Things doesn’t necessarily have to be connected to the internet; it can also be a network of things.

What is the case with India?

- IoT is the natural evolution of the internet and has many benefits including boosting global economies, improving public utilities, and increasing efficiencies.
- Many of our global counterparts have already begun reaping the rewards of investing in IoT-based infrastructure.
- The Indian government outlined a plan to leverage IoT as part of the Digital India mission.
- Indian IoT market is expected to reach \$15 billion by 2020 and constitute 5% of the global market.
- Investing in IoT will boost our economy on par with global leaders and it will also bring in investments, create jobs and improve Indian public infrastructure.

What are the concerns?

- IoT devices collect and share personal data in real-time, thus raising concerns on protecting personal information and privacy.
- There is growing concern about the potential for increased government surveillance and a resulting encroachment of civil rights to suppress dissent or marginalise communities.
- Additionally, the annual cost of cybercrime is over \$1 trillion.
- Since the IOT is capable of processing the tremendous amount of real-time data, it is possible for hackers and miscreants from accessing and manipulating those data.
- Also, several regulations across the world indicate that IoT companies need to collect user consent prior to collecting the said data.
- However, there is a debate around how best to communicate and receive consent for personal data collected.
- Thus, IoT manufacturers will have to build and sustain consumer trust in their devices.

What should be done?

- Policy-makers, regulators, device manufacturers, supporting industries and service providers will all have to join hands in creating a safer space online.
- The state of California in the US just passed the first IoT Cybersecurity law that holds IoT device manufacturers to higher security standards.
- The EU and the UK published guidelines and codes for IoT manufacturers.
- The Internet Society’s Online Trust Alliance (OTA) Trust Framework provides strategic principles to increase the security of IoT devices and data.
- In India, the NDCCP (National Digital Communications Policy) brought alignment from critical stakeholders to advance India’s infrastructure and security around digital communications.
- The draft IoT policy seeks to establish committees to govern and drive IoT-specific initiatives.
- It is not yet clear how much access to personal data these committees get and how their actions will be monitored.
- The Justice Srikrishna Committee had recommended some provisions for personal data protection including a consumer’s right to information, consent, and right to request companies to erase their data if preferred.
- However, it leaned heavily towards greater regulations and did not specify how to protect consumer data from unnecessary government surveillance.
- Despite these challenges, India must drive full speed ahead towards IoT technology for the greater good of our citizens.
- With effective global alliances and Indian stakeholder alignment, we can work to create more secure devices and help our citizens.



4.8 National Common Mobility Card

What is NCMC?

- NCMC cards are bank-issued cards on debit/credit/pre-paid card product platform.
- NCMC enables people to pay multiple kinds of transport charges, including metro services and toll tax, across the country.
- It is also known as 'One Nation One Card'.
- It is the first **Indigenously Developed Payment Eco-system** for transport consists of
 - i. NCMC Card
 - ii. SWEEKAR (Swachalit Kiraya: Automatic Fare Collection System (AFC))
 - iii. SWAGAT (Swachalit Gate).
- Ministry of Housing & Urban Affairs brought to the fore the National Common Mobility Card (NCMC) to enable seamless travel by different metros and other transport systems.
- The inter-operable transport card would allow the holders to pay for their bus travel, toll taxes, parking charges, retail shopping and even withdraw money.
- It is a bank-issued card on debit or credit or pre-paid card product platform.
- AFC System (gates, readers/validators, backend infrastructure etc.) is the core of any transit operator to automate the fare collection process.

What are its Advantages?

- It helps commuters to save time and efforts.
- It promotes smart travel as a card can be used in different modes of transport.
- It gives high degree convenience to people as they have no longer stand in a line for the ticket.
- It works as a debit card ensures proper customer support services.
- Time efficient, very easy and cashless.

What are its Disadvantages?

- It is very difficult for uneducated people as they are unable to read and write.
- As the technology changes the whole process of a transaction even the upgrade affects the people.
- Sometimes delay leads to poor customer services.
- Due to large dependency on technology there will be large setting up cost and for solving the problem of the public more manpower is needed.

4.9 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 (LEDs) 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.

Fiber Optics

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

4.10 LiFi

- 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.
- 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

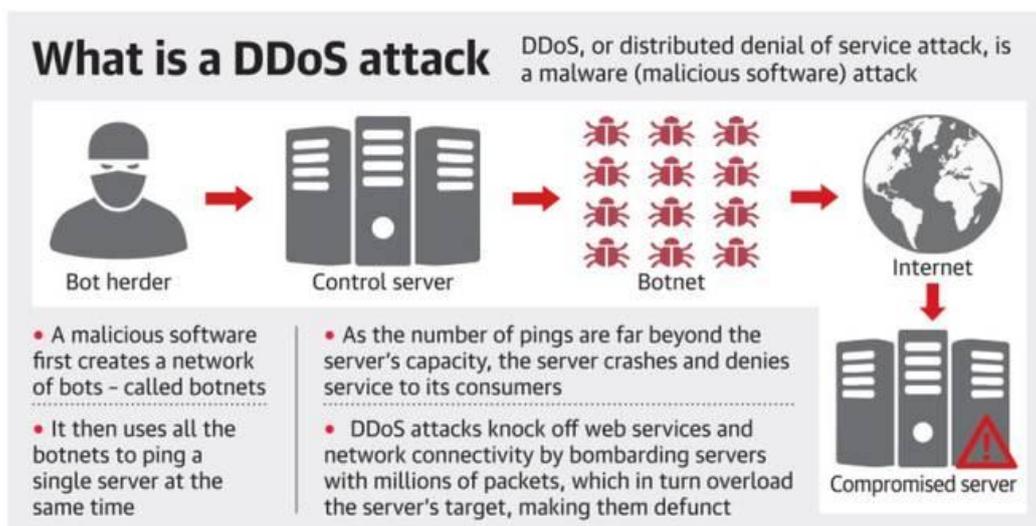
4.11 Dark Net

- In some registered cases, 'Dark Net' was used for sale and purchase of Narcotic Drugs and Psychotropic Substances as per the records of Narcotics Control Bureau.
- It is a computer network with restricted access that is used chiefly for illegal peer-to-peer file sharing.
- It also refers to networks that are not indexed by search engines such as Google, Yahoo or Bing.
- These are networks that are only available to a select group of people and not to the general internet public, and only accessible via authorization, specific software and configurations.
- In recent past ,Silk road ,an online dark market was busted which was used to sell drugs, weapons and stolen identities.

4.12 DDOS Attack

- Cyber security agencies have detected a new malware called Saposhi, which is capable of taking over electronic devices and turning them into 'bots'.

- Once turned into bots they can be used for purpose such as a Distributed Denial of Service attack.



- In 2017, CERT had issued an alert about Reaper.
- Reaper is a highly evolved malware capable of hacking devices like Wi-Fi routers and security cameras and also hiding its own presence in the bot – a device taken over by a malware.
- Mirai is also a malware that used a botnet of 5 lakh devices to crash the servers of Dyn, a leading domain name service provider, affecting services of popular websites like Twitter, Netflix and Reddit.

4.13 Augmented & Virtual Reality

- 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.



5. ROBOTICS

5.1 Significance of Artificial Intelligence

What is the issue?

- The countries with advantage in Artificial Intelligence (AI) could soon take form as concentrations of global power.
- It is high time that India use to its fullest advantage the IT and entrepreneurial competence, and a huge domestic market.



What is Artificial Intelligence (AI)?

- The human brain uses multiple techniques to both formulate and cross-check results.
- AI is the simulation of this human intelligence processes by machines, especially computer systems.
- These processes include learning, reasoning and self-correction.

Why is AI unique?

- Most industrial technologies develop in laboratories and then get applied by businesses.
- But, uniquely, AI develops within business processes as data are mined from digital platforms.
- These are then turned into intelligence and reprocessed to produce more data and intelligence.
- So any country's AI largely exists within its huge, domestically owned commercial digital/data systems.
- E.g. in the U.S. it is with Google, Amazon, Facebook, Apple and Microsoft.
- In China it lies with Baidu, Alibaba and Tencent.

How is India in this regard?

- India is not making a rational use of its great advantages of high IT capabilities.
- It also leaves unplanned, the big domestic market required for data harvesting.
- India is thus far behind in this emerging Artificial Intelligence race.
- It has no large domestically owned commercial data systems as that of US and China.
- Bleak chance, if any, could be hampered by allowing takeovers like that of Flipkart by Walmart.

What is the threat?

- **Economic** - India's consumer-behavioural and other economic data may soon be owned by Walmart and Amazon.
- This will offer them the scope to develop various kinds of Artificial Intelligence.
- Eventually, such AI will allow them to control everything.
- Every participant, along various economic value chains linked to consumer goods would be under their control.
- **Power** - Intelligent systems typically tend to centralise and monopolise control.
- Thus beyond economic dominance, AI influences cultural, political and military power.
- Notably, Google and Microsoft are partnering with U.S. military on AI applications.
- Likewise, China's AI platforms are working even more closely with its military.
- Logically, in the coming time, whoever rules Artificial Intelligence will rule the world.
- A non-AI military against an AI-powered one would be at a great disadvantage.

What are the concerns for India?

- **Competition** - The digital/AI industry works in huge ecosystems with global digital corporations at the centre.
- The US and Chinese firms are trying to ensure the largest number of clients and followers possible.
- Given this, start-ups, including in India, are struggling to find a place in huge global ecosystems.
- **Understanding** - Indian IT industry leaders are conveying a wrong message that India is doing well with AI.
- But these are only in reference to the fragment of IT/digital business.
- The real need is creating the highest levels of new value chains that AI will create in every sector.
- **Applications** - AI applications talked about in India are largely in reference to eased agriculture output, precision medicine or tailored learning.
- But these are just a miniscule of global digital/AI corporations, giving one-off benefits here and there.

- Evidently, the AI engine owned by Google or Microsoft is gathering further data from each new instance.
- In the course of time, they become more intelligent about India's problems and solutions.
- So a big nation like India cannot derive satisfaction from rapidly becoming a client country for AI.
- Owning the centres of systemic AI from controlling huge commercial data ecosystems is the real power.

What is the way forward?

- Policy makers should aim at building the systemic cores of AI where the real national advantage lies.
- India must welcome global technology companies to help India's digital development.
- But the challenge is, while technology is global, data are essentially local.
- So India must start treating its collective social/economic data as a strategic national asset.
- It thus has a right to provide domestic data protection through policy.
- So data-based sectoral platforms, like in e-commerce, agriculture, health, education, should largely be domestic.
- Such policy protection will encourage large-scale data-driven Indian companies to develop the highest AI in every sector.
- After developing enough AI proficiency domestically, it should be used to go global.

5.2 Need for a Legal Framework for AI in India

What is the issue?

Artificial Intelligence-/AI-driven tech will become counterproductive if a legal framework is not devised to regulate it.

What are the recent developments?

- Recently, the Kerala police inducted a robot for police work.
- Around the same time, Chennai got its second robot-themed restaurant.
- Here, robots not only serve as waiters but also interact with customers in English and Tamil.
- In Ahmedabad, a cardiologist performed the world's first in-human telerobotic coronary intervention on a patient nearly 32 km away.
- All these examples symbolise the arrival of Artificial Intelligence (AI) in everyday lives of human beings.

What are the global measures in this regard?

- Only recently, there has been interest across the world to develop a law on smart technologies.
- In the U.S., discussions are being taken up about regulation of AI.
- Germany has come up with ethical rules for autonomous vehicles.
- It stipulates that human life should always have priority over property or animal life.
- China, Japan and Korea are following Germany in developing a law on self-driven cars.

What is the need now in India?

- Traffic accidents lead to about 400 deaths a day in India, 90% of which are caused by preventable human errors.
- Autonomous vehicles that rely on AI can reduce this significantly, through smart warnings and preventive and defensive techniques.
- Patients dying due to non-availability of specialised doctors can be prevented with AI reducing the distance between patients and doctors.
- AI has several positive applications, as seen in the above examples.
- AI systems have the capability to learn from experience and to perform autonomously for humans.
- This also makes AI the most disruptive and self-transformative technology of the 21st century.



- So, if AI is not regulated properly, it is bound to have unmanageable implications.
- E.g. the consequence if electricity supply suddenly stops while a robot is performing a surgery and access to a doctor is lost
- These questions have already confronted courts in the U.S. and Germany.
- All countries, including India, need to be legally prepared to face such kind of disruptive technology.

What are the challenges involved?

- Predicting and analysing legal issues in regards with AI use and their solutions are not that simple.
- E.g. an AI-based driverless car getting into an accident that causes harm to humans or damages property
- In such cases, criminal law may face drastic challenges as the party to be held liable is disputable.

How is the AI policy progress in India?

- In India, NITI Aayog released a policy paper, 'National Strategy for Artificial Intelligence', in June 2018.
- The paper considered the importance of AI in different sectors.
- The Budget 2019 also proposed to launch a national programme on AI.
- But notably, all these developments are taking place on the technological front.
- No comprehensive legislation to regulate this growing industry has been formulated in India till date.

What should the priorities be?

- The first need is to have a legal definition of AI in place.
- It is essential to establish the legal personality of AI which means AI will have a bundle of rights and obligations, in the context of India's criminal law jurisprudence.
- Since AI is considered to be inanimate, a liability scheme that holds the producer or manufacturer of the product liable for harm must be considered.
- Moreover, since privacy is a fundamental right, certain rules to regulate the usage of data possessed by an AI entity should be framed.
- This should be a part of the Personal Data Protection Bill, 2018.

5.3 The Potential of Artificial Intelligence

What is the issue?

- AI is likely to become one of the most important technologies of our era.
- In this context, McKenzie's report that analyses the potential impact of AI is a worthy consideration.

What is Artificial Intelligence (AI)?

- Artificial Intelligence is an advanced stage of automation, where machines become capable of some form of decision making and cognitive functions.
- By virtue of analytical techniques, some form of preliminary automation has been existent since the 1970s.
- But performance of traditional analytics tends to plateau as the data set become considerably large, which was a major impediment.
- Contrarily, the evolving "Machine Learning Techniques" perform better with larger data sets, and their data requirements are also more massive.
- Machine learning methods are particularly valuable in extracting patterns from complex, unstructured data, including audio, speech, images and video.
- However, if a threshold of data volume is not reached, robust AI that could add value to the traditional analytics techniques, can't be built.
- AI has the potential to play a major role in three important business functions namely - process automation, cognitive analytics, and people engagement.

How is AI development progressing?

- Over the last few years, the necessary ingredients have come together to propel AI beyond research labs and into the marketplace.
- Among them are – Powerful but inexpensive computer technologies; huge amounts of data; and advanced algorithms including machine learning.
- Nonetheless, it is still early stages, and only leading-edge technology companies are presently in procession of advanced AI systems.
- But considering the rapidity in the way AI is progressing, it is pertinent for us to ideate now on - AI's economic potential, its limitations and challenges etc...
- In this context, McKinsey recently published a paper on the marketplace potential of AI, which is a worthy read.

What does Mckinsey's paper state?

- The paper is focused on machine learning and based its study on more than 400 use-cases across 19 industries and 9 business functions.
- **Applications** - Two-thirds of the opportunities to use AI are in improving the performance of existing analytical tools, and reducing human intervention.
- This implies that, AI majorly being applied successfully to tasks that not long ago were viewed as the exclusive domain of humans.
- Only 15% of the use cases studied by McKinsey are green-field cases, in which only machine learning techniques can be used.
- In the remaining 15% of cases, machine learning provided limited additional performance over existing analytical methods.
- **Economics** - It has been estimated that the potential value that AI would add to the global economy ranged between \$3.5 trillion and \$5.8 trillion annually.
- This is about 40% of the overall value for all analytical techniques.
- The most probable areas where AI's potential could be reaped are retail, transport, logistics, and travel.

What is the way ahead?

- In line with the current trend, companies are likely to adopt AI by incrementally leveraging and ramp up their existing analytics capabilities.
- For this, they need to make sure that they have access to the necessary data for the envisioned up-gradation.
- Such a pragmatic approach to getting on the AI learning curve is more sensible than attempting to tackle advanced, green-field AI problems.
- Notably, the latter requires the kinds of skills and data that are generally only available to tech giants.

5.4 Cyber-Physical Systems

- Union Cabinet has recently approved the launching of “National Mission on Interdisciplinary Cyber-Physical Systems”.
- The mission aims at establishment of Technology Innovation Hubs (TIH), Application Innovation Hubs (AIH) and Technology Translation Research Parks (TTRP).
- It is a Pan India mission covering Central Ministries, State Governments, Industry and Academia, to effectively use Cyber Physical System (CPS) technologies.
- CPS is an interdisciplinary field that deals with the deployment of computer-based systems that do things in the physical world.
- Smart grids, where electricity is optimally distributed on the basis of calculations in real time by micro-processors and autonomous unmanned vehicles and aircraft navigation systems qualify as ‘cyber physical systems.’



- Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning (ML), Deep Learning (DP), Big Data Analytics, Robotics, Quantum Computing, Quantum Communication, Quantum encryption (Quantum Key Distribution) are associated technologies of CPS.

6. NANO TECHNOLOGY AND BIO TECHNOLOGY

6.1 EU Ruling on Gene Editing

Why in news?

The European Court of Justice recently ruled that organisms obtained by mutagenesis are also GMOs within the meaning of the GMO Directive.

What is the ruling?

- The guidelines on genetically modified organisms (GMOs) will apply to plants bred using gene editing technology (mutagenesis).
- The techniques of mutagenesis should alter the genetic material of an organism in a way that does not occur naturally.
- These organisms will come, in principle, within the scope of the GMO Directive.
- They are subject to the obligations laid down by that directive.
- The ruling, however, leaves out other mutagenesis techniques like irradiation.
- It's because these have a proven track record and need not be considered under the same bracket.

What is 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.
- CRISPR was talked about recently for its successful use in human embryos.
- 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.

What are the benefits?

- Along with GMOs, gene-edited crops are considered to play an important role in increasing productivity.
- With gene editing, under appropriate regulations and policy, product development would be faster.
- It can be used to tackle specific traits by creating mutations.
- It is hoped that gene editing technologies would find wider acceptance than GM which faced opposition.
- As, gene editing does not involve introducing a foreign element into the plant's genetic code.
- **Concerns** - Questions over the efficiency of gene editing and its potential to disrupt the natural order exist.
- Also, the new ruling will affect research, with over 14,000 papers on gene editing having been published in 2017 alone.

What is the case with India?

- Indian experience with gene editing technology is mainly confined to research and not the field.
- Today India does not have any regulations on CRISPR as it does on GMO crops.
- But the Department of Biotechnology and Indian Council of Agricultural Research are in talks in this regard.
- There are demands from various sides for regulation on gene editing, for bio-safety.
- There is a need for a regulatory framework that does not take long processes for approval.

- India, instead of following the EU model of regulation, should take up models followed in the US, Australia and Canada.
- As, regulation has traditionally been stricter in Europe than in the US and Canada.

6.2 Genetically Modified Mosquitoes

Why in news?

The Department of Biotechnology (DBT) is hesitant to permit field trials to release GM mosquitoes to tackle certain diseases.

What is the initiative?

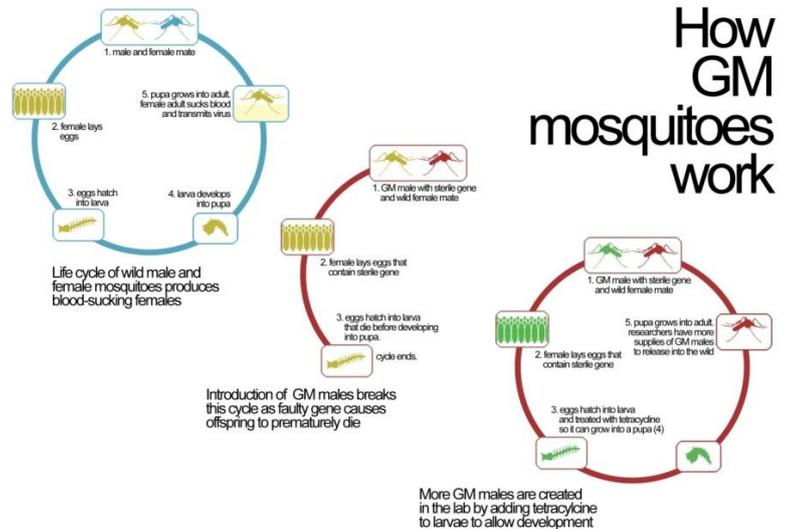
- *Aedes aegypti* mosquito is the carrier of diseases such as Zika, dengue and chikungunya.
- A new initiative thus aims at reducing the population of *Aedes aegypti* mosquito.
- It comes from the Mumbai-based company, Gangabishan Bhikunal Investment and Trading Limited (GBIT).

What is the new gene?

- Diseases such as Zika, dengue and chikungunya are transmitted when an infected, pregnant female mosquito bites somebody.
- Males do not bite and are, therefore, harmless.
- So GBIT wants to introduce a new Genetically Modified (GM) male *Aedes aegypti* mosquito.
- This GM insect has been bred by Oxitec, an R&D biotech company with roots in the University of Oxford.
- Oxitec has bio-engineered a *transgenic male Aedes aegypti* mosquito.
- This carries a *new gene fatal only to female mosquitoes*.

What does it do?

- The idea is to release a large number of such GM male mosquitoes into the trial zone.
- These 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.



How is it justified?

- The life cycle of a mosquito is only around two-three weeks.
- So the effects of the trial should be apparent in a few months.
- Transgenic males do not bite and the modified genes are said to be harmless to humans.
- The so-called “**Friendly Aedes**” project launched “closed cage” trials at the Oxitec facility in Maharashtra.
- Trials have been launched in Malaysia, Brazil, and Florida as well.
- Given these, permission has now been sought for open field trials in India.

Why is DBT hesitant to approve?

- Indian policy has been very cautious about allowing the genetically modified technologies.

- 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.

6.3 Potentials of Genetic Modification

What is the issue?

Despite the critical views on Genetic Modification (GM), there have been substantial benefits out of it, which needs recognition for further betterment.

What benefits has the GM technology brought?

- *Bacillus thuringiensis* (Bt) in maize and cotton from 1996 to 2015 contributed to a reduction in the gap between actual yield and potential yield.
- This was under circumstances in which targeted pests caused substantial damage to non-GE (Genetic Engineering) varieties.
- Also, synthetic chemicals could not provide practical control.
- But GM technology adoption has reduced pesticide use by 37%, increased crop yield by 22%, and increased farmer profits by 68%.
- Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops.
- Yield and profit gains are higher in developing countries than in developed countries.

What is the case with India?

- **Cotton** - Certainly, Bt cotton is not a failure in India. Farmers continue to grow Bt cotton.
- The yields hovering around 300 kg/ha at the time of introduction of Bt cotton (2002) have increased to an average of over 500 kg/ha.
- It has converted India from a cotton-importing country to the largest exporter of raw cotton.
- There was a small dip for a couple of years and the yield has now increased to over 550 kg/ha.
- Further, the development of resistance can be tackled through practices like Integrated Pest Management and by stacking Bt genes to fight secondary pests.
- The priority now is to accelerate development of Bt cotton varieties that can be packed densely in fields.
- By doing so, yields could be increased to over 800 kg/ha, as is the case with other countries.
- **Mustard** - GM mustard (DMH-11) is a technology to create mustard hybrids.
- Being a self-pollinator, mustard is difficult to hybridise through conventional methods.
- So genetic modification allows different parents to be combined easily, helping yields go up substantially.

What lies ahead?

- Genetic engineering technology has opened up new avenues of molecular breeding.
- However, their potential undesirable impacts will have to be kept in view.
- What is important is to choose the one which can take the country to the desired goal sustainably, safely and economically.

- There is scope for further improvement in terms of technology and regulatory protocols for GM technology in India.

6.4 Gene editing in a human embryo

Why in news?

A Chinese researcher recently made a claim that he had altered the genes of a human embryo that eventually resulted in the birth of twin girls.

What is his research on?

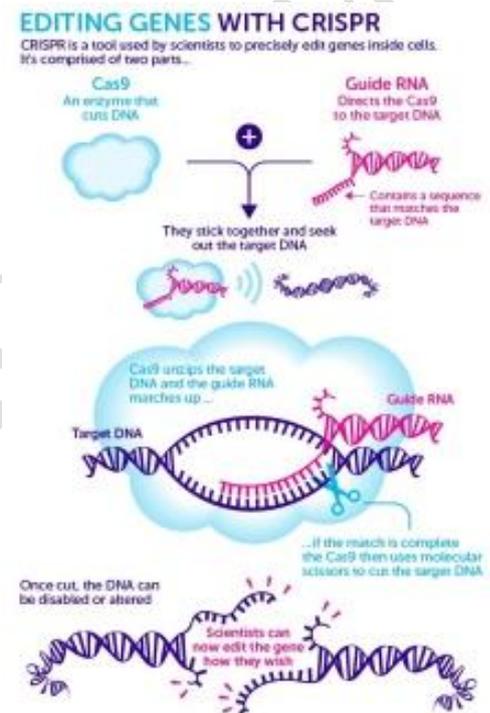
- The researcher worked with seven volunteered couples, wherein each couple had one partner who was HIV-positive.
- The aim was to ensure that HIV is not transmitted to the child.
- He used the Crispr Cas9 technology, which works like a genetic cut-and-paste tool, that allows researchers to permanently modify genes in living cells and organisms.
- Under the technology, he edited the genomes of 16 embryos to disable a gene, CCR5, which allows HIV to infect cells.
- He then used the in-vitro fertilisation (IVF) technique to implant edited embryos, that lead to the birth of genetically edited babies.
- The changes so made are inheritable and passed on to descendants.

What is the technology behind?

- Genes contain the bio-information that defines any individual.
- The information encoded in the genetic material can be attributed to
 1. Height, skin or hair colour
 2. Intelligence or eyesight
 3. Susceptibility to certain diseases
 4. Behavioural traits
- CRISPR (short for Clustered Regularly Interspaced Short Palindromic Repeats) technology is a relatively new, and the most efficient tool for gene “editing” developed in the last one decade.
- The technology replicates a natural defence mechanism in bacteria to fight virus attacks, using a special protein called Cas9.
- The specific location of the genetic codes that need to be changed is identified on the DNA strand.
- Using the Cas9 protein, which acts like a pair of scissors, the specified location is cut off from the strand.
- A DNA strand, when broken, has a natural tendency to repair itself.
- Scientists intervene during this auto-repair process, supplying the desired sequence of genetic codes that binds itself with the broken DNA strand.

How useful it has been so far?

- CRISPR-Cas9 is a simple, effective, and incredibly precise technology.
- The most promising use of the CRISPR technology is in treatment of diseases.
- For example, in sickle cell anaemia, a single gene mutation makes the blood sickle-shaped, which can be reversed using gene editing technology.
- In the case of the new-born Chinese babies, the genes were “edited” to ensure that they do not get infected with HIV.



- However, leading scientists in the field have for long been calling for a “global pause” on clinical applications of the technology in human beings, until internationally accepted protocols are developed.

What is the ethical dilemma involved?

- **Verification** - Tampering with the genetic material can have unintended and unknown consequences.
- The scientific community has no way to verify the claims on whether the gene editing was carried out in the proper manner.
- **Precision** - There is a possibility that some other genes also get targeted, resulting in unintended impacts.
- **Approval** - In most countries of the world, such experiments are banned and are punishable by law.
- Without regulatory approvals, there will be data and information gaps about the experiments on gene editing.
- **Consequence** - The recent research has edited the genes of an embryo, which would be passed on to the offspring and make changes in the genome of the next generation.
- Thus there is a possibility to produce designer babies with very specific traits in the future.

What are the concerns?

- **Complications** - Modifying the DNA of an embryo to create a “designer” baby may have many consequences, including long-term ones affecting the species.
- In this case, disabling of the CCR5 gene is known to lead to higher risks such as heightened susceptibility to flu.
- **Targeting** - The Crispr Cas9 technique is also controversial because it is known to cause damage by “off-target editing” that damages untargeted genes.
- Since the changes are inheritable, the gene-edited babies may even have to forego having children, if any negative genetic traits are witnessed in the course of their life.
- **Population composition** - Genetic editing in humans with customised traits could empower eugenicists and racists, thereby encouraging selective breeding of the human population by eliminating undesirable traits.
- **Regulation** - Gene editing is banned in most countries, including China.
- In the UK, where gene editing of embryos is permitted only after strict regulatory approval.
- Hence, many people from the scientific community have asked for a moratorium on editing human embryos.
- The scientific, commercial and ethical implications of this technique have to be researched further before getting it implemented on a large scale.

6.5 Significance of MediPix Technology

Why in news?

Scientists has recently used accelerated particles to produce first three-dimensional colour images of the human body.

What are the concerns with traditional radiological practices?

- **X-Ray Techniques** - X-ray based technology suffer from the deficit that they can sharply visualise only hard tissues.
- The shadows of soft tissues are less precise, Blood vessels and other conduits are imaged with invasive dyes.
- **Magnetic resonance imaging (MRI)** - It provides a slightly different picture, based on the difference in water and fat content in tissues.
- **Positron emission tomography (PET)** - It finds widest use in oncology, all but MRIs use radiation and dyes and chemical markers

What is the recent discovery about?

- A chip of the Medipix family developed by CERN, the European Organisation for Nuclear Research, has been used by MARS Bioimaging to take colour see-through images of body parts.
- The hybrid pixel detector technology which the Large Hadron Collider used to track accelerated particles, to produce the first three-dimensional colour images of the human body.

- The chip family has been in production for 20 years, and CERN's Knowledge Transfer Group had expected it to contribute to areas outside quantum physics.

What is the significance of MediPix Technology?

- Researchers have already used Medipix to image cancerous tissue, bones and joints and the blood supply to the heart.
- The Medipix3, which MARS Bioimaging intends to commercialise, promises a single solution superior to its predecessors.
- Using algorithms to model very accurate spectroscopic data in three dimensions, it shows all tissues with equal clarity, in colour.
- In the case of a fracture, it show physical damage to a bone and also reveal trauma to surrounding tissue and reveal if blood and nerve supply is compromised.
- It would depict structures exactly as they are, and not all of us are built exactly the same.
- In the near future, when medical care will be customised to the individual, this exactitude would make a difference to the efficacy of care.
- Thus the technology is scaling up rapidly, and holds incredible promise.

6.6 DNA Technology (Use and Application) Regulation Bill

Why in news?

The Cabinet has cleared the DNA Technology (Use and Application) Regulation Bill, 2018 once again, for its re introduction in Parliament.

What is the need?

- To create a **regulatory framework for obtaining, storing and testing of DNA samples** of human beings, mainly for the purposes of **criminal investigations**, and with the objective of establishing the identity of a person.
- The proposed law seeks to bring in a **supervisory structure** so that the DNA technology is not misused.

What are the provisions of the Bill?

- The Bill regulates the use of DNA technology for **establishing the identity of persons** in respect of matters listed in a Schedule. These include,
 1. Criminal matters (offences under the IPC, 1860)
 2. Civil matters (parentage disputes, transplantation of human organs etc).
- The Bill **establishes National and Regional DNA Data Banks**. Every Data Bank will maintain the following indices:
 1. crime scene index
 2. suspects' or undertrials' index,
 3. offenders' index
 4. missing persons' index, and
 5. unknown deceased persons' index.
- It **establishes a DNA Regulatory Board**. Every DNA laboratory that analyses a DNA sample to establish the identity of an individual, has to be accredited by the Board.
- **Written consent is required** from individuals to collect DNA samples from them.
- **Consent is not required** for offences with punishment of more than 7 years of imprisonment or death.
- It also provides for the **removal of DNA profiles** of suspects on filing of a police report or court order, and of undertrials on the basis of a court order.
- Profiles in the crime scene and missing persons' index will be removed on a written request.



What are all the issues with this bill?

- **Clarity** - The Schedule lists civil matters where DNA profiling can be used. This includes issues relating to establishment of individual identity.
- So, it is unclear if it intends to regulate the medical or research laboratories where the DNA testing is carried out.
- **Consent** - The Bill hasn't specified for any requirement of the consent of the individual when DNA profiling is used in civil matters.
- **Privacy** - DNA laboratories are required to share DNA data with the Data Banks.
- It is unclear whether DNA profiles for civil matters will also be stored in the Data Banks which may violate the right to privacy.
- **Removal** - The Bill specifies the process by which DNA profiles may be removed from the Data Banks.
- However, the Bill does not require DNA laboratories to remove DNA profiles.

6.7 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.

6.8 Bacteria to degrade Toluene

Why in News?

- Scientists have successfully degraded toluene into less-toxic byproducts by using bacteria isolated from Soil and effluents near an oil refinery.

What is Toluene?

- Toluene is an aromatic solvent that is primarily used as a thinner or diluent in several end-user products, such as paints, coatings and cleaners.
- It is colorless and insoluble in water.
- Toluene can be dangerous when its fumes are inhaled, causing neurological damage and intoxication.



- Because of this, toluene is sometimes abused as an inhalant drug.
- Individuals, who use paints and thinners frequently, like those who work with such products professionally, wear face masks in order to minimize the inhalation of toluene.
- Toluene, also known as methylbenzene, is an organic chemical compound.
- Its Chemical formula is C_7H_8 .

What are the effects of Toluene?

- Toluene is one of the petrochemical wastes that get released without treatment from industries such as refineries, paint, textile, paper and rubber.
- Toluene has been reported to cause serious health problems to aquatic life, and studies point that it has genotoxic and carcinogenic effects on human beings.

What are the uses of Toluene?

- Toluene is a very good solvent because, unlike water, it can dissolve many organic compounds.
- In many commercial products, toluene is used as a solvent that is present in paint thinners, nail polishremover, glues, and correction fluid.
- Toluene has many uses in different industries.
- In the explosives industry, it is essential in making the flammable, explosive compound known as TNT or trinitrotoluene.
- In the plastics industry, it is a component in the manufacturing of nylon and plastic bottles.
- Hair dyes and nail products include toluene, as well, utilized by the cosmetics industry.
- It is also used to manufacture inks and paint thinners.

6.9 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.
- It will provide a complete Digital Library of Life that contains the collective biological intelligence of 3.5 billion years of evolutionary history.
- The last project of a similar scale and importance was the 13-year Human Genome Project which was completed in 2003.
- So far, less than 0.2% of eukaryote genomes have been sequenced and these are at the level of "draft genomes", meaning that they are still at the crudest resolution.

6.10 3D Printed Skin

- Indian Institute of Technology (IIT) Delhi have successfully 3D bio printed human skin models.
- It has certain anatomically relevant structural, mechanical and biochemical features similar to native human skin.
- The bio printed skin model will have wide applications in testing cosmetics.
- It can also reduce and probably even replace testing on animals.
- It can also be used for testing dermatology drugs on human skin and at a future date even help in testing drugs for personalized medicine.

Bio-Printing

- Bioprinting originated in early 2000s, when it was discovered that living cells could be sprayed through the nozzles of inkjet printers without being damaged.



- Today, using multiple print heads to squirt out different cell types, along with polymers that help the structure keep its shape, it is possible to deposit layer upon layer of cells that will bind together and grow into living, functional tissue.
- Researchers are using bioprinting technology to produce kidney, liver tissues, skin, bones, cartilage and even human heart, as well as the networks of blood vessels needed to keep body parts alive.

6.11 Triboelectric Nanogenerators - Wireless Transmission of Electrical Energy

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

Applications

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

7. Electronics

7.1 National Policy on Electronics 2019

Why in news?

The Union Cabinet recently gave its approval to the National Policy on Electronics 2019 (NPE 2019).

What is the policy for?

- The National Policy of Electronics 2019 (NPE 2019) replaces the National Policy of Electronics 2012 (NPE 2012).
- It was proposed by the Ministry of Electronics and Information Technology (MeitY).

- The NPE 2019 aims to position India as a global hub for Electronics System Design and Manufacturing (ESDM).
- The policy will lead to the formulation of several schemes, initiatives, and measures for the development of ESDM sector.
- **Targets** - The policy aims at achieving a turnover of US\$ 400 billion (approximately Rs 26,00,000 crore) by 2025 in the ESDM sector through domestic manufacturing and export.
- This will include a targeted production of 1 billion mobile handsets by 2025, valued at US\$ 190 billion.
- A part of this includes 600 million mobile handsets valued at US\$ 110 billion for export.

What are the key features of the policy?

The National Policy on Electronics 2019 provides for the following:

- creating an eco-system for globally competitive ESDM sector for promoting domestic manufacturing and export in the entire value-chain
- providing incentives and support for manufacturing of core electronic components
- providing special package of incentives for mega projects which are extremely high-tech and entail huge investments; e.g. semiconductor facilities display fabrication, etc
- formulating suitable schemes and incentive mechanisms to encourage new units and expansion of existing units
- promoting Industry-led R&D (research and development) and innovation in all sub-sectors of electronics
- [These include grass root level innovations and early stage Start-ups in emerging technology areas such as 5G, IoT/Sensors, Artificial Intelligence, Machine Learning, Virtual Reality, Drones, Robotics, Additive Manufacturing, Photonics, Nano-based devices, etc.]
- providing incentives and support for significantly enhancing the availability of skilled manpower, including re-skilling
- offering special focus on Chip Design Industry, Medical Electronic Devices Industry, Automotive Electronics Industry and Power Electronics for Mobility and Strategic Electronics Industry
- creating Sovereign Patent Fund (SPF) to promote the development and acquisition of IPs (Intellectual Property) in ESDM sector
- promoting trusted electronics value chain initiatives to improve national cyber security profile

How will it be beneficial?

- The provisions are likely to enable the flow of investment and technology, leading to -
 - i. higher value addition in the domestically manufactured electronic products
 - ii. increased electronics hardware manufacturing in the country and their export
 - iii. generation of substantial employment opportunities, to over one crore people
- The global electronics ecosystem has been looking beyond China due to the rising labour costs there.
- So NPE 2019 could pave the way to make India the next major global hub for manufacturing of mobile phones, refrigerators, televisions, ACs, etc.
- **Shortfalls** - Robust R&D is a pre-requisite to move up the value chain.
- Given this, interest subvention and a credit guarantee fund may not be adequate.
- There are other factors that hamper R&D investment by industry, beyond the tax structure, which need redressal.

How is electronics manufacturing in India at present?

- Since the 2012 policy, the Centre has been trying to make India a global hub for electronics equipment but has achieved limited success.
- Imports of electronics hardware account for more than half of India's domestic production.

- This has been increasing rapidly, from \$37 billion in 2014-15 to \$53 billion in 2017-18.
- India's electronics hardware output accounts for just 1.5% of world output.
- Actual investments into the electronics sector have not been impressive.
- E.g. an incentive package for setting up a fabrication unit for semiconductor, which is the heart of any electronic product, has had no takers
- Getting a global player to start semiconductor manufacturing in India will be the key to the Make in India vision.
- The Modified Special Incentive Package Scheme (M-SIPS) which offers subsidies for electronics industry was launched in 2012.
- However, the rate of approval for applications filed and the investments made thereafter remain low.
- There has been some success in the manufacturing of mobile phones in the country.
- But even in this area, local value addition is only around 7-8% as most of the critical components are imported.

What should be done?

- The demand for electronics hardware is expected to rise rapidly to about \$400 billion by 2023-24.
- India cannot afford to bear a huge foreign exchange outgo on the import of electronics alone.
- The production deficit is best remedied by adopting an export-orientation as against an import-substitution bias.
- Certainly, the policy should go beyond credit sops to address the R&D deficit.
- India's scientific human resource pool needs to be engaged in this respect.
- R&D institutions could be promoted through the PPP route, so as to balance the market orientation and long-term priorities.

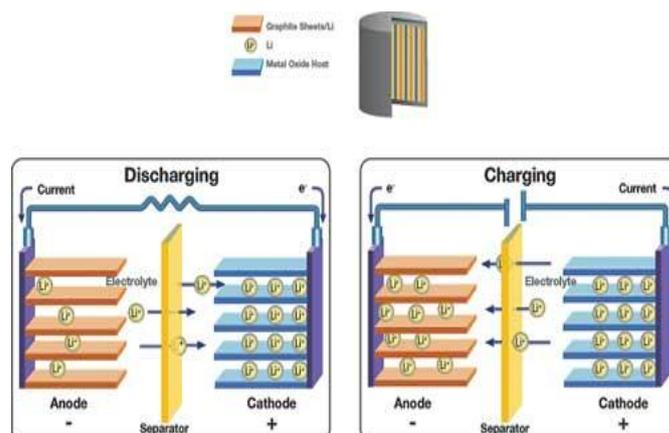
7.2 Lithium-ion Battery

Why in news?

- 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.
- CSIR-CECRI has set up a demo facility in Chennai to manufacture prototype Lithium-Ion cells.
- It has secured global IPRs with potential to enable cost reduction, coupled with appropriate supply chain and manufacturing technology for mass production.
- Currently, Indian manufacturers source Lithium Ion Battery from China, Japan and South Korea among some other countries.

What is Lithium ion battery?

- ISRO has approved commercial use of lithium-ion battery technology and the battery makers will be required to pay Rs 1 crore as a one-time technology transfer fee to ISRO for every e-vehicle.
- It is expected to save 10-15 per cent of the cost of e-vehicles.
- The process of remodelling the battery made by ISRO to be used in e-vehicles, will take time to scale up production.
- At present, lithium-ion batteries are not manufactured in India and therefore the country has to depend on imports from Japan or China.





- But there is a concern about the property of flammability of lithium-ion battery.
- Lithium-ion batteries are all about the movement of lithium ions.
- The ions move one way when the battery charges (when it's absorbing power); they move the opposite way when the battery discharges (when it's supplying power).
- Lithium ion batteries are more reliable than older technologies such as nickel-cadmium.
- Nickel batteries appear to become harder to charge unless they're discharged fully first, it is not the case with lithium ion batteries.
- Lithium-ion batteries don't contain cadmium, a toxic, heavy metal.
- It has high energy density i.e. it store more energy per unit of weight when compare to other kind of batteries.
- But it still stores a hundred times less energy dense than gasoline (which contains 12,700 Wh/kg by mass or 8760 Wh/L volume).
- It has a much lower energy density i.e it store less energy per unit of weight.
- It is used in every modern cellphone, laptop, tablet, and most other rechargeable gadgets.

7.3 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.

7.4 Optical Tweezers

Why in News?

- American scientist Arthur Ashkin, French engineer Gérard Mourou and Canadian professor Donna Strickland have been awarded the Nobel Prize in Physics for their work in the field of laser physics.

What are their contributions?

- Arthur Ashkin invented optical tweezers that grab particles, atoms, viruses and other living cells with their laser beam fingers.
- This new tool allowed Ashkin to realise an old dream of science fiction – using the radiation pressure of light to move physical objects.
- He succeeded in getting laser light to push small particles towards the centre of the beam and to hold them there.
- The tweezers are used to capture living bacteria without harming them.
- Gérard Mourou and Donna Strickland paved the way towards the shortest and most intense laser pulses ever created by mankind.



- They invented a technique, called chirped pulse amplification, CPA, soon became standard for subsequent high-intensity lasers.
- Its uses include the millions of corrective eye surgeries that are conducted every year using the sharpest of laser beams.

What is a Laser?

- The acronym laser stands for "light amplification by stimulated emission of radiation."
- A laser is a device that emits a beam of coherent light through an optical amplification process.
- There are many types of lasers including gas lasers, fiber lasers, solid state lasers, dye lasers, diode lasers and excimer lasers.
- All of these laser types share a basic set of components.
 1. Gain medium capable of sustaining stimulated emission
 2. Energy source to pump the gain medium
 3. Total reflector to reflect energy
 4. Partial reflector
 5. Laser beam output
- The gain medium and resonator determine the wavelength of the laser beam and the power of the laser.

What Is Chirped Pulse Amplification?

- Chirped pulse amplification (or CPA) is a way of amplifying a laser pulse without destroying the amplifying medium, or, in other words, the material the laser pulse is traveling through, which in turn prevents further amplification.

7.5 Hyperloop Technology

Why in news?

- The Maharashtra government has already declared it an official infrastructure project.
- An estimated 80 to 199 million passengers travel between the two Indian cities annually, hyperloop can meet this demand by sending pods several times per minute.

What is Hyperloop Technology?

- A hyperloop is a sealed tube or system of tubes through which a pod may travel free of air resistance or friction conveying people or objects at high speed while being very efficient.

What are the potential implications?

Positives

- The pod floats through Magnetic Levitation so the energy consumption is low.
- The technology offers very fast speed of transportation which is twice that of aircraft.
- It has very low power consumption.
- It is low cost transportation system on long run.
- It is immune to bad weather conditions.
- It is resistant to earthquakes.

Negatives

- High speed of capsule (almost at speed of sound) may cause dizziness to the passengers travelling due to vibration and jostling.
- Initial cost of investment to have the system in place is very high.
- Moreover this is costly and also risky to maintain.
- Land use rights will be concern for deployment of the project.



- It has limited space in the train and hence people can not move freely.
- As hyperloop uses steel for track, it expands and changes shape when outside temperature is changed. This may destroy the track of hyperloop technology.

7.6 The Dilemma with e-cigarettes

What is the issue?

- There are conflicting claims about health effects of 3-cigarettes.
- Hence, Indian policy makers should tread cautiously in this regard.

What is e-Cigarettes?

- Electronic cigarettes or e-cigarettes, are devices that do not burn or use tobacco leaves but instead vaporize 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.
- 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).

What are the health implications of e-cigars?

- Instead of burning tobacco, e-cigars heat a liquid to generate a nicotine-containing aerosol that does not produce toxic tars.
- But this doesn't mean they are completely safe, as at high temperatures, e-cigarettes produce carcinogens such as formaldehyde.
- They also increase the odds of lung disease and myocardial infarction.
- Nonetheless, its carcinogenic and other health implications are believed to be lesser than for normal cigarettes, although long-term data isn't available.

What is the dilemma about?

- **Positives** - Some researchers argued that e-cigarettes must be viewed from a "harm minimisation" perspective as they are a better alternative.
- Given that combustible cigarettes are more noxious than electronic ones, switching from the former to the latter can help addicts to lead healthier lives.
- **Negatives** - But others feel the need to adopt a precautionary approach as e-cigarettes is a young technology, whose long term effects aren't known.
- Further, some carcinogens in e-cigarettes have already been discovered to have a non-linear effect (even small quantities having big effects) on cancer.
- There is also the risk of e-cigarettes acting as a gateway drug for young people and surveys have indicated that e-cigars are likely to increase addictions.
- Further, due to its branding as a healthier alternative it may end up promoting the habit of smoking.

What is the way ahead?

- Completely banning the technology, while selling normal cigarettes, could take away a promising smoking-cessation aid.



- A more pragmatic option would be to regulate e-cigarettes tightly, by creating standards for the aerosols and banning underage and public use.
- This would leave smokers with a therapeutic alternative, while protecting youngsters from a gateway drug.
- Either ways, conflicting evidence makes it a tough call for policymakers and India should tread cautiously.

7.7 e-waste menace in India

What is the issue?

The hazardous e-waste generated is getting accumulated in the country at an alarming pace, causing grave concern for public health and environment.

How is the e-disposal infrastructure in India?

- 2 million tonnes of e-waste is generated annually.
- Just a fraction of it is being disposed off safely.
- Most of the discarded computers, phones and batteries and age-expired electrical gadgets are sold to junk dealers.
- They are ultimately recycled in the unorganised sector in a crude and clumsy manner.
- This causes more harm than the unprocessed items.
- A sizeable part of the e-waste is mixed with garbage and finds its way to landfill sites.
- Mumbai tops the list of e-waste generating cities, followed by Delhi, Bangalore and Chennai.
- India, as a whole, is 3rd in Asia and 5th in the world as an e-waste producer - the others being the US, China, Japan and Germany.

What are the harmful effects?

- They contain several hazardous substances, such as mercury, arsenic and other heavy metals.
- They emit harmful radiation, degrades the soil, and releases toxins to pollute air and ground water.
- About 40% of lead and 70% of other heavy metals found in landfills are traceable to e-waste.
- Prolonged exposure to these pollutants can damage the nervous system, kidneys, and brain, and can cause respiratory disorders, lung cancer, skin ailments and other health problems.
- 2/3rd of the workers in the unorganised e-waste recycling sector suffer from breathing difficulties, coughing, irritation, and other maladies.

What is the legal framework?

- The country's e-waste disposal policy is actually robust.
- The e-waste management rules, laid down by the environment ministry, even revolve round the judicious concept of "extended producer responsibility" (EPR).
- Manufacturers are mandated to take back 30% of the discarded electronic equipment for appropriate disposal in the first two years of the enforcement of these rules.
- This level is to be raised to 70% in the next five years.
- However, none of this happening due to the lax regulatory infrastructure in the country.

What should be done?

- India has a vibrant, informal waste-gathering sector with millions of waste pickers going door-to-door to collect garbage.
- Industry can use this infrastructure gainfully to retrieve its discarded e-gadgets.
- Besides, the government, especially the local pollution control boards, needs to consider training the unskilled e-waste recyclers to do their job in a safe and scientific manner.
- A well-planned integration of the informal and organised waste-processing sectors can help in reducing the menace of e-waste to a perceptible extent.

8. Issues Related to IPR

8.1 EU's New Copyright Law

Why in news?

The European Union's Parliament recently passed a new copyright directive.

What is the EU Copyright Directive?

- The Directive comprises of a set of measures designed to reform the way copyright works in the EU.
- The objective is to “protect creativity in the digital age”, as stated by the European Commission.

What triggered the changes?

- Lawmakers have become concerned about what is uploaded and shared on the internet platforms in the recent times.
- These include the spread of fake news, psychological profiling of users to influence their behaviour. E.g. Cambridge Analytica scandal
- Also, violent, harmful content being spread on platforms such as YouTube targeting children and other vulnerable communities have raised concerns.
- Moreover, the tech companies such as Google and Facebook do not take the responsibility for the damages caused by content they disseminate.
- When challenged on multiple global legal platforms and rights forums, companies did not express their willingness to filter such contents.
- Certainly, such lethargic, revenue-focussed approach has driven the lawmakers to make the regulations stricter.

What are the controversial provisions?

- Among the reforms, it is Article 11 and 13 of the Directive which have sparked controversy.
- Article 11 notes that search engines like Google and news curation platforms (like Google News) must pay to use links from news websites.
- Article 13 basically deals with how online content-sharing services should deal with content for which someone holds a copyright.
- The company, say YouTube, must make all the ‘best’ efforts to get permission from copyright holders for all the content uploaded.
- If not, the technology firms will be penalised for all non-copyrighted content appearing on their platforms.
- The rules are applicable for almost all services, except those that are less than 3 years old in the EU or have an annual turnover of less than \$11.2 million.
- It covers most services that help people surf for stuff that is uploaded online including YouTube, Soundcloud, Vimeo, etc.
- There are some exceptions such as
 - i. online encyclopaedia that do not target profits (like the wikis)
 - ii. open source software development platforms
 - iii. cloud storage services
 - iv. online marketplaces
 - v. communication services

What does it mean for the users?

- **Favourable** - The new rules would help musicians in the digital age gain their fair share of royalties and rights from the technology companies.
- Earlier, companies have been using such content at will and free of cost.



- It would strengthen Europe's creative industries, which represent 11.65 million jobs, 6.8% of GDP and are worth €915,000 million a year.
- **Negatives** - If a fan of AR Rahman living in the EU want to upload an ARR song on YouTube for fun or to share among friends, s/he may not be able to do it that easily now.
- An activist who wants to share some archival footage of a strike, showing human rights violations, may not be able to upload.
- This is because s/he may not be able to bypass the filters content platforms may put in place.

What are the concerns?

- The new law is expected to change the way content is used and disseminated on the World Wide Web.
- For the firms, it is not that easy to seek and buy licence for all the content that goes up on YouTube.
- So, eventually the companies will be forced to introduce mass-filters that would make uploading content legally and logistically difficult.
- It could hand over the free and open internet to corporate giants at the expense of ordinary people.
- Moreover, big tech companies may be able to introduce the checks and balances needed.
- But small entities will end up shutting shop, paving the way for more concentration of power in techbusiness.
- Also, it will help governments in the EU and/or elsewhere use these clauses to crush dissent and free speech.

What could the global ramifications be?

- Europe's approach in dealing with user data and online privacy has caught the attention of policy-makers and rights activists across the globe.
- This is especially after the EU introduced the stringent General Data Protection Regulation (GDPR).
- In such a context, the copyright directive will trigger a global debate and the results may change the way the Web is used.
- The legislation only applies to countries in the European Union.
- But, it is bound to have a much wider impact on a global scale, particularly with regard to the US tech giants such as Google or Facebook.
- These will obviously be affected by the legislation, in their European operations.

8.2 PepsiCo and Potato Farmers Case

Why in news?

- PepsiCo India Holdings (PIH) announced it is withdrawing lawsuits against nine farmers in north Gujarat.
- It had earlier sued 11 farmers for "illegally growing and selling" a potato variety registered in the company's name.

What is the case about?

- The patent is for the potato plant variety FL-2027 (commercial name FC-5).
- Pepsi's North America subsidiary Frito-Lay has the patent until October 2023.
- For India, PIH has patented FC-5 until January 2031 under the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001.
- The FC-5 variety, used to make Lay's chips, is grown under a contract farming deal, by 12,000 farmers in Gujarat's Sabarkantha district.
- PIH has a buyback agreement with some Gujarat farmers.
- It has now accused 11 farmers of illegally growing, producing and selling the variety "without permission of PIH".
- The government reportedly held out-of-court settlement talks with the company, which eventually announced the withdrawal of cases.



What do the farmers say?

- Farmers say that the agreement was only that PIH would collect potatoes of diameter greater than 45 mm.
- Farmers would store the smaller potatoes for sowing next year.
- Some of the other accused farmers said they got registered seeds from known groups and farmer communities.
- They had been sowing these for the last four years or so, and had no contractual agreement with anyone.
- They said they learnt they were growing a registered variety only when they got a court notice.

Is PHI's claim valid?

- Rights on a patented seed differ from country to country.
- In the US, if someone has patented a seed, no other farmer can grow it.
- But the Section 39(1)(iv) of the PPV&FR Act of India has clauses in defence of the farmers in this case.
- Under this, farmers were allowed to continue to practise in the same manner as was entitled before the coming into force of this Act.
- In other words, they could save, use, sow, resow, exchange, share or sell farm produce including seed of a variety protected under this Act.
- It was only specified that the farmer shall not be entitled to sell branded seed of a variety protected under this Act.
- Certainly, in Pepsico's case, the seeds were not sold as branded seeds.

Why is the PPV&FR Act significant?

- India's choice in this regard is a conscious departure from UPOV (International Union for the Protection of New Varieties of Plants) 1991.
- The UPOV 1991 gives breeders the right to monitor all aspects of a farmer's activity.
- It bars the scope for farmers to re-use seeds without their permission.
- But the PPV&FR Act was formulated to give farmers free access to seeds.
- Japan and Canada, besides other developing countries, have also voiced their reservations against UPOV.
- The argument that food should be kept out of rigid patent-like frameworks gains ground here.
- It is not clear whether enhanced breeders' rights under UPOV have enhanced research and public welfare along expected lines.
- But monopoly concerns as well as those related to health and the environment have assumed centre-stage over time.
- To see in the Green Revolution context in India, indigenous varieties of rice have been rendered extinct by the propagation of hybrids.

What lies ahead?

- Plant diversity is crucial in a time of growing pest attacks, rising temperatures and climate change.
- UPOV does not appear to be in sync with these realities.
- However, breeder research should be promoted in drought resistant varieties of millets and pulses.
- There is no reason to believe that India's legal framework does not allow this space, given the private participation in these areas.
- Government efforts should balance among the aspects of providing for new varieties, farmers rights, and environmental concerns in this regard.

8.3 Common Geographical Indication Logo

Why in news?

Recently, the Commerce and Industry Minister unveiled a tricolour logo that is common for all Geographical Indications (GI), with a tagline “invaluable treasures of incredible India”.

What is Geographical Indication?

- GI indicates the ‘link’ between a product and the place it belongs to.
- The link could be the natural resources, climatic factor or human skills that render uniqueness to the product.
- The essential difference between GI and other intellectual properties (IP) is that, GI is a collective intellectual property right.
- It is thus owned by all the producers within the defined GI territory.
- Unlike this, the IPs like patent and trademark are owned by an individual or a business entity.
- So unlike the commercial use of patent that would benefit an innovator or a firm, the commercialisation of GI would benefit all the producers in the GI territory.
- It could promote tourism and rural development, and some of the Sustainable Development Goals - empowering women, fostering sustainable communities and reducing poverty.

What are the concerns in India in this regard?

- The potential of GI has not yet been realised in India.
- **Procedure** - Filing a GI application is a huge task that involves documenting historical evidences about the linkage of the product with the region.
- Also, the application has to be filed by an association or group of persons.
- So despite India's diversity in handicrafts or agricultural products, only about 320 products have so far been registered with the GI registry.
- Some of them include Kanchipuram saris, Darjeeling tea, Channapatna toys, Gir kesar mango, Sindhudurg and Ratnagiri Kokum, Kulu shawls, Ratlami sev, Pochampalli Ikat.
- **Commercialisation** - The efforts have so far mainly focused on the first step of filing GI applications (Part A of GI registration).
- Mere filing of the GI applications amounts to cultural accounting of regional products.
- But post registration activities in terms of utilising the GI certification as a marketing/branding tool has not been attempted in most products.
- This is due to limited awareness about GI in the country among producers, consumers and policy makers.
- **Stakeholders** - As per the GI Act (1999), the term producer can include any one who ‘deals’/‘exploits’ the GI product.
- It could thus include a wide range of stakeholders including a trade facilitator, online marketer, who may or may not belong to the GI territory.
- But the registered proprietors of GI fail to identify the value chain and do not register the authorised users (Part B of GI registration).
- So the majority of the ‘producers’ (other stakeholders in the value chain) are unaware of the GI registration itself.

How could a logo help?

- After 15 years of the GI Registry coming into being, the GI logo that is common for all registered GIs is now in place.
- Logos convey a specific message to the consumers about the product, as the ISI or Agmark assures about the quality.
- Promotion of common GI logo will create an edge for GI products over similar products.



- It will also bring more awareness among consumers in distant markets as well and result in increased demand.
- It could enhance market access and preserve unique local economies, provided the producers benefit.
- This will check distress migration, promote biodiversity, prevent artisans and farmers leaving their livelihoods.
- Importantly, it will arrest the erosion of traditional knowledge and practices.

What are the challenges ahead?

- Mere unveiling of the logo may not serve any purpose for the producers of registered GIs.
- Determining the protocols for actual use by 'producers' and preventing the misuse of the logo are essential tasks.
- Enormous human efforts and financial resources are required to position the common GI logo so that it is used as a marketing tool.
- The GI logo needs to be widely popularised for consumers to associate it with the uniqueness and authenticity of GI products.
- But the shortfalls in Part B registration make it difficult to identify the authorised users and check GI infringement.

What should be done?

- The use of common GI logo has to be inclusive of all the stake holders in the value chain.
- At the product level, besides the producer organisations, other stakeholders like traders, processors, packagers, etc should also be organised into groups/associations.
- These different associations should work in unison in the actual use of the logo in all their transactions.
- This is essential to promote the sale of genuine GI products and design strategies to prevent the misuse of the logo.
- Assuring consumers on the authenticity of the product would go a long way in increasing the demand and production.
- **Marketing** - Efforts should start in India with all the State emporiums and handicraft hubs where products are on permanent display, to showcase GI products.
- There should be clear signboards with GI logos on the national highways or major bus/railway stations/airports about the GI Production centres in that region.
- Information about the sales points where the products may be procured should also be available.

8.4 Secondary Patents

What is the issue?

India's rejection of secondary patents has kept blockbuster medicines affordable for many.

How are patents and drug pricing related?

- Patents offer their owners market exclusivity for a limited period of time.
- For medicines, this exclusivity should last as long as the primary patent is in effect, typically 20 years.
- Primary patent relates to the active pharmaceutical ingredient (API) of the medicine.
- The end of patent exclusivity is referred to as a patent cliff.
- This is because drug prices fall steeply by as much as 80% after the end of patent exclusivity.
- The price fall is driven by the generic competition that sets in.
- Resultantly, pharmaceutical companies witness fall in profits.

What are secondary patents?

- Secondary patents are claimed for derivatives and variants of the API.



- This may include a physical variant of the API, a new formulation, a dosage regimen, or a new method of administering the medicine.
- The pharmaceutical companies, who face losses, attempt to postpone their patent exclusivity by filing secondary patents.
- The secondary patents prop up before the expiry of a primary patent.
- It thereby stretches the patent exclusivity beyond 20 years.
- This practice of extension of patent exclusivity is called “evergreening”.
- The strategy is most lucrative when employed in the context of so-called blockbuster medicines.
- These are medicines that reap annual revenues exceeding \$1 billion.
- The U.S. recognises and encourages secondary patents.
- India, however, does not encourage and has limitations in securing secondary patents.

How is the Indian patent law unique?

- As per the Patents Act, the product in question must feature a **technical advance** over what came before.
- Secondary patents for pharmaceuticals are often sought for trivial variants.
- They typically fail to qualify as an invention as prescribed in the Act.
- Further, when a medicine is merely a variant of a known substance, the Patents Act necessitates a **demonstration**.
- This is mandated in terms of showing the improvement in its **therapeutic efficacy**.
- The provision also bars patents for new uses and new properties of known substances.
- This additional requirement is unique to Indian law.
- Thus, to be deemed patentable, applications for secondary patents have to clear significant hurdles.
- The patent approval procedure ensures that bad patents stay out of the system.
- Indian patent law is thus commendable in preventing the evergreening practices by pharmaceutical companies.
- This is supportive in making affordable the blockbuster medicines which are crucial to the success of public health.

8.5 Draft Pharma Policy

Why in news?

The draft pharma policy was recently released by the Department of Pharmaceuticals (DOP).

What are the highlights of draft pharmaceutical policy?

- The new pharmaceutical policy proposes to balance the need for price control over medicines.
- Union government will gain a greater role in deciding prices of medicines and medical devices.
- Pricing authority will regulate only medicines that are specified by the government in the National List of Essential Medicines.
- The price caps being imposed on patented medicines are reduced.
- Policy allows pharmaceutical manufacturers to sell their medicines under only under generic names and not under differently-priced brands.
- Manufacturing of drugs under WHO standards is made mandatory.
- The policy seeks to bring down the unreasonable trade margins offered by various stockists to hospitals.

What are the issues with the policy?

- The policy fails to lay controls over the chemists, this may facilitates the sale of fake drugs.

- The policy doesn't have any mechanisms to boost production standards.
- Instead of an appellate authority, it seeks to give bureaucrats more powers on drug controls.
- **Direct price control** – Government takes role of fixing the drug price.
- This will affect the quality, innovation, and hurts patients as much as it does companies.
- It opens the door to lobbying and rent-seeking with all the attendant dangers for competition and for corruption.

What measures can be taken?

- It will be better if price monitoring focuses on essential drugs, there are about 200.
- Strict price control measures need to be avoided and market friendly pricing should be followed.
- Domestic production of import drugs should be promoted, with better quality and affordability.
- The government should also consider specific steps against overcharging of prices by the industries.

8.6 USTR Watch List

- Priority Watch List and Watch List countries are identified by the annual Special 301 Report.
- **Priority Watch list countries** - are judged by the United States Trade Representative (USTR) as having "serious intellectual property rights deficiencies" that require increased USTR attention.
- **Watch List countries** - have been identified by the USTR as having "serious intellectual property rights deficiencies" but are not yet placed on the "Priority Watch list".
- The USTR can move countries from one list to the other, or remove them from the lists, throughout the year.
- India has been on the priority watch list reportedly for over 25 years, for "lack of sufficient measurable improvements to its IP framework that have negatively affected US right holders".
- The Priority Watch List is topped by China also includes Indonesia, Russia, Saudi Arabia and Venezuela.
- Countries under the priority watch list will be the subject of increased bilateral engagement with the USTR to address Intellectual Property (IP) concerns.

8.7 Global Trade Mark System Agreements

- Union government approves the proposal for accession to Nice, Vienna and Locarno Agreements.
1. **Nice Agreement** - Based on the international classification of goods and services for the purposes of registration of marks.
 2. **Vienna Agreement** - Leads to setting up an International classification of the figurative elements of marks.
 3. **Locarno Agreement** - It is for establishing an International classification for industrial designs.
- Accession to the above agreements would give an opportunity to include Indian designs, figurative elements and goods in the international classification systems.
 - The accession is expected to instil confidence in foreign investors in relation to the protection of Intellectual Property in India.

8.8 TKDL

- Traditional Knowledge Digital Library (TKDL) is a globally recognized proprietary database on Indian systems of medicine for preventing bio-piracy and misappropriation of traditional knowledge.
- CSIR jointly with Department of AYUSH (now Ministry) developed the Traditional Knowledge Digital Library (TKDL).
- The objective of the library is to protect the ancient and traditional knowledge of the country by documenting it electronically and classifying it as per international patent classification systems.
- Apart from that, the non-patent database serves to foster modern research based on traditional knowledge, as it simplifies access to this vast knowledge of remedies or practices.



9. Defence

9.1 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.

9.2 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.

9.3 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,
 - i. The Prithvi Defence Vehicle (PDV) for exo-atmospheric (high) altitudes of 50–80 km and
 - ii. 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.

9.4 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.

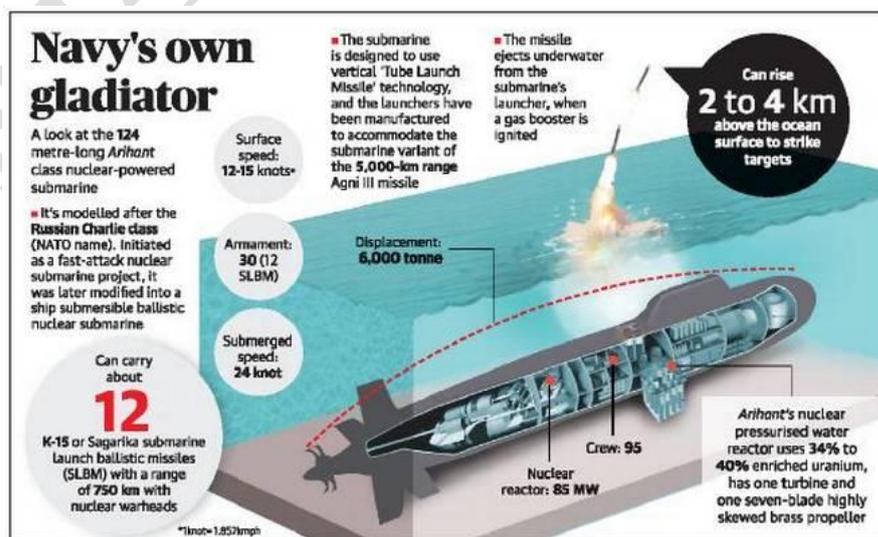
- For the first time, an IL-78 refueller aircraft has recently carried out air-to-air refuelling of the Embraer aircraft.
- Air-to-air refuelling allows the aircraft to stay airborne much beyond their limits, allowing better exploitation of capabilities.

9.5 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).

9.6 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).

9.7 BOLD-QIT

- BOLD-QIT (Border Electronically Dominated QRT Interception Technique) under CIBMS (Comprehensive Integrated Border Management system) on India-Bangladesh border in Assam will be launched soon.
- It is the project to install technical systems under the CIBMS.
- It enables Border Security Force to equip Indo-Bangladesh borders with different kind of sensors in unfenced riverine area of Brahmaputra and its tributaries.
- The area has been covered with data network generated by Microwave communication, day and night surveillance Cameras and intrusion detection system etc.,

9.8 Air Independent Propulsion

- Six Scorpene-class submarines are being built under '**Project 75**' of the Indian Navy.
- The Project 75I-class submarine is a follow-on of the Project 75 Kalvari-class submarine for the Indian navy.
- The first Scorpene-class submarine **INS Kalvari** has already undergone various trials and is expected to be inducted into the Indian Navy later this year.
- **INS Khanderi**, the second of the six Scorpene class submarines, has sailed out from Mumbai harbour for its maiden sea sortie, in a step closer to its induction into the Indian Navy.
- Under this project, the Indian Navy intends to acquire 6 diesel-electric submarines, which will also feature advanced **Air Independent Propulsion (AIP) systems** to enable them to stay submerged for longer duration and substantially increase their operational range.
- 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.

10. Miscellaneous

10.1 Blocking Mobile Apps

Why in news?

The Department of Telecom (DoT) is evaluating the possibility of blocking some mobile applications during emergencies.

What is DoT's move?

- The DoT has written to telecom service providers (TSPs) and internet service providers (ISPs).
- It noted that issues had been raised by Ministry of Electronics and IT, and Law Enforcement Agencies for blocking.
- TSPs/ISPs were thus asked to explore possible ways to block mobile applications.
- This would be as per the provisions of the IT Act, 2000.
- It includes Instagram, Facebook, WhatsApp, Telegram and such other mobile applications.

What is the need?

- The reasons are, reportedly, to stop child abuse/pornography and to curb the spread of fake news.
- It comes as a move to deal with emergencies, especially when national security and public order are under threat.
- The growing incidence of lynchings across the country invariably based on some fake news is the immediate reason.
- The move aims at blocking the applications in an emergency, rather than blocking access to the Internet as a whole.



- However, MeitY has informed DoT that blocking such apps during emergency situations was difficult.
- This is because they work through multiple IP addresses and on different protocols, and hence the request for other possible ways.

What are the concerns?

- **Cause** - Violence triggered by spread of fake news is not purely a law and order issue.
- It is indicative of the social malaise of intolerance and prejudice in the society.
- So using blunt instruments of state censorship such as blocking applications would miss the real problem.
- **Rights** - Any such ban would violate the fundamental right of free speech.
- It would further dent India's image as a modern society that values and protects democratic principles.
- It would, in fact, penalise majority of the users and withhold services for most genuine consumers.
- Also, it would ignore the efforts of the industry to self-regulate and make such social media platforms less prone to being misused.
- **Loss** - According to estimates, internet shutdowns cost the Indian economy over \$3 billion between 2012 and 2017.
- Some of the recent examples are the bans in Jammu & Kashmir and Rajasthan.
- The better option thus would be for the government to work with the companies concerned instead of banning the apps.

10.2 Formalin: A Banned Preservative

What is the issue?

- Fish laced with formalin has flooded the markets across states.
- This is creating a massive health scare and the Goa government has recently banned fish supplies from other states temporarily.

Why did Goa ban fish from other states?

- Due to fears of alleged formalin contamination, officials of the Food and Drug Administration (FDA) inspected fish markets in Goa.
- They picked up various fish samples from various states for testing and had confirmed traces of formalin, which is a banned preservative.
- The episode caused a scare, which prompted the Goa government to announce a 15 day ban on entry of fish from other states.
- Border checks have also been established to inspect trucks for fish.

What is formalin?

- Formalin is a form of hydrated formaldehyde, which is used as a preservative in museums to ensure the specimens doesn't decompose.
- It is also used to harden human tissue for post mortem examinations.
- It can cause gastric irritation and it also speculated to be carcinogenic, and thereby not fit for human consumption even in minimalistic proportions.
- Notably, even in laboratories, only diluted formalin is said to be used.
- Some amount of formalin is naturally formed while fish is transported with ice, but these are usually bound with tissues and not a risk.
- Contrastingly, if fish is laced externally with formalin (to prolong shelf-life), it remains free and can cause serious health issue.

Where else was formalin detected in fish?



- The first reports of formalin-laced fish came from Kerala, a state that consumes around 10,000 tonnes of fish every day.
- Some consumers raised the issue that the fish didn't smell and didn't decompose even when placed outside the fridge for as long as two days.
- Subsequently, Kerala government has been carrying out a storm of raids under its fish safety and hygiene campaign "Operation Sagar Rani".
- Inspections led to the seizure of about 9,600 kg of contaminated fish in Kollam district and about 6,000 Kg of fish in Palakkad district.
- Notably, Tamil Nadu officials have also been carrying out raids for the last two weeks, but laboratory tests have so far returned negative for formalin.

Where is the formalin contamination originating from?

- Andhra Pradesh has around 4,000 hectares of aqua-culture farms, whose output peaks during the monsoon season (when coastal fishing is banned).
- To meet the market demand, cultured fish from Andhra is to be transported widely, with sufficient quantity of ice for retarding degradation.
- But as distances are large, the fish nonetheless tends to get spoilt in transport.
- This has led Andhra fish suppliers to lace fish with formalin, which retards degradation to more than 10 times its natural rate.
- Notably, even a state as far as Assam found that formalin laced fish from Andhra was reaching its market (Assam has also banned outside fish now).
- Also, Data from across the southern states indicates that it is the fish sourced from Andhra that is the most likely to be contaminated with formalin.

What is the way ahead?

- **Technology** - Kochi-based "Central Institute of Fisheries Technology" (CIFT) had earlier developed a detection kit for easy detection of formalin.
- This has proven really effective presently and is being widely used now.
- **Inspections** - Regular inspections, testing and seizures from the markets would help in reducing this malpractice.
- Some states have sent official communication to Andhra Pradesh regarding the same, and which now needs to crackdown on unscrupulous suppliers.
- **Infrastructure** - The most common reason for "dishonest traders" using formalin is the unavailability of good quality ice at harvest centres.
- Inadequate insulation during domestic transport and lack of warehousing facility for bulk storage of fish are also additional reasons for formalin lacing.

10.3 Internet shutdowns in India

Why in news?

India topped the world with the highest number of internet shutdowns by government authorities, according to a report by Delhi-based Software Freedom Law Centre (SLFS).

What does the report say?

- Internet shutdown is defined as "disablement of access to internet as a whole within one or more localities for any duration of time".
- There have been 233 reported instances of suspension of internet services in India in the last seven years.
- However, 73% of these shutdowns have happened only in the last year and a half.
- Internet shutdowns go against the human rights of citizens and should call for further questioning on their purpose in the interest of transparency.

- The researchers also say that centre issues 7000-8000 orders for phone tapping per month in India.
- Also, an US based think tank released the 'Freedom on the Net' report which offers a bleak perspective on the state of internet freedom across the world.
- Out of the 65 countries assessed, 26 countries are said to have experienced a deterioration and almost half of all declines were related to elections.

What are the consequences of Internet shutdowns?

- There may have been even more shutdowns than reported since many states refuse to respond to RTI (Right to Information) applications asking for details of shutdowns.
- These can last anywhere from a day to 72 hours, or even longer than that.
- Every shutdown negates the official policy thrust of promoting greater digitisation by removing the channel for digital communication.
- In states such as Jammu & Kashmir and Manipur, multiple shutdowns make normal online activities almost impossible.
- Quite apart from the disturbing impact on freedom of expression, shutdowns impose huge costs as well.
- The Indian Council for Research on International Economic Relations (Icrier) estimates that there were 16,315 hours of internet shutdowns between 2012 and 2017, costing an equivalent of \$3.04 billion.
- The costs in 2018 alone would have been of the same order, or higher, given both an increase in shutdowns and the increasing volume of online business.

What are the concerns?

- Local governments use the Temporary Suspension of Telecom Services Rules (Public Safety or Public Emergency), which were introduced in August 2017 to order a suspension of internet services.
- In the past, Section 144 of the Indian Penal Code was used for the same purpose.
- This section allows the authorities to lay down guidelines to impose temporary measures to maintain public tranquility.
- Reports suggest shutdowns are often imposed by low-ranking officials, and then retrospectively cleared at higher levels.
- Moreover, news of a shutdown is rarely disseminated directly to the public, which learns about it the hard way.
- This draconian measure seems to have become a default option during election periods, public protests or during the periods of communal tension.
- These are usually related to apprehensions that social media channels such as WhatsApp may be used to instigate mob violence or to coordinate some act of public protest.
- But shutdowns have been ordered for all sorts of other reasons.
- For example, a shutdown was ordered to prevent cheating in police recruitment exams in Rajasthan and many others were ordered in Maharashtra to “prevent rumour-mongering”.
- Thus, India was critiqued for its internet shutdowns as “collective punishment” it imposes on its own people.
- This is undoubtedly true since every shutdown inconveniences millions of ordinary citizens and causes large, quantifiable losses.

What should be done?

- Resorting to this measure represents a failure of policing in the country.
- However, in states such as Telangana, the local administration has been unwilling to resort to this measure.
- Hence, the police have developed more effective methods of interacting with local communities and gathering intelligence to scotch the spread of inflammatory fake news.
- Thus, instead of using a blunt instrument such as a complete shutdown, the law and order machinery across the country must find less damaging ways of dealing with increasingly connected populations.

- Otherwise, the country could see an increasing number of shutdowns, which would run counter to the policy of encouraging digitisation.

10.4 Rising Game revolution in India

What is the issue?

A gaming revolution has started in India which expects to have over 300 million digital gamers by 2021.

How does the industry fare?

- Gaming, as an industry, has enormous potential that gaming companies, advertisers, retailers and promoters are looking to make the most of.
- The global gaming industry grossed a staggering \$108 billion in 2017.
- The market in India currently forms less than 1% of the global market and it is expected to grow at a quick rate.
- With increasing popularity and adoption of gaming especially amongst the new generation, the opportunity in digital gaming has prompted investors and companies to keep a keen eye on the sector.
- Affordable internet connectivity, smartphone penetration, power of data, emergence of eSports that augments gaming for professional gamers, and better economics for gaming companies are creating new monetisation avenues in gaming.

What is the case with India?

- Investors, marketers, advertisers and gaming companies are aware that digital gaming is a trillion-dollar market in the making.
- According to the 2017 report “India’s Trillion Dollar Digital Opportunity” by McKinsey, India has over 7.7 billion app downloads, second only to China.
- A user base of such size has created and opened ample opportunities, beyond imagination, for all kinds of games and apps.
- By 2021, the average data consumption of Indians will reach 7 GB per person, a quantum jump from the 1 GB per person in 2016.
- Also, the number of gamers is expected to cross 300 million by 2021, helped by the increasing affordability of smartphones.
- In fact, India’s digital gaming adoption growth rate of 56% is second only to Indonesia (among 17 major digital economies).
- New gaming technologies like AR, VR and console gaming are not only making an impact in the gaming industry, but also in sectors like education and healthcare.

What are the opportunities?

- Over the last two years, the popularity of gaming has soared, with millions of users watching professional gamers game on large screens.
- eSports has the potential for advertisements to capture the eyeballs of about 2 million eSports viewers in India, a market that is expected to grow five times by 2021.
- Gamers are also taking it up professionally as a career, thus expanding the digital gaming landscape.
- An increased focus on local development of games, large volume of users and rising potential of monetisation means gaming can emerge as a significant sector in the future.
- It can create jobs for thousands of millennials who can join the creative workplace and there are also a variety of courses that have emerged on gaming.
- College students can intern at gaming companies or even organise and conduct game championship tournaments on their campuses.
- This is turning out to be the next avenue for event management firms as well.

What should be done?

- From games as simple as Candy Crush and Ludo to midcore ones like Sachin Saga played on smartphones to PUBG, Dota 2 and Counter-Strike played by hardcore gamers, a gaming revolution is on in India.
- The country had over 198 million mobile gamers in 2015, and this number is expected to grow to 628 million gamers on multiple portable devices by 2020.
- Games like Pokémon GO took Indian gamers by storm even before its launch.
- A delayed release in India might have resulted in a loss of potential revenue considering how the game went viral through off-the-store sources.
- Thus there are immense opportunity for companies to release games in India as part of their launch strategy, to get a wider popularity from a larger gamer base.

10.5 APSARA - U

- Apsara is the first research reactor in Asia became operational in Trombay campus of Bhabha Atomic Research Centre in 1956 and the reactor was shut down in 2009.
- Recently a swimming pool type research reactor “Apsara-upgraded”, of higher capacity was setup at Trombay.
- The reactor, made indigenously, uses plate type dispersion fuel elements made of Low Enriched Uranium (LEU).
- This reactor will increase indigenous production of radio-isotopes for medical application by about fifty percent and would also be extensively used for research in nuclear physics, material science and radiation shielding.

10.6 International Thermonuclear Experimental Reactor (ITER)

- ITER, the world’s largest experimental fusion facility is in France.
- It is the most complex science project in human history, started in 2010.
- It will use hydrogen fusion, controlled by superconducting magnets, to produce massive heat energy.
- This nuclear fusion facility is an international cooperation among the European Union, Russia, the US, Japan, China, India and South Korea.
- It is the first industrial-scale fusion reactor and it will illuminate the way to produce clean, cheap, and abundant energy for millions of years.
- It will start generating a molten mass of electrically-charged gas “plasma” inside a core by 2025.

HL-2M Tokamak

- China plans to complete the construction of the artificial sun device (HL-2M Tokamak).
- It is designed to replicate the nuclear fusion process that occurs naturally in the sun and stars.
- The device provides almost infinite clean energy through controlled nuclear fusion.
- Its plasma is mainly composed of electrons and ions.
- The country's existing Tokamak devices have achieved an electron temperature of over 100 million degrees Celsius in its core plasma, and an ion temperature of 50 million degrees Celsius.
- The new HL-2M device shall provide main technical support for China's participation in the experiment and operation of the International Thermonuclear Experimental Reactor (ITER).

10.7 PM-STIAC

- Prime Minister has recently interacted with the members of Science, Technology and Innovation Advisory Council (PM-STIAC).
- It is a 21-member panel, advise the Prime Minister on all matters related to S&T, innovation and monitor the implementation of PM’s vision on the same.

- It is chaired by government's Principal Scientific Advisor.
- It is expected to act as a high-level advisory body to several ministries and execute mission-oriented programmes.
- Secretaries of various scientific ministries such as education, environment and health would be 'special invitees' to the council meetings.
- Scientific Advisory Committees (SAC) - Cabinet and SAC-PM was dissolved and replaced by PM-STIAC.

10.8 YUVIKA

- ISRO has launched a special programme residential training program for School Children called "Young Scientist Programme" "YUvaVIgyaniKaryakram.
- The Program is primarily aimed at imparting basic knowledge on Space Technology, Space Science and Space Applications to the younger ones with the intent of arousing their interest in the emerging areas of Space activities.
- The programme will be of around two weeks duration during summer holidays and it is proposed to select 3 students each from each State/ Union Territory to participate in this programme covering state, CBSE, and ICSE syllabus.
- Those who have just finished 9th standard (in the academic year 2018-19) and waiting to join or in 10th standard will be eligible for the programme.
- The selection will be based on the 8th std marks (academic performance and extracurricular activities).

10.9 UNNATI

- UNNATI (UNISpace Nano-satellite Assembly and Training by ISRO) programme is a capacity building programme on nanosatellite development.
- The UNNATI Programme is to commemorate the 50th anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50).
- The programme will be conducted for 3 years in 3 batches and will target to benefit 90 officials from 45 countries.
- The primary objectives of the programme are:
 1. To offer a simplified and increased exposure to satellite fabrication technologies, as part of the UNISPACE initiative.
 2. To provide theoretical course on satellite technology.
 3. To provide hands-on training to assemble, integrate and test a low cost, modular Nano satellite.