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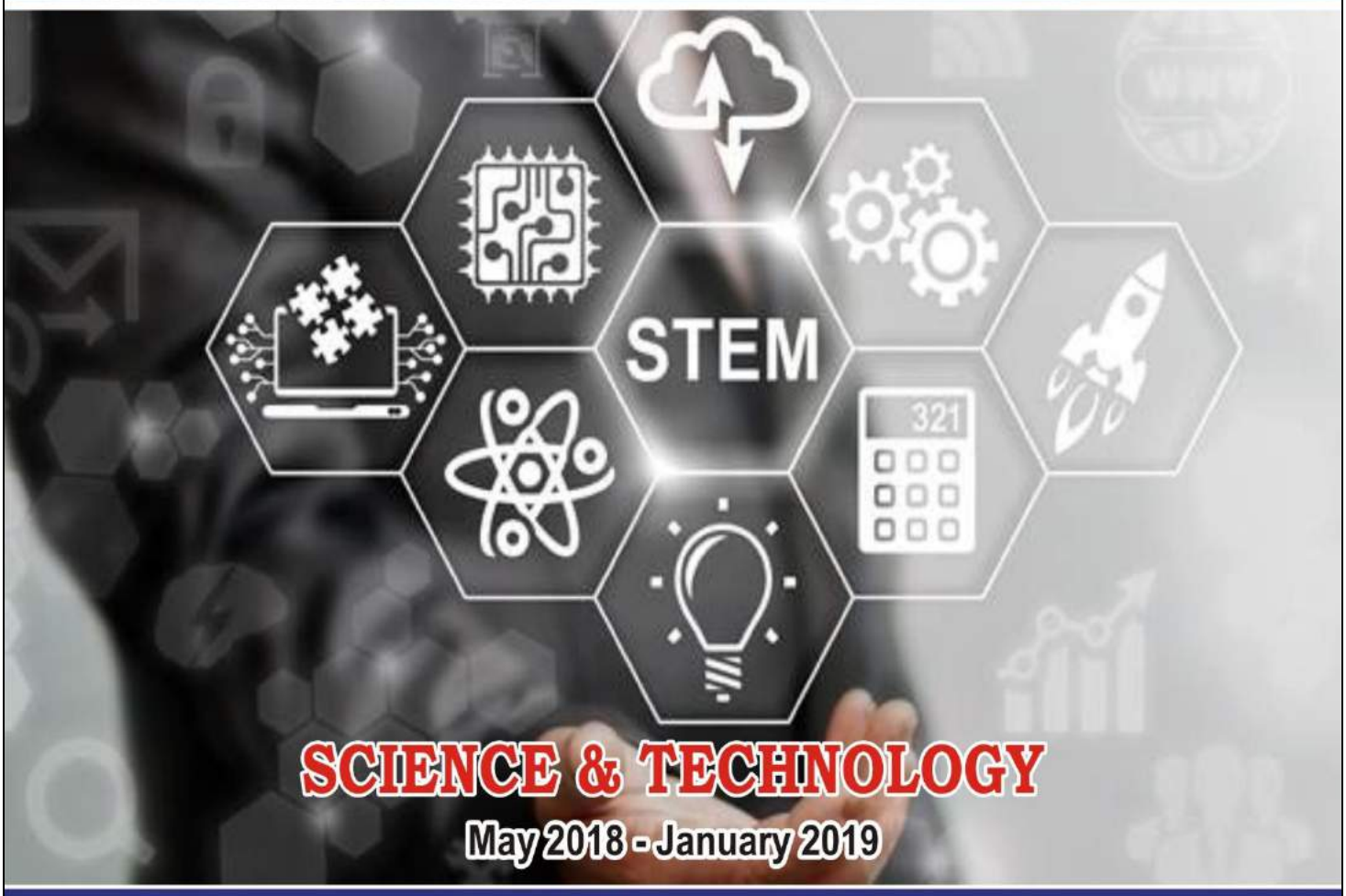

SCIENCE & TECHNOLOGY

May 2018 - January 2019

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Defence Technology

1. Mother of All Bombs

- China has developed a massive bomb, said to be the country's answer to the **US-built 'Mother of All Bombs',** the most powerful non-nuclear weapon.
- It is dubbed as the Chinese version of the "Mother of All Bombs" due to its huge destruction potential that is claimed to be only second to nuclear weapons.
- ***Background:***
    - Last year, while waging war against militants in Afghanistan, the US military dropped a **GBU-43/B Massive Ordnance Air Blast (MOAB) weapon**, more commonly known as the "Mother of All Bombs," on the Islamic State.
    - Although China is using the same nickname for its bomb, said to weigh several tonnes, the Chinese weapon is smaller and lighter than its American counterpart.
- ***Mother of all Bombs:***
    - The Moab or GBU-43/B is the **world's largest non-nuclear weapon**.
    - It is designed to destroy heavily reinforced targets or to shatter ground forces and armour across a large area.
    - While it has a blast radius that stretches a mile in each direction the **bomb leaves no lasting radiation effect because it is non-nuclear.**
- ***Father of all Bombs:***
    - To match the U.S. weapon, Russia developed the "Father of All Bombs" which is both bigger and thermobaric, meaning it uses gas to create a huge fireball rather than a shockwave.

2. INS Kohassa

- (Indian Naval Station) INS Kohassa has been commissioned at Diglipur on North Andaman.
- *Significance:* Indian Navy will have full command over the new airbase, which will play an important role in strengthening the monitoring capabilities of Indian Navy in this part of the Indian Ocean.
- *Geographical importance:* Located in the region close to the opening of the Straits of Malacca, INS Kohassa is just 90 km from Indonesia, 45 km from Myanmar and 550 km from Thailand.

3. Agni –I Missile

- India has successfully conducted the night trial of the **indigenously developed nuclear capable Agni-I ballistic missile** off the Odisha coast.
- The surface-to-surface missile test was test-fired as part of a user-trial from the Abdul Kalam Island off Odisha coast.
- **About Agni –I:**
    - Agni-I is a **short-range ballistic missile** developed by DRDO of India under the **Integrated Guided Missile Development Program.**
    - Agni-I missile has a specialised navigation system which ensures it reaches the target with a high degree of accuracy and precision.

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- It is sleek single-stage missile, powered by solid propellants developed after the Kargil War to fill the gap between 250 km range of Prithvi-II and 2,500 km range of Agni-II.
- The 15-metre-long Agni-I, which can carry payloads up to 1000 kg, has already been inducted into the Indian Army.

4. Agni IV Missile

- Agni-IV, the **Long Range Surface to Surface Ballistic Missile** with a range of 4,000 kms was successfully flight tested recently.
- The missile is developed by the Defence Research and Development Organisation under the Integrated Guided Missile Development Program.
- Agni IV is **nuclear capable**, with a payload capacity of one tonne of high-explosive warhead.
- The most accurate Ring Laser Gyro based Inertial Navigation System (RINS) and supported by highly reliable redundant Micro Navigation System (MINGS), ensures the vehicle reaches the target within two digit accuracy.
- **Integrated Guided Missile Development Programme (IGMDP):**
  - The Integrated Guided Missile Development Programme (IGMDP) was an Indian Ministry of Defence programme for the **research and development of the comprehensive range of missiles.**
  - **Five missile systems have been developed under this programme namely Agni, Akash, Trishul, Prithvi and Nag.**
  - The project started in 1982–83 under the leadership of Abdul Kalam who oversaw its ending in 2008 after these strategic missiles were successfully developed.

5. Agni- 5 Missile

- India successfully test-fired Agni-5 missile, which has a strike range of 5,000 km, from Dr Abdul Kalam island off the Odisha coast recently.
- Agni- 5 is ***the intercontinental surface-to-surface nuclear capable ballistic missile***. It is the latest in India's "Agni" family of medium to intercontinental range missiles.
- ***Agni-5 has a range of over 5,000 km and can carry about a 1500-kg warhead***. It can target almost all of Asia including Pakistan and China and Europe.
- The 17-metre long Agni-5 Missile weighs about 50 tonnes and is a very agile and modern weapon system.
- The surface-to-surface missile is ***a fire-and-forget system*** that cannot be easily detected as it follows a ballistic trajectory. India describes the Agni – 5 missile system as a **'weapon of peace'.**
- India has already joined an elite club of nations that possess the ICBM launch capability when the maiden test-firing of Agni-V was successfully conducted in April, 2012.
- Only the five permanent members of the United Nations Security Council – China, France, Russia, the United States and Britain, along with Israel, have so far possessed such long-range missiles.

6. BrahMos

- The BrahMos is the **fastest cruise missile** of its class in the world.

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- BrahMos missile flies almost three times the speed of sound at Mach 2.8 and has a range of 290 km.
- The missile has been **jointly developed with Russia** and is named after the rivers Brahmaputra and Moskva in Russia.
- The BrahMos is extremely difficult to be intercepted by surface to air missiles deployed on leading warships around the world.
- The range of the BrahMos missile can be extended up to 400 km as certain technical restrictions were lifted after India became a full member of the Missile Technology Control Regime or MTCR in 2016.
- It is capable of being **launched from land, sea, sub-sea and air against sea and land targets**.

7. Helicopter-launched NAG (HELINA)

- It is **indigenously developed Helicopter launched Anti-Tank Guided Missile**.
- The Missile is guided by an Infrared Imaging Seeker (IIR) operating in the Lock on Before Launch mode. It is one of the most advanced Anti-Tank Weapons in the world.
- Nag is a **third-generation, fire-and-forget, anti-tank guided missile** developed by DRDO to support both mechanised infantry and airborne forces of the Indian Army.
- Nag can be launched from land and air-based platforms.

8. Pinaka Rocket System

- The indigenous Pinaka rocket system of the Defence Research and Development Organisation (DRDO) is being evolved into a precision-guided missile, with enhanced range and accuracy to hit its targets.
- The rocket has been developed by the Armament cluster of the DRDO, with a lead from Pune-based Armament Research and Development Establishment (ARDE).
- The advanced versions of this system can also be used to conduct surgical strikes even without entering into the enemy area.
- Pinaka is capable of working in different modes – autonomous mode, stand-alone mode, remote mode and manual mode.
- The second variant of Pinaka, known as Mark-II, has a maximum range of 75 km.

9. Dhanush Artillery Gun

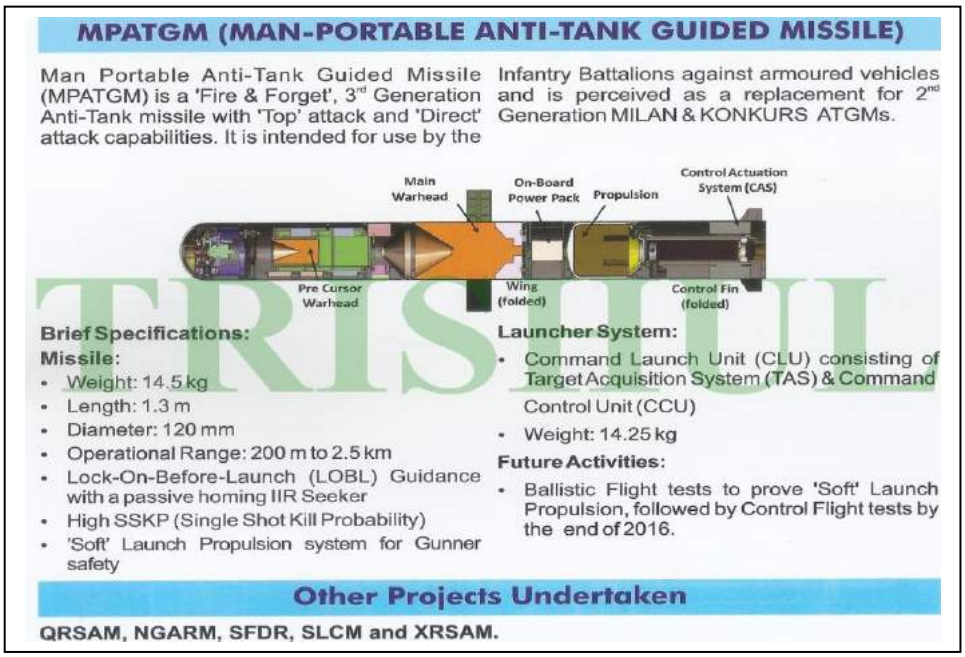
- The indigenously upgraded artillery gun Dhanush has successfully completed final user trials and is ready for induction into the Army.
- Dhanush is an **upgraded version of the Swedish Bofors gun** procured by India in the mid-1980s.
- Dhanush has a maximum range of 40 km in salvo mode.
- It has been developed by **Ordnance Factory Board (OFB).**

10. Advanced Towed Artillery Gun System (ATAGS)

- The Army has begun finalising the Preliminary Specifications Qualitative Requirements (PSQR) of the **indigenously-designed heavy artillery gun, the *Advanced Towed Artillery Gun System (ATAGS)*.**

11. Man Portable Anti-Tank Guided Missile (MPATGM)

- Defence Research and Development Organisation (DRDO) recently conducted first successful trials of indigenously developed third generation ***Man Portable Anti-Tank Guided Missile (MPATGM)***.
- **About MPATGM:**
  - The MPATGM is a third-generation anti-tank guided missile (ATGM), which has been under development by DRDO in partnership with Indian defense contractor VEM Technologies Ltd. since 2015.
  - Fitted with a high-explosive anti-tank (HEAT) warhead, the MPATGM reportedly boasts a top attack capability and has a maximum engagement range of about 2.5 kilometers.



12. Missile 'Prahar'

- Defence Research and Development Organisation (DRDO) successfully flight tested the indigenously developed **surface-to-surface tactical missile 'Prahar'**, from Launch Complex-III, ITR, Balasore.
- **About Prahar:**

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- ‘Prahar’, developed by the Defence Research and Development Organisation (DRDO), is capable of filling the gap between the multi-barrel rocket system ‘Pinaka’ and medium-range ballistic missile ‘Prithvi’. It can also engage multiple targets in different directions.
- It is a solid-fuelled short-range missile fitted with inertial navigation system.
- The missile is equipped with state-of-the-art navigation, guidance and electromechanical actuation systems with advanced on-board computer.
- It is a quick-reaction, all-weather, all-terrain, highly accurate battlefield support tactical weapon system.

13. Prithvi Defence Vehicle (PDV) Mission

- India successfully conducted an interceptor missile test off the Odisha coast, achieving a major milestone in developing a two-layer Ballistic Missile Defence system.
- The interceptor was launched from Abdul Kalam Island, earlier known as Wheeler Island of the Integrated Test Range (ITR).
- **About Prithvi Defence Vehicle (PDV) mission:**
  - PDV mission is for engaging the targets in the exo-atmosphere region at an altitude above 50 km of the earth’s atmosphere DRDO.
  - The PDV is slated to replace the existing Prithvi Air Defense (PAD)/Pradyumna Ballistic Missile Interceptor, which has a maximum interception altitude of 80 kilometers.
  - The new two-stage solid-fueled PDV interceptor is fitted with an Imaging Infrared (IIR) seeker, developed by DRDO, to distinguish between incoming warheads and decoys.
  - It is guided by high-accuracy Inertial Navigation System (INS) supported by Redundant Micro Navigation System for estimating point of interception.

14. Astra Missile

- Astra, the indigenously developed **Beyond Visual Range Air-to-Air Missile (BVRAAM),** was recently successfully test fired by the Indian Air Force from Su-30 aircraft.
- It is an all-weather, state-of-the-art missile developed by DRDO and can engage and destroy enemy aircraft at supersonic speed (1.2 Mach to 1.4 Mach) in head-on (up to 80 km) and tail-chase (up to 20 km) modes.
- The 3.8 metre tall Astra is a radar homing missile and the smallest of the DRDO-developed missiles and can be launched from different altitudes.
- It can reach up to 110 km when fired from an altitude of 15 km, 44 km when launched from an altitude of eight km and 21 km when fired from sea level.

15. Ballistic Missile Interceptor Advanced Area Defence (AAD)

- DRDO conducted the successful test of the Ballistic Missile Interceptor Advanced Area Defence (AAD) from Abdul Kalam Island, Odisha.
- **About Ballistic Missile Interceptor AAD:**
  - It is ***an endo-atmospheric missile***, capable of intercepting incoming targets at an altitude of 15 to 25 kms.

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- ***Indigenously developed by DRDO***, the AAD interceptor is a single-stage missile powered by solid propellants.
- It has been developed ***as part of indegenous efforts to have multi-layer ballistic missile defence system***, capable of destroying incoming hostile ballistic missiles.
- The interceptor missile has its own mobile launcher, secure data link for interception, independent tracking and homing capabilities and sophisticated radars.

- **Background:**
  - The ***Indian Ballistic Missile Defence (BMD) Programme*** is an attempt to develop and to use a multi-layered ballistic missile defence system to protect from ballistic missile attacks.
  - The India's decision to develop Ballistic Missile Defense (BMD) was introduced in the light of the ballistic missile threat mainly from Pakistan, especially can be attributed to the Kargil War in 1999.

16. Project 75-I

- The **Project 75I-class submarine** is a follow-on of the Project 75 *Kalvari*-class submarines for the Indian Navy.
- Under this project, the Indian Navy intends to acquire six diesel-electric submarines, which will also feature advanced air-independent propulsion systems to enable them to stay submerged for longer duration and substantially increase their operational range.
- All six submarines are expected to be constructed in Indian shipyards.

17. INS Kalvari

- **INS Kalvari is Indian Navy's first indigenous Scorpene-class stealth submarine**.
- It is a **diesel-electric attack submarine** which is built under the strategic Project 75 by Mazagon Dock Limited (MDL) in collaboration with French naval defence and Energy Company DCNS.
- INS Kalvari is also known as **Tiger Shark (or S50).**
- It can undertake various operations including multifarious warfare, Antisubmarine warfare, Intelligence gathering, mine laying, area surveillance etc.
- It can launch attack on the enemy using precision guided weapons and attack can be launched from underwater or on surface.
- **Background:**
  - Six Scorpene submarines are being built under Project-75 by Mazgaon Docks Limited (MDL) with technology transfer from France.
  - All the six submarines under this project will be **indigenously built at Mumbai's Mazagaon Dockyard Ltd.**
  - These attack submarines have **diesel propulsion and additional air-independent propulsion.**

18. Rustom 2 Drone

- Rustom 2 drone is a **medium-altitude, long-endurance unmanned aerial vehicle**, developed on the lines of predator drones of the United States.
- The objective of this drone is to carry out surveillance for the armed forces with an endurance of 24 hours.

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- The drone was developed for use by all three services of the Indian armed forces, primarily for **intelligence, surveillance and reconnaissance (ISR) operations**.
- The medium-altitude prototype can fly at over 22,000 ft and is a long-endurance (MALE) UAV that has an approximate flight time of 20 hours.
- It can fly at around 280 km/h and carry a variety of payloads like Medium Range Electro Optic (MREO), Long Range Electro Optic (LREO), Synthetic Aperture Radar (SAR), Electronic Intelligence (ELINT).
- Rustom 2 can fly missions on manual as well as autonomous modes. The onboard way-point navigation system allows the drone to conduct missions autonomously.

19. Arrow 3 Interceptor System

- Arrow 3 interceptor system was recently successfully tested.
- Arrow 3 is intended to serve as **Israel's highest-altitude missile interception system**.
- It is ***jointly funded, developed and produced by Israel and the United States***.
- The system is designed to shoot down missiles above the atmosphere.

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Space Technology

1. Microsat-R and Kalamsat

- India has successfully launched Microsat-R, a military satellite and Kalamsat onboard its Polar rocket PSLV C44, in the first mission for the ISRO in 2019.
- *Microsat-R* is meant for military use.
- *Kalamsat* is a communication satellite with a life span of two months. The nanosatellite is a 10cm cube weighing 1.2 kg. It was the first to use the rocket's fourth stage as an orbital platform. It is the world's lightest and first ever 3D-printed satellite.

2. Polar Satellite Launch Vehicle

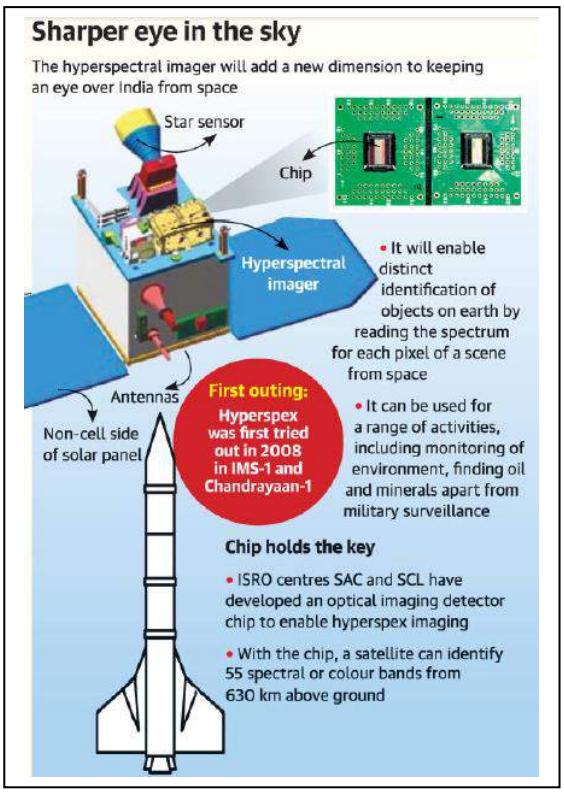
- Polar Satellite Launch Vehicle (PSLV) is the third generation launch vehicle of India. It is the first Indian launch vehicle to be equipped with liquid stages.
- It is a four-stage launch vehicle.
- A large solid rocket motor forming the **first stage**,
- An earth storable liquid stage as the **second stage**,
- A high-performance solid rocket motor as **third stage**, and
- A liquid stage with engines as **fourth stage**.
- PSLV has emerged as a versatile launch vehicle to carry out Sun-Synchronous Polar Orbit (SSPO), Geo- synchronous Transfer Orbit (GTO) and low inclination Low Earth Orbit (LEO) missions.
- It is the first Indian launch vehicle to be equipped with liquid stages.
- The operationalisation of PSLV has made the country self-reliant in the launching capability of satellites for earth observation, disaster management, navigation and space sciences.
- The vehicle successfully launched – Chandrayaan-1 in 2008, Mars Orbiter Spacecraft in 2013 and India's first space observatory, Astrosat.
- **About GSLV Mk III rockets:**
    - GSLV Mk III is a three-stage heavy lift launch vehicle developed by ISRO. The vehicle has two solid strap-ons, a core liquid booster and a cryogenic upper stage.
    - GSLV Mk III is designed to carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO) or about 10 tons to Low Earth Orbit (LEO), which is about twice the capability of GSLV Mk II.
    - This is India's first fully functional rocket to be tested with a cryogenic engine that uses liquid propellants — liquid oxygen and liquid hydrogen.
- **About ASTROSAT:**
    - ASTROSAT is India's first dedicated **multi wavelength space observatory.** This scientific satellite mission endeavours for a more detailed understanding of our universe.
    - ASTROSAT is designed to observe the universe in the Visible, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum simultaneously with the help of its five payloads.
    - ASTROSAT aims at understanding the high energy processes in binary star systems containing neutron stars and black holes, to estimate

magnetic fields of neutron stars, to study star birth regions and high energy processes in star systems lying beyond the Milky Way galaxy.

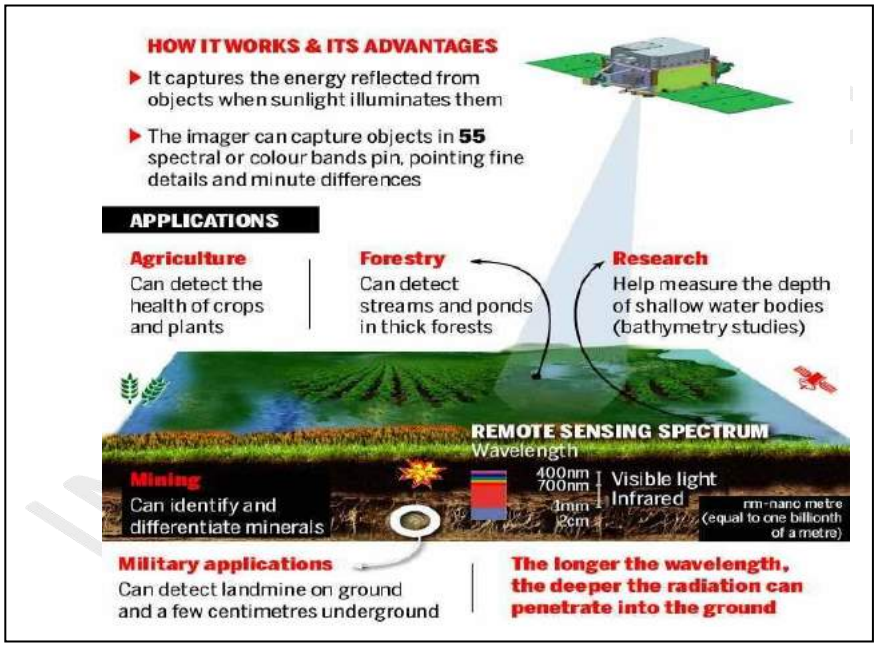
- This mission has put ISRO in a very exclusive club of nations that have space-based observatories. Only the United States, European Space Agency, Japan and Russia have such observatories in space.

3. Hyper Spectral Imaging Satellite (HysIS)

- The **Indian Space Research Organization's (ISRO) Polar Satellite Launch Vehicle (PSLV-C43)** successfully launched 31 satellites from Satish Dhawan Space Centre (SDSC) in Sriharikota.
- **About HysIS and its significance:**
  - The primary goal of HysIS is ***to study the Earth's surface in visible, near- infrared and shortwave infrared regions of the electromagnetic spectrum***.
  - HysIS will be ***ISRO's first full-scale working satellite*** with this capability. While the technology has been around, not many space agencies have working satellites with hyperspectral imaging cameras as yet.
  - 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 defence, agriculture, land use, minerals and so on.



- **HysIS:**
  - Hyper Spectral Imaging Satellite **(HysIS)** It is an **earth observation satellite** built around ISRO's **Mini Satellite 2 (IMS-2)** bus weighing about 380 kg.
  - The life of the satellite is **five years.**
- **Primary Goal:**
  - It is to **study the earth's surface in both the visible**, near infrared and shortwave infrared regions of the electromagnetic spectrum.
  - Data from the satellite will **be used for various applications including agriculture, forestry, soil/geological environments, coastal zones and inland waters**, etc.



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4. GSAT- 29

- The Indian Space Research Organisation (ISRO) has launched its latest communication satellite, GSAT- 29, from its second developmental flight GSLV-MkIII D2.
- **About GSAT-29:**
  - GSAT-29 is a multiband, multi-beam communication satellite, intended to serve as test bed for several new and critical technologies. Its Ku-band and Ka-band payloads are configured to cater to the communication requirements of users including those from remote areas especially from Jammu & Kashmir and North-Eastern regions of India.
- **Significance of the launch:**
  - The success of GSLV MkIII-D2 marks an important milestone in Indian space programme towards achieving **self-reliance in launching heavier satellites**.
  - The success of this flight also signifies the completion of the experimental phase of GSLV Mark III.

5. GSAT-11

- India's heaviest and most advanced satellite GSAT-11 was recently launched from the Guiana Space Centre at Kourou in French Guiana.
- ***GSAT- 11- key facts:***
  - GSAT-11 is ***ISRO's heaviest satellite*** and weighs about 5854 kilograms.
  - It was launched onboard ***Ariane-5 launch vehicle from French Guiana***.
  - ISRO has revealed that the satellite will be initially placed in the Geosynchronous Transfer Orbit and will be later raised to Geostationary Orbit.
  - GSAT-11 is part of ISRO's new family of ***high-throughput communication satellite*** *(HTS) fleet* that will drive the country's **Internet broadband from space to untouched areas.**
  - According to ISRO, GSAT-11's multiple spot beam coverage will deliver an improved service of 16 gbps over the Indian region and nearby islands.

6. GSAT-7A

- ISRO has launched **military communication satellite GSAT-7A**. GSAT-7A was successfully injected into its orbit by GSLV-F11 that was launched from Sriharikota, Andhra Pradesh.
- ***About GSAT-7A:***
  - GSAT-7A has been placed ***in the geostationary orbit*** and this communication satellite is expected to help the IAF to interlink different ground radar stations, airbases and AWACS (Airborne Warning And Control System) aircraft. The idea is to improve the IAF's network-centric warfare capabilities.
  - It is an **advanced communication satellite with a Gregorian Antenna** and many other new technologies.
  - It is the **heaviest satellite** being launched by GSLV with an indigenously developed cryogenic stage.

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- The GSAT-7A is also expected to be a big push for drone operations as it will help the Navy reduce the reliance on on-ground control stations and take satellite-control of military unmanned aerial vehicles (UAV) which should help boost the range and endurance of the UAVs.
- The satellite, being dubbed as **'angry bird'** by some, is likely to enhance the range of communication and also aid in aircraft to aircraft communication.

- ***GSLV:***
  - The GSLV is ISRO's fourth generation launch vehicle that has three stages. The four-liquid strap-ons and a solid rocket motor at the core constitute the first stage. The second stage is equipped with a high thrust engine that uses liquid fuel.
  - The cryogenic upper stage forms the third and final stage of the vehicle.

7. ExeedSAT 1

- With the launch of ExseedSAT 1, Exseed Space has become the first Indian privately-funded startup to successfully send a satellite into space.
- ExseedSAT 1 was launched into space by Space X along with 63 other satellites from 17 countries.
- **About ExseedSAT 1 and its applications:**
  - The mini communication satellite weighing just a kg with double the size of a Rubik's cube (10 cm x 10 cm x 10 cm) is made up of aluminium alloy.
  - The satellite looks to serve the amateur radio community.
  - The satellite would provide a big boost to private radio operators and help in coordinating messages among them and help the country in time of disaster.

8. Gaganyaan

- Indian Space Research Organisation (**ISRO**) and Russia's Roscosmos State Corporation for Space Activities (**ROSCOSMOS**) have signed an MoU to work together for ***Gaganyaan***.
- As per the MoU, ROSCOSMOS has offered ride to Indian astronaut short visit to International Space Station (ISS) on board Soyuz spacecraft for short training mission in 2022.
- **About Gaganyaan:**
  - It is **India's first manned space mission**. Under it, India is planning to send three humans (Gaganyatris) into space i.e. in low earth orbit (LEO) by 2022 i.e. by 75th Independence Day for period of five to seven days.
  - Gaganyaan is part of the **Indian Human Spaceflight Programme**.
  - Isro's **Geosynchronous Satellite Launch Vehicle GSLV Mk III**, the three-stage heavy-lift launch vehicle, will be used to launch Gaganyaan as it has the necessary payload capability.
  - If India does launch the Gaganyaan mission, it will be the fourth nation to do so after the United States, Russia and China.

9. Pad Abort Test

- ISRO recently conducted the first 'pad abort' test critical for a future human space mission. The Pad Abort Test demonstrated the **safe recovery of the crew module in case of any exigency at the launch pad.**

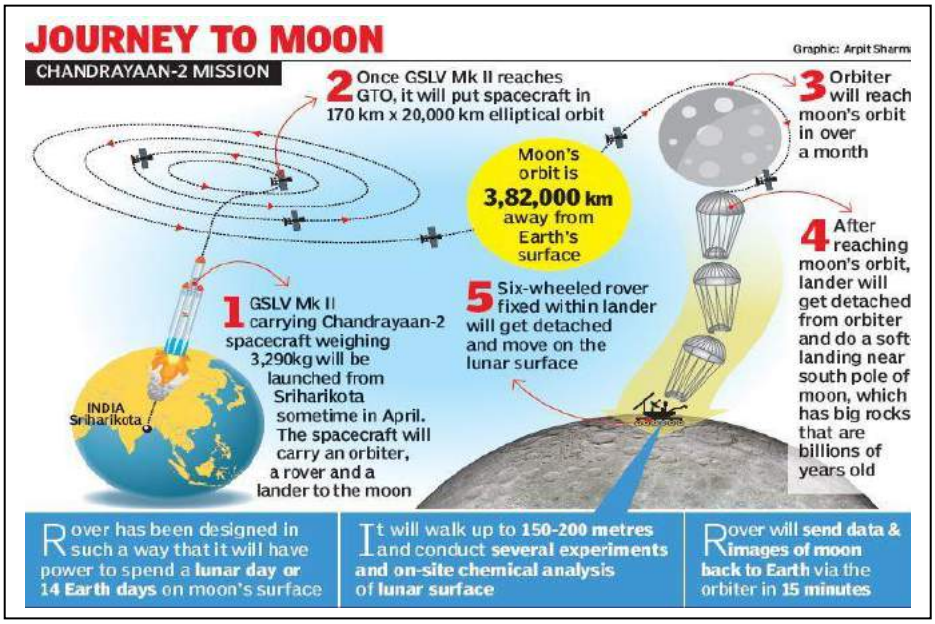
- **What is PAT?**
  - PAT (pad abort test) is the first in a series of tests to qualify a crew escape system technology of a manned mission in the future.
- **What is Crew Escape System?**
  - It is an emergency escape measure to quickly pull the astronaut cabin along with crew out to a safe distance from launch vehicle during a launch abort.

10. Chandrayaan- 1

- Scientists have found frozen water deposits in the darkest and coldest parts of the Moon's polar regions using data from the Chandrayaan-1 spacecraft, that was launched by India 10 years ago.
- Indian Space Research Organisation (ISRO) lost communication with Chandrayaan-1 on August 29, 2009, barely a year after it was launched on October 22, 2008.
- The Chandrayaan-1 mission performed **high-resolution remote sensing of the moon** in visible, near infrared (NIR), low energy X-rays and high-energy X-ray regions.
- One of the objectives was to prepare a three-dimensional atlas (with high spatial and altitude resolution) of both near and far side of the moon.
- It aimed at conducting chemical and mineralogical mapping of the entire lunar surface for distribution of mineral and chemical elements such as Magnesium, Aluminium, Silicon, Calcium, Iron and Titanium as well as high atomic number elements such as Radon, Uranium and Thorium with high spatial resolution.

11. Chandrayaan 2

- Chandrayaan-2's journey has been rather slow so far. Although the mission was envisioned way back in November 2007, as a **joint mission between India and Russia**, it had faced a series of setbacks.
- Chandrayaan-2 includes **soft-landing on Moon and moving a rover on its surface.**
- It is an advanced version of the previous Chandrayaan-1 mission. It consists of an orbiter, lander and rover configuration.



- The Orbiter spacecraft when launched from Sriharikota will travel to the Moon and release the Lander, which will in turn deploy a tiny Rover to roam the lunar surface — all three sending data and pictures to Earth.
- Soft-landing on the lunar surface is the most challenging part of the mission. Till now,only the US, Russia and China have been able to soft-land spacecraft on the lunar surface.

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12. Navic- Powered Satellite- Enabled Communication Devices

- The Tamil Nadu government has distributed 200 ***Navic- powered satellite-enabled communication devices*** developed by ISRO to 80 fishing boat groups.
- ***Significance:***
  - These gadgets will help the Tamilnadu fishermen know about ***cyclones and provide weather updates*** on a real- time basis.
  - These gadgets are basically receivers which will produce a beep when alerts are received by the device. ***They are Bluetooth enabled and the alerts received can be read on the Navic app***.
- ***What is NAVIC?***
  - NAVIC is an independent regional navigation satellite system designed to provide **position information in the Indian region and 1500 km around the Indian mainland**.
- ***Services provided:***
  - IRNSS would provide two types of services, namely Standard Positioning Services available to all users and Restricted Services provided to authorised users.
- ***Its applications include:***
  - Terrestrial, Aerial and Marine Navigation.
  - Disaster Management.
  - Vehicle tracking and fleet management.
  - Integration with mobile phones.
  - Precise Timing.
  - Mapping and Geodetic data capture.
  - Terrestrial navigation aid for hikers and travelers.
  - Visual and voice navigation for drivers.
- ***How many satellites does NAVIC consist of?***
  - It is a regional system and so ***its constellation will consist of seven satellites***. **Three of these will be geostationary** over the Indian Ocean, i.e., they will appear to be stationary in the sky over the region, and **four will be geosynchronous** – appearing at the same point in the sky at the same time every day.
  - This configuration ensures each satellite is being tracked by at least one of fourteen ground stations at any given point of time, with a high chance of most of them being visible from any point in India.
- ***Why it is necessary to have indigenous global navigation system?***
  - Having a global navigation system bolsters the ability of a nation to serve as a **net security provider,** especially through the guarantee of such assurance policies.
  - It can also play a significant role in **relief efforts post disasters** such as the tsunami in the Indian Ocean region in 2004 and the Pakistan-India earthquake in 2005.

13. GROWTH-India Telescope

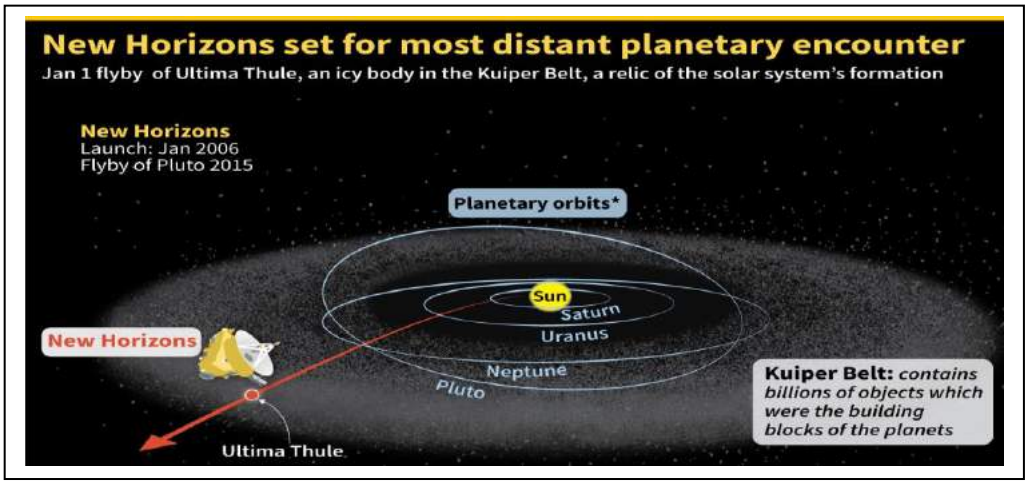
- The 0.7 m GROWTH-India telescope at the Indian Astronomical Observatory located in Hanle, Ladakh, has made its first science observation which is a follow-up study of a nova explosion.
- **About GROWTH-India Telescope:**

- The GROWTH-India telescope is part of a **multi-country collaborative initiative** – known as the ***Global Relay of Observatories Watching Transients Happen (GROWTH)*** – to observe transient events in the universe.
- The fully robotic telescope is designed to **capture cosmic events** occurring over relatively shorter periods of the cosmological timescale: years, days and even hours.
- Universities and research institutes from the US, the UK, Japan, India, Germany, Taiwan and Israel are part of the initiative.
- Their primary research objective is time-domain astronomy, which entails the study of explosive transients and variable sources (of light and other radiation) in the universe.

- **Nova Observation:**
  - Novae are explosive events involving violent eruptions on the surface of white dwarf stars, leading to temporary increase in brightness of the star.
  - Unlike a supernova, the star does not go on to die but returns to its earlier state after the explosion.
  - The recurrent nova, named M31N-2008, has been observed to erupt several times, the most recent eruption happening in November 2018.

14. NASA's New Horizons Spacecraft

- On January 1 2019, ***NASA's New Horizons spacecraft became the first explorer to fly past the mysterious object- Ultima Thule***, located some 4 billion miles from Earth.
- This is a historic flyby of the farthest, and quite possibly the oldest, cosmic body ever explored by humankind.

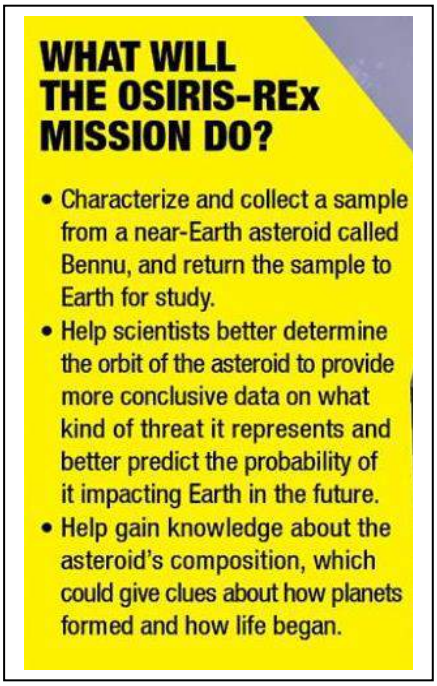


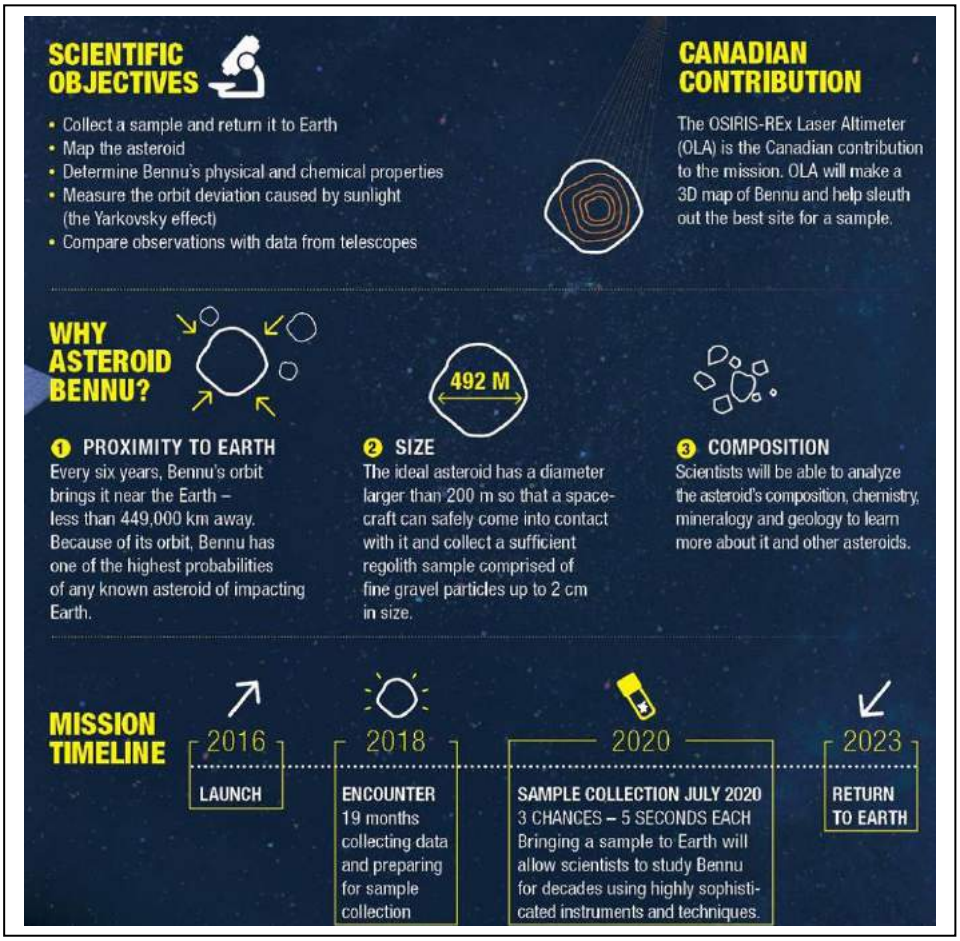
- ***Key facts- Ultima Thule:***
  - Ultima Thule is ***located in the Kuiper belt*** in the outermost regions of the Solar System, beyond the orbit of Neptune.
  - It measures approximately 30 km in diameter, and is irregularly shaped.
  - Ultima Thule has a reddish color, probably caused by exposure of hydrocarbons to sunlight over billions of years.
  - ***Ultima Thule belongs to a class of Kuiper belt objects called the "cold classicals"***, which have nearly circular orbits with low inclinations to the solar plane.
- ***Background:***
  - New Horizons was launched on 19 January 2006, and has been travelling through space for the past nine years.
  - New Horizon's core science mission is to map the surfaces of Pluto and Charon, to study Pluto's atmosphere and to take temperature readings.
- **Facts for Prelims:**
  - ***The Kuiper belt*** sometimes called the Edgeworth–Kuiper belt, is a region of the Solar System beyond the planets, extending from the orbit of Neptune (at 30 AU) to approximately 50 AU from the Sun.

- It is similar to the asteroid belt, but it is far larger—20 times as wide and 20 to 200 times as massive.

15. NASA's OSIRIS-Rex Spacecraft

- ***NASA's OSIRIS-Rex*** spacecraft has set a new milestone in cosmic exploration by entering orbit around an asteroid, ***Bennu, the smallest object ever to be circled by a human-made spaceship***.
- ***Significance:***
  - ***OSIRIS-Rex is the first-ever US mission designed to visit an asteroid and return a sample of its dust back to Earth***.
- ***About the mission:***
  - OSIRIS-Rex stands for ***Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer***.
  - OSIRIS-REx is ***the third mission in NASA's New Frontiers program***, which previously sent the New Horizons spacecraft zooming by Pluto and the Juno spacecraft into orbit around Jupiter.
- ***Why was Bennu chosen?***
  - Bennu was selected for the OSIRIS-REx mission from over 500,000 known asteroids, due to it fitting a number of key criteria. These include:
  - ***Proximity to Earth:*** In order for OSIRIS-REx to reach its destination in a reasonable timeframe, NASA needed to find an asteroid which had a similar orbit to Earth.
  - ***Size:*** Small asteroids, those less than 200m in diameter, typically spin much faster than larger asteroids, meaning the regolith material can be ejected into space. Bennu is around 500m in diameter, so rotates slowly enough to ensure that the regolith stays on its surface.





- ***Composition:*** Ben-nu is a primitive asteroid, meaning it hasn't significantly changed since the beginning of the Solar System. It is also very **carbon-rich**, meaning it may contain organic molecules, which could have been precursors to life on Earth.
- Additionally, Bennu is of interest as it is ***a Potentially Hazardous Asteroid (PHA)***. Every 6 years, Bennu's orbit brings it within 200,000 miles of the Earth, which means it has a high probability of impacting Earth in the late 22nd Century.

16. NASA's Orion Spacecraft

- Europe's Airbus has delivered the "powerhouse" for **NASA's new Orion Spaceship that will take astronauts to the Moon and beyond** in coming years.
- **About Orion:**
  - NASA's Orion spacecraft is built to **take humans farther** than they've ever gone before.
  - Orion will serve as the exploration vehicle that will carry the crew to space, provide emergency abort capability, sustain the crew during the space travel, and provide safe re-entry from deep space return velocities.
  - Orion will launch on NASA's new heavy-lift rocket, the Space Launch System.

17. NASA's Kepler Space Telescope

- The Kepler Space Telescope has been officially retired by NASA. Its successor space telescope, called TESS, has already started collecting data.
- **About Kepler Mission:**
  - Launched in 2009, the Kepler mission is specifically designed to **survey our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets in or near the habitable zone** and determine the fraction of the hundreds of billions of stars in our galaxy that might have such planets.
  - Since the launch of the observatory in 2009, astronomers have discovered thousands of extra-solar planets, or exoplanets, through this telescope alone.
  - As of March 2018, Kepler had found 2,342 confirmed planets; add potential planets, and its find of exoworlds stands at 4,587.

What is the habitable zone?

If a planet is too close to the star it orbits, any water on the surface quickly boils off, forming a steam atmosphere. If the planet is too far from the star, any water on the surface freezes.

- **The habitable zone (or "Goldilocks zone") is the range of orbital distances from a star at which liquid water can exist on the surface of a planet.**
- This range of distances changes depending on the size and temperature of the star.
- **Earth is in the habitable zone of the sun** – one of the reasons our planet has liquid water like oceans and lakes.

18. Transiting Exoplanet Survey Satellite (Tess)

- Nasa which launched ***Transiting Exoplanet Survey Satellite (Tess)*** for searching exoplanets in April, 2018 has discovered a third small planet outside our solar system.
- ***About TESS mission:***
  - The Transiting Exoplanet Survey Satellite (TESS) is a NASA mission that will ***look for planets orbiting the brightest stars in Earth's sky***. It was led by the Massachusetts Institute of Technology with seed funding from Google.
  - ***Mission:*** The mission will monitor at least 200,000 stars for signs of exoplanets, ranging from Earth-sized rocky worlds to huge gas giant planets. This will help astronomers better understand the structure of solar systems outside of our Earth, and provide insights into how our own solar system formed.

- ***Orbit:*** TESS will occupy a never-before-used orbit high above Earth. The elliptical orbit, called P/2, is exactly half of the moon's orbital period; this means that TESS will orbit Earth every 13.7 days.
- ***How it works?*** It will use transit method to detect exoplanets. It watches distant stars for small dips in brightness, which can indicate that planet has passed in front of them. This data has to be validated by repeated observations and verified by scientists.

19. NASA's Dawn Mission

- Dawn, a NASA spacecraft that launched 11 years ago and studied two of the largest objects in the asteroid belt, has ended its mission after running out of fuel.
- **About the Dawn Mission:**
  - It was launched by NASA in 2007 to **study the two massive protoplanets of the asteroid belt: Vesta and the dwarf planet Ceres**, celestial bodies believed to have accreted early in the history of the solar system.
  - Dawn is the only mission ever to orbit two extra-terrestrial targets. It orbited giant asteroid Vesta for 14 months from 2011 to 2012, then continued on to Ceres, where it has been in orbit since March 2015.

20. NASA's Ralph and Lucy

- NASA's Ralph and Lucy are all set to **explore Jupiter's Trojan asteroids**, which are remnants from the earliest days of our solar system.
- **What are they?**
  - Ralph is a space instrument that has travelled as far as Pluto, while Lucy is a mission payload, or the spacecraft which would be carrying various scientific instruments including Ralph to study the properties of the asteroids.
  - The mission will be launched in 2021 and would be the **very first space mission to study the Trojans.**
- **About Jupiter's Trojan asteroids:**
  - Trojan Asteroids are any one of a number of asteroids that occupy a stable Lagrangian point in a planet's orbit around the Sun.
- **What are Lagrange points?**
  - Lagrange points are sweet spots in a planetary orbit where the pull of gravity working from two opposing celestial bodies is balanced due to the centripetal force of their orbits.

21. NASA's InSight Mission

- The US space agency's **unmanned Mars Insight lander**, which touched down on the Red Planet recently, has successfully deployed its key, quake-sensing instrument- ***Seismic Experiment for Interior Structure***– on the alien world's surface.
- NASA last landed on Mars in 2012 with the Curiosity rover.
- **About InSight Mission:**
  - InSight is part of **NASA's Discovery Program**.
  - It will be the **first mission to peer deep beneath the Martian surface**, studying the planet's interior by measuring its heat output

About Seismic Experiment for Interior Structure:

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

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and listening for **marsquakes,** which are seismic events similar to earthquakes on Earth.
    - It will use the seismic waves generated by marsquakes to **develop a map of the planet's deep interior.**
- **Significance of the mission:**
    - The findings of Mars' formation will help better understand how other rocky planets, including Earth, were and are created.
    - But InSight is more than a Mars mission – it is a terrestrial planet explorer that would address one of the most fundamental issues of planetary and solar system science – **understanding the processes that shaped the rocky planets of the inner solar system** (including Earth) more than four billion years ago.
    - InSight would measure the planet's "vital signs": Its "pulse" (seismology), "temperature" (heat flow probe), and "reflexes" (precision tracking).

22. NASA's Voyager 2 Spacecraft

- NASA's Voyager 2 has entered interstellar space, leaving behind the solar system.
- ***Accomplishments so far:***
    - Voyager 2 is ***the only probe ever to study Neptune and Uranus during planetary flybys***.
    - ***Voyager 2 is the only spacecraft to have visited all four gas giant planets — Jupiter, Saturn, Uranus and Neptune*** — and discovered 16 moons.
- ***What is Interstellar space?***
    - Scientists use the heliopause to mark where interstellar space begins, although depending on how you define our solar system it can stretch all the way to the Oort Cloud, which begins 1,000 times farther away from the sun than Earth's orbit.
- ***The Heliosphere:***
    - The heliosphere is a bubble around the sun created by the outward flow of the solar wind from the sun and the opposing inward flow of the interstellar wind.
    - That heliosphere is the region influenced by the dynamic properties of the sun that are carried in the solar wind–such as magnetic fields, energetic particles and solar wind plasma.
    - The heliopause marks the end of the heliosphere and the beginning of interstellar space.

23. NASA's ICESat-2

- NASA's ICESat-2 has **mapped melting ice sheets in Antarctica** and the resulting sea level rise across the globe, which could help improve climate forecasts.
- The satellite is measuring the height of sea ice to within an inch, tracing the terrain of previously unmapped Antarctic valleys, surveying remote ice sheets, and peering through forest canopies and shallow coastal waters.
- ***About ICESat- 2 mission:***

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- ICESat-2 will **measure the average annual elevation change of land ice covering Greenland and Antarctica** to within the width of a pencil, capturing 60,000 measurements every second.
- ICESat-2's **Advanced Topographic Laser Altimeter System (ATLAS)** measures height by timing how long it takes individual light photons to travel from the spacecraft to Earth and back.

24. NASA's Apollo 8 Mission

- NASA's Apollo 8 mission completes its 50th anniversary.
- Apollo 8, the second manned spaceflight mission in the United States Apollo space program, was launched on December 21, 1968, and became the **first manned spacecraft to leave low Earth orbit**, reach the Moon, orbit it, and safely return.
- The three-astronaut crew—became the first humans to travel beyond low Earth orbit, see Earth as a whole planet, and enter the gravity well of another celestial body.

25. NASA's Chandra X-ray Observatory

- NASA's Chandra X-ray Observatory has entered protective "safe mode" due to a malfunction of some soft.
- The Chandra X-Ray Observatory is a **NASA telescope that looks at black holes, quasars, supernovas,** and the like – all sources of high energy in the universe. It shows a side of the cosmos that is invisible to the human eye.
- It was previously known as the **Advanced X-ray Astrophysics Facility (AXAF).**
- The telescope is named after the Nobel Prize-winning Indian-American astrophysicist Subrahmanyan Chandrasekhar.

26. NASA's Cassini Spacecraft

- Launched in 1997, the Cassini mission — ***a cooperation between NASA, the European Space Agency and the Italian Space Agency*** — has sent back thousands of stunning images and made numerous discoveries about the ringed planet and its moons.
- ***Cassini–Huygens is an unmanned spacecraft sent to the planet Saturn***. Cassini is the fourth space probe to visit Saturn and the first to enter orbit.
- Its design includes a Saturn orbiter and a lander for the moon Titan. The lander, called Huygens, landed on Titan in 2005. The spacecraft was launched on October 15, 1997.
- **Objectives of the mission:**
  - Determine the three-dimensional structure and dynamic behavior of the rings of Saturn.
  - Determine the composition of the satellite surfaces and the geological history of each object.
  - Study the dynamic behavior of Saturn's atmosphere at cloud level.

27. NASA's MAVEN Spacecraft

- NASA's MAVEN spacecraft has beamed back a selfie to mark its four years orbiting Mars and studying the upper atmosphere of the red planet.

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- ***MAVEN completed its primary mission in November 2015*** and has been operating in an extended mission since that time, continuing its **investigation of Mars' upper atmosphere**.
- **About MAVEN mission:**
    - Mars Atmosphere and Volatile Evolution (MAVEN) mission was developed by NASA to **study the Martian atmosphere while orbiting Mars**.
    - Mission goals include determining how the planet's atmosphere and water, presumed to have once been substantial, were lost over time.

28. NASA's Spitzer Space Telescope

- NASA's Spitzer Space Telescope, the youngest member of the **"Great Observatory" programme**, has completed 15 years in space.
- NASA's Spitzer Space Telescope was launched in 2003 to study the universe in the infrared.
- ***The goal*** of the Great Observatories is to observe the universe in distinct wavelengths of light.
- Spitzer focuses on the infrared band, which normally represents heat radiation from objects. The other observatories looked at visible light (Hubble, still operational), gamma-rays (Compton Gamma-Ray Observatory, no longer operational) and X-rays (the Chandra X-Ray Observatory, still operational.)

29. Hubble Space Telescope

- NASA's Hubble Space Telescope has detected a stunning image of a huge collection of ageing stars, believed to be 10 billion-years-old.
- **About the Hubble Space Telescope:**
    - The Hubble Space Telescope is a large telescope in space. **NASA** launched Hubble in **1990**.
    - It was built by the United States space agency NASA, with contributions from the European Space Agency.
    - Hubble is the only telescope designed to be serviced in space by astronauts.
    - Expanding the frontiers of the visible Universe, the Hubble Space Telescope looks deep into space with cameras that can see across the entire optical spectrum from infrared to ultraviolet.

30. High Resolution Imaging Science Experiment (HiRISE)

- High Resolution Imaging Science Experiment (HiRISE)- A camera aboard Nasa's Mars Reconnaissance Orbiter (MRO) has captured the image of the InSight lander, which recently touched down on the Red Planet.
- The High Resolution Imaging Science Experiment (HiRISE) will photograph hundreds of targeted swaths of Mars' surface in unprecedented detail.
- ***HiRISE operates in visible wavelengths***, the same as human eyes, but with a telescopic lens that will produce images at resolutions never before seen in planetary exploration missions.
- HiRISE also makes observations at near-infrared wavelengths to obtain information on the mineral groups present.

31. China Unveils 'Heavenly Palace' Space Station

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- China has unveiled a replica of its **first permanently-crewed space station**, which would replace the international community's orbiting laboratory- the International Space Station (ISS) and symbolises the country's major ambitions beyond Earth.
- **About China's space station:**
  - It is a 17-metre core module. Three astronauts will be permanently stationed in the 60-tonne orbiting lab, which will enable the crew to conduct biological and microgravity research.
  - Assembly is expected to be completed around 2022 and the station would have a lifespan of around 10 years.
- **Significance:**
  - The International Space Station – a collaboration between the United States, Russia, Canada, Europe and Japan – has been in operation since 1998 and is due to be retired in 2024.
  - China will then have the only space station in orbit, though it will be much smaller than the ISS which weighs 400 tonnes.
- **About the International Space Station (ISS):**
  - The International Space Station (ISS) is a space station, or a habitable artificial satellite, in **low Earth orbit**. The ISS is now the largest artificial body in orbit.
  - The ISS serves as a **microgravity and space environment research laboratory** in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology and other fields.
  - The station is suited for the testing of spacecraft systems and equipment required for missions to the Moon and Mars.
  - The ISS programme is a joint project among five participating space agencies: NASA, Roscosmos, JAXA, ESA, and CSA.
  - The ownership and use of the space station is established by intergovernmental treaties and agreements.
  - The station is divided into two sections, the Russian Orbital Segment (ROS) and the United States Orbital Segment (USOS), which is shared by many nations.

32. Soyuz Spacecraft

- A Soyuz rocket carrying Russian, American and Canadian astronauts took off from Kazakhstan and has reached orbit, in the first manned mission since a failed launch in October.
- The Soyuz (SAW-yooz) is a Russian spacecraft. Astronauts and cosmonauts travel to the International Space Station on the Soyuz.
- The Soyuz transports crews to the International Space Station and returns them to Earth after their missions.
- The Soyuz is the only means of reaching the ISS since the U.S. retired the space shuttle in 2011.

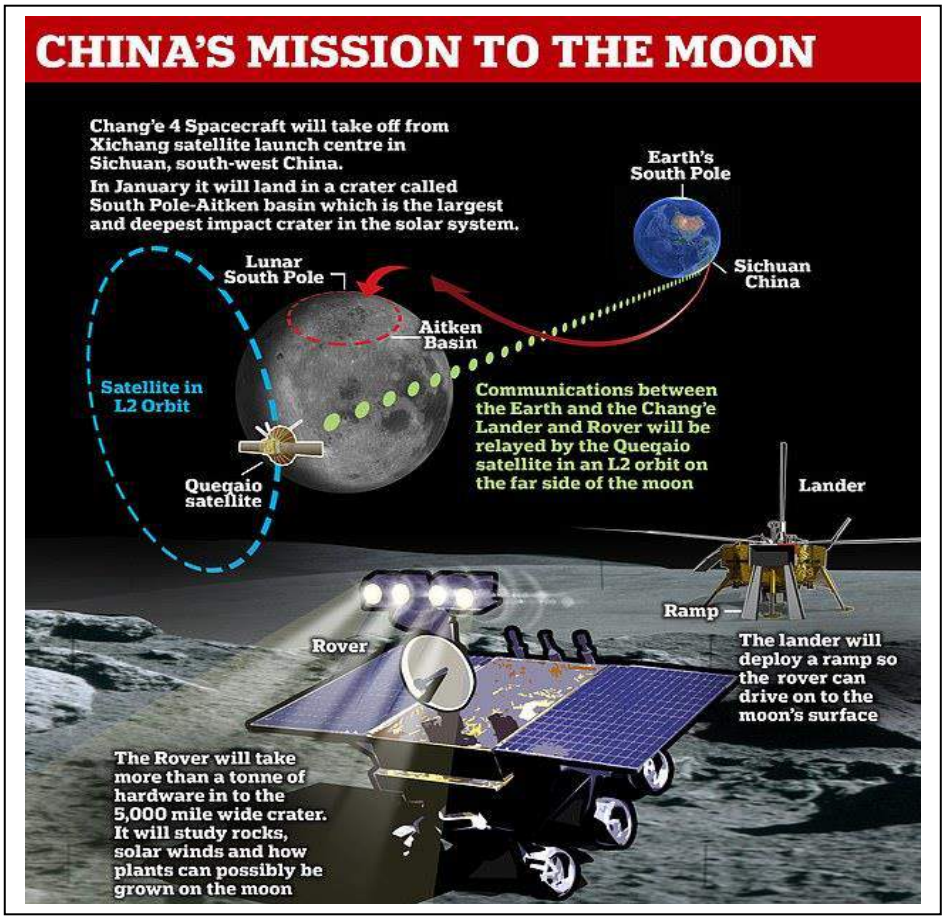
33. Yutu 2

- China has named the ***lunar rover***, successfully deployed to carry out a string of experiments on the far side of the moon, as ***'Yutu-2'***. The rover's touchdown is ***part of China Chang'e-4 lunar probe***.

- It follows the BeiDou Navigation Satellite System — China's homegrown Global Positioning System that started worldwide service last month.
- The rover has been programmed to ***launch ground penetration radar that would help map the moon's inner structures***.
- It would ***also analyse soil and rock samples for minerals***, apart from ***activating a radio telescope to search for possible signals from deep space***.

34. Chang'e 4 Mission

- China has launched Chang'e-4, a first probe ever to **explore the dark side of the Moon**.
- The Chang'e-4, carried by a Long March-3B rocket, has entered a planned orbit "to prepare for the first-ever soft landing on the far side of the moon".



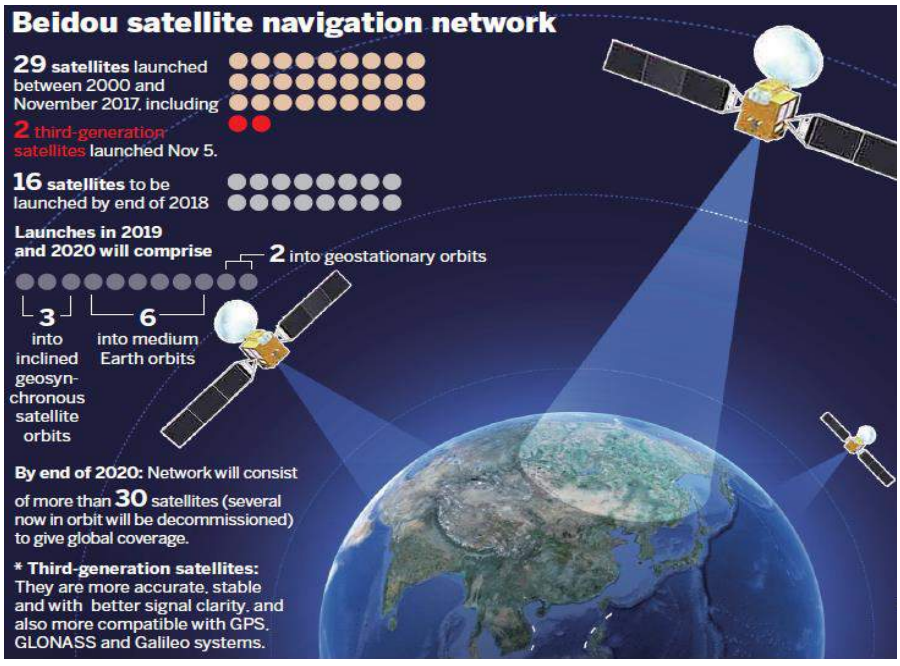
- ***Background:***
  - The Moon is tidally locked to Earth, rotating at the same rate that it orbits our planet, so the far side is never visible from Earth.
  - The probe, the Chang'e-4, is expected to make the first-ever soft landing on the far side of the Moon.
  - Previous spacecraft have seen the far side of the Moon, but none has landed on it.
  - The far side of the moon known as '***South Pole-Aitken Basin'*** still remains a mystery among space scientists.
- ***About the mission:***
  - Chang'e 4 is the fourth mission in the country's lunar mission series which is being named after the Chinese moon goddess.
  - The tasks of the Chang'e-4 probe include low-frequency radio astronomical observation, surveying the terrain and landforms, detecting the mineral composition, and measuring the neutron radiation and neutral atoms to study the environment on the far side of the moon.
- ***Difficulties:***
  - Communication difficulties will be the main problem faced by the Chinese team as they try to land on the other side of the moon. China is expected to consider using options like **radio telescopes to communicate in the absence of a transmitting medium**.

35. Hongyun Project

- China has launched ***its first communication satellite to provide broadband internet services worldwide***. The satellite is the first in ***the Hongyun project*** planned by China Aerospace Science and Industry Corp (CASIC).
- ***About Hongyun project:***
  - The Hongyun project, started in September 2016, ***aims to build a space-based communications network to provide broadband internet connectivity to users around the world, especially those in the underserved regions***.
  - When the Hongyun project is complete, it will cover the whole world and offer round-the-clock communication services to users in polar regions, who now have difficulties accessing telecommunication and internet services.
  - The Hongyun system will feature lower production and operational costs and fewer occurrences of data transmission delays compared with existing communication satellite networks.

36. BeiDou Navigation Satellite System (BDS)

- China's BeiDou Navigation Satellite System (BDS), touted as a rival to the widely-used American GPS, has started providing global services.
- The positioning accuracy of the system has reached 10 metres globally and five metres in the Asia-Pacific region. Its velocity accuracy is 0.2 metres per second, while its timing accuracy stands at 20 nanoseconds.
- ***Pakistan has become the first country to use the BeiDou system*** ending its reliance on the Global Positioning System (GPS).
- ***Significance:***
  - It will be ***the fourth global satellite navigation system*** after the US GPS, Russia's GLONASS and the European Union's Galileo.



- ***About BeiDou Satellite System:***
  - Named after the Chinese term for Big Dipper, the BeiDou system started providing independent services over China in 2000.
  - The full constellation is scheduled to ***comprise 35 satellites***.
  - ***BeiDou has two separate constellations***, BeiDou-1 and BeiDou-2. BeiDou-1 also known as first generation was a constellation of three satellites.
  - ***BeiDou-2, also known as COMPASS***, is the second generation of the system. It became operational in the year 2011.
- ***What are the various GNSS systems?***

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- ***The four global GNSS systems are*** – GPS (US), GLONASS (Russia), Galileo (EU), BeiDou (China). Additionally, there are two regional systems – QZSS (Japan) and IRNSS or NavIC (India).

37. Atacama Large Millimeter/submillimeter Array (ALMA)

- Astronomers have obtained stunning, high-resolution images of 20 nearby protoplanetary disks, depicting the birth of planets, using Chile's Atacama Large Millimeter/submillimeter Array (ALMA).
- ***About ALMA telescope:***
  - The Atacama Large Millimeter/submillimeter Array (ALMA) is ***an international partnership of the European Southern Observatory (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan, together with NRC (Canada), NSC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile***.

  - ALMA is a single telescope of revolutionary design, located on the Chajnantor plateau, 5000 meters altitude in northern Chile.
  - ALMA allows scientists to unravel longstanding and important astronomical mysteries, in search of our Cosmic Origins.

38. Mobile Asteroid Surface Scout (MASCOT)

- The Hayabusa2 probe launched the French-German Mobile Asteroid Surface Scout, or MASCOT towards the **Ryugu asteroid's surface**.
- The 10-kg box-shaped MASCOT is loaded with sensors. It has been built by the German Aerospace Center (DLR) and the French Space Agency (Cnes).
- It can take images at multiple wavelengths, investigate minerals with a microscope, gauge surface temperatures and measure magnetic fields.
- Background:
  - Hayabusa2, about the size of a large fridge and equipped with solar panels, is the successor to **JAXA's first asteroid explorer, Hayabusa**.

39. BepiColombo

- ***The ESA-JAXA BepiColombo mission*** has successfully completed its near-Earth commissioning phase and is now ready for the operations that will take place during the cruise and, eventually, for its scientific investigations at Mercury.
- ***About BepiColombo:***
  - BepiColombo is ***a joint mission between ESA and the Japan Aerospace Exploration Agency (JAXA), executed under ESA leadership***.
  - The mission ***comprises two spacecraft:*** the ***Mercury Planetary Orbiter (MPO)*** and the ***Mercury Magnetospheric Orbiter (MMO)***.
  - The MPO will study the surface and internal composition of the planet, and the MMO will study Mercury's magnetosphere, that is, the region of space around the planet that is influenced by its magnetic field.
- **Significance:**
  - **Mercury is a poorly explored planet.** So far, only two spacecraft have visited the planet: NASA's Mariner 10, and NASA's MESSENGER spacecraft.

- The information obtained when BepiColombo arrives will throw light not only on the **composition and history of Mercury**, but also on the history and formation of the inner planets in general, including Earth.

40. Earth has three Moons

- After more than half a century of speculation, it has now been confirmed that Earth has two dust 'moons' orbiting it which are nine times wider than our planet.
- The new moons exist at a distance of approximately 250,000 miles — more or less the same distance as our moon.
- Background:
  - The presence of the ***dust 'moons' or Kordylewski clouds*** had been inferred by researchers since long before.
  - But the first glimpse of the clouds was seen only in 1961 by Polish astronomer Kazimierz Kordylewski, after whom the dust clouds were named.

About Kordylewski clouds:

- The Kordylewski clouds are always changing.
- They might be stable in orbit and may have existed for millions of years, but the ingredients that make the clouds — the dust particles — are always getting swapped for others.
- Some escape to gravitational pulls from Earth or the moon, while others come from interplanetary spaces and meteor showers.

41. Saturn's Rings

- New NASA research confirms that ***Saturn is losing its iconic rings*** at the maximum rate estimated from Voyager 1 & 2 observations made decades ago.
- ***The rings are being pulled into Saturn by gravity*** as a dusty rain of ice particles under the influence of Saturn's magnetic field.
- ***Composition and structure:***
  - Saturn's rings are ***made up of billions of particles ranging from grains of sand to mountain-size chunks***. Composed predominantly of water-ice, the rings also draw in rocky meteoroids as they travel through space.
  - Though Saturn appears surrounded by a single, solid ring when viewed by an amateur astronomer, several divisions exist. ***The rings are named alphabetically in the order of discovery***. Thus the main rings are, from farthest from the planet to closest, A, B and C.
  - A gap 2,920 miles wide (4,700 kilometers), known as the Cassini Division, separates the A and B rings.
  - The rings themselves contain a number of gaps and structures.
- ***Is it only the Saturn to have rings?***
  - Saturn is not the only planet in the solar system to have rings — Jupiter, Uranus and Neptune also contain faint ring systems.

42. Parker Solar Probe

- NASA's historic mission- Parker Solar Probe- to solve the mysteries of the Sun has successfully completed its flyby of Venus.
- NASA's Parker Solar Probe mission will revolutionize our understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth and other worlds.
- Parker Solar Probe will travel through the sun's atmosphere, closer to the surface than any spacecraft before it, facing brutal heat and radiation conditions.
- In order to unlock the mysteries of the sun's atmosphere, **Parker Solar Probe will use Venus' gravity** during flybys over nearly seven years to gradually bring its orbit closer to the sun.
- The primary science goals for the mission are to **trace how energy and heat move through the solar corona** and to explore what accelerates the solar wind as well as solar energetic particles.

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- This will be **NASA's first mission to the sun** and its outermost atmosphere corona.
- **Benefits:**
  - The mission can help scientists to **better understand solar flares** – brief eruptions of intense high-energy radiation from the sun's surface that can knock out communications on Earth.
  - These events have impacts on Earth as well as the satellites and astronauts in space.
- **Why study the corona?**
  - The corona is the sun's outer atmosphere.
  - It is unstable and produces solar wind and flares.
  - Millions of tons of highly magnetised material can erupt from the sun at speeds of several million miles an hour.
  - Therefore, we need to get closer to it in order to understand how it works.

43.Sun Spots

- 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.
- ***Why study sunspots?***
  - For the understanding of the **long-term variations of the sun and its impact on our climate** which is one of the science objectives of Aditya mission. The forecast will be also useful for scientific operational planning of the Aditya mission.
  - To know the **effects on space weather**. This refers to the effect of radiation, particle flux and magnetic flux in the region around the sun. During extreme events, space weather can affect electronics-driven satellite controls, communications systems, air traffic over polar routes and even power grids.
- ***'Maunder-like minimum':***
  - There have been predictions that the next cycle (cycle 25) will show reduced sunspot activity. There have even been speculations that the sun may be heading towards a period of prolonged low activity – what solar physicists describe as a 'Maunder-like minimum'.
  - The Maunder minimum refers to a period from 1645 to 1715 where observers reported minimal Sunspot activity — the number of sunspots reduced by a factor of nearly 1,000, over a period of 28 years.
  - During this and other such periods of low activity, some parts of Europe and North America experienced lower-than-average temperatures. While the connection between the Maunder minimum and the climate on earth is still debated, it gives another reason to watch the sunspots.

44.Super- Earth

- Researchers have discovered a new exotic planet outside our solar system in the constellation Cassiopeia.

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- Located 21 light years away from us, this planet, dubbed *HD219134 b*, has a mass almost five times that of Earth, which is considered a so-called "super-Earth".
- Unlike the Earth, however, it most likely does not have a massive core of iron, but is rich in calcium and aluminium alongside magnesium and silicon.
- ***What is a Super- Earth?***
    - A super-Earth is an **extrasolar planet with a mass higher than Earth's**, but substantially below those of the Solar System's ice giants, Uranus and Neptune, which are 15 and 17 times Earth's, respectively.
    - The term "super-Earth" refers only to the mass of the planet, and so does not imply anything about the surface conditions or habitability.

45.CIMON

- CIMON is a small **robot endowed with artificial intelligence (AI)** launched on a two-day trip to the International Space Station aboard SpaceX's Dragon cargo capsule.
- CIMON was developed by the European aerospace company Airbus on behalf of the German space agency.
- The robot can converse with people, and it knows whom it's talking to thanks to facial-recognition software.

46.Korolev Crater

- It is an **icy- crater on Mars** found recently. It was captured by European Space Agency's (ESA) Mars Express mission.
- The crater floor can reach depths of two kilometers below its rim, deeper than Earth's Grand Canyon.
- ***Mars Express Mission*** was launched back in June 2003 and entered orbit around the red planet in December of the same year. Since then, the probe has been surveying the surface of Mars using a high-resolution camera as well as other tools like radars and spectrometers.

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Technologies / New Discoveries

1. Paper Sensor that can detect Freshness of Milk

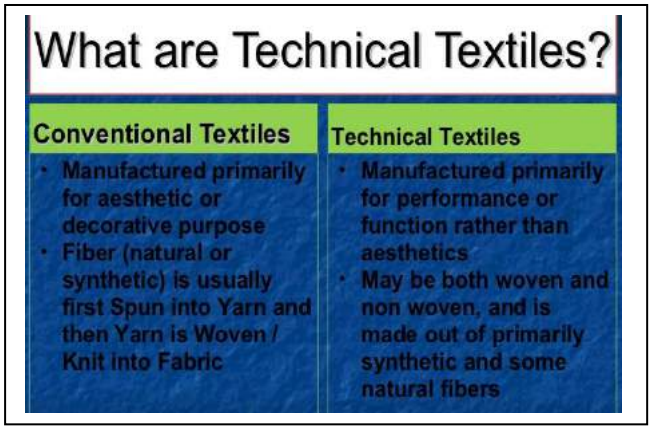
- Scientists at Indian Institute of Technology, Guwahati, have developed a simple paper kit that can test freshness of milk and tell how well it has been pasteurized.
- A **milk enzyme, Alkaline Phosphatase or ALP, is considered an indicator of milk quality** because its presence even after pasteurization indicates presence of microbes that may not have been rendered inactive with pasteurization.

2. Roadeo

- The traffic police authorities of Pune are planning to introduce a **robot named 'Roadeo'** which would move around city roads, functioning as a **quasi-traffic policeman** and cautioning commuters about traffic rules and offences.
- It is a first of its kind initiative in the entire country.

3. Technical Textiles

- **Ministry of Textiles** held National Conclave on Technical Textiles in Mumbai.
- Technical Textiles are defined as Textile material and products manufactured primarily for their Technical performance and functional properties rather than aesthetic and decorative characteristics.



- ***Technical textiles include*** textiles for automotive applications, medical textiles (e.g., implants), geotextiles (reinforcement of embankments), agrotextiles (textiles for crop protection), and protective clothing (e.g., heat and radiation protection for fire fighter clothing, molten metal protection for welders, stab protection and bulletproof vests, and spacesuits).

4. KATRIN Experiment

- Researchers in Germany with the Karlsruhe Tritium Neutrino experiment have started collecting data
  to determine the mass of the universe's lightest particle- neutrino. Those are sometimes called **"ghost particles"** because they're so difficult to detect.
- **About KATRIN experiment:**
  - KATRIN measures the neutrino mass in a model-independent way via ultrahigh precision measurements of the kinematics of electrons from beta-decay.
- **About Neutrinos:**
  - Neutrinos are the most **abundant massive elementary particles in nature**. Due to their minimalistic properties they are **key particles for**

understanding physics on the smallest scale (elementary particle physics) up to the largest scale – the universe (cosmology).

- Neutrinos are the only elementary particles of matter, which **do not carry electrical or strong charge** and thus are blind to the electromagnetic and the strong interaction and cannot be bound.
- In the context of particle physics, they participate only in the weak interaction. This made neutrinos the most prominent candidate to explore with them the properties of the weak interaction.

5. SpiNNaker

- It is the **world's largest supercomputer designed to work in the same way as the human brain**.
- The newly formed million-processor-core **Spiking Neural Network Architecture (SpiNNaker)** machine is capable of completing more than 200 million actions per second, with each of its chips having 100 million transistors.
- **What is unique about SpiNNaker?**
  - SpiNNaker is unique because, unlike traditional computers, it does not communicate by sending large amounts of information from point A to B via a standard network.
  - Instead it mimics the massively parallel communication architecture of the brain, sending billions of small amounts of information simultaneously to thousands of different destinations.

What are biological neurons?

- The SpiNNaker machine, designed and built in The University of Manchester in the UK, can model more biological neurons in real time than any other machine on the planet.
- Biological neurons are basic brain cells present in the nervous system that communicate primarily by emitting 'spikes' of pure electro-chemical energy.
- Neuromorphic computing uses large scale computer systems containing electronic circuits to mimic these spikes in a machine.

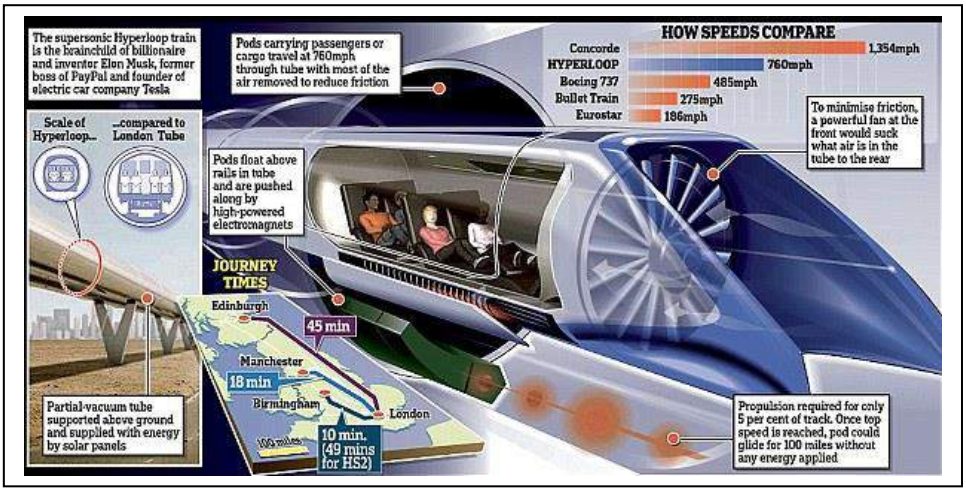
6. Graphene

- A group of researchers at Nagpur-based Visvesvaraya National Institute of Technology have developed ***a new technique which promises to help produce high value graphene from discarded dry cells batteries***.
- ***Significance:***
  - Since graphene is made out of graphite, its production is both expensive and has significant environmental impact. The new technique helps both reduce the cost and preserve environment.
- ***About Graphene:***
  - Graphene has been touted in ***the global electronics industry as a "miracle material"*** given its **strength, electrical conductivity and elasticity**, and has been seen as an **alternative to lithium-ion batteries** since its discovery in 2004.
  - It is a form of carbon that can be used to develop smaller, slimmer batteries but with higher capacity.
  - ***Graphene is a carbon material that is one atom thick***. Its thin composition and high conductivity means it is used in applications ranging from miniaturised electronics to biomedical devices.
  - These properties also enable thinner wire connections; providing extensive benefits for computers, solar panels, batteries, sensors and other devices.
- ***Applications:***
  - Graphene is widely used in making solar cells, light-emitting diodes, touch panels and smart windows. Graphene supercapacitors serve as energy storage devices with a capacity for faster charging and longer life span than traditional electrolytic batteries.

- Other potential applications of graphene include water filtration and purification, renewable energy, sensors, personalised healthcare and medicine, to name a few.

7. Hyperloop Technology

- Hyperloop Transportation Technologies Inc. has unveiled its first full-scale passenger capsule in Spain.
- The capsule is 105 feet (32 meters) long and weighs 5 tons. Named as the **Quintero One**, the product is made almost entirely out of composite material.
- **What is hyperloop transportation system?**
  - It is a transportation system where a **pod-like vehicle is propelled through a near-vacuum tube** connecting cities at speeds matching that of an aircraft.
  - The hyperloop concept is a brainchild of Tesla founder Elon Musk.
  - US-based Hyperloop Transport Technology (HTT) claimed it costs $40 million per kilometre to build a hyperloop system while building a high-speed train line would cost almost twice.
  - The hyperloop system is being designed to transport passengers and freight.



- **Facts for Prelims:**
  - The government of Andhra Pradesh has signed a Memorandum of Understanding (MoU) with California-based Hyperloop Transportation Technologies (HTT) to develop India's first Hyperloop route in the state.
  - The proposed route for the Hyperloop between the city centers of Vijayawada and Amaravati could potentially turn a trip of more than one hour into a 6-minute ride.

8. Nobel Prizes

- **Nobel Prize in Physiology or Medicine:**
  - The Nobel Prize in Physiology or Medicine is awarded once a year for outstanding discoveries in the fields of life sciences and medicine.
  - It is one of five Nobel Prizes established in 1895 by Swedish chemist Alfred Nobel, the inventor of dynamite, in his will.
  - The **2018 Nobel Prize in Physiology** or Medicine has been jointly conferred to James P. Allison and Tasuku Honjo "for their **discovery of cancer therapy by inhibition of negative immune regulation".**
  - The duo successfully established an entirely new principle for cancer therapy by stimulating the ability of immune system to attack tumour cells. It is called **"Immune checkpoint therapy"**. They showed how different strategies for slowing down the brakes on the immune system can be used in the treatment of cancer. Their discoveries are landmark in fight against cancer.
- **Nobel Prize in Chemistry:**

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- US scientists Frances Arnold and George Smith and British researcher Gregory Winter have won the 2018 Nobel Prize in Chemistry.
- They were selected for **harnessing power of evolution to develop enzymes and antibodies that have led to new pharmaceuticals and biofuels**.

- **Nobel Physics Prize:**
  - Three scientists Arthur Ashkin (USA), Gerard Mourou (France) and Donna Strickland (Canada) have won the 2018 Nobel Prize in Physics.
  - They were selected for ground-breaking inventions in the field of **laser physics.**
  - Arthur Ashkin: He received prize for **optical tweezers and their application** to biological systems. His optical tweezers are able to grab particles, atoms, viruses and other living cells with their laser beam fingers, allowing use of radiation pressure of light to move physical objects.
  - Gerard Mourou and Donna Strickland: They were jointly awarded for their method of **generating high-intensity, ultra-short optical pulses**. They have created ultrashort high-intensity laser pulses without destroying amplifying material, thus paving way towards shortest and most intense laser pulses ever created by mankind. Their innovative technique is known as **'chirped pulse amplification' (CPA),** has now become standard for high-intensity lasers, including ultra-sharp beams used in corrective eye surgeries.

9. OneerTM

- CSIR-IITR has developed an affordable **Water Disinfection System "OneerTM".** The device will go a long way in meeting the requirements of potable water in rural and urban areas.
- ***Use:*** It is useful for continuous treatment of water and eliminates all disease-causing pathogens such as virus, bacteria, fungi, protozoa and cyst to provide safe drinking water to domestic and communities settings as per National and International standards prescribed for potable water (BIS, WHO etc.).

10. India's First Bitcoin ATM

- Unocoin Technologies Private Ltd has set up India's first ATM kiosk to trade in cryptocurrencies in Bengaluru.
- **What is bitcoin?**
  - Bitcoin is one of many **cryptocurrencies** that have gained popularity across the world.
  - A cryptocurrency is a basically a **digital asset** that has been created to function as a medium of exchange, like cash.
  - It uses cryptography to ensure the security of transactions — authentication and prevention of duplicate transactions — and to control the creation of new units of currency.
  - This is different from cash in that **cryptocurrencies have no physical form**. These blur the boundaries between fiat and non-fiat currencies.
  - They are simply numbers on a screen and there is no central bank that issues new currency. However, bitcoin has emerged as the popular face of cryptocurrencies.

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11. Tiny Spheres to trap Water Contaminants

- Scientists have created tiny spheres that can catch and destroy **bisphenol A (BPA), a synthetic chemical used to make plastics that often contaminates water.**
- **Bisphenol A (BPA):**
  - BPA is commonly used to coat the insides of food cans, bottle tops and water supply lines, and was once a component of baby bottles.
  - Concerns: While BPA that seeps into food and drink is considered safe in low doses, prolonged exposure is suspected of affecting the health of children and contributing to high blood pressure.

12. Less Polluting Firecrackers

- CSIR develops Less Polluting Firecrackers named – s**afe water releaser (SWAS), safe minimal aluminium (SAFAL) and safe thermite cracker (STAR).**
- These crackers have unique property of releasing water vapour and /or air as dust suppressant and diluent for gaseous emissions and matching performance in sound with conventional crackers.
- SWAS crackers eliminates usage of (KNO3) Potassium nitrate and Sulphur with consequent reduction in particulate matter (30-35%) SO2 and NOx. It has matching sound intensity with commercial crackers in the range of 105-110 dBA.

13. Cyclone-30

- The country's biggest cyclotron facility that will produce radioisotopes vital for diagnosis and treatment of cancer has become operational.
- ***The machine – Cyclone-30*** — is housed at the Kolkata-based Variable Energy Cyclotron Centre (VECC) under the Department of Atomic Energy (DAE).
- **Significance:**
  - With increasing number of Indians diagnosed with cancer every year, the cyclotron machine will produce radioisotopes for nuclear imaging specifically for cancer detection.
  - At present, many radioisotopes are imported while some are produced in nuclear research reactors such as the Apsara at the Bhabha Atomic Research Centre (BARC), and remaining in cyclotrons facilities run by large private hospitals.
  - The addition of Cyclone-30 will increase the availability of radioisotopes and bring down the cost of treatment.
- **What are Cyclotrons?**
  - Cyclotrons are used to **produce radioisotopes for diagnostic and therapeutic use for cancer care**. Radiations from these isotopes are used to destroy cancer cells.

14. NASA Balloon Mission

- The mission recently captured the images of ***noctilucent clouds or polar mesospheric clouds (PMCs)***. These images may help scientists better understand turbulence in the atmosphere, as well as

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in oceans, lakes and other planetary atmospheres.

- **About the Mission:**
  - NASA's polar mesospheric clouds (PMCs) Turbo mission launched a giant balloon to study PMCs at a height of 50 miles above the surface. For five days, the balloon floated through the stratosphere from its launch at Esrange, Sweden, across the Arctic to Western Nunavut, Canada.
  - During its flight, cameras on board the balloon captured six million high-resolution images filling up 120 terabytes of data storage — most of which included a variety of PMC displays, revealing the processes leading to turbulence.
- **Objectives of the mission:**
  - The mission aimed at **studying atmospheric motions, such as airflow over mountains or the motions caused by thunderstorms,** which can cause disturbances in the atmosphere which are generated through something called gravity waves.
  - Besides, with this mission, scientists want to understand the processes of matter in near-Earth space, including how matter there interacts with Earth's atmosphere and weather.
- **What are PMCs?**
  - Polar mesospheric clouds (PMCs) form 50 miles above the poles during summer. They're mostly made up of ice crystals and appear like faint lines in the sky.
  - The clouds are only visible during twilight, when the angle of the sun reflects off them and causes them to shine a bright electric blue or white colour.
  - These clouds are affected by what is known as **atmospheric gravity waves** – caused by the convecting and uplifting of air masses, such as when air is pushed up by mountain ranges.
  - The waves play major roles in transferring energy from the lower atmosphere to the mesosphere.

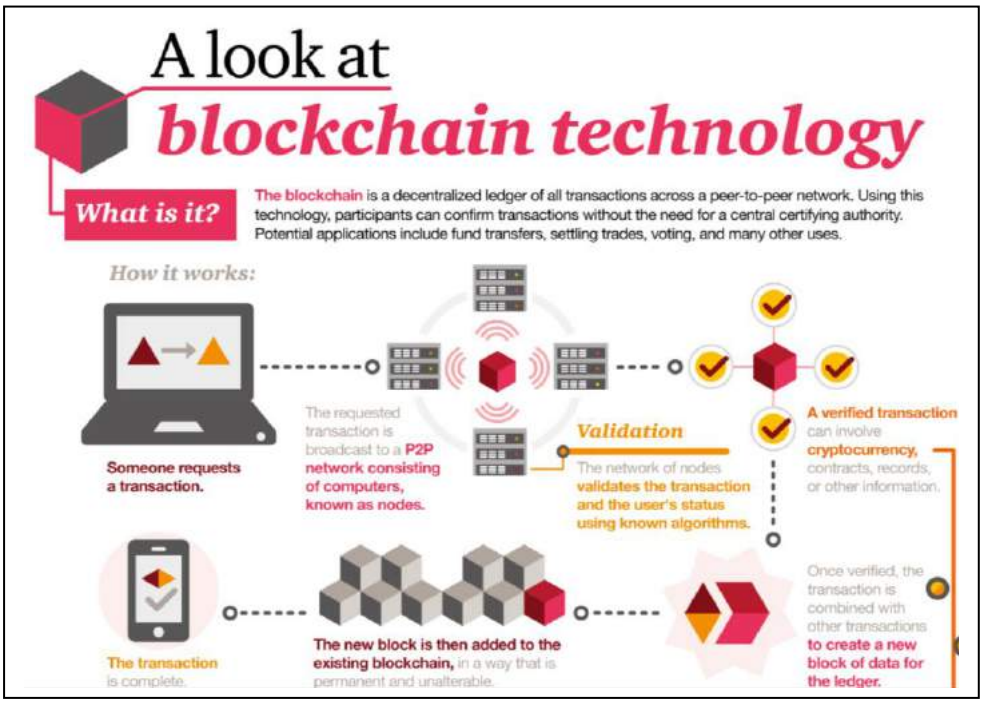
15. WAYU (Wind Augmentation Purifying Unit)

- **Air pollution control device WAYU (Wind Augmentation Purifying Unit)** for traffic junctions was recently inaugurated in Delhi.
- WAYU is developed by **Council of Scientific and Industrial Research – National Environmental Engineering Research Institute (CSIR-NEERI)** as a part of Technology Development Project funded by Department of Science and Technology.
- The device has the capacity to purify air in an area of 500 meter square. The device consumes only half a unit of electricity for 10 hours of running and has a maintenance cost of only Rs. 1500 per month.

16. Blockchain Technology

- Tech Mahindra and the Telangana government have signed an agreement to establish ***a Blockchain district in Hyderabad, a first-of-its-kind*** Centre of Excellence for Blockchain in India.

- Cabinet has approved MoU on Collaborative Research on Distributed Ledger and Block Chain Technology in the context of Development of digital economy by Exim Bank under BRICS Interbank Cooperation Mechanism.



- **Background:**
  - ***The Xiamen Declaration signed in China on digital economy by the BRICS leaders*** had highlighted the importance of the digital economy and how the BRICS nations could leverage the thriving and dynamic digital economy that will foster global economic development and benefit everyone.
- **What are Blockchains?**
  - Blockchains are a new data structure that is **secure, cryptography-based, and distributed across a network**.
  - The technology supports cryptocurrencies such as Bitcoin, and the transfer of any data or digital asset.
  - Blockchains achieve consensus among distributed nodes, allowing the transfer of digital goods without the need for centralized authorisation of transactions.
  - The present blockchain ecosystem is like the early Internet, a permission less innovation environment in which email, the World Wide Web, Napster, Skype, and Uber were built.
- **How this operates?**
  - The technology allows **transactions to be simultaneously anonymous and secure**, peer-to-peer, instant and frictionless.
  - It does this by distributing trust from powerful intermediaries to a large global network, which through mass collaboration, clever code and cryptography, enables a tamper-proof public ledger of every transaction that's ever happened on the network.
  - A block is the "current" part of a blockchain which records some or all of the recent transactions, and once completed, goes into the blockchain as permanent database. Each time a block gets completed, a new block is generated. Blocks are linked to each other (like a chain) in proper linear, chronological order with every block containing a hash of the previous block.
- **Benefits of blockchain technology:**
  - As a public ledger system, **blockchain records and validate each and every transaction made,** which makes it secure and reliable.
  - All the transactions made are authorized by miners, which makes the transactions immutable and prevent it from the threat of hacking.
  - Blockchain technology discards the need of any third-party or central authority for peer-to-peer transactions.

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- It allows decentralization of the technology.

17. Blockchain Bond

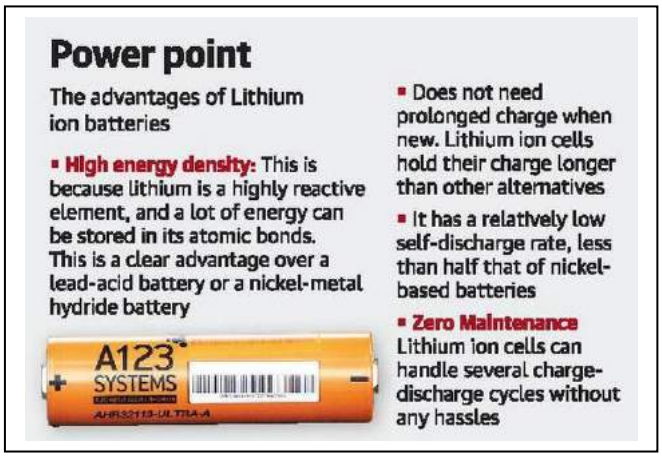
- World Bank has launched ***world-first blockchain bond***.
- The prototype deal, dubbed ***a "Bondi" bond – standing for Blockchain Operated New Debt Instrument*** is being viewed as an initial step in moving bond sales away from manual processes towards faster and cheaper automation.
- This issue of World Bank bond will be the first time that capital is raised from public investors through a legally valid bond issuance that uses blockchain from start to finish.

18. Thermal Battery

- India has become home to ***the world's first-ever thermal battery plant***. The thermal battery facility, ***inaugurated in Andhra Pradesh***, will be owned by Bharat Energy Storage Technology Private Limited (BEST).
- **What is thermal battery technology?**
  - A thermal energy battery is used **for storing and releasing thermal energy**. It allows for available energy to be temporarily stored and be released for use whenever necessary. Standard battery technology is based on charging and discharging cycles mainly operated by electricity.
  - The most commonly used Lithium-ion battery works on electrical energy. However, thermal batteries operate on thermal energy, which can be defined as **energy created by temperature differences.**
- **Applications with power grids:**
  - The possible **integration of thermal batteries with power grids** is one of its main applications. This will help **boost industrial demand** and provide substantial support to public transport and telecom grids.
  - Thermal batteries can function as long as heat is available for them to operate, which can be helpful in power transmission to remote areas.
  - The telecom industry will also benefit as thermal batteries will help boost signal strength and network connectivity, which will thereby increase internet and smartphone penetration.
- **Use in e-vehicles technology:**
  - The thermal batteries can be used in electric vehicles as well.
- Why is it good compared to other technologies?
  - The solar energy generation is not possible after sunset and high rainfall areas, which brings in the need for a robust energy storage infrastructure. Thus, the coming of **thermal battery is a landmark development in the field of technology and environmental protection**.
  - Existing energy storage technologies depend on Lithium-based batteries, which are limited by life cycles, making it a very expensive proposition with replacements needed every six to seven years. They are also low on energy density and need a high footprint.
- Facts for Prelims:
  - Thermal battery technology was patented in India by Dr Patrick Glynn in 2016.

19. Lithium-ion Battery

- **Council of Scientific & Industrial Research (CSIR) lab** has signed Memorandum of Agreement (MoA) with RAASI Solar Power Pvt Ltd for transfer of technology for India's first Lithium Ion (Li-ion) Battery project.
- Lithium ion batteries have the advantage of being **less weight, having high power, and less volume** in comparison to conventional batteries.
- Lithium-ion batteries are **nearly 100% efficient in both charge and discharge** while the lead batteries have the 70% efficiency.
- Rechargeable lithium-ion batteries cycle 5000 times or more compared to just 400-500 cycles in lead acid.
- Lithium-ion batteries are a **much cleaner technology and are safer for the environment**.
- It also maintains constant voltage throughout entire discharge cycle whereas voltage in lead acid battery drops consistently throughout its discharge cycle.



20. Aerogel

- Scientists have developed a **transparent heat-resistant gel- called aerogel**- using beer waste.
- The "aerogel" looks like a flattened plastic contact lens. The transparent gel is highly resistant to heat.
- The gel is cheaper to produce because it comes from beer waste. Aerogels are at least 90% gas by weight, but their defining feature is air. Their thin films are made up of crisscrossing patterns of solid material that trap air inside billions of tiny pores, similar to the bubbles in bubble wrap. It is that trapping capacity that makes them such good insulators.
- **Potential applications:**
  - It may one day be used to build greenhouse-like habitats for human colonised on Mars.
  - It could also be used on buildings on Earth to help make huge savings on energy costs.

21. LIGO (Laser Interferometer Gravitational-wave Observatory)

- The LIGO (Laser Interferometer Gravitational-wave Observatory) is a massive observatory for **detecting cosmic gravitational waves** and for carrying out experiments.
- The objective is to use gravitational-wave observations in astronomical studies.
- The project operates three gravitational-wave (GW) detectors. Two are at Hanford in the state of Washington, north-western US, and one is at Livingston in Louisiana, south-eastern US. The proposed LIGO India project aims to move one advanced LIGO detector from Hanford to India.
- **About LIGO- India project:**
  - Known as the LIGO-India project, it is piloted by **Department of Atomic Energy (DAE) and Department of Science and Technology (DST).**

What are Gravitational Waves?

- Gravitational waves are the **ripples in the pond of spacetime.** The gravity of large objects warps space and time, or "spacetime" as physicists call it, the way a bowling ball changes the shape of a trampoline as it rolls around on it.
- Smaller objects will move differently as a result – like marbles spiraling toward a bowling-ball-sized dent in a trampoline instead of sitting on a flat surface.

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- The LIGO-India project will be jointly coordinated and executed by three Indian research institutions: the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune and Department of Atomic Energy organisations: Institute for Plasma Research (IPR), Gandhinagar and the Raja Ramanna Centre for Advanced Technology (RRCAT), Indore.

- **Benefits for India:**
  - The project will bring unprecedented opportunities for scientists and engineers to dig deeper into the realm of gravitational wave and take global leadership in this new astronomical frontier.
  - The LIGO-India project will also bring considerable opportunities in cutting-edge technology for the Indian industry which will be engaged in the construction of the eight-km long beam tube at ultra-high vacuum on a levelled terrain.
  - With its establishment, India will join the global network of gravitational wave detectors.
  - Establishing an observatory in India also assumes importance because the further the distance between the observatories, the greater will be the accuracy in locating gravity waves.

22. Higgs Boson

- Six years after its discovery, the Higgs boson has at last been observed decaying into fundamental particles known as bottom quarks.
- The Higgs boson is an elementary particle in the Standard Model of particle physics, produced by the quantum excitation of the Higgs field, one of the fields in particle physics theory.
- It is named after physicist Peter Higgs, who in 1964, along with six other scientists, proposed the mechanism, which suggested the existence of such a particle.
- Its existence was confirmed by the ATLAS and CMS collaborations based on collisions in the LHC at CERN.
- **About Large Hadron Collider (LHC):**
  - LHC is the world's largest and most powerful particle accelerator situated in a tunnel beneath the France Switzerland border near Geneva.
  - **Built by**: European Organization for Nuclear Research (CERN)
  - **Aim**: to allow physicists to test the predictions of different theories of particle physics and high-energy physics, and particularly prove or disprove the existence of the theorized Higgs boson and of the large family of new particles predicted by supersymmetric theories.
  - The LHC consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

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Government Initiatives / Departments

1. UNNATI Programme

- National space agency, the Indian Space Research Organisation (ISRO) has launched the ***UNNATI (UNispace Nano-satellite Assembly and Training by ISRO)*** programme at the U R Rao Satellite Centre, Bengaluru.
- ***UNNATI is a capacity building programme on nanosatellite development***.
- ***UNNATI Programme:***
    - 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)***.
    - UNNATI programme is planned to be ***conducted by U R Rao Satellite Centre (URSC)*** of ISRO for 3 years in 3 batches and will target to benefit 90 officials from 45 countries.
- ***The primary objectives of the programme are:***
    - To offer a simplified and increased exposure to satellite fabrication technologies, as part of the UNISPACE initiative.
    - To provide theoretical course on satellite technology.
    - To provide hands-on training to assemble, integrate and test a low cost, modular nano satellite.

2. Quadricycles

- The **ministry of road transport and highways** has approved the sale of quadricycles for personal use.
- Quadricycle – a vehicle of the size of a 3-wheeler but with 4 tyres and fully covered like a car. It has an engine like that of a 3-wheeler.

- Ministry of Road Transport & Highways notified the insertion of 'Quadricycle' as a 'non-transport' vehicle under the Motor Vehicles Act 1988.
- Quadricycles were only allowed for transport usage under the Act, but now has been made usable for non-transport also (Personal use).
- Advantage:
    - It is cheap and safe mode of transport for last mile connectivity.
- Exceptions:
    - Quadricycles will not be allowed for transporting cargo or luggage.
- Facts for Prelims:
    - Bajaj Auto Ltd's Qute is the first locally produced quadricycle.

3. Open Transit Data Platform

- To increase transparency and build transport solutions, the transport department of the Delhi government has launched ***the Open Transit Data platform*** which provides real-time datasets free of cost.
- **About the Open Transit Data Platform:**
    - Through this the government aims to provide **real-time data** which can be used by third party app developers and researchers. This includes

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geo-coordinates of all bus stops, route maps, timetables as well as the real time GPS feeds of bus locations which will be updated every 10 seconds.

4. ISRO's Young Scientist Programme

- Indian Space Research Organisation (ISRO) has announced ***Young Scientist Programme***.
- ***About Young Scientist Programme:***
  - ***Aim:*** Inculcate and nurture space research fervour in young minds.
  - It would be ***a one-month programme***. The students will be exposed to the practical experience of building small satellites.
  - ***Eligibility:*** Mostly 8th standard passed out students will be given lecturers and access to research laboratories. 3 students from each of the 29 States and 7 Union Territories will be selected for the Young Scientist program.

5. Mission Raksha Gyan Shakti

- The event showcased salient **inventions and innovations achieved by Defence Research and Development Organisation (DRDO), Defence Public Sector Undertakings (DPSUs), and Ordnance Factories (OFs) which have resulted in successful filing of Intellectual Property Rights (IPR) applications.**
- The **Directorate General of Quality Assurance (DGQA)** has been entrusted with the responsibility of coordinating and implementing the programme.
- **Objective:**
  - As part of the ongoing initiatives to enhance self-reliance in defence, the Mission Raksha Gyan Shakti aims to **provide a boost to the IPR culture in indigenous defence industry.**
- **IP Facilitation Cell:**
  - It was established in April 2018.
    - To achieve ambitious targets of training 10,000 personnel of Ordnance Factories (OFs) and Defence Public Sector Undertakings (DPSUs) on IPR.
    - To facilitate filing of at least 1,000 new IPR applications.
- **What are Intellectual Property Rights?**
  - According to the World Trade Organization (WTO), IPRs are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time.

6. Digital Sky Platform

- In August 2018, India had announced the release of its Civil Aviation Regulations (CAR) to enable safe flying of **RPAS (Remotely Piloted Aerial Systems)** in India.
- **Remotely Piloted Aerial Systems (RPAS), also known as drones, are a technology platform with wide-ranging applications.**
- **Digital Sky Platform:**
  - New features will be developed to ease the process of flying for users.
  - To provide oversight to security agencies.

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- It is envisioned that in the future **Digital Sky Service Providers (DSPs)** will be extending the functionality of the platform through **Application Program Interfaces (APIs)**.

- **Permissions to fly in different zones:**
  - To get permissions, RPAS operators or remote pilots will have to file a flight plan.
  - **Green zones** – Flying in the green zones, requires only intimation of the time and location via the portal or the app.
  - **Yellow zones** – Permission will be required for flying in yellow zones.
  - **Red zones** – Flights will not be allowed to fly.
  - If an RPAS does not have permission to fly, it will not be allowed to take-off under the policy of **No-Permission-No-Takeoff (NPNT).**

7. National Supercomputing Mission (NSM)

- French IT services firm Atos has won a three-year contract to build the first phase of supercomputers under India's Rs 4,500-crore ***National Supercomputing Mission (NSM).***
- **National Supercomputing Mission (NSM):**
  - The Mission envisages empowering national academic and R&D institutions spread over the country by installing a vast supercomputing grid comprising of more than 70 high-performance computing facilities.
  - These supercomputers will also be networked on the National Supercomputing grid over the **National Knowledge Network (NKN).**
  - The NKN is another programme of the government which connects academic institutions and R&D labs over a high-speed network.
  - The Mission includes development of highly professional **High-Performance Computing (HPC)** aware human resource for meeting challenges of development of these applications.
  - India looks forward to create a cluster of machines for weather forecasting, drug discovery and data mining.
- ***Agencies involved:***
  - The Mission would be implemented and steered jointly by the Department of Science and Technology (**DST**) and Department of Electronics and Information Technology (**DeitY**) over a period of seven years.
  - The tender to build these high-performance computers (HPC) had been floated by the Centre for Development of Advanced Computing (**C-DAC**).
  - Atos would be deploying its energy efficient Direct Liquid Cooled Bull Sequana supercomputers in India.

8. Train 18

- India's first engine-less train-breached the 180 kmph speed threshold during a test run in the Kota-Sawai Madhopur section, becoming the country's fastest train.
- Train 18 is a flagship train set; the first prototype has been built by the Integral Coach Factory, Chennai, in a

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record time of 20 months.

- The train is a **100% 'Make in India' project** and is claimed to be built at half the cost of a similar train set that is imported.
- T-18 is a **self-propelled engine-less train (similar to the Metro trains)** and is energy-efficient as its coaches will be fitted with LED lights. Coaches will have automatic doors and retractable footsteps.
- It will be inter-connected with fully sealed gangways along with a GPS-based Passenger Information System. It is provided with of Bio toilets.
- The full AC train is equipped to run at a speed of up to 160 kmph as against Shatabdi's 130 kmph which will cut down travel time by 15%.

9. Intellectual Property (IP) mascot – IP Nani

- The government has launched the Intellectual Property (IP) mascot – IP Nani.
- Mascot IP Nani is a tech-savvy grandmother who helps the government and enforcement agencies in **combating IP crimes** with the help of her grandson "Chhotu" aka Aditya.
- The IP mascot will spread awareness about the importance of Intellectual Property Rights (IPRs) among people, especially children, in an interesting manner.
- This character is also in line with the World Intellectual Property Organization's (WIPO) campaign for the World IP Day which celebrates the brilliance, ingenuity, curiosity and courage of the women who are driving change in our world and shaping our common future.

10. Cell for IPR Promotion and Management (CIPAM)

- The Cell for IPR Promotion and Management (CIPAM) recently organized a conference on successful completion of two years of the **National Intellectual Property Rights (IPR) Policy** adopted by the Government of India in May 2016.
- **About the IPR Policy:**
    - The National Intellectual Property Rights (IPR) Policy, which was approved by the Union Cabinet in May 2016, is a significant move forward to encourage creativity and stimulate innovation in the country.
    - Outreach and Promotion is the first and foremost objective of the National IPR Policy and is critical to shaping an IP environment that is conducive to fostering creativity & innovation in the country.
- **About CIPAM:**
    - Cell for IPR Promotion and Management (CIPAM) has been created as a professional body under the aegis of **Department for Promotion of Industry and Internal Trade (DPIIT)** to take forward the implementation of the National IPR Policy that was approved by the Government in May 2016, with the slogan – "Creative India; Innovative India".
    - **Functions**: CIPAM is working towards creating public awareness about IPRs in the country, promoting the filing of IPRs through facilitation, providing inventors with a platform to commercialize their IP assets and coordinating the implementation of the National IPR Policy in collaboration with Government Ministries/Departments and other stakeholders.

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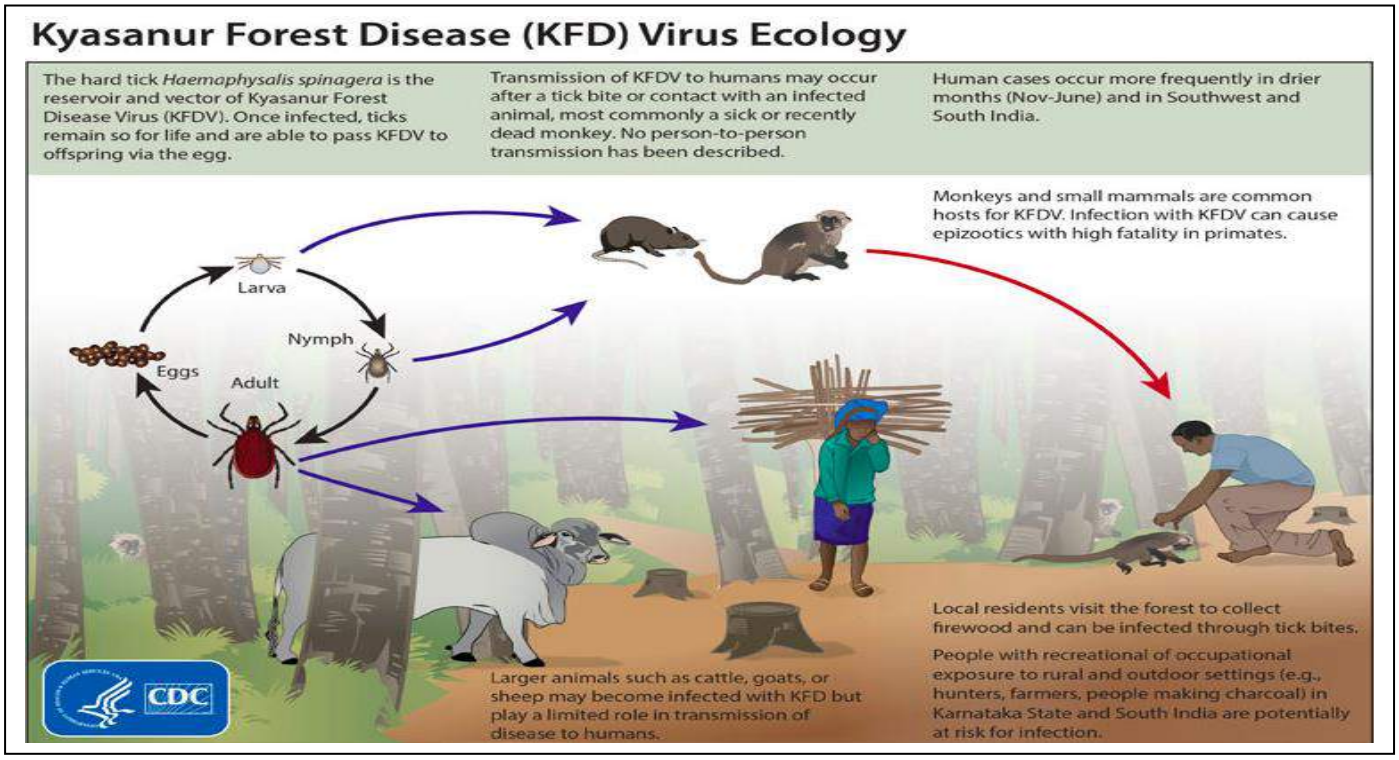
Diseases / Infections

1. Kyasanur Forest Disease (KFD)

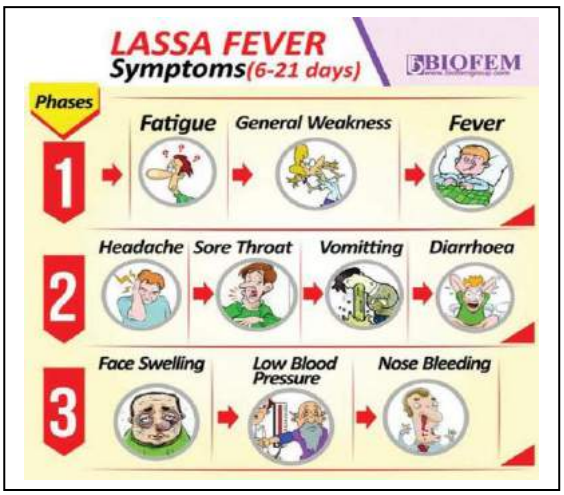
- Karnataka is currently reeling under an outbreak of monkey fever or Kyasanur forest disease (KFD). Authorities are taking measures, including vaccination to combat the disease and spread of it in the state.
- ***About the Disease:***
  - ***KFD is caused by the Kyasanur Forest Disease Virus (KFDV)***. The virus was identified in 1957 when it was isolated from a sick monkey from the Kyasanur Forest. Since then, between 400-500 humans cases per year have been reported.
  - ***Hard ticks (Hemaphysalis spinigera) are the reservoir*** of the KFD virus and once infected, remain so for life.
  - ***Rodents, shrews, and monkeys are common hosts*** for KFDV after being bitten by an infected tick. KFDV can cause epizootics with high fatality in primates.
- ***Transmission:***
  - ***Transmission to humans*** may occur after a tick bite or contact with an infected animal, most importantly a sick or recently dead monkey. No person-to-person transmission has been described.
  - ***The disease as of now is stated to be transmitted through monkeys***. Large animals such as goats, cows, and sheep may become infected with KFD but play a limited role in the transmission of the disease.
  - ***These animals provide the blood meals*** for ticks and it is possible for infected animals with viremia to infect other ticks, but transmission of KFDV to humans from these larger animals is extremely rare. Furthermore, there is no evidence of disease transmission via the unpasteurised milk of any of these animals.
- ***Symptoms:***
  - After an incubation period of 3-8 days, the symptoms of KFD begin suddenly with chills, fever, and headache. Severe muscle pain with vomiting, gastrointestinal symptoms and bleeding problems may occur 3-4 days after initial symptom onset. Patients may experience abnormally low blood pressure, and low platelet, red blood cell, and white blood cell counts.
  - After 1-2 weeks of symptoms, some patients recover without complication. However, the illness is biphasic for a subset of patients (10-20 %) who experience a second wave of symptoms at the beginning of the third week. These symptoms include fever and signs of neurological manifestations, such as severe headache, mental disturbances, tremors, and vision deficits.
- ***Vulnerable Group:***
  - People with **recreational or occupational exposure to rural or outdoor settings** (e.g., hunters, herders, forest workers, farmers) are potentially at risk for infection by contact with infected ticks.
  - Seasonality is another important risk factor as more cases are reported during the dry season, from November through June.

- ***Diagnosis:***
  - Diagnosis can be made in the early stage of illness by molecular detection by PCR or virus isolation from blood. Later, serologic testing using enzyme-linked immunosorbent serologic assay (ELISA) can be performed.
- ***Prevention:***
  - Doctors say there is no specific treatment for KFD, but early hospitalisation and supportive therapy is important. Supportive therapy includes the maintenance of hydration and the usual precautions for patients with bleeding disorders.
  - A vaccine does exist for KFD and is used in endemic areas of India. Additional preventative measures include insect repellents and wearing protective clothing in areas where ticks are endemic.



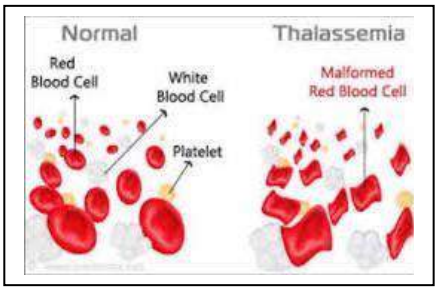
2. Lassa Fever

- Nigeria has announced that it is free from Lassa fever outbreak. The announcement follows the epidemiological review by the Nigeria Centre for Disease Control (NCDC) and the World Health Organisation (WHO).
- **Lassa fever- key facts:**
  - Lassa fever is an **acute viral haemorrhagic illness** of 2-21 days duration that occurs in West Africa.
  - The Lassa virus is transmitted to humans via contact with food or household items contaminated with rodent urine or faeces.
  - Person-to-person infections and laboratory transmission can also occur, particularly in hospitals lacking adequate infection prevention and control measures.



- Lassa fever is known to be endemic in Benin, Ghana, Guinea, Liberia, Mali, Sierra Leone, and Nigeria, but probably exists in other West African countries as well.
- The overall case-fatality rate is 1%. Observed case-fatality rate among patients hospitalized with severe cases of Lassa fever is 15%.
- Early supportive care with rehydration and symptomatic treatment improves survival.

3. Thalassemia



- Thalaseemia is a **chronic blood disorder**. It is a genetic disorder due to which a patient cannot make enough hemoglobin found in Red Blood Cells (RBC's). This leads to anemia and patients also require blood transfusions every two to three weeks to survive.
- Thalassemias are **inherited disorders passed from parents to children** through genes. Each red blood cell can contain between 240 and 300 million molecules of haemoglobin. The severity of the disease depends on the mutations involved in the genes, and their interplay.
- India is the thalassaemia capital of the world with 40 million carriers and over 1,00,000 thalassaemia majors under blood transfusion every month.

4. Nipah Virus

- It was first identified in 1998 at Kampung Sungai Nipah village, Malaysia. The virus is named after this village.
- **What are the symptoms in humans?**
  - The symptoms of Nipah are similar to that of influenza: fever, muscle pain, and respiratory problems. Inflammation of the brain can also cause disorientation. Late onset of Encephalitis can also occur. Sometimes a person can have an asymptomatic infection, and be a carrier of Nipah and not show any symptoms.
- **Are there any vaccines?**
  - **Currently, there are no vaccines** for both humans and animals. Intensive supportive care is given to humans infected by Nipah virus.
  - According to WHO, ribavarin can reduce the symptoms of nausea, vomiting, and convulsions associated with the disease. Individuals infected need to be hospitalised and isolated. Special care should be taken to prevent human-to-human transmission. Surveillance systems should be established to detect the virus quickly and to initiate appropriate control measures.

What is Nipah Virus?

- According to WHO, the Nipah virus infection is a newly emerging zoonosis, that is, a disease transmitted from animals to humans. The virus belongs to a new genus termed Henipavirus (subfamily Paramyxovirinae).
- The natural host of the virus are fruit bats belonging to the family Pteropodidae. In 2004, humans were affected after eating the date palm contaminated by infected fruit bats. Pigs can also act as intermediate hosts.

5. Measles-Rubella

- Aiming to eliminate measles and curb instances of rubella by 2020, the Centre had rolled out the **second phase of its measles-rubella (MR) vaccination campaign** in the country.
- Under the measles-rubella (MR) vaccination campaign, **all children in the age group of 9 months to less than 15 years will be vaccinated** in a phased manner across the nation.
- Following the campaign, **MR vaccine will become a part of routine immunization** replacing measles vaccine, currently given at 9-12 months and 16-24 months of age of child.
- **Measles:**
  - Measles is a deadly disease and one of the **important causes of death in children.**

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- It is **highly contagious** and spreads through coughing and sneezing of an infected person.
- Measles can make a child vulnerable to life threatening complications such as pneumonia, diarrhoea and brain infection.

- **Rubella:**
  - **Rubella** is generally a mild infection, but has serious consequences if infection occurs in pregnant women, causing **congenital rubella syndrome (CRS),** which is a cause of public health concern.
  - CRS is characterized by congenital anomalies in the foetus and new-borns affecting the eyes (glaucoma, cataract), ears (hearing loss), brain (microcephaly, mental retardation) and heart defects.

6. Polio

- Polio is a highly infectious **viral disease**, which mainly affects young children.
- The virus is **transmitted by person-to-person** spread mainly through the **faecal-oral route** or, less frequently, by a common vehicle (e.g. **contaminated water or food**) and multiplies in the **intestine**, from where it can invade the **nervous system** and can cause paralysis.
- **Injectable inactivated polio vaccine (IPV):**
  - IPV is produced from **wild-type poliovirus strains** of each serotype that have been **inactivated (killed)** with formalin.
  - As an injectable vaccine, it can be administered alone or in combination with other vaccines.
  - IPV provides serum immunity to all three types of poliovirus, resulting in **protection against paralytic poliomyelitis.**
  - Studies have confirmed that **two fractional doses** (one fractional dose is one-fifth of a full dose) of IPV, given twice to infants — first at the age of six weeks and then at 14 weeks — provide the **same protection against all polio viruses as does one full dose of IPV.**
  - **India became the first country globally to introduce fractional doses of IPV** in childhood immunisation programme in eight states and Union territories in early 2016.
- **Difference between IPV and OPV:**
  - There are two types of vaccine that protect against polio: inactivated poliovirus vaccine (IPV) and oral poliovirus vaccine (OPV).
  - **IPV contains live killed virus** and **OPV contains live weakened virus.**
  - **OPV** is made up of attenuated or weakened poliovirus and there is a **risk of vaccine derived polio.**
  - **IPV** is made up of inactivated (killed) polio virus and will provide **immunity from all three strains of polio.**

7. Leprosy

- Leprosy is ***a chronic infectious disease caused by Mycobacterium leprae***. It usually affects the skin and peripheral nerves, but has a wide range of clinical manifestations.
- The disease is ***characterized by long incubation period generally 5-7 years and is classified as paucibacillary or mulitbacillary***, depending on the bacillary load.
- The disease affects nerve endings and destroys the body's ability to feel pain and injury.

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- It mainly **affects skin and peripheral nervous system**. It can also affect the eyes and respiratory system.
- It is curable with **multidrug therapy (MDT).** Treatment provided in the early stages averts disability.
- Leprosy is a leading cause of permanent physical disability.
- ***Timely diagnosis and treatment of cases***, before nerve damage has occurred, is the most effective way of preventing disability due to leprosy.
- According to the World Health Organisation (WHO), **despite being eliminated globally as public health problem in 2000**, leprosy continues to mar lives of individuals, and impacts families and communities.

8. Triple-drug Therapy for Lymphatic Filariasis

- A pilot project to administer triple drug therapy with the long term aim of eradicating lymphatic filariasis was recently launched.
- **Triple drug therapy:**
  - The **World Health Organization (WHO) is recommending three drug treatment to accelerate the global elimination of lymphatic filariasis**.
  - The treatment, known as IDA, involves a combination of ivermectin, diethylcarbamazine citrate and albendazole. It is being recommended annually in settings where its use is expected to have the greatest impact.
  - The third drug being used in this therapy will help control adult worms of lymphatic filariasis.
  - Micro filariasis, which is produced by adult worms, is the cause of swollen leg.
  - Previously the adult worms were sterilized by drugs and remained inactive for a year. Now that period will increase to two years.
  - The plan is to administer these drugs for two consecutive years. The life of the adult worm is hardly four years, so it would die a natural death without causing any harm to the person.
- **Need for and significance of the therapy:**
  - Lymphatic filariasis poses a grave threat to India. Over 40% of worldwide cases are found in India.
  - Since 2004, two drug therapy for lymphatic filariasis has been in place but the addition of the third drug now will give a boost to the overall campaign.
  - India has missed earlier deadlines to eradicate the disease by 2015 and 2017. **The global deadline now is 2020** and the three-drug approach may help the country get there.
- **Lymphatic filariasis** (also known as elephantiasis):
  - Caused by infection with **parasitic worms living in the lymphatic system**. The larval stages of the parasite (microfilaria) circulate in the blood and are transmitted from person to person by mosquitoes.
  - Manifestation of the disease after infection takes time and can result in an altered lymphatic system, causing **abnormal enlargement of body parts**, and leading to severe disability and social stigmatization of those affected.
  - The parasites are transmitted by four main types of mosquitoes: Culex, Mansonia, Anopheles and Aedes.

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- Lymphatic filariasis can be eliminated by stopping the spread of infection through **preventive chemotherapy with safe medicine** combinations repeated annually.

9. Rare Disease

- A rare disease, also referred to as ***an orphan disease***, is any disease that affects a small percentage of the population.
- **Most rare diseases are genetic**, and are present throughout a person's entire life, even if symptoms do not immediately appear. In Europe a disease or disorder is defined as rare when it affects less than 1 in 2000 citizens.
- Rare diseases are characterised by a wide diversity of symptoms and signs that vary not only from disease to disease but also from patient to patient suffering from the same disease. Relatively common symptoms can hide underlying rare diseases, leading to misdiagnosis.
- ***The most common rare diseases recorded in India are*** Haemophilia, Thalassemia, sickle-cell anaemia and primary immuno deficiency in children, auto-immune diseases, Lysosomal storage disorders such as Pompe disease, Hirschsprung disease, Gaucher's disease, Cystic Fibrosis, Hemangiomas and certain forms of muscular dystrophies.

10. Neglected Tropical Diseases

- A new report has found that the ***Indian government is the fourth largest funder for research and development into neglected tropical diseases***.
- The country tops the number of cases for different neglected tropical diseases such as lymphatic filariasis, visceral leishmaniasis, trachoma, tapeworm, roundworm, hookworm, whipworm, dengue and leprosy.
- Neglected tropical diseases **persist under conditions of poverty** and are concentrated almost exclusively in impoverished populations in the developing world.
- More than 70% of countries and territories that report the presence of neglected tropical diseases are **low-income or lower middle-income economies.**
- Many neglected tropical diseases can be prevented, eliminated or even eradicated with improved access to existing safe and cost-effective tools.

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Biotechnology

1. Earth BioGenome Project (EBP)

- International biologists have launched Earth BioGenome Project (EBP)- an ambitious project to read all the DNA in each of the world's known animal, plant and fungal species over the next 10 years, sequencing 1.5m different genomes at an estimated cost of $4.7bn.
- The Earth BioGenome Project plans to record the genomes — the DNA blueprint of life — of 1.5 million species of animal, plant, protozoa and fungi within a decade.
- So far, 19 research institutions around the world have signed up to take part in the EBP and more plan to join.
- They expect to read the full **DNA sequence of all the world's eukaryotic species** — organisms whose cells have a nucleus enclosed by membranes. These are animals, plants, fungi and protozoa, which encompass all of life except simple microbes (bacteria and archaea).
- Participating institutions aim to raise the required funds from governments, foundations and charities. The project's first phase — producing a reference genome for each of the 9,000 taxonomic families of eukaryotic life — will require $600m, of which about one-third has already been provided.

2. Microbiome Research

- Recently Pune hosted an international conference on microbiome research — a field of study that is still in its infancy in India.
- **What is "Human Microbiome"?**
    - The human body carries diverse communities of microorganisms, which are mainly bacterial. These are referred to as "human microbiome".
- **Their role:**
    - These organisms play a key role in many aspects of host physiology, ranging from metabolism of otherwise complex indigestible carbohydrates and fats to producing essential vitamins, maintaining immune systems and acting as a first line of defense against pathogens.
- **Significance of research on the human microbiome:**
    - Research on the human microbiome has thrown light on various aspects — how different parts of the human body are occupied by characteristic microbial communities, and how various factors contribute in shaping the composition of the microbiome, including the genetics, dietary habits, age, geographic location and ethnicity.
    - These studies laid a strong foundation to decipher the microbiome's implications on health and a wide range of diseases.

3. Transgenic Rice

- Arsenic accumulation in rice grains is one of the serious agricultural issues in India. To address this, researchers at Lucknow-based **CSIR-National Botanical Research Institute** have developed transgenic rice by inserting a novel fungal gene, which results in **reduced arsenic accumulation in rice grain.**
- **How was it achieved?**

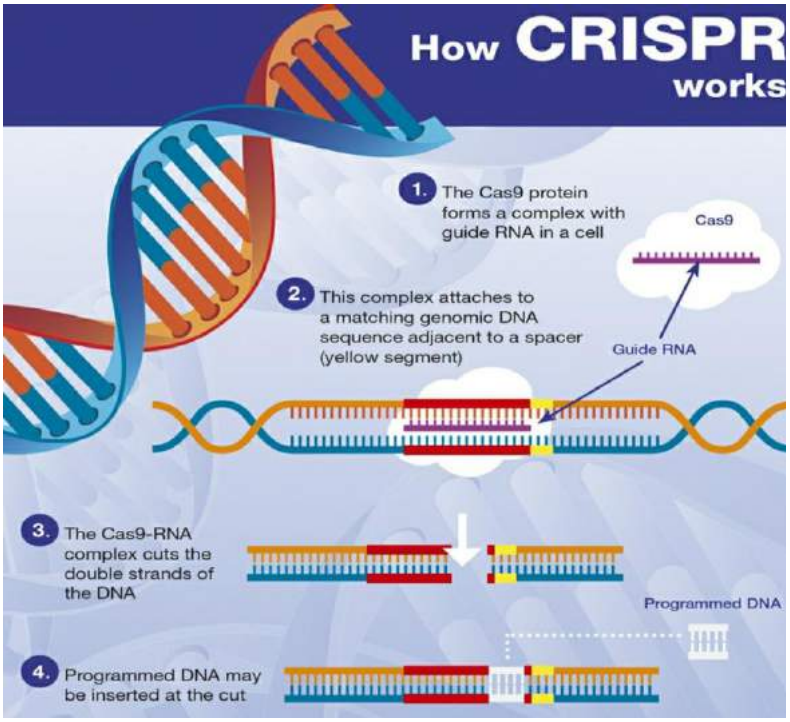
- Researchers have cloned ***Arsenic methyltransferase (WaarsM) gene*** from a soil fungus, Westerdykellaaurantiaca, and inserted the same into the rice genome with the help of Agrobacterium tumefaciens, a soil bacterium which has natural ability to alter the plant's genetic makeup.
- The newly developed transgenic rice along with normal rice was then treated with arsenic. Comparison of transgenic and non-transgenic rice showed that **transgenic plants accumulated less arsenic in root as well as shoot as compared to non-transgenic lines**.

4. CRISPR Technology

- A Chinese researcher recently claimed that he had altered the genes of a human embryo that eventually resulted in the birth of twin girls. The genes were claimed to be "edited" to ensure that they do not get infected with HIV, the virus that causes AIDS.
- **What is CRISPR-Cas9?**
  - The clustered, regularly interspaced, short palindromic repeats, or CRISPR/CRISPR-associated protein 9 (Cas9) (CRISPR-Cas9) system has revolutionised genetic manipulations and made gene editing simpler, faster and easily accessible to most laboratories.
  - ***CRISPR technology is basically a gene-editing technology*** that can be used for the purpose of altering genetic expression or changing the genome of an organism.
  - The technology can be used for targeting specific stretches of an entire genetic code or editing the DNA at particular locations.
  - CRISPR technology allows researchers to easily alter DNA sequences and modify gene function.
  - Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops. However, its promise also raises ethical concerns.

What are Genes and what is gene-editing?

- ***Genes contain*** the bio-information that defines any individual. Physical attributes like height, skin or hair colour, more subtle features and even behavioural traits can be attributed to information encoded in the genetic material.
- An ability to alter this information gives scientists the power to control some of these features. ***Gene "editing"*** — sometimes expressed in related, but not always equivalent, terms like genetic modification, genetic manipulation or genetic engineering — is not new.



- **How it works?**
  - CRISPR-Cas9 technology behaves like a **cut-and-paste mechanism on DNA strands** that contain genetic information.

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- The specific location of the genetic codes that need to be changed, or "edited", is identified on the DNA strand, and then, using the **Cas9 protein, which acts like a pair of scissors**, that 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.

- Issues:
  - Study by Stanford University, U.S., found that the CRISPR-Cas9 system ***introduces unexpected off-target (outside of the intended editing sites) effects in mice***. The fear that the CRISPR system is being prematurely rushed for clinical use lingers. Three recent reports have exacerbated this fear even further.
  - Studies highlighted that CRISPR-Cas9-edited ***cells might trigger cancer***.
  - ***May increase the risk of mutations elsewhere*** in the genome in those cells.
  - Although, CRISPR-Cas9 technology has been successfully used to cure several diseases however, it remains many things are not clear like how we should determine which disease or traits are appropriate for gene editing.
  - ***Ethical concerns:*** In addition, there are concerns with manipulating human embryos for own interest.

5. 100k GenomeAsia Project

- A group of Indian scientists and companies are involved with a 100k GenomeAsia project, led out of the Nanyang Technological University (NTU), Singapore, to **sequence the whole genomes of 100k Asians, including 50,000 Indians.**
- **About 100k Genome Asia Project:**
  - A non-profit consortium called GenomeAsia 100K has announced an ambitious plan to sequence 100,000 Asian individuals in hopes of accelerating precision medicine applications for Asian populations.
  - It will also leverage on big data analytics and advances in data science and artificial intelligence. Participants from 12 South Asian countries and at least seven North and East Asian countries will be selected.
  - The sequencing of 100,000 individual genomes will be paired with microbiome, clinical and phenotype information to allow deeper analysis of diseased and healthy individuals in the context of inferred local ancestries.

6. India's First Genetic Bank for Wildlife Conservation

- In a step that would further the cause of conservation of endangered and protected animals, India has got its first scientific and most modern national wildlife genetic resource bank.
- It is located in Hyderabad at the Laboratory for the Conservation of Endangered Species (LaCONES), a research wing of the Centre for Cellular and Molecular Biology (CCMB).
- **Key facts:**

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- The state-of-the-art bank is equipped with sophisticated equipment to preserve the genetic resources that could be utilised to virtually resurrect an animal species in case it goes extinct.
- The bank that contains genetic resources of about 250 wildlife species.
- The Genetic Resource Bank will store genetic material of Indian species. It will also help in protecting India's biodiversity and environment.

- **Achievements of Laboratory for the Conservation of Endangered Species (LaCONES):**
  - ***It is India's only research facility engaged in conservation and preservation of wildlife and its resources***.
  - It was established in 1998 with the help of Central Zoo Authority of India, CSIR and the government of Andhra Pradesh.
  - LaCONES has helped the Mouse Deer Conservation Breeding Centre at Nehru Zoological Park to increase the population of mouse deer in Telangana forests.
  - Amrabad forest, for instance, ran out of mouse deer and through the efforts of LaCONES, the animal is now reintroduced in Amrabad Tiger Reserve.
  - Earlier, LaCONES has developed universal DNA based marker for identification of wild animals from parts and remains. It has a DNA banking of more than 250 species of mammals, birds and reptiles.

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Events / Celebrations

1. Indian Science Congress

- 106th 'Indian Science Congress (ISC)' session was held at Jalandhar, Punjab.
- Theme – Future India: Science and Technology.
- Background:
  - Indian Science Congress is organised by the **Indian Science Congress Association** every year in the first week of January.
- **About Indian Science Congress Association:**
  - The Indian Science Congress Association was started in the year 1914 in Kolkata and has a membership of more than 30,000 scientists.
  - Origin: It owes its origin to the foresight and initiative of two British chemists, namely, Professor J. L. Simonsen and Professor P. S. MacMahon.
- **Objectives:**
  - To advance and promote the cause of science in India.
  - To hold an annual congress at a suitable place in India.
  - To publish such proceedings, journals, transactions and other publications as may be considered desirable.
  - To secure and manage funds and endowments for the promotion of Science including the rights of disposing of or selling all or any portion of the properties of the Association.
  - To do and perform any or all other acts, matters and things as are conductive to, or incidental to, or necessary for, the above objects.

2. National Children's Science Congress (NCSC)

- 26th National Children's Science Congress (NCSC) is being held in Odisha.
- ***Theme:*** "Science, Technology and Innovation for a Clean, Green and Healthy Nation."
- ***National Children's Science Congress (NCSC):***
  - National Children's Science Congress (NCSC) is a nationwide Science Communication programme started in the year 1993.
  - It is a programme of National Council for Science and Technology Communication (NCSTC), Department of Science and Technology, New Delhi.
  - ***It is a forum for children of the age-group of 10-17 years***, both from formal school system as well as from out of school, to exhibit their creativity and innovativeness and more particularly their ability to solve a societal problem experienced locally using by method of science.
- ***About National Council for Science and Technology Communication (NCSTC):***
  - It is mandated to communicate science & technology to masses. The programmes of the Council aim at building capacity for informed decision making in the community.
  - NCSTC encourages **research in areas of S & T communication**, training of communicators, development of books, manuals, posters, exhibitions, films, radio programmes, and television programmes on

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different facets of science & technology and recognizing outstanding efforts through awards and incentives all over the country.
    - It is a registered body guided by a Board of Governors with headquarters at Delhi.

3. India International Science Festival (IISF-2018)

- India International Science Festival (IISF-2018) has held in Lucknow.
- ***Theme:*** "Science for Transformation".
- IISF is conceivably the **biggest platform in India that brings together students, researchers, artists and general public** to celebrate our nation's achievements in science and technology.
- It is a medium to encourage the young minds towards the field of science and to promote the networking of stakeholders working towards the propagation of science.

4. International Year Of The Periodic Table

- To celebrate the 150th anniversary of the organisation of the periodic table, **UNESCO has launched the International Year Of The Periodic Table.**
- **Key facts relevant for Prelims:**
    - 1869 is considered as the year of discovery of the Periodic System by the Russian scientist, Dmitri Mendeleev.
    - The table organizes all chemical elements by the number of protons in a given atom and other properties.
    - **There are seven rows, called periods, and 18 columns, called groups**, in the table.
    - Elements in the same group share similar properties. Those in the same period have the same number of atomic orbitals.
    - Most elements on the table are metals divided into six broad categories – alkali metals, alkaline earths, basic metals, transition metals, lanthanides and actinides. They are located on the left, separated from the non-metals on the right by a zig-zag line.
    - Lanthanides and actinides, often called "inner transition metals", are commonly hived off as a separate section under the main table as including all 30 – including Uranium – would make the table too wide.
    - The table is a useful tool for people to derive relationships between the different properties of the elements. It can also help predict the properties of new elements that have yet to be discovered or created.
- **Who maintains periodic table?**
    - The **International Union of Pure Applied Chemistry (IUPAC)** is responsible for maintaining the periodic table.
    - **IUPAC is an international federation of National Adhering Organizations** that represents chemists in individual countries. It is a member of the **International Council for Science (ICSU).**
    - Headquarters of IUPAC is in Zürich, Switzerland.
    - Established in 1919 as the successor of the International Congress of Applied Chemistry for the advancement of chemistry.
- **1001 Inventions:**
    - UNESCO has also launched its educational initiative, 1001 Inventions: Journeys from Alchemy to Chemistry.

- Consisting of educational material and science experiments to help young people improve their understanding of chemistry and its numerous uses, the initiative will be brought to schools around the world during 2019.

5. National Mathematics Day

- *National Mathematics Day is celebrated every year on December 22*.
- ***It is observed to honor the birth anniversary of the famous mathematician Srinivasa Ramanujan*** who greatly contributed towards mathematical analysis, number theory, infinite series and continued fractions.
- In 2011, on the 125th anniversary of his birth, the Indian Government declared that 22 December will be celebrated every year as National Mathematics Day.
- Ramanujan's home state of Tamil Nadu celebrates 22 December as 'State IT Day', memorialising both the man and his achievements, as a native of Tamil Nadu.

6. UNISPACE+50

- UNISPACE+50 was held recently to celebrate the **50th anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space** and highlight past and future Agency activities in support of the UN's space- related actions.
- It was a chance to assess results following the three prior UNISPACE conferences, held in 1968, 1982 and 1999, and consider how the future course of global space cooperation can benefit everyone on Earth.
- **Facts for Prelims:**
  - The **United Nations Office for Outer Space Affairs (UNOOSA)** works to promote international cooperation in the peaceful use and exploration of space, and in the utilisation of space science and technology for sustainable economic and social development.
  - The Office assists any United Nations Member States to establish legal and regulatory frameworks to govern space activities and strengthens the capacity of developing countries to use space science technology and applications for development by helping to integrate space capabilities into national development programmes.
  - UNOOSA is also responsible for implementing the Secretary-General's responsibilities under international space law and maintaining the United Nations Register of Objects Launched into Outer Space.
  - UNOOSA is the current secretariat of the **International Committee on Global Navigation Satellite Systems (ICG).**

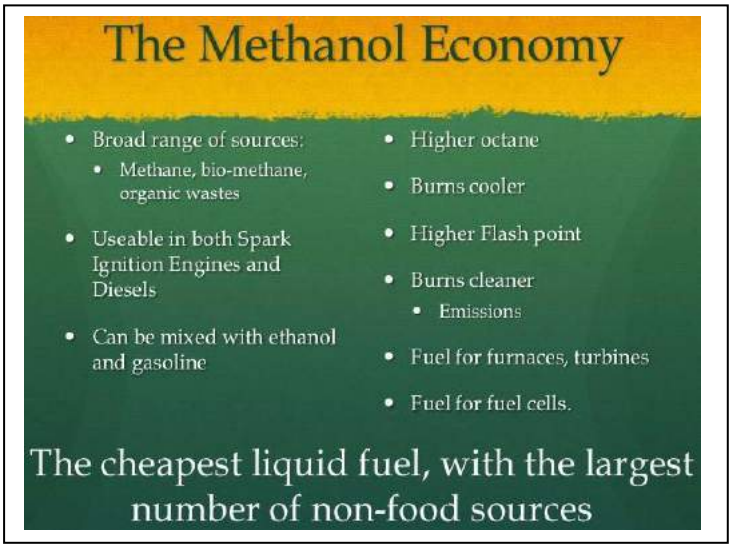
'Space2030' agenda:

- The event aimed at shaping the UN's comprehensive 'Space2030' agenda. The Space2030 agenda will map out how spaceflight and space-related activities can help achieve the 17 Sustainable Development Goals (**SDGs**), addressing overarching, long- term development concerns, through the peaceful exploration and uses of outer space.

Miscellaneous

1. Methanol Economy

- The NITI Aayog is working on a roadmap for full-scale implementation of methanol economy in the country in near future, which would not only **curb pollution, but reduce India's dependence on oil imports as well.**
- **Methanol as an alternative fuel:**
  - Methanol is a promising fuel as it is **clean, cheaper than fossil fuels** and a good substitute for heavy fuels.
  - India imports methanol from Saudi Arabia and Iran at present. Across the world, methanol is emerging as a clean, sustainable transportation fuel of the future.
- **Why Methanol?**
  - Methanol can be used as an **energy producing fuel, transportation fuel and cooking fuel**, cutting down India's oil import bill by an estimated 20% over the next few years.
  - Unlike CNG, using methanol as a transportation fuel would require **minimal alteration in the vehicles**.
  - Methanol is a **clean-burning fuel that produces fewer smog-causing emissions** — such as sulphur oxides (SOx), nitrogen oxides (NOx) and particulate matter — and can **improve air quality** and related human health issues.



  - Methanol is most commonly produced on a commercial scale from natural gas. It can also be produced from renewable sources such as biomass and recycled carbon dioxide.
  - As a **high-octane vehicle fuel**, methanol offers **excellent acceleration and power**. It also improves vehicle efficiency.
- **Advantages of methanol:**
  - Methanol is a clean burning drop in fuel which can replace both petrol & diesel in transportation & LPG, Wood, Kerosene in cooking fuel.
  - It can also replace diesel in Railways, Marine Sector, Gensets, Power Generation and Methanol based reformers could be an ideal complement to Hybrid and Electric Mobility.
  - Methanol is a scalable and sustainable fuel, that can be produced from a variety of feedstocks like Natural Gas, Coal (Indian High Ash Coal), Bio-mass, Municipal Solid waste and most importantly from CO2.
  - The gaseous version of Methanol – DME can blended with LPG and can be excellent substitute for diesel in Large buses and trucks.

2. Stratospheric Aerosol Injection (SAI)

- Scientists have found that spraying sun-dimming chemicals high above the earth to slow global warming could be remarkably inexpensive costing about $2.25 billion a year over a 15-year period.
- This geo-engineering technique known as stratospheric aerosol injection (SAI) could limit rising temperatures that are causing climate change.

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- **What are Stratospheric Sulphur Aerosols?**
  - **Stratospheric sulfur aerosols are sulfur-rich particles** exist in the stratosphere region of the Earth's atmosphere.
  - These particles consist of a mixture of sulfuric acid and water. They are created naturally, such as by photochemical decomposition of sulfur-containing gases, e.g. carbonyl sulfide.
  - Sulfur aerosols are common in the troposphere as a result of pollution with sulfur dioxide from burning coal, and from natural processes.
  - Volcanoes are a major source of particles in the stratosphere as the force of the volcanic eruption propels sulfur-containing gases into the stratosphere.
- **What is Stratospheric Aerosol Injection (SAI)?**
  - Under SAI delivery of precursor sulfide gases such as sulfuric acid, hydrogen sulfide (H2S) or sulfur dioxide (SO2) are sprayed by artillery, aircraft and balloons.
- Benefits of the SAI:
  - efficient.
- Possible side effects:
  - Tropospheric Ozone depletion.
  - Whitening of the sky.
  - Tropopause warming and the humidification of the stratosphere.
  - Involves Health effects.
  - Stratospheric temperature rise and circulation.

3. 'Shakti' - India's First Indigenous Microprocessor

- **Indian Institute of Technology Madras (IIT Madras)** researchers have designed India's first indigenous microprocessor called 'Shakti'.
- **About Shakti:**
  - It is aimed at developing **industrial-grade microprocessors** and other components of the microprocessor ecosystem.
  - It has been developed under project partly funded by Ministry of Electronics and Information Technology (MeitY), as part of two-decade-old efforts to develop indigenous microprocessors.
- **Significance:**
  - The microprocessor will reduce dependency on imported microchips especially in communication and defence sectors and thus eliminate risk of cyber-attacks.
  - It can be used in mobile computing, wireless and networking systems. It may also provide power to mobile phones, smart meters and surveillance cameras.

4. Antimicrobial Resistance

- To ensure judicious use of antibiotics in healthcare facilities, the ***Indian Council of Medical Research (ICMR)*** has released **Antimicrobial Stewardship Guidelines** to advise hospitals in setting up ***Antimicrobial Stewardship Programmes (AMSP)*** for the purpose.
- ***What is Antimicrobial resistance and why is it on rise?***
  - Antimicrobial resistance (AMR) is a major public health challenge, which is recognised as high priority area by the government.

- The **increasing consumption of antibiotics** is one of the key drivers of antimicrobial resistance seen in bugs.
- ***The National Health Policy, 2017***, terms antimicrobial resistance as one of the key healthcare issues and prioritises development of guidelines regarding antibiotic use, limiting over-the-counter use of antibiotics and restricting the use of antibiotics as growth promoters in livestock.

5. Ozone Hole

- A recent study by NASA has confirmed the **recovery of the ozone layer** due to the absence of chlorine from Chlorofluorocarbon (CFC) in the atmosphere.
- **Highlights of the study:**
  - The study revealed that chlorine levels declined by 0.8% each year between 2005 and 2016 and speculates that it could be the effect of the worldwide ban on the use of CFC.
  - Previous research had hinted at the decrease in the depletion of ozone layer.
  - Scientists believe that the ozone layer would fully recover by 2080.
- **What are CFCs?**
  - Chlorofluorocarbons, or CFCs, are compounds made up of combinations of the elements chlorine, fluorine and carbon; aerosols, refrigerants and foams contain CFCs.
  - When these CFCs enter the air, they rise up into the atmosphere to meet up with and destroy ozone molecules.
  - First used in 1928, CFCs have since become more common as various other CFC compounds were created. Some of the better-known CFCs are the Freon compounds, which were used as cooling ingredients in refrigerators and air conditioners.
  - CFCs have lifetimes from 50 to 100 years.
- **How CFCs destroy the ozone?**
  - Once in the atmosphere, CFCs drift slowly upward to the stratosphere, where they are broken up by ultraviolet radiation, releasing the chlorine that catalytically destroys ozone.
- **Applications of CFCs:**
  - CFCs are not flammable; therefore they were used as propellants that would push other molecules out of the aerosol sprays. For the same reason CFCs were used to form foamed plastics.
  - Also low flammability enabled people to use these molecules to dry clean hot electronic components of devices such as air conditioning.

What is ozone layer?

- A layer of ozone envelops the Earth and keeps damaging ultraviolet, or UV, radiation from reaching living things on the planet's surface.
- The ozone layer exists mainly in the stratosphere, a layer of the atmosphere that reaches from 10 to 50 kilometers above the Earth's surface.

What is ozone hole?

- The ozone hole is a region of depleted layers of ozone above the Antarctic region, whose creation is linked to increased cases of skin cancer.

Factors responsible for the depletion of ozone:

- Depletion of ozone is due to many factors, the most dominant of which is the release of chlorine from CFCs (Chlorofluorocarbons) which destroys the ozone. CFCs are released by products such as hairsprays, old refrigerators etc.

6. Achievements of Indian Scientists in 2018

- ***A gel that can protect farmers from toxic pesticides:*** It is a protective gel—***poly-Oxime***—that can be applied on skin and can break down toxic chemicals into safe substances, preventing farmers from going deep into the skin and organs like the brain and the lungs.

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- ***World's thinnest material with novel technique:*** It is a material that is 100,000 times thinner than a sheet of paper. Researchers synthesized a two-dimensional material of just one-nanometre in thickness using Magnesium diboride—a compound of boron. This is said to be the world's thinnest material. It can find a range of applications—from next-generation batteries to ultraviolet absorbing films.
- ***Gene editing applied to banana genome:*** Using the gene editing technique—CRISPR/Cas9—researchers at the National Agri-Food Biotechnology Institute, Mohali, edited the banana genome. This is the first such work in any fruit crop in India. Banana is the fourth most important food crop after wheat, rice and corn in terms of gross value of production. Gene editing could be deployed to improve nutritional quality, agronomical important traits as well as pathogen resistance in banana.
- ***Faster diagnostic tests for tuberculosis:*** Scientists have developed highly sensitive and rapid tests for detection of tuberculosis infection in lungs and surrounding membranes. Unlike current tests that use antibodies for detection of bacterial proteins in sputum samples, new tests use **Aptamer Linked Immobilized Sorbent Assay (ALISA) and Electrochemical Sensor (ECS)** for detection of a bacterial protein in the sputum.
- ***New tool developed for autism screening:*** In many cases, autism is misdiagnosed as mental retardation and attention deficit hyperactivity disorder (ADHD). Early identification and interventions may help children with autistic disorders. To help this process, scientists have developed an Indian tool for screening children for autism.
- ***Hope for Alzheimer's and Huntington's patients:*** Scientists at the Indian Institute of Science (IISc), Bengaluru, have figured out the way memory deficit develops in early stages, resulting in Alzheimer's disease. They have found that early breaking down of a protein, fibrillar actin or F-actin, in the brain leads to disruption in communication among nerve cells and consequently memory deficits.
- ***Green technique can address plaster of Paris pollution:*** A team of scientists at Pune-based National Chemical Laboratory (CSIR-NCL) has developed a technique that helps recycle plaster of Paris waste from hospitals in an eco-friendly and economical way. The new technique disinfects waste and converts it into useful products like ammonium sulphate and calcium bicarbonate. The technique can also be used to disintegrate PoP waste from idols immersed in water bodies.
- ***Stone Age tools, genetic studies throw new light on early civilisation in India:*** The Stone Age tools discovered in a village near Chennai suggest that a Middle Palaeolithic culture was present in India around 385,000 years ago—roughly the same time that it is known to have developed in Africa and in Europe. The discovery pushes back the period when populations with a Middle Palaeolithic culture may have inhabited India, and challenges popular theory that the Middle Palaeolithic was brought to India by modern humans dispersing from Africa only around 125,000 years ago or later.
- ***Sikkim gets real-time landslide warning system:*** A real-time landslide warning system has been set up in the Sikkim-Darjeeling belt of north-eastern Himalayas which is highly vulnerable to landslides. The warning system consists of over

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200 sensors that can measure geophysical and hydrological parameters like rainfall, pore pressure and seismic activities. The system is capable of warning about 24 hours in advance. It has been deployed by researchers of Kerala-based Amrita University and Sikkim State Disaster Management Authority.

- ***Computing capacity for weather forecasting gets a boost:*** During the year, the Indian Institute of Tropical Meteorology (IITM) upgraded its computing capacity for weather forecasting and climate monitoring, taking its total high performance computing (HPC) power to as high as 6.8 Petaflop. With this, India rose to the fourth position, next only to United Kingdom, Japan and USA in terms of dedicated capacity for HPC resources for weather and climate proposes.
- ***Scientists use silk polymer to develop artificial vertebral disc:*** Scientists at Indian Institute of Technology, Guwahati, developed a silk-based bioartificial disc that may find use in disc replacement therapy in future. The group has developed a fabrication procedure for a silk-based bioartificial disc adopting a "directional freezing technique". The disc mimics internal intricacy of human disc and its mechanical properties too are similar to those of the native ones.
- ***Transgenic rice with reduced arsenic accumulation:*** To address the problem of arsenic accumulation in rice grains, researchers at Lucknow- based CSIR-National Botanical Research Institute developed transgenic rice by inserting a novel fungal gene, which results in reduced arsenic accumulation in rice grain. They cloned Arsenic methyltransferase (WaarsM) gene from a soil fungus and inserted it into rice genome.
- ***Flowering mustard***: TERI School of Advanced Studies has developed an early flowering transgenic variety of mustard.

7. International Commission on Non Ionizing Radiation Protection (ICNIRP)

- The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is ***an international commission specialized in non-ionizing radiation protection***.
- The organization's activities include determining exposure limits for electromagnetic fields used by devices such as cellular phones.
- ICNIRP is an independent non-profit scientific organization chartered in Germany. ***It was founded in 1992 by the International Radiation Protection Association (IRPA)*** to which it maintains close relations.
- The mission of ICNIRP is to screen and evaluate scientific knowledge and recent findings toward providing protection guidance on non-ionizing radiation, i.e. radio, microwave, UV and infrared.

8. World's first "floating" Nuclear Power Plant (FNPP)

- Akademik Lomonosov is the world's first "floating" nuclear power plant (FNPP). It is coming up in Russia.
- An FNPP is basically a mobile, low-capacity reactor unit operable in remote areas isolated from the main power distribution system, or in places hard to access by land.

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9. Apsara-U Reactor

- THE BHABHA Atomic Research Centre has recommissioned an upgraded version of 'Apsara', the country's oldest research reactor that was decommissioned almost a decade ago. ***Apsara is now operational as 'Apsara-U' on Trombay campus of Maharashtra***.
- **About Apsara Nuclear reactor:**
  - Apsara is the oldest of India's research reactors. The reactor was designed by the Bhabha Atomic Research Center (BARC) and built with assistance from the United Kingdom (which also provided the initial fuel supply consisting of 80% enriched uranium).
- **Apsara- Upgraded:**
  - "Apsara-upgraded", made indigenously, uses plate type dispersion fuel elements made of Low Enriched Uranium (LEU).
  - By virtue of higher neutron flux, this reactor will increase indigenous production or 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. Staphylococcus Epidermidis

- Australian scientists have warned that ***Staphylococcus epidermidis***, a superbug resistant to all known antibiotics that can cause "severe" infections or even death is spreading undetected through hospital wards across the world.
- Key facts:
  - ***The bacteria, known as Staphylococcus epidermidis***, is related to the better-known and more deadly MRSA superbug.
  - ***Where it is found?*** It's found naturally on human skin and most commonly infects the elderly or patients who have had prosthetic materials implanted, such as catheters and joint replacements.
  - ***Who is more vulnerable?*** It can be deadly, but it's usually in patients who already are very sick in hospital. it can be quite hard to eradicate and the infections can be severe.
  - ***Concerns:*** Some strains of the bug can make a small change in DNA that can lead to resistance to two of the most common antibiotics.
- **What is a superbug?**
  - A superbug, also called multi-resistant, is a bacterium that carries several resistance genes.
  - These are **resistant to multiple antibiotics** and are able to survive even after exposure to one or more antibiotics.

11. Model International Center for Transformative Artificial Intelligence (ICTAI)

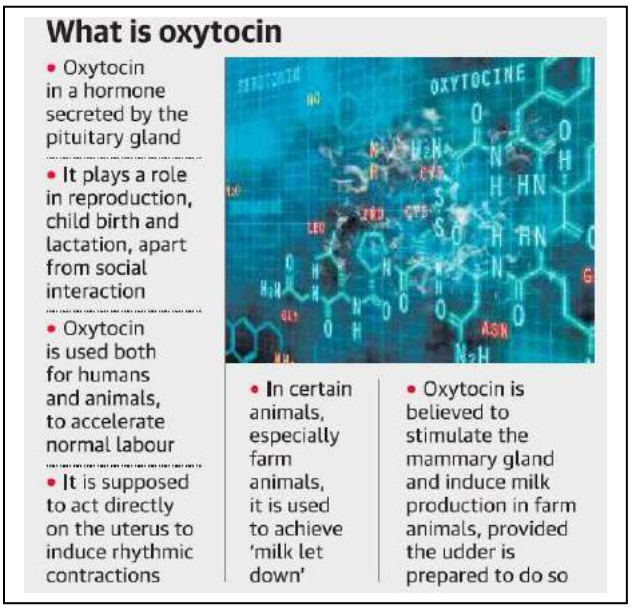
- NITI Aayog, Intel, and Tata Institute of Fundamental Research (TIFR) are collaborating to set up ***a Model International Center for Transformative Artificial Intelligence (ICTAI)*** towards developing and deploying AI-led application-based research projects.
- This initiative is part of ***NITI Aayog's 'National Strategy for Artificial Intelligence'*** Discussion Paper that focuses on establishing ICTAI in the country through private sector collaboration.

12. Kudankulam Power Plant

- The Supreme Court has granted the Nuclear Power Corporation of India Ltd. (NPCIL) an extension of time till April 30, 2022, to build an ***Away From Reactor (AFR) facility*** to store spent nuclear fuel from the Kudankulam power plant.
- **About Kudankulam Nuclear Power Plant:**
  - Kudankulam Nuclear Power Plant is situated in Koodankulam in the Tirunelveli district of Tamil Nadu.
  - It is the single largest nuclear power station in India.
  - The reactors are ***pressurised water reactor*** of Russian design.
  - KKNPP is scheduled to have six VVER-1000 reactors with an installed capacity of 6,000 MW of electricity.
- **What are Pressurized water reactors (PWRs)?**
  - They are one of three types of light water reactor (LWR), the other types being boiling water reactors (BWRs) and supercritical water reactors (SCWRs).
  - In a PWR, the primary coolant (water) is pumped under high pressure to the reactor core where it is heated by the energy released by the fission of atoms.
  - The heated water then flows to a steam generator where it transfers its thermal energy to a secondary system where steam is generated and flows to turbines which, in turn, spin an electric generator.
  - In contrast to a boiling water reactor, pressure in the primary coolant loop prevents the water from boiling within the reactor. All LWRs use ordinary water as both coolant and neutron moderator.

13. Oxytocin

- The **Ministry of Health and Family Welfare** has restricted the manufacture of Oxytocin formulations for domestic use to **public sector only**. Coupled with this, it has also banned the import of Oxytocin and its formulations.
- **Who can manufacture?**
  - Only Karnataka Antibiotics & Pharmaceuticals Ltd. (KAPL), a public sector company, will manufacture this drug for domestic use. It will supply the drug to registered hospitals and clinics in public and private sector directly.
- **Why a ban on oxytocin?**
  - The drug is misused in the dairy industry where livestock is injected with Oxytocin to make them release milk at a time convenient to farmers.
  - Oxytocin is also used to increase the size of vegetables such as pumpkins, watermelons, eggplants, gourds, and cucumbers.
- **Oxytocin:**
  - Oxytocin has also been dubbed the **hug hormone**, cuddle chemical, moral molecule, and the bliss hormone due to its effects on behaviour, including its role in love and in female reproductive biological functions in reproduction.



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- Oxytocin is a hormone that is made in the brain, in the hypothalamus. It is transported to, and secreted by, the pituitary gland, which is located at the base of the brain.
- It acts both as a hormone and as a brain neurotransmitter.
- The release of oxytocin by the pituitary gland acts to regulate two female reproductive functions: Childbirth and Breast-feeding.

- **Facts for Prelims:**
  - **Carbetocin*:*** The World Health Organization (WHO) has come up with a safe and effective alternative to the controversial drug oxytocin.
  - While Oxytocin, must be stored and transported at 2–8 degrees Celsius, and becomes less effective when exposed to heat, Carbetocin does not require refrigeration and retains its efficacy for at least three years even if it is stored at 30 degrees Celsius, and in 75% relative humidity.

14. Elysia Chlorotica

- It is a green **sea slug** which can suck out an algae's plastids that generate energy from sunlight — and incorporate them into its own biology. In doing so, it becomes an animal with the photosynthetic ability of a plant.

- **What makes it unique?**
  - What makes Elysia chlorotica unique is it takes only the plastids, or the organelles that contain chlorophyll and perform photosynthesis, from the algae.
  - The slug then uses its own genome to keep the plastids operating within its own body throughout the rest of its life.
- **Where is it found?**
  - The sea slug Elysia chlorotica, a mollusk that can develop to a length of 2 inches has been discovered in intertidal zone between Nova Scotia, Canada, and Martha's Vineyard, Massachusetts, as well as in Florida.