

**MANIDHANA EYAM FREE IAS ACADEMY – TNPSC GROUP II & IIA**  
**UNIT – IV – CURRENT AFFAIRS**  
**SCIENCE AND TECHNOLOGY, DRDO, TELESCOPE AND HEALTH**  
**SCIENCE AND TECHNOLOGY**

**1) PSLV- C52**

1. The PSLV-C52 mission has also injected three satellites into the orbits.
2. It has placed an EOS-04 radar imaging satellite weighing 1710 kgs into orbit.
  1. EOS-04 is designed to provide high-quality images under all weather conditions for applications such as agriculture, forestry and plantations, soil moisture and hydrology and flood mapping.
  2. This satellite will be positioned into a Sun synchronous polar orbit gradually.
3. As a co-passenger INS-2TD technology demonstrator satellite and INSPIRE sat 1 student satellite were also placed into orbit.
4. INS-2TD is a precursor to India-Bhutan Joint Satellite INS-2B.
  - INS-2TD carries a thermal imaging camera to assess land and water surface temperature and thermal inertia at day and at night.
5. INSPIRE sat-1 is a small satellite from the Indian Institute of Space Science and Technology in association with the Laboratory of Atmospheric and Space Physics at University of Colorado.

**Polar Satellite Launch Vehicle:**

1. Polar Satellite Launch Vehicle (PSLV) is the third generation launch vehicle of India.
2. It is a four-staged launch vehicle with first and third stages using solid rocket motors and second and fourth stages using liquid rocket engines.
3. It is the first Indian launch vehicle to be equipped with liquid stages.

**2) BGR – 34**

- BGR – 34 is an Anti-Diabetics Ayurvedic Drug.
- Developed in 2015 jointly by i) National Botanical Research Institute (NBRI) and ii) Central Institute for Medicinal and Aromatic Plants (CIMAP) under Council of Scientific and Industrial Research (CSIR).
  - It was launched commercially in 2016.
- It is licensed under the proprietary Ayurvedic Medicine category and its availability is possible only through tenders.

**3) SSLV – DI (SAT Micro)**

Recently, the Indian Space Research Organization (ISRO) has launched satellites Microsat-R and KalamSat onboard Polar Satellite Launch Vehicle (PSLV) C-44.

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- This was also a technology demonstrator of PSLV, as this launch was the first launch done with just 2 strap-on motors and is named as the PSLV-DL, D standing for demonstration.
- It provided an alternative to its normal six strap-on motors (side rocket boosters) on PSLV. This will enable it to carry a slightly higher payload than its Core-Alone version (in which there is no strap on motors).

#### Significance of the Mission:

##### ▪ **Microsat-R**

- Microsat-R is a military imaging satellite, weighing 130 kilograms, was made by Defence Research and Development Organization (DRDO).
- This was launched in low orbit. It is the first time an Indian satellite was being placed by ISRO in a low orbit at an altitude of 274 km.

##### ▪ **Kalamsat**

- ISRO also launched a student satellite, Kalamsat, made by Space Kidz India, weighing just 1.26kg.
- Kalamsat is the world's smallest and lightest communication satellite.
- Space Kidz India is an organization dedicated to designing innovative concepts for students in the field of education.

##### ▪ **Fourth Stage (PS4) Usability**

- ISRO also used this launch as an opportunity to demonstrate the usability of the fourth stage of the rocket after the satellites are ejected into orbit.
- The fourth and final stage of the rocket normally turns into debris after ejecting a satellite.
- Now any agency that wants to conduct experiments in space can use the fourth stage until it disintegrates naturally. The fourth stage of the rocket will be orbiting in space for six months to a year. ISRO is aiming to use this time-frame to enable agencies to run short time experiments.
- Kalamsat will be the first to use the fourth stage as an orbital platform.
- The experiment with Kalamsat will start about 1.5 hours from take-off and will last for about 14 hours. Later duration of experiments with PS4 will be improved gradually.

#### 4) INDIAN HUMAN SPACE MISSION YOUTH SAT

YOUTHSAT is a joint Indo-Russian stellar and atmospheric satellite mission with the participation of students from Universities at graduate, post graduate and research scholar level. With a lift-off mass of 92 kg, Youthsat is a mini satellite and the second in the Indian Mini

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Satellite (IMS) series. Youthsat mission intends to investigate the relationship between solar variability and thermosphere-Ionosphere changes. The satellite carries three payloads, of which two are Indian and one Russian. Together, they form a unique and comprehensive package of experiments for the investigation of the composition, energetics and dynamics of earth's upper atmosphere.

**The Indian payloads are:**

1. RaBIT (Radio Beacon for Ionospheric Tomography)- For mapping Total Electron Content (TEC) of the Ionosphere.
2. LiVHySI (Limb Viewing Hyper Spectral Imager) - To perform airglow measurements of the Earth's upper atmosphere (80- 600 km) in 450-950 nm.

**The Russian payload**

SOLRAD - To study temporal and spectral parameters of solar flare X and gamma ray fluxes as well as charge particles in the earth polar cap regions.

**5) CHANDRAYAAN-3**

- The Chandrayaan-3 mission is a follow-up of Chandrayaan-2 of July 2019, which aimed to land a rover on the lunar South Pole.
- The subsequent failure of the Vikram lander led to the pursuit of another mission to demonstrate the landing capabilities needed for the Lunar Polar Exploration Mission proposed in partnership with Japan for 2024.
- It will have an orbiter and a landing module. However, this orbiter won't be loaded with scientific instruments like the Chandrayaan-2.
  - Its job will only be confined to carry the lander to the moon, oversee the landing from its orbit and communicate between the lander and the earth station.”

**6) MANGALYAAN**

ISRO has planned seven mega missions, including Chandrayaan-2, to be conducted over a period of 10 years.

- Of these, only two missions have been defined — XPoSat and Aditya-L1.
- The four other undefined missions, which are in the planning stage, are Mangalyaan-2, Venus mission, Lunar Polar Exploration and Exoworlds.
- Xposat will be launched to study cosmic radiation in 2020, Aditya-L1 to the Sun in 2021, Mars Orbiter Mission-2 in 2022, Venus Mission in 2023, Lunar Polar Exploration or Chandrayaan-3 in 2024 and Exoworlds, an exploration outside the solar system in 2028.
- Aditya-L1 will play a key role in understanding and predicting climate change on Earth. The payloads will study the solar corona. Corona has an influence on the upper atmosphere and that impacts climate change on earth.

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- Aditya-L1 will be placed in a 'libration orbit', which is about 1.5 million km from Earth. It is about 1% of the distance between the Sun and the Earth, where the gravity of the two celestial objects equalises. Placing it in such an orbit allows the spacecraft to circle along with the earth, thereby constantly facing the Sun.
- Xposat will be a five-year mission, carrying a polarimeter instrument made by Raman Research Institute to measure cosmic radiation. The spacecraft will be placed in a circular 500-700km orbit.

#### 7) SHUKRAYAAN

##### In News:

- Recently, the new Chairman of Indian Space Research Organization (ISRO) has announced plans to launch the Venus mission by December 2024.

##### About:

- **Aim:** To study what lies below the surface of the solar system's hottest planet, and also unravel the mysteries under the Sulfuric Acid clouds enveloping it.

##### Objective of the Mission:

- **Possibility of Water:**
  - In the solar system's early days when the Sun was cooler, scientists think the planet may have had liquid water on the surface for 2 billion years — far longer than Mars, which had liquid water for a relatively shorter 300 million years.
- **Elements of Life:**
  - In 2020 scientists announced they had found phosphine, a chemical strongly associated with life, in Venus's clouds — though the existence of the signal is currently being reviewed.
- **Earth like planet:**
  - By studying Venus, scientists learn how Earth-like planets evolve and what conditions exist on Earth-sized exoplanets.
  - Venus also helps scientists model Earth's climate, and serves as a cautionary tale on how dramatically a planet's climate can change.

##### Significance:

- Studying Venus helps get a better understanding of the evolution of the planet, especially the study of exoplanets.
- It will help in modelling Earth's climate and serves as a cautionary tale on how dramatically a planet's climate can change.

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- Studying the thick Venus atmosphere will also pave the way for future air balloon type missions which can float in the upper atmosphere where the conditions are more benign than that on the ground.

#### Challenges:

- Venus is scorching hot because a majority of its atmosphere is composed of carbon dioxide. The surface is said to be hot enough to melt lead, and dappled with innumerable volcanoes.
- Venus is also infamous for its extreme surface air pressure— about 90 times higher than the pressure at sea level on Earth.
- Unlike Mars, Venus has a thick atmosphere. Visual imagining payloads will not help in understanding the sub-surface topologies.
- In order to have a deeper understanding, the instruments need to go deep through the atmosphere.

#### Earlier Studies and Missions:

- **NASA:**
  - Venus was the first planet to be explored by a spacecraft – NASA’s Mariner 2 on Dec. 14, 1962.
  - NASA's Pioneer Venus mission (1978), the Soviet Union's Venera 15 and 16 missions (1983-1984), and NASA's Magellan radar mapping mission (1990-1994) provided together with a comprehensive picture of a dry world, with landscapes shaped by volcanic and intense geological activity.
- **Indian missions:**
  - Shukrayaan
  - India plans to launch a new orbiter to Venus in 2024. It will be the first mission to Venus by the India Space Research Organisation (ISRO) and will study the planet for four years.

#### About Venus:

- **Earth’s Twin:**
  - Venus is Earth’s closest planetary neighbour which is similar in structure but slightly smaller than Earth, it is the second planet from the sun. Therefore, Venus has been called Earth’s twin.
- **Thick & Toxic Atmosphere:**
  - Venus has an atmosphere 50 times denser than Earth’s.
  - Venus is wrapped in a thick, toxic atmosphere filled with carbon dioxide that traps in heat.

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- **Inhabitable:**

- Venus is the hottest planet in the solar system.
- The temperature of Venus is too high, and its atmosphere is highly acidic, just two of the things that would make life impossible.
- Surface temperatures reach a scorching 880 degrees Fahrenheit (471 degrees Celsius), hot enough to melt lead.

- **Other Features:**

- It has no moons and no rings.
- Venus' solid surface is a volcanic landscape covered with extensive plains featuring high volcanic mountains and vast ridges.
- It spins from east to west, the opposite direction from all other planets in our solar system but the same as Uranus.

**8) CSIR – 1<sup>ST</sup> WOMAN DIRECTOR GENERAL (KALAI SELVI)**

1. Dr. Kalaiselvi Nallathamby is the first woman director general in the Council of Scientific and Industrial Research's 80-year history. She will be in charge for two years. The new director general was named this week, after the current DG Shekhar Mande's term expired in April.
2. Earlier, Kalaiselvi smashed the glass ceiling in the CSIR by becoming the first female scientist to lead the Central Electrochemical Research Institute (CSIR-CECRI) in 2019.
3. During her growing-up years, Kalaiselvi had finished her education in a humble Tamil medium school in the Tamil Nadu district of Tirunelveli. From there, she continued to pursue her interest in science and excelled at it. She began her career as an entry-level scientist and now has 25 years of experience in the field of research.
4. Kalaiselvi joined CECRI in 1997 and progressed through the ranks to become its director in 2019, another first for a female scientist. She had no prior experience in electrochemistry before she joined CECRI. She was an organic chemist who had taught the subject at a private college for almost three years after receiving her PhD from Annamalai University in Chidambaram.
5. Kalaiselvi focusses largely concerned with electrochemical power systems, particularly the development of electrode materials and the electrochemical evaluation of in-house manufactured electrode materials for appropriateness in energy storage device assembly. Lithium and beyond lithium batteries, supercapacitors, and waste-to-wealth driven electrodes and electrolytes for energy storage and electrocatalytic applications are among her research interests. She is currently working on the development of Sodium-ion/Lithium-sulfur batteries and supercapacitors.

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6. Additionally, Kalaiselvi contributed significantly to the National Mission for Electric Mobility. She has published over 125 academic publications and holds six patents.
7. Scientists and researchers are congratulating her on her appointment as Director General of the CSIR.

#### 9) 5G and 6G

##### 5G Technology

##### About 5G Technology:

- 5G is the 5<sup>th</sup> generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks.
- It enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.
- Internet speeds in the high-band spectrum of 5G has been tested to be as high as 20 Gbps (gigabits per second), while, in most cases, the maximum internet data speed in 4G has been recorded at 1 Gbps.

##### Different Bands of 5G:

- 5G mainly works in 3 bands, namely low, mid and high frequency spectrum — all of which have their own uses as well as limitations.
  - **Low Band Spectrum:** In terms of coverage and speed of Internet and data exchange, the maximum speed is limited to 100 Mbps (Megabits per second).
    - This means that telecom companies can use and install it for commercial cellphone users who may not have specific demands for very high speed Internet.
    - However, the low band spectrum may not be optimal for specialised needs of the industry.
  - **Mid Band Spectrum:** It offers higher speeds compared to the low band, but has limitations in terms of coverage area and penetration of signals.
    - This band may be used by industries and specialised factory units for building captive networks that can be moulded into the needs of that particular industry.
  - **High Band Spectrum:** It offers the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength.
    - This band greatly enhances futuristic 5G technology applications like Internet of Things (IoT) and smart technology but will require considerable infrastructure.

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**Uses of 5G:**

- Broadly speaking, 5G is used across three main types of connected services, including enhanced mobile broadband, mission-critical communications, and the massive IoT.
  - **Enhanced Mobile Broadband:** In addition to making our smartphones better, 5G mobile technology can usher in new immersive experiences such as Virtual reality (VR) and Augmented Reality (AR) with faster, more uniform data rates, lower latency, and lower cost-per-bit.
  - **Mission-Critical Communications:** 5G can enable new services that can transform industries with ultra-reliable, available, low-latency links like remote control of critical infrastructure, vehicles, and medical procedures.
  - **Massive Internet of Things:** 5G is meant to seamlessly connect a massive number of embedded sensors in virtually everything through the ability to scale down in data rates, power, and mobility—providing extremely lean and low-cost connectivity solutions.
    - Combined with IoT, cloud, big data, Artificial Intelligence, and edge computing, 5G could be a critical enabler of the fourth industrial revolution.

**Challenges for 5G Rollout in India:**

- Low Fiberization Footprint: There is a need to upgrade fibre connectivity across India, which at present connects only 30% of India's telecom towers.
  - For an efficient 5G India launch and adoption, this number has to double.
- 'Make in India' Hardware Challenge: The ban on certain foreign telecom OEMs (original equipment manufacturer) upon which most of the 5G technology development depends, presents a hurdle in itself.
- High Spectrum Pricing: India's 5G spectrum pricing is several times costlier than the global average.
  - This will be of detriment to India's cash-strapped telcos.
- Choosing the Optimal 5G Technology Standard: The tussle between the homegrown 5Gi standard and the global 3GPP standard needs to be concluded in order to hasten 5G technology implementation.
  - While 5Gi brings obvious benefits, it also increases 5G India launch costs and interoperability issues for telcos.



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**6G TECHNOLOGY**

- 6G (sixth-generation wireless) is the successor to 5G cellular technology.
- It will be able to use higher frequencies than 5G networks and provide substantially higher capacity and much lower latency (delay).
- One of the goals of 6G internet will be to support one microsecond-latency communication (delay of one-microsecond in communication).
  - This is 1,000 times faster - or  $1/1000^{\text{th}}$  the latency - than one millisecond throughput.
- It seeks to utilize the terahertz band of frequency which is currently unutilized.
  - Terahertz waves fall between infrared waves and microwaves on the electromagnetic spectrum.
  - These waves are extremely tiny and fragile, but there's a huge amount of free spectrum up there that would allow for spectacular data rates.

**Significance:**

- **More facilitation:**
  - The 6G technology market is expected to facilitate large improvements in imaging, presence technology and location awareness.
  - 6G's higher frequencies will enable much faster sampling rates, in addition to providing significantly better throughput and higher data rates.
- **Advancement in Wireless sensing technology:**
  - The combination of sub-mm waves (e.g., wavelengths smaller than one millimeter) and frequency selectivity to determine relative electromagnetic absorption rates could potentially lead to significant advances in wireless sensing technology.
- **Emergence of Digital Capabilities:**
  - It will see the emergence of simple, easy-to-wear-and-carry devices with a huge set of digital capabilities.
  - This will help the paramedics, educators and agro-technicians to jumpstart the village ecosystems with little or limited need for on-site presence of doctors, professors and agro-experts.
- **Optimising mass public transportation:**
  - For India, such an enabling set of technologies will bring manifold utilisation of scarce rail, air and road networks and make mass

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transportation far more efficient; Artificial Intelligence (AI) and massively parallel computing architectures will help solve transportation and scheduling operations research problems.

**Challenges:**

- **Maintaining Protection Mechanisms:**
  - The key technical challenges are energy efficiency, avoiding signal attenuation due to obstructions and water droplets in the air, and, of course, maintaining end-to-end trust through robust cyber security and data protection mechanisms.
- **Adoption of New Models:**
  - Need innovations in antenna design, miniaturisation, edge cloud and distributed AI models. In addition, we need to ensure end-to-end security and privacy by design, instead of as an afterthought.
- **Availability of Semiconductor:**
  - We don't have semiconducting materials that can use multi-THz frequencies. Getting any kind of range out of those frequencies may require enormous arrays of extremely tiny antennas.
- **Complex Design for Carrier Wave:**
  - Water vapor in the atmosphere blocks and reflects THz waves, so mathematicians will have to design models that allow data to take very complex routes to its destination.

**10) NOBEL PRIZE 2022**

**Physics:**

Pennsylvania, USA, May 11, 2022 – Dr. Frank Wilczek, a Nobel Prize-winning theoretical physicist and author, whose boundary-pushing investigations into the fundamental laws of nature have transformed our understanding of the forces that govern our universe, was announced today as the winner of the 2022 Templeton Prize.

**Chemistry:**

The Wolf Prize in Chemistry for 2022 is awarded to Bonnie L. Bassler, Princeton University, NJ, USA, Carolyn R. Bertozzi, Stanford University, CA, USA, and Benjamin F. Cravatt III, Scripps Research, La Jolla, CA, USA, “for their seminal contributions to understanding the chemistry of cellular communication and inventing chemical methodologies to study the role of carbohydrates, lipids, and proteins in such biological processes.”

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#### Medicine:

1. The Nobel Prize in Physiology or Medicine was awarded jointly on Monday to David Julius and Ardem Patapoutian, two scientists who independently discovered key mechanisms of how people sense heat, cold, touch and their own bodily movements.
2. Dr. Julius, a professor of physiology at the University of California, San Francisco, used a key ingredient in hot chili peppers to identify a protein in nerve cells that responds to uncomfortably hot temperatures.
3. Dr. Patapoutian, a molecular biologist at Scripps Research in La Jolla, Calif., led a team that, by poking individual cells with a tiny pipette, hit upon a receptor that responds to pressure, touch and the positioning of body parts.

#### 11) PARKER SPACE SHUTTLE

The Parker Solar Probe, launched by NASA, has become the first spacecraft to fly through the outer atmosphere of the Sun- ‘Corona’.

- The spacecraft flew through Corona and sampled magnetic fields and particles there.

#### Significance:

The achievement would help scientists discover critical information about the sun and its influence on our solar system.

**About the mission:** Launched in 2018, 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 — and ultimately providing humanity with the closest-ever observations of a star.

#### Journey:

- In order to unlock the mysteries of the sun’s atmosphere, Parker Solar Probe will use Venus’ gravity during seven flybys over nearly seven years to gradually bring its orbit closer to the sun.
- The spacecraft will fly through the sun’s atmosphere as close as 3.9 million miles to our star’s surface, well within the orbit of Mercury and more than seven times closer than any spacecraft has come before.

#### Parker Solar Probe has three detailed science objectives:

1. Trace the flow of energy that heats and accelerates the solar corona and solar wind.
2. Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
3. Explore mechanisms that accelerate and transport energetic particles.

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**12) VOYAGER-2**

NASA's Voyager 2 has become the second human-made object in history to exit the Heliosphere (bubble created by solar winds).

- Spacecraft Voyager 1, crossed this boundary in 2012.
- The Voyager spacecraft are the third and fourth spacecraft to fly beyond all the planets in our solar system. Pioneers 10 and 11 preceded Voyager in going beyond the planets in the solar system.
- Voyager 2 is the only spacecraft to have visited all four gas giant planets — Jupiter, Saturn, Uranus, and Neptune.
- The two probes, Voyager 1 and Voyager 2 have left the heliosphere, but have not yet left the solar system as they are not out of the sun's gravitational field yet.

**Significance and Challenges:**

- Together, the two Voyagers provide a detailed information on how heliosphere interacts with the constant interstellar wind flowing from outer space. Their observations will be used to complement data from NASA's Interstellar Boundary Explorer (IBEX), a mission that is remotely sensing the solar system's boundary.
- The challenge for the spacecraft operations is to deal with the gradual loss of heat and power. Voyager 2 is currently operating in temperatures of just about 38.5 degrees Fahrenheit (3.6 degrees Celsius), and for each year that passes the spacecraft's power production drops 4 watts.

**About the Mission:**

- Launch: Voyager 2 was launched on August 20, 1977, and Voyager 1 was launched on September 5, 1977.
- The spacecraft were built to last five years and conduct close-up studies of Jupiter and Saturn.
- Voyager 2 is NASA's longest-running mission.

**Terminologies:**

- **Termination Shock:**
  - Blowing outward billions of kilometers from the Sun is the solar wind, a thin stream of electrically charged gas. This wind travels at an average speed ranging from 300 to 700 kilometers per second (700,000 - 1,500,000 miles per hour) until it reaches the termination shock. At this point, the speed of the solar wind drops abruptly as it comes in contact with the interstellar wind.

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- **Heliosphere:**
  - The solar wind, emanating from the Sun, creates a bubble that extends far past the orbits of the planets. This bubble is the heliosphere, shaped like a long windsock as it moves with the Sun through interstellar space.
- **Heliosheath:**
  - The heliosheath is the outer region of the heliosphere, just beyond the termination shock, the point where the solar wind slows abruptly, becoming denser and hotter. The solar wind piles up as it presses outward against the approaching wind in interstellar space.
- **Heliopause:**
  - The boundary between solar wind and the interstellar wind is the heliopause, where the pressure of the two winds are in balance. This balance in pressure causes the solar wind to turn back and flow down the tail of the heliosphere.
- **Bow shock:**
  - As the heliosphere plows through interstellar space, a bow shock forms, similar to what forms as a ship plowing through the ocean.
- **Oort Cloud:**
  - It is a collection of small objects that are still under the influence of the sun's gravity.
  - The boundary of the solar system is considered to be beyond the outer edge of the Oort cloud.
  - The width of the Oort cloud is not known precisely, but it is estimated to begin at about 1,000 astronomical units (AU) from the sun and to extend to about 100,000 AU (1 AU is the distance from the sun to Earth).
- **The Golden Record:**
  - The Golden Record is the 12-inch gold-plated copper disk, phonograph record onboard Voyager 1 and 2. It carries data containing sounds and images selected to portray the diversity of life and culture on Earth.
- **Deep Space Network:**
  - The Deep Space Network (DSN) supports NASA and non-NASA missions that explore the furthest points of our solar system. The DSN has three ground stations located approximately 120 degrees apart on Earth ( $120 + 120 + 120 = 360$ ). This is to ensure that any satellite in deep space is able to communicate with at least one station at all times.

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- **Location of DSN:**
  - Canberra, Australia
  - Madrid, Spain
  - Goldstone, California, US
- **Interstellar Mapping and Acceleration Probe**
  - It is NASA's additional mission due to launch in 2024 to follow on the Voyagers' observations.
- **Interstellar Boundary Explorer (IBEX)**
  - NASA's Interstellar Boundary Explorer (IBEX) mission objective is to discover the nature of the interactions between the solar wind and the interstellar medium at the edge of our solar system.
  - It was launched on Oct. 19, 2008.

### 13) ARTIFICIAL SUN

China successfully powered up its “artificial sun” nuclear fusion reactor for the first time recently, marking a great advance in the country's nuclear power research capabilities. The nuclear reactor is expected to provide clean energy.

#### **Key Points:**

- The HL-2M Tokamak reactor is China's largest and most advanced nuclear fusion experimental research device, and scientists hope that the device can potentially unlock a powerful clean energy source.
  - HL-2M Tokamak device is used in it to replicate the nuclear fusion process that occurs naturally in the sun.
- It uses a powerful magnetic field to fuse hot plasma and can reach temperatures of over 150 million degrees Celsius, approximately ten times hotter than the core of the sun.
- Located in Sichuan province, the reactor is often called an “artificial sun” on account of the enormous heat and power it produces.
- **Other Similar Experiment:**
  - International Thermonuclear Experimental Reactor
    - International Thermonuclear Experimental Reactor (ITER) is a collaboration of 35 nations launched in 1985.
    - It is located in France.
      - **Aim:**  
It aims to build the world's largest tokamak to prove the feasibility of fusion as a large-scale and carbon-free source of energy.

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- The tokamak is an experimental machine designed to harness the energy of fusion. Inside a tokamak, the energy produced through the fusion of atoms is absorbed as heat in the walls of the vessel. Like a conventional power plant, a fusion power plant uses this heat to produce steam and then electricity by way of turbines and generators.

#### 14) XENOBOTS

Scientists in the United States have created the world's first "living robots" named "xenobots".

- The tiny robots have been built from the cells of the African clawed frog. Scientists have repurposed living cells scraped from frog embryos and assembled them into entirely new life-forms.
- The robots have been named after the species of aquatic frog *Xenopus laevis*, found across sub-Saharan Africa from Nigeria and Sudan to South Africa.
- While humans have been manipulating organisms for their benefit since at least the dawn of agriculture, and genetic editing has created a few artificial organisms in recent years, the latest research is a breakthrough because it designs, for the first time ever, "completely biological machines from scratch".
- The xenobots can move toward a target, perhaps pick up a payload (like a medicine that needs to be carried to a specific place inside a patient) — and heal themselves after being cut.
- Many useful applications of these living robots include searching out nasty compounds or radioactive contamination, gathering microplastic in the oceans, travelling in arteries to scrape out plaque, etc.

#### Why *Xenopus Laevis*?

- *Xenopus* is a genus of African frogs that are commonly known as the African clawed frogs.
- Two species of *Xenopus* are regularly used by biologists, *Xenopus laevis* and *Xenopus tropicalis*. Both species are fully aquatic, and are easy to maintain in captivity.
- *Xenopus* is a valuable tool because they are:
  - Hardy, fully aquatic and easy to maintain in the laboratory,
  - Produce eggs year-round,
  - Eggs are a reliable and flexible material for research,
  - Embryos are a good model for vertebrate development,
  - Genetically similar to humans thus a good model for human disease

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#### 15) DHAWAN-1

Skyroot Aerospace successfully tested Dhawan-1 last month. It became the country's first privately developed fully cryogenic rocket engine.

- The indigenous engine was developed using 3D printing with a superalloy.
- It runs on two high-performance rocket propellants — liquid natural gas (LNG) and liquid oxygen (LoX).
- This was after successfully designing and developing the solid propulsion rocket engine, the first private firm in the country to do so.

#### Other projects by Skyroot

- Skyroot is working simultaneously on different stages of both solid propulsion and liquid propulsion engines.
- It is named after eminent scientists, like Kalam (Abdul Kalam) series for the former and Dhawan (Satish Dhawan).
- The launch vehicles are named after Vikram Sarabhai.

#### 16) ARTIFICIAL MOON

China has built an artificial moon research facility that is capable of lowering the gravity level using magnetism.

- The research facility is scheduled to officially launch later this year.
- This research facility is also said to be the first of its kind in the world.

#### Objective of the project:

The idea is to make gravity “disappear” by using powerful magnetic fields inside a 60cm vacuum chamber.

#### About the mini moon:

- The mini-moon is about two feet in diameter and the artificial surface has been made with rocks and dust.
- The facility is located in the eastern city of Xuzhou, in Jiangsu province.

#### Uses, applications and benefits of this facility:

- China plans to use this research facility to test out instruments and technology in a low-gravity environment similar to that of the moon, and see whether its experiments can be successful on the lunar surface.
- The research facility is also expected to help in determining the possibility of human settlement on the moon.



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**Magnetic levitation:**

1. The idea to develop artificial moon facility has its roots in the Russian-born physicist Andre Geim's experiments to levitate a frog with a magnet. The physicists later won a Nobel for this groundbreaking experiment.
2. Magnetic levitation is certainly not the same as antigravity, but there is a variety of situations where mimicking microgravity by magnetic fields could be invaluable to expect the unexpected in space research.

**The principle behind this:**

Atoms are made up of atomic nuclei and tiny electrons that orbit them in little loops of current; these moving currents, in turn, induce tiny magnetic fields.

- Usually, the randomly oriented magnetic fields of all the atoms in an object, whether they belong to a drop of water or a frog, cancel out, and no material-wide magnetism manifests.
- Apply an external magnetic field to those atoms, however, and everything changes: The electrons will modify their motion, producing their own magnetic field to oppose the applied field.
- If the external magnet is strong enough, the magnetic force of repulsion between it and the field of the atoms will grow powerful enough to overcome gravity and levitate the object — whether it's an advanced piece of lunar tech or a confused amphibian — into the air.

**17) VIKAS ENGINE**

- The Vikas engine (a portmanteau from initials of *VIKram Ambalal Sarabhai*) is a family of liquid fuelled rocket engines conceptualized and designed by the Liquid Propulsion Systems Centre in the 1970s.
- The design was based on the licensed version of the Viking engine with the chemical pressurization system.
- The early production Vikas engines used some imported French components which were later replaced by domestically produced equivalents.
- It is used in the Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous Satellite Launch Vehicle (GSLV) series of expendable launch vehicles for space launch use.
- Vikas engine is used to power the second stage of PSLV, boosters and second stage of GSLV Mark I and II and also the core stage of GSLV Mark III.
- The propellant loading for Vikas engine in PSLV, GSLV Mark I and II is 40 tons, while in GSLV Mark III is 55 tons.

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- Two new types of Vikas engines, HTVE (High Thrust VIKAS Engine) and HPVE (High Pressure or High Speed VIKAS Engine), are of particular interest.
- Its recent test was conducted at ISRO Propulsion Complex in Mahendragiri, Tamil Nadu.
- It was done to see how the engine performed in conditions that were not optimal, such as change in the fuel-oxidiser ratio or pressure in the fuel chamber.
- With regard to the Vikas engine qualification for the Gaganyaan mission, two engines have already undergone tests under nominal operating conditions for a total duration of 480 seconds.
- The first stage of the launch vehicle, which used solid propellant, is already qualified for the mission.
- Three more tests are set to be conducted for a cumulative duration of 75 seconds under varying operating conditions as the agency prepares for the first Indian astronaut mission.
- Another high thrust Vikas engine will undergo a long-duration test for 240 seconds to complete the Vikas engine qualification for Gaganyaan mission.

#### 18) LONG MARCH

Recently, China has successfully launched the Long March 5B' rocket and prototype spacecraft.

- It is being considered as China's successful step to operate a permanent space station and send astronauts to the Moon.
- India is also planning to launch its own space station.
  - A space station is a spacecraft capable of supporting crew members, designed to remain in space for an extended period of time and for other spacecraft to dock.
  - One fully functional space station in the Earth's lower orbit is the International Space Station and astronauts conduct different experiments in it.

#### Key Points:

- **Long March 5B' Rocket:**
  - It was launched from the Wenchang launch site in the southern island of Hainan.
  - It weighs 849 tonnes.
- **Unmanned Prototype Spaceship:**
  - It is expected to transport astronauts to a space station that China plans to complete by 2022 — and eventually to the Moon. It will have capacity for a crew of six.
- **Future Missions by China:**
  - The assembly of the Tiangong space station is expected to begin in 2020 and finish in 2022.

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- China plans to send an astronaut to the Moon in about a decade and then build a base there.
  - The United States is so far the only country to have successfully sent humans to the Moon.

#### 19) GAOFEN-3

1. A new Earth-observation satellite was successfully launched by China on Thursday, 7th April 2022, from the Jiuquan Satellite Launch Center in the north-western part of the country.
2. Long March-4C rocket launched Gaofen-3 03 at 7:47 a.m. (Beijing Time) and it went into orbit as planned.
3. Together with two satellites from the Gaofen-3 series that have already been launched, the three will work together to make a "sky eye" in space.
4. The three satellites are all on the same orbital plane, and they work together to be more efficient by going around the Earth every 99 minutes.
5. To assist China's maritime development, environmental resource monitoring, and disaster prevention and mitigation, the design will increase the number of times satellites view the Earth, improve their revisiting capabilities, and expand worldwide coverage.
6. The Gaofen-3 02 and 03 include an auto-identification system (AIS) and other improvements over the first satellite of its type, launched in 2016.
7. With the new satellite network, it only takes five hours for a satellite to return to the same location as the first satellite, which took 3.5 days.
8. Using three satellites, the same region may be imaged five times a day with high-resolution synthetic aperture radar pictures.
9. Tuesday, 12th April, it was reported that data has been successfully received from the freshly launched Gaofen-3 03 satellite, according to the Aerospace Information Research Institute under the Chinese Academy of Sciences.
10. There were 44 gigabytes of data sent to the remote sensing satellite ground station in Miyun on the borders of Beijing and the ground station in southern China, Sanya.
11. Together with Gaofen-3 and Gaofen-3 02 satellites, Gaofen-3 03 satellite will provide a land-sea radar network capable of capturing high-quality synthetic aperture radar (SAR) imagery.

#### 20) PARAM PORUL

PARAM PORUL, a state-of-the art Supercomputer at NIT Tiruchirappalli under National Supercomputing Mission (NSM) was inaugurated.

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- PARAM PORUL supercomputing facility is established under Phase 2 of the NSM. Majority of the components have been manufactured and assembled within the country, along with an indigenous software stack developed by C-DAC, in line with the Make in India initiative.

#### What are the Features of PARAM PORUL?

- PARAM PORUL system is equipped with a mix of CPU (Central Processing Unit) nodes, GPU (Graphics Processing Unit) nodes, High Memory nodes, High throughput storage and high-performance InfiniBand interconnect to cater the computing needs of various scientific and engineering applications.
- This system is based on Direct Contact Liquid Cooling technology to obtain a high-power usage effectiveness and thereby reducing the operational cost.
- Multiple applications from various scientific domains such as Weather and Climate, Bioinformatics, Computational Chemistry, Molecular Dynamics, Material Sciences, Computational Fluid Dynamics etc. have been installed on the system for the benefit of researchers.

#### What is the National Supercomputing Mission?

- In 2015, the National Supercomputing Mission was launched to enhance the research capacities and capabilities in the country by connecting them to form a Supercomputing grid, with National Knowledge Network (NKN) as the backbone.
  - The NKN project is aimed at establishing a strong and robust Indian network which will be capable of providing secure and reliable connectivity.
  - A supercomputer is a computer that performs at or near the currently highest operational rate for computers.
- The Mission plans to build and deploy 24 facilities with cumulative compute power of more than 64 Petaflops.
  - Generally, PETAFLUP is a measure of a Supercomputer's processing speed and can be expressed as a thousand trillion floating point operations per second.
- It supports the government's vision of 'Digital India' and 'Make in India' initiatives.
- The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY).
  - It is implemented by the Centre for Development of Advanced Computing (C-DAC), Pune, and the IISc, Bengaluru.
- The mission was planned in three phases:
  - Phase I looking at assembling supercomputers,
  - Phase II looking at manufacturing certain components within the country.
  - Phase III where a supercomputer is designed by India.

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- Recent developments under National Supercomputing Mission:
  - Under Phase 1 & Phase 2, 15 systems with computer power of 22 Petaflops (PF) have been built at IIT's, C-DAC, NIT, JNCASR, and IISER.
  - NSM deployed “PARAM Ganga” at IIT Roorkee in March 2022 with a supercomputing capacity of 1.66 Petaflops as a part of phase 2.
  - PARAM Siddhi-AI is the fastest supercomputer in India built under NSM with a capacity of 5.26 PF.
    - Japan's Fugaku is the world's fastest supercomputer.

## 21) QUANTUM TECHNOLOGY

In recent years, the global quantum industry has taken incredible strides and seen massive investments made by both governments and the private sector.

Countries like the US, France, Germany, China and Russia have already been investing resources and human capital on Quantum Technology since the last decade, however, India may have to work overtime to bridge the gap in its bid to gain supremacy in this field.

While much progressive is not what India has done in the field of quantum tech yet, it is better late than never. India's willingness to be at par with other technologically advanced countries can be seen via the announcement of the National Mission for Quantum Technologies and Applications (NM-QTA).

### Quantum Technology:

- **About:** Quantum Technology is based on the principles of Quantum mechanics that was developed in the early 20<sup>th</sup> century to describe nature at the scale of atoms and elementary particles.
  - The first phase of this revolutionary technology has provided the foundations of understanding of the physical world and led to ubiquitous inventions such as lasers and semiconductor transistors.
  - The second revolution is currently underway with the goal of putting properties of quantum mechanics in the realms of computing.
- **A Comparison between India and China:**
  - **R&D in China:** China started its research and development (R&D) in the field of quantum technology in 2008.
    - In 2022, China boasts of developing the world's first quantum satellite, creating a quantum communication line between Beijing and Shanghai, and owning two of the world's fastest quantum computers.
    - This was a result of decade-long research carried out in the hope of achieving critical breakthroughs.

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- **India:** Quantum Technology remains a field highly concentrated in long-term R&D in India.
  - Just a few hundred researchers, industry professionals, academicians, and entrepreneurs are in the field right now without a constant focus on R&D.
- **Quantum Tech and Private Sector:** Large Technology Corporations such as Google, Microsoft, and IBM have dedicated programmes for quantum computing and its applications.
  - Similarly, several Indian startups such as QNu Labs, BosonQ, and Qulabs.ai are also doing remarkable work in developing quantum-based applications for cryptography, computing, and cybersecurity.
- **India's Related Initiatives:**
  - In 2018, the Department of Science & Technology unveiled a programme called Quantum-Enabled Science & Technology (QuEST) and committed to investing Rs. 80 crore over the next three years to accelerate research.
  - In the 2020 Budget speech, the Finance Minister of India announced the National Mission for Quantum Technologies and Applications (NM-QTA) with a total outlay of ₹8000 crore over five years for strengthening the quantum industry in the country.
  - In October 2021, the government also inaugurated C-DOT's Quantum Communication Lab and unveiled the indigenously developed Quantum Key Distribution (QKD) solution.

#### Challenges Associated:

- **Slow Progress in Legislative Procedures:** Although the NM-QTA was announced in the 2020 Budget speech, the mission has still not received any approval and no funds were allocated, disbursed or utilised under NM-QTA during the FY 2020-21.
- **Limited Private Sector Involvement in NM-QTA:** The Union Minister of Science & Technology has also claimed that for the NM-QTA, no private sector partners had been identified yet and no one from outside the government had been tapped for consultations for the national mission.
  - The government must recognise the leaps made by these companies.
- **Security Related Issues:** Quantum computing can have a disruptive effect on cryptographic encryption, which secures communications and computers.
  - It might pose a challenge for the government also because if this technology goes into the wrong hands, all the government's official and confidential data will be at risk of being hacked and misused.

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- **Technological Issues:** The challenge lies in harnessing the properties of quantum superposition in a highly controlled manner. The qubits tend to be very fragile and lose their “quantumness” if not controlled properly.
  - Also, a careful choice of materials, design and engineering is required to get them to work.
  - On the theoretical front lies the challenge of creating the algorithms and applications for quantum computers.

**Way Forward:**

- **Better Policy Making and Regulations:** The focus should be to develop an overarching strategy for the next 10-15 years. The strategy must ensure that there is no misallocation of resources and that the efforts put in are concentrated in key areas that provide both economic and strategic benefits.
  - Additionally, adequate attention to those who can contribute to developing quantum technology must be the government’s top priority.
  - It would also be prudent to develop a regulatory framework for quantum computing before it becomes widely available, defining the limits of its legitimate use, nationally and internationally.
- **Establishing Centres of Excellence:** The primary focus must be on establishing centres of excellence dedicated to quantum science and technology within academic institutions as well as government research institutes.
  - A majority of the Indian government’s outlay has to be pumped into such institutions specialising in quantum R&D. This can pay dividends in two ways:
    - It will help create crucial intellectual property (IP) infrastructure that can be used for the country’s benefit.
    - The focus on research and academia will also improve the talent pool and strengthen the domestic quantum technology workforce.
- **Centre-State Coordination:** The state governments can play an integral role in setting up semiconductor fabs in the near future, quantum tech can benefit immensely from these domestic manufacturing facilities and units.
  - The joint establishment of “quantum innovation hubs” by Centre and states can help direct investments efficiently and build a well-connected quantum research network in the country.
  - The central and state governments should establish a conducive fiscal and legal environment to foster innovation and attract international firms while involving local talent.

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- **Private Sector Involvement:** The power of startups and Big Tech corporations involved in developing quantum technology and applications must be harnessed.
  - While academic institutions are largely involved on the research side, quantum tech corporations and startups are vital in converting and commercialising this research into applications or products that can be of use.
  - Facilitations must be made by the government to connect academic institutions and industry to translate research into real-world applications.
- **International Cooperation:** The quantum value chain remains highly complicated and it will be hard for India to remain self-reliant to build a successful quantum ecosystem.
  - Quantum technology agreements with the US, Australia, Canada, UK and others should serve as a base for India to pursue a joint effort on projects related to quantum technologies.
    - India can also pursue engagement with its allies in key groupings such as Quad and BRICS.

## 22) W BOSON

Recently, researchers from Collider Detector at Fermilab (CDF) Collaboration, in the US, announced that they have made a precise measurement of the mass of the W boson.

- It has been stated that this precisely determined value did not match with the estimates from the standard model of particle physics.

### What is W Boson?

- The W boson was first seen in 1983 at CERN, located on the Franco-Swiss border.
  - In contrast to the photon, which is massless, the W bosons are quite massive, so the weak force they mediate is very short ranged.
  - European Organisation for Nuclear Research (CERN) is the world's largest nuclear and particle physics laboratory and best known as operator of the Large Hadron Collider, which found the elusive Higgs boson in 2012.
- Unlike the photon, which is electrically neutral, the W-plus and W-minus are both massive and charged.
- By exchanging such W bosons, a neutron can change into a proton, for example:
  - This is what happens in beta decay, a radioactive interaction that takes place in the sun.
- Thus, the W boson facilitates the interactions that make the sun burn and produce energy.



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**What is the Standard Model of Elementary Particle Physics?**

- The standard model of elementary particles is a theoretical construct in physics that describes particles of matter and their interaction.
- It describes the elementary particles of the world as being connected by mathematical symmetry, just as two objects are connected by bilateral (left-right) symmetry.
- These are mathematical groups generated by continuous transformations from, say, one particle to another.
- According to this model there are a finite number of fundamental particles which are represented by the characteristic “eigen” states of these groups.
- The particles predicted by the model, such as the Z boson, have been seen in experiments.
  - The last to be discovered, in 2012, was the Higgs boson which gives mass to the heavy particles.

**Why is the Standard Model believed to be Incomplete?**

- Because it gives a unified picture of only three of the four fundamental forces of nature — electromagnetic, weak nuclear, strong nuclear and gravitational interactions — it totally omits gravity.
  - So, in the grand plan of unifying all forces so that a single equation would describe all the interactions of matter, the standard model was found to be lacking.
- Also, it does not include a description of dark matter particles.
  - So far these have been detected only through their gravitational pull on surrounding matter.

**How are the Symmetries related to Particles?**

- The symmetries of the standard model are known as gauge symmetries, as they are generated by “gauge transformations”.
  - Gauge transformations are a set of continuous transformations (like rotation is a continuous transformation). Each symmetry is associated with a gauge boson.
  - For example, the gauge boson associated with electromagnetic interactions is the photon. The gauge bosons associated with weak interactions are the W and Z bosons. There are two W bosons —  $W^+$  and  $W^-$ .

**23) HS200 BOOSTER**

Recently, the **Indian Space Research Organization (ISRO)** has completed the static test of the human-rated solid rocket booster (HS200) for Gaganyaan programme.

What is the HS200 Solid Rocket Booster?

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- The booster engine is part of the Geosynchronous Satellite Launch Vehicle MkIII (GSLV Mk III) rocket that will carry Indian astronauts to space.
  - The GSLV Mk-III rocket which will be used for the Gaganyaan mission will have two HS200 boosters which will supply the thrust for lift-off.
  - The HS200 is a 20-metre-long booster with a diameter of 3.2 metres and is the world's second largest operational booster using solid propellants.
- The HS200 is the human-rated version of the S200 rocket booster of satellite launch vehicle **GSLV Mk III**, popularly known as LVM3.
  - Since Gaganyaan is a crewed mission, the GSLV Mk-III will have improvements to increase reliability and safety to meet the requirements of 'human rating.'
- The S200 motor - the first stage of the LVM3 launch vehicle designed to deliver 4,000 kg satellites to geosynchronous transfer orbit - was configured as a strap-on rocket booster.
- This full-duration test of the first stage of the launch vehicle marks a major milestone for the Gaganyaan programme.
- Design and development of the HS200 booster was completed at the Vikram Sarabhai Space Centre (VSSC) in Kerala's Thiruvananthapuram, and propellant casting was completed at Sriharikota.
- Out of the three propulsion stages of LVM3, the human-rated versions of the second-stage known as L110-G loaded with liquid propellant and the third stage C25-G with cryogenic propellant are in the final phase of qualification, including tests with static firing.

#### What is Gaganyaan Mission?

- **About:**
  - Gaganyaan is a mission by the Indian Space Research Organisation (ISRO).
  - Under the Gaganyaan schedule (to be launched in 2023):
    - Three flights will be sent into orbit.
    - There will be two unmanned flights and one human spaceflight.
  - The Gaganyaan system module, called the Orbital Module will have three Indian astronauts, including a woman.
  - It will circle Earth at a low-earth-orbit at an altitude of 300-400 km from earth for 5-7 days.
- **Payloads:**
  - The payload will consist of:
    - Crew module - spacecraft carrying human beings.
    - Service module - powered by two liquid propellant engines.
    - It will be equipped with emergency escape and emergency mission abort.

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- **Launch:**
  - GSLV Mk III, also called the LVM-3 (Launch Vehicle Mark-3,) the three-stage heavy lift launch vehicle, will be used to launch Gaganyaan as it has the necessary payload capability.
- **Training in Russia:**
  - In June 2019, the Human Space Flight Centre of the ISRO and the Russian government-owned Glavkosmos signed a contract for the training, which includes Russian support in the selection of candidates, their medical examination, and space training.
    - The candidates will study in detail the systems of the Soyuz manned spaceship, as well as be trained in short-term weightlessness mode aboard the Il-76MDK aircraft.
    - The Soyuz is a Russian spacecraft. The Soyuz carries people and supplies to and from the space station.
    - The Il-76MDK is a military transport plane specially designed for parabolic flights of trainee astronauts and space tourists.
- **Significance:**
  - It will help in enhancement of science and technology levels in the country and help inspire youth.
    - Gaganyaan will involve numerous agencies, laboratories, disciplines, industries and departments.
  - It will help in the improvement of industrial growth.
    - Recently, the Government has announced a new organisation, IN-SPACe, part of reforms to increase private participation in the space sector.
  - It will help in the development of technology for social benefits.
  - It will help in improving international collaboration.
    - One International Space Station (ISS) put up by multiple countries may not be enough. Regional ecosystems will be needed and Gaganyaan will focus on regional needs: food, water and energy security.
- **India's Other Upcoming Projects:**
  - Chandrayaan-3 Mission: India has planned a new moon mission named Chandrayaan-3. It is likely to be launched in 2022.
  - Shukrayaan Mission: The ISRO is also planning a mission to Venus, tentatively called Shukrayaan.

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**24) GSAT-24**

- GSAT-24 satellite was launched on Ariane 5 space launch vehicle, by French company Arianespace.
- It was launched from Kourou in French Guiana, in South America.
- GSAT-24 is a 24-Ku band communication satellite. It weighs 4180 kg. The satellite will provide coverage to pan-India, to meet DTH application needs.

**Why was GSAT-24 launched on a French rocket?**

The GSAT-24 satellite was launched on French rocket Ariane 5, because currently India does not have space-launch rocket which can lift a satellite weighing over 4 tons into geostationary orbit. India's most powerful rocket GSLV MK3 is capable of lifting a maximum of 4 tons into geostationary orbit. It is not enough to lift a satellite over 4 ton like GSAT-24.

**Why are communication satellites placed in geostationary orbit?**

Communications satellites are placed in a geostationary orbit, so that satellite antennas based on Earth, do not have to rotate to track them. They can be pointed permanently at a position in sky where the satellites are located.

**What is GSAT-24?**

GSAT-24 is a 24-Ku band communication satellite, launched to provide Pan India coverage to meet DTH application needs. It is a 4180 kg satellite. Entire satellite capacity has been leased by NSIL to M/s Tata Play. It is the first demand driven satellite, that has been configured by ISRP. It is owned, funded and operated by NSIL, for commercial user. It has been configured with the objective of augmenting satellite based VSAT and DTH services in BSS Ku-band.

**Uses of the GSAT-24 satellite**

- The satellite has enhanced EIRP, which provides more HD channels, more DTH channels within same spectrum, or more system robustness with additional rain fade margin.
- It will provide a satellite based interactive educational services to classes employing DTH quality broadcast.
- It will be helpful in telecommunications and emerging applications such as high speed backhaul links, digital cinema, bulk-data transfer etc.

**NewSpace India Limited (NSIL)**

NSIL is a Public Sector Undertaking (PSU) and commercial arm of Indian Space Research Organisation (ISRO). It was established on March 6, 2019. It works under the administrative control of Department of Space (DoS). The organisation seeks to increase the participation of industries in Indian space programmes.

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**25) ALH Mk III**

Recently, Indian Naval Air Squadron (INAS) 323, the first unit of the indigenously built ALH (Advanced Light Helicopter) Dhruv Mk III aircraft, was commissioned into the Indian Navy.

▪ **About:**

- The indigenously designed and developed Advanced Light Helicopter (ALH-DHRUV) is a twin engine, multi-role, multi-mission new generation helicopter in the 5.5 ton weight class.
- It is a multi-role chopper with the Shakti engine manufactured by Hindustan Aeronautics Limited (HAL).
  - HAL is an Indian state-owned aerospace and defence company, headquartered in Bangalore, India. It is governed under the management of the Ministry of Defence.
  - HAL conceptualised the Advanced Light Helicopter programme in 1984. The major variants of Dhruv are classified as Dhruv Mk-I, Mk-II, Mk-III & Mk-IV.

▪ **Features:**

- The aircraft, a step up from Mk 1, will be able to mitigate low visibility during search and rescue operations even at night.
- It has a 0.7 mm gun, which will give a huge capability from a LIMO (low intensity maritime operations) standpoint.
- The automatic flight control system is hugely superior to the previous one.

▪ **Role:**

- The Mk III version of the ALH has an all glass cockpit and will be used for search and rescue, special operations and coastal surveillance.

**26) SPACE SOLAR POWER PLANT**

The radiation that is received from the sun and utilized in the form electricity and thermal energy by using various available technologie like photovoltaic panels, solar heater etc.

**Background:**

- India lying in tropical belt has an advantage of receiving peak solar radiation for 300 days, amounting 2300-3,000 hours of sunshine equivalent to above 5,000 trillion kWh.
- India's current installed solar power capacity, according to Central electricity authority, is 26025.97 MW which is 34% of total renewable energy sources i.e, 75055.92 MW till February 2019.
- India facing problems in fulfilling its energy demand, solar energy can play an important role in providing energy security.

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- Debate of global warming and climate change is compelling the world to move from fossil based energy towards clean and green energy.
- With its pollution free nature, virtually inexhaustible supply and global distribution, solar energy is very attractive energy resource.
- India's Intended Nationally Determined Contributions (INDC's) commitment include 100 GW of solar power out of 175 GW renewable energy by 2022.

**Need of solar energy:**

- **Energy security:**
  - India energy demands is largely fulfilled by non-renewable source of energy.
  - The scarcity of these fossil resources stresses the need for renewable energy sources.
  - Abundance of solar energy can fulfill India clean energy demands.
  - India is dependent on imports to fulfill its energy demands, thereby incurring huge expenditure and uncertainty with regards to energy security.
- **Economic development:**
  - India being a developing economy needs proper electricity for industrial growth and agriculture.
  - India also needs self sufficiency and minimal cost in power generation, assured regular supply, which will boost industries and economy.
- **Social development:**
  - The problem of power cuts and unavailability of electricity especially in rural area, leads to improper human development.
  - Mostly energy demands are fulfilled by subsidised kerosene, leading to loss for exchequer.
- **Environment concern:**
  - India's large part of energy demand is fulfilled by thermal energy largely dependent on fossil fuels.
  - It also causes environment pollution
  - Solar energy is clean form of energy resource, which can be a substitute.

**Technology:**

- **Solar Photovoltaic:** Solar photovoltaic (SPV) cells convert solar radiation (sunlight) into electricity. A solar cell is a semi-conducting device made of silicon and/or other materials, which, when exposed to sunlight, generates electricity.
- **Solar thermal:** Solar Thermal Power systems, also known as Concentrating Solar Power systems, use concentrated solar radiation as a high temperature energy source to produce electricity using thermal route.

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**Types:**

- **Solar for grid connected electricity:**
  - Grid interactive solar energy is derived from solar photovoltaic cells and concentrated solar power Plants on a large scale.
- **Solar for off-grid solutions:**
  - While, the areas with easier grid access are utilizing grid connectivity, the places where utility power is scant or too expensive to bring, have no choice but to opt for their own generation.
  - They generate power from a diverse range of small local generators using both fossil fuels (diesel, gas) and locally available renewable energy technologies (solar PV, wind, small hydro, biomass, etc.) with or without its own storage (batteries). This is known as off-grid electricity.

**Advantages:**

- Solar Energy is available throughout the day which is the peak load demand time.
- Solar energy conversion equipments have longer life and need lesser maintenance and hence provide higher energy infrastructure security.
- Low running costs & grid tie-up capital returns (Net Metering).
- Unlike conventional thermal power generation from coal, they do not cause pollution and generate clean power.
- Abundance of free solar energy in almost all parts of country.
- No overhead wires- no transmission loss

**Challenges in adoption:**

- India's solar story is largely built over imported products.
- India's domestic content requirement clause is facing legal challenge at WTO.
- India is facing challenge to balance Prioritising domestic goals and WTO commitments.
- The dumping of products is leading to profit erosion of local manufacturers.
- Indian domestic manufacturers aren't technically and economically strong to compete with Chinese companies.
- China's strong manufacturing base is giving stiff challenge to domestic manufacturer.
- Land availability in India for solar plant is less due to high population density.
- India's solar waste is estimated to be around 1.8 million by 2050 also needs to be tackled.

**Government initiatives:**

- Ministry of new and renewable energy is the nodal agency to tackle India's renewable energy issues.

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- National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge.
- The Indian Renewable Energy Development Agency (IREDA) is a Non-Banking Financial Institution under the administrative control of this Ministry for providing term loans for renewable energy and energy efficiency projects.
- National institute of solar energy is created as autonomous institution under MoNRE is apex body for R&D.
- Establishment of solar parks and ultra major solar power project and enhancing grid connectivity infrastructure.
- Promotion of canal bank and canal tank solar infrastructure.
- Sustainable rooftop implementation of Solar Transfiguration of India (SRISTI) scheme to promote rooftop solar power projects in India.
- Suryamitra programme to prepare qualified workforce.
- Renewable purchase obligation for large energy consumer customers.
- National green energy programme and green energy corridor.

#### **Potential:**

For a developing country like India, where electricity for every home was once considered a dream is now close to reality. The government initiative of 'power for all' is changing the socio-economic structure of the country.

- The sector also has immense potential to create new jobs; 1 GW of Solar manufacturing facility generates approximately 4000 direct and indirect jobs.
- In addition solar deployment, operation and maintenance creates additional recurring jobs in the sector.
- Advancements are underway for storage, which has the potential to revolutionise this sector globally, till then dependence on fossils can be reduced by gradually increasing the share of renewables.
- India is expected to be 8% of global solar capacity by 2035. With the future potential capacity of 363 Gigawatts (GW), India can be a global leader in term of encashing energy sector advantages.

#### **International initiatives:**

- India's commitment as part of INDC at Paris climate deal to reduce the emissions intensity of its GDP by 33 to 35% by 2030 from 2005 level.
- To achieve about 40 per cent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030, with the help of transfer of technology and low cost international finance, including from Green Climate Fund.



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- The establishment of International Solar Alliance (ISA) of more than 122 countries initiated by India, most of them being sunshine countries, which lie either completely or partly between the Tropic of Cancer and the Tropic of Capricorn to promote solar energy.
- To mobilize more than US \$ 1000 billion of investments needed by 2030 for massive deployment of solar energy, and pave the way for future technologies adapted to the needs.

#### 27) DAVINCI MACHINE

Recently, Insurance Regulatory and Development Authority of India (IRDAI) has standardised health policies across all health insurers to even cover robotic and bariatric surgeries.

- Bariatric surgery is an operation that helps lose weight by making changes to the digestive system.
- Recently, India became the first country to perform a telerobotic coronary surgery on humans.

#### Key Points:

- **Robotics:** It is the intersection of science, engineering and technology that produces machines, called robots, to substitute for (or replicate) human actions.
  - **Application of Robotics:**
    - **Industrial Sector:** Industrial robots are electronically controlled, both programmable and reprogrammable to carry out certain tasks with high precision and accuracy.
    - **Aerospace:** Another application of robots is in aerospace for outer space exploration. Aerospace robots or unmanned robotic spacecraft play a key role in outer space probes.
    - **Outer Space:** Robotic arms that are under the control of a human being are employed to unload the docking cove of outer-space shuttles to launch satellites or to build a space station.
    - **Exploration:** Robots can enter the environments that are injurious to human beings. An illustration is observing the atmosphere within a volcano or investigating our deep marine life.
    - **Healthcare Delivery:** A highly possible advancement in healthcare is using robots in Robotic Surgery. Due to technological advancement, this is possible even if the patient is located in remote areas. This possibility defies distance.

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- **Robotic Surgery:**
  - Robotic or Robot-assisted surgery integrates advanced computer technology with the experience of the skilled surgeons. This technology provides the surgeon with a 10x magnified, high-definition, 3D-image of the body's intricate anatomy.
  - The surgeon uses controls in the console to manipulate special surgical instruments that are smaller, as well as more flexible and manoeuvrable than the human hand. The robot replicates the surgeon's hand movements, while minimizing hand tremors.
- **Benefits of Robotic Surgery:**
  - **Easy Procedures:** Makes the performance of complicated procedures much easier.
  - **Increases Flexibility, Precision and Control:** It allows doctors to perform different types of complex procedures with more precision, flexibility, and control than possible with conventional techniques.
  - **Reduces Trauma:** It reduces the trauma caused to the patient by allowing surgery to be performed through small ports or 'keyholes' rather than via large incisions.
  - **Simplifies Surgeries:** The instruments can access hard-to-reach areas of a patient's body more easily through smaller incisions compared with traditional open and laparoscopic surgeries.
  - **Reduces Recovery Time:** It helps in shorter recovery times, with fewer complications and a shorter hospital stay.
  - **Other Advantages:** Less pain and blood loss, and smaller, less noticeable scars.
- **Reasons for High Demand of Robotic Surgery:** Factors which are pushing the demand of robotic surgery are:
  - Advancements in technology.
  - Rising incidence of chronic diseases.
  - High incidence of medical errors.
  - Demand for faster recovery and reduction in pain.
  - Increase in awareness about the benefits of robot-assisted surgery.
- **Reasons for Slow Growth of the Sector:**
  - High cost of installation: Instruments are not only expensive but also incur a large recurring cost due to the disposable nature of instruments and ancillaries.
  - Monopoly: There exist only a few companies that manufacture the equipment for robotics surgery. The monopoly of few companies makes it difficult to expand robotics surgery in the Indian healthcare system.

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- Untrained Resource: Another challenge is the unavailability of trained surgeons for conducting robotic surgeries.
- **Robotic Surgery in India:**
  - Quality: India is the most preferred destination for getting high-quality treatment across the globe, and is dotted with various multi-speciality hospitals and patient-care centres.
  - Infrastructure: The hospitals are well equipped with advanced, highly sophisticated and world-class infrastructure facilities using state-of-the-art technologies for the treatment of various critical illnesses.
  - Cost: India is very affordable unlike in the U.S., U.K., and Canada. Overall, the cost of such procedures in India is pocket-friendly, that too, without compromising on the quality of services and infrastructure.

#### Way Forward:

- Government should establish fellowship programmes and offer structured training to surgical teams. With the increase in the number of robotic surgeries, there will be an acute need for training of doctors for carrying out such surgical processes. In India, training and certifying of surgeons remains a challenge.
- It should also promote collaboration between hospitals and insurance companies to come up with innovative ways to tackle the high cost of robotic surgeries.

#### 28) Cryptojacking

Cryptojacking attacks on computer systems have gone up by 30% to 66.7 million in the first half of 2022 compared to the first half of last year, according to a report by SonicWall, a US-based cybersecurity firm.

- While volume increases were widespread, some business sectors were hit harder than others, such as the finance industry, which saw a rise of 269%

#### What is cryptojacking?

- Cryptojacking is a cyber attack wherein a computing device is hijacked and controlled by the attacker, and its resources are used to illicitly mine cryptocurrency.
- In most cases, the malicious programme is installed when the user clicks on an unsafe link, or visits an infected website — and unknowingly provides access to their Internet-connected device.

#### Why is cryptojacking done?

- Coin mining is a legitimate, competitive process used to release new crypto coins into circulation or to verify new transactions.

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- It involves solving complex computational problems to generate blocks of verified transactions that get added to the blockchain.
- The reward for the first miner who successfully manages to update the crypto ledger through this route is crypto coins.
- But the race to crack this 64-digit hexadecimal number code needs considerable computing power involving state-of-the-art hardware, and electrical power to keep the systems involved up and running.
- Cryptojackers co-opt devices, servers, and cloud infrastructure, and use their resources for mining. The use of stolen or cryptojacked resources slashes the cost involved in mining.

#### **Why have cryptojacking incidents gone up?**

- According to the SonicWall's Cyber Threat Report, the crackdown on ransomware attacks is forcing cybercriminals to look for alternative methods.
- Cryptojacking involves lower risk, and promises potentially higher payday.
- Cryptojacking is an appealing alternative for cybercriminal gangs as it has a lower potential of being detected by the victim; unsuspecting users across the world see their devices get unaccountably slower, but it's hard to tie it to criminal activity, much less point to the source.
- Unlike ransomware, which announces its presence and relies heavily on communication with victims, cryptojacking can succeed without the victim ever being aware of it.

#### **Why should this be a concern?**

- Cryptojacking is hard to detect and the victims of these attacks mostly remain unaware that their systems have been compromised.
- Some telltale signs are the device slowing down, heating up, or the battery getting drained faster than usual.
- Apart from individuals, businesses too are on the target list of cryptojackers.
- The primary impact of cryptojacking is performance-related, though it can also increase costs for the individuals and businesses affected because coin mining uses high levels of electricity and computing power.

#### **29) Vyom Mitra:**

Recently, Indian Space Research Organisation (ISRO) unveiled its first 'woman' astronaut, named Vyom Mitra who will ride to space in the first test flight of the human space mission, Gaganyaan.

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**Key Points:**

- She is half-humanoid and her body stops at the torso and has no legs. She is capable of switching panel operations, performing Environment Control and Life Support Systems (ECLSS) functions, conversations with the astronauts, recognising them and solving their queries.
  - The humanoid can detect and give out warnings if the environment changes within the cabin.
- She will simulate the human functions required for space before real astronauts take off before August 2022. She will be sent in a space capsule around the end of 2020 or early 2021 to study how astronauts respond to living outside earth in controlled zero-gravity conditions.
- The humanoid has been developed by the ISRO Inertial Systems Unit, Thiruvananthapuram.

**30) PARAM PRAVEKA:**

Recently, the Indian Institute of Science (IISc) Bengaluru installed the supercomputer 'Param Pravega'. It has a supercomputing capacity of 3.3 petaflops.

- It has been installed under the government's National Supercomputing Mission.
- The National Supercomputing Mission is intended to indigenise the development and manufacturing of powerful computers.

**What is a Supercomputer?**

- A supercomputer is a computer that performs at or near the currently highest operational rate for computers.
- Generally, PETAFLOP is a measure of a Supercomputer's processing speed and can be expressed as a thousand trillion floating point operations per second.
  - FLOPS (floating point operations per second) are typically used to measure the performance of a computer's processor.
  - Using floating-point encoding, extremely long numbers can be handled relatively easily.
- Supercomputers are primarily designed to be used in enterprises and organizations that require massive computing power.
  - For example: weather forecasting, scientific research, intelligence gathering and analysis, data mining etc.
- Globally, China has the maximum number of supercomputers and maintains the top position in the world, followed by the US, Japan, France, Germany, Netherlands, Ireland and the United Kingdom.
- India's first supercomputer was PARAM 8000.

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- PARAM Shivay, the first supercomputer assembled indigenously, was installed in IIT (BHU), followed by PARAM Shakti, PARAM Brahma, PARAM Yukti, PARAM Sanganak at IIT-Kharagpur, IISER, Pune, JNCASR, Bengaluru and IIT Kanpur respectively.
- In 2020, PARAM Siddhi, the High-Performance Computing-Artificial Intelligence (HPC-AI) supercomputer, achieved global ranking of 62<sup>nd</sup> in Top 500 most powerful supercomputer systems in the world.

#### What is the National Supercomputing Mission?

- In 2015, the National Supercomputing Mission was launched to enhance the research capacities and capabilities in the country by connecting them to form a Supercomputing grid, with National Knowledge Network (NKN) as the backbone.
  - The NKN project is aimed at establishing a strong and robust Indian network which will be capable of providing secure and reliable connectivity.
- It supports the government's vision of 'Digital India' and 'Make in India' initiatives.
- The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY).
  - It is implemented by the Centre for Development of Advanced Computing (C-DAC), Pune, and the IISc, Bengaluru.
- The mission was planned in three phases:
  - Phase I looking at assembling supercomputers,
  - Phase II looking at manufacturing certain components within the country.
  - Phase III where a supercomputer is designed by India.
- An indigenously developed server platform called 'Rudra' is being tried out in a pilot system, with an interconnect for inter node communication called Trinetra also having been developed.

#### 31) PARAM GANGA

The National Supercomputing Mission (NSM) has deployed PARAM Ganga-a High-Performance Computational (HPC) facility at IIT Roorkee, with a supercomputing capacity of 1.66 Petaflops.

- Earlier, the Indian Institute of Science (IISc) Bengaluru installed the supercomputer 'Param Pravega'.

#### What are the Key Points?

- It has been established by the Centre for Development of Advanced Computing (C-DAC) under the approach of NSM.

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- The basic idea behind building a Petascale Supercomputer with manufactured in India components is to lead the path towards Aatmanirbhar Bharat and accelerate the problem-solving capacity in multidisciplinary domains simultaneously.
  - It will aid researchers to solve complex problems of national importance and global significance.
- It will serve as an essential computer environment for the modern-day research along with their theoretical and experimental work.
- The focus is to provide computational power to the user community of IIT Roorkee and neighbouring academic institutions.

#### What is a Supercomputer?

- A supercomputer is a computer that performs at or near the currently highest operational rate for computers.
- Generally, PETA FLOP is a measure of a Supercomputer's processing speed and can be expressed as a thousand trillion floating point operations per second.
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  - The NKN project is aimed at establishing a strong and robust Indian network which will be capable of providing secure and reliable connectivity.
- The Mission plans to build and deploy 24 facilities with cumulative compute power of more than 64 Petaflops.
  - Till now C-DAC has deployed 11 systems at IISc, IITs, IISER Pune, JNCASR, NABI-Mohali and C-DAC under NSM Phase-1 and Phase-2 with a cumulative compute power of more than 20 Petaflops.
- It supports the government's vision of 'Digital India' and 'Make in India' initiatives.
- The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY).
  - It is implemented by the Center for Development of Advanced Computing (C-DAC), Pune, and the IISc, Bengaluru.
- The mission was planned in three phases:
  - Phase I looking at assembling supercomputers,
  - Phase II looking at manufacturing certain components within the country.
  - Phase III where a supercomputer is designed by India.
- An indigenously developed server platform called 'Rudra' is being tried out in a pilot system, with an interconnect for inter node communication called Trinetra also having been developed.

### 32) VIGYAN

Recently, the Science and Engineering Research Board (SERB), has invited applications under 'ABHYAAS', a program of 'Accelerate Vigyan' scheme, for summer season.

- SERB is an autonomous body of the Department of Science & Technology (DST), Union Ministry of Science & Technology.

#### **What is the Accelerate Vigyan Scheme?**

- "Accelerate Vigyan" (AV) strives to provide a big push to high-end scientific research and prepare a scientific workforce, which can venture into research careers and a knowledge-based economy.
- AV aims to expand the research base in the country, with three broad goals — consolidation / aggregation of all scientific training programs, initiating high-end orientation workshops and creating opportunities for training and skill internships.



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**What are the Components of the Accelerate Vigyan Scheme?**

- **ABHYAAS:**
  - It is a program of AV scheme, is an attempt to boost research and development in the country by enabling and grooming potential postgraduate / PhD students by developing dedicated research skills in selected areas / disciplines / fields through its two components — high-end workshops (“KAARYASHALA”) and Training and Skill Internship (“VRITIKA”).
    - This is especially important for researchers with limited opportunities to access such learning capacities / facilities / infrastructure.
- **SAMMOHAN:** It has been sub-divided into SAYONJIKA and SANGOSHTI.
  - SAYONJIKA is an open-ended program to catalogue capacity building activities in science and technology supported by all government funding agencies in the country.
  - SANGOSHTI is a pre-existing program of SERB for the organisation of workshops.

**How are such Steps Helpful?**

- **Capacity Building:** The database of skilled manpower developed across different disciplines through all the sub-components of the AV would help in capacity building.
- **Social Responsibility:** The scheme also seeks to garner the social responsibility of the scientific community in the country.

**33) MATSYA 6000**

Recently, the Ministry of Earth Sciences (MoES) has launched India’s first manned ocean mission “Samudrayaan” in Chennai.

- With this Unique Ocean Mission, India joined the elite club of nations such as the US, Russia, France, Japan, and China to have niche technology and vehicles to carry out subsea activities.

**Key Points:**

- **About:**
  - It is India’s first unique manned ocean mission that aims to send men into the deep sea in a submersible vehicle for deep-ocean exploration and mining of rare minerals.
  - It will send three persons in a manned submersible vehicle MATSYA 6000 to a depth of 6000 metres into the sea for deep underwater studies.
    - Submarines go only about 200 metres.

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- It is a part of the Rs 6000-crores Deep Ocean Mission.

**Deep Ocean Mission:**

- It was approved in June 2021 by the (MoES). It aims to explore the deep ocean for resources, develop deep-sea technologies for sustainable use of ocean resources, and support the Blue Economy Initiatives of the Indian Government.
- The cost of the Mission has been estimated at Rs. 4,077 crore over a five-year period and will be implemented in phases.

▪ **MATSYA 6000:**

- It is an indigenously developed manned submersible vehicle.
- It will facilitate the MoES in conducting deep ocean exploration of resources such as gas hydrates, polymetallic manganese nodules, hydro-thermal sulfides, and cobalt crusts which are located at an approximate depth between 1000 and 5500 metres.
  - Polymetallic nodules, also called manganese nodules, are mineral concretions on the sea bottom formed of concentric layers of iron and manganese hydroxides around a core.

▪ **Significance:**

- This will open up more growth avenues to explore ocean resources for clean energy, drinking water, and blue economy.
- Developed countries have already carried out similar ocean missions. India is the 1<sup>st</sup> country among the developing nations to carry out a deep ocean mission.

**34) NISAR**

NASA and ISRO are collaborating on developing an SUV-sized satellite called NISAR, which will detect movements of the planet's surface as small as 0.4 inches over areas about half the size of a tennis court.

- The satellite will be launched in 2022 from the Satish Dhawan Space Center in Sriharikota (Andhra Pradesh) into a near-polar orbit.

**Key Points:**

- The Name 'NISAR': The name NISAR is short for NASA-ISRO-SAR.
  - SAR here refers to the Synthetic Aperture Radar that NASA will use to measure changes in the surface of the Earth.
  - It refers to a technique for producing high-resolution images. Because of the precision, the radar can penetrate clouds and darkness, which means that it can collect data day and night in any weather.

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- **Function:** It will scan the globe every 12 days over the course of its three-year mission of imaging the Earth's land, ice sheets and sea ice to give an unprecedented view of the planet.
- **Role of NASA:**
  - National Aeronautics and Space Administration (NASA - space agency of the USA) will provide one of the radars for the satellite, a high-rate communication subsystem for science data, GPS receivers and a payload data subsystem.
  - NISAR will be equipped with the largest reflector antenna ever launched by NASA.
- **Role of ISRO:**
  - Indian Space and Research Organisation (ISRO) will provide the spacecraft bus, the second type of radar (called the S-band radar), the launch vehicle and associated launch services.
- **Primary Goals:**
  - Tracking subtle changes in the Earth's surface,
  - Spotting warning signs of imminent volcanic eruptions,
  - Helping to monitor groundwater supplies, and
  - Tracking the rate at which ice sheets are melting.
- **Expected Benefits:**
  - NISAR's data can help people worldwide better manage natural resources and hazards, as well as providing information for scientists to better understand the effects and pace of climate change.
    - The images will be detailed enough to show local changes and broad enough to measure regional trends.
  - As the mission continues for years, the data will allow for better understanding of the causes and consequences of land surface changes.
  - It will also add to our understanding of our planet's hard outer layer, called its crust.

### 35) ARTEMIS - I

#### What is Artemis I Mission?

- Artemis I is an uncrewed mission of NASA.
- It will test the agency's Space Launch System (SLS) rocket and Orion crew capsule.
- Artemis I will be the first in a series of increasingly complex missions to build a long-term human presence at the Moon for decades to come.

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- The primary goals for Artemis I are to demonstrate Orion’s systems in a spaceflight environment and ensure a safe re-entry, descent, splashdown, and recovery prior to the first flight with crew on Artemis II.

#### **What will be the Key Events during the Mission?**

- **Artemis I launch**
  - The SLS rocket and Orion spacecraft have completed their journey from their assembly building to Launch Complex 39B at the Kennedy Space Centre in Florida.
  - At launch, the rocket will produce a maximum of more than 3.9 million kilograms of thrust from its four RS-25 engines and five-segment boosters.
  - Shortly after launch, the boosters, service module and launch abort systems will be offloaded.
  - Then, the core stage engines will be shut down and the core stage will separate from the spacecraft.
- **Artemis I: Trajectory to the moon**
  - After launch, the spacecraft will orbit the Earth and deploy its solar arrays.
  - Next, the Interim Cryogenic Propulsion Stage (ICPS) will give Orion a “push” to help it leave Earth’s orbit and travel toward the planet’s only natural satellite.
  - Then, within about two hours from launch time, when the spacecraft is on a trajectory to the Moon, it will separate from ICPS.
  - When it separates from the spacecraft, ICPS will deploy small satellites, known as CubeSats to send them on their journey to deep space.
    - This includes BioSentinel, which will carry yeast into deep space to study the effects of deep space radiation on living matter.
    - The other CubeSats will also perform many science and technology demonstrations.
- **Artemis I: Moon orbit**
  - On its path to the Moon, Orion will be propelled by a service module built by the European Space Agency.
    - Apart from supplying the spacecraft’s propulsion system and power, the service module is also designed to house air and water for future crewed missions.
  - Once it enters the Moon’s orbit, the spacecraft will collect data.
  - Afterwards, Orion will use a precisely timed engine firing of the service module in combination with the Moon’s gravity to accelerate back towards our planet.
- **Artemis I: Reentry into Earth’s atmosphere**
  - After a total mission time of around 6 weeks, Orion will enter Earth’s atmosphere.

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- And if all goes as planned, it will land in the sea, within eyesight of a recovery ship stationed off the coast of Baja in California.

## DRDO

### 1) SMART SYSTEM

The Defence Research and Development Organisation (DRDO) conducted a successful flight test of the Supersonic Missile Assisted Release of Torpedo (SMART) from Wheeler Island off the coast of Odisha.

- This follows the successful test firing of indigenously developed nuclear capable hypersonic missile 'Shaurya'.
- In 2017, the Odisha government formally named the Outer Wheeler island in Bhadrak district as APJ Abdul Kalam Island as a tribute to the former President on his second death anniversary.

### Key Points

- **About:** SMART is a missile assisted release of lightweight Anti-Submarine Torpedo System for anti-submarine warfare (ASW) operations far beyond torpedo range.
- **Functioning:**
  - SMART, when launched from a warship or a truck-based coastal battery, takes off like a regular supersonic missile.
  - It covers most of its flight in the air at lower altitudes with two-way data link from the warship or an airborne submarine target detection system and provides the exact location of the hostile submarine to correct its flight path midway.
  - Just when it approaches close enough to the submerged submarine, the missile will eject the torpedo system into the water and the autonomous torpedo will start moving towards its target to take out the submarine.
    - Torpedo is a cigar-shaped, self-propelled underwater weapon, launched from a submarine, surface vessel, or airplane and designed for exploding upon contact with the hulls of surface vessels and submarines.
    - Varunastra is the first indigenous heavyweight ship launched anti-submarine electric torpedo.
- **Significance:**
  - Strengthens the country's maritime strategic capabilities.
  - A major breakthrough for stand-off capability in anti-submarine warfare.

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- Project 28, approved in 2003, is a class of anti- submarine warship corvettes currently in service with the Indian Navy. It includes INS Kamorta, INS Kadmatt, INS Kiltan and INS Kavaratti.
- Project 75 is a programme by the Indian Navy that entails building six Scorpene-Class attack submarines (Kalvari, Khanderi, Karanj, Vela, Vagir and Vagsheer).

#### 2) AGNI PRIME

Recently, a new generation nuclear capable ballistic missile Agni-P (Prime) was successfully test-fired by the Defence Research and Development Organisation (DRDO) from Dr. APJ Abdul Kalam Island off the coast of Odisha, Balasore.

#### Key Points:

- Agni-P is a new generation advanced variant of the Agni class (under IGMDP - Integrated Guided Missile Development Program).
- It is a canisterised missile with range capability between 1,000 and 2,000 km.
  - Canisterisation of missiles reduces the time required to launch the missile while improving its storage and mobility.
- Many advanced technologies including composites, propulsion systems, innovative guidance and control mechanisms and state-of-the-art navigation systems have been introduced. The Agni-P missile would further strengthen India's credible deterrence capabilities.
- In comparison to other Agni class missiles, Agni-P has improved parameters including manoeuvring and accuracy.
- **Agni Class of Missiles:**
  - They are the mainstay of India's nuclear launch capability.
  - **Range of other Agni Missiles:**
    - **Agni I:** Range of 700-800 km.
    - **Agni II:** Range more than 2000 km.
    - **Agni III:** Range of more than 2,500 Km
    - **Agni IV:** Range is more than 3,500 km and can fire from a road mobile launcher.
    - **Agni-V:** The longest of the Agni series, an Inter-Continental Ballistic Missile (ICBM) with a range of over 5,000 km.

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▪ **Nuclear Triad:**

- Nuclear triad, a three-sided military-force structure consisting of land-launched nuclear missiles, nuclear-missile-armed submarines, and strategic aircraft (e.g. Rafale, Brahmos) with nuclear bombs and missiles.
- DRDO had in January 2020 successfully test-fired a 3,500-km range submarine-launched ballistic missile, K-4, from a submerged pontoon off the Visakhapatnam coast.
- Once inducted, these missiles will be the mainstay of the Arihant class of indigenous ballistic missile nuclear submarines (SSBN) and will give India the stand-off capability to launch nuclear weapons submerged in Indian waters.
  - INS Arihant, the only SSBN in service, is armed with K-15 missiles with a range of 750 km.
- In the past few years, India has been able to complete its nuclear triad. This is especially important given India's No-First-Use policy while reserving the right of massive retaliation if struck with nuclear weapons first.

**3) MPATGM (Man Portable Anti Tank Guided Missile)**

Recently, the Defence Research & Development Organisation (DRDO) successfully flight-tested the New Generation Akash Missile (Akash-NG) and the Man Portable Anti Tank Guided Missile (MPATGM).

- In June 2021 a new generation nuclear capable ballistic missile Agni-P (Prime) was successfully test-fired by the DRDO.
- In February 2021 India also successfully test-fired indigenously-developed anti-tank guided missile systems 'Helina' and 'Dhruvastra'.

**Man Portable Anti Tank Guided Missile:**

- It is an indigenously-developed anti-tank guided missile.
  - Anti Tank guided missile is a medium or long-range missile whose primary purpose is to destroy tanks and other armoured vehicles.
- It is a low weight, fire and forget missile. It is incorporated with state-of-the-art Miniaturized Infrared Imaging Seeker along with advanced avionics.
- It is launched using a tripod designed for a maximum range of 2.5 km with a launch weight of less than 15 Kg.
- Its successful test marked a major boost for the government's Atmanirbhar Bharat campaign and would strengthen the Indian Army.

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#### 4) SFDR

Recently, India successfully flight tested Solid Fuel Ducted Ramjet (SFDR) Booster, a missile system, at the Integrated Test Range (ITR) in Chandipur off the Odisha coast.

- The Defence Research and Development Organisation (DRDO) began developing SFDR first in 2017 and had conducted successful tests in 2018 and 2019 as well.

#### What is SFDR?

- **About:**

- It is a missile propulsion technology jointly developed by India and Russia.
- SFDR technology is a missile propulsion system based on the concept of Ramjet Engine principle.
  - A ramjet is a form of air-breathing jet engine that uses the vehicle's forward motion to compress incoming air for combustion without a rotating compressor.
  - In a ramjet, the high pressure is produced by "ramming" external air into the combustor using the forward speed of the vehicle. The external air that is brought into the propulsion system becomes the working fluid.
  - Ramjets produce thrust only when the vehicle is already moving, ramjets cannot produce thrust when the engine is stationary or static.
- The system utilises a solid fuelled air-breathing ramjet engine.
  - Unlike solid-propellant rockets, the Ramjet takes up oxygen from the atmosphere during flight. Thus, it is light in weight and can carry more fuel.
- The SFDR has been developed by Defence Research and Development Laboratory, Hyderabad in collaboration with other DRDO laboratories such as Research Centre Imarat, Hyderabad and High Energy Materials Research Laboratory, Pune.

- **Significance:**

- It enables the missile to intercept aerial threats at very long range at supersonic speeds.
- At present, such technology is available only with a handful of countries in the world.
- Air-to-air missiles which use SFDR technology can achieve longer ranges as they do not require oxidisers (take oxygen from the atmosphere).
- The missile based on SFDR fly at supersonic speeds and high manoeuvrability ensures the target aircraft cannot get away.



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### 5) ABHYAS

Recently, India successfully tested the indigenously-designed Abhyas - a High-speed Expendable Aerial Target (HEAT) - in Odisha.

- The trial was carried out by the Defence Research and Development Organisation (DRDO) from the Integrated Test Range (ITR) in Odisha's Chandipur.

#### What are the Key Points of ABHYAS?

- **Designed and developed by:**
  - Aeronautical Development Establishment (ADE), of DRDO.
    - ADE is a key Aeronautical Systems Design Laboratory under DRDO.
    - It is involved in the design and development of the state-of-the-art Unmanned Aerial Vehicles (UAV) and Aeronautical Systems and technologies to meet the requirements of the Indian Armed forces.
- **Features:**
  - It is powered by a gas turbine engine to sustain a long endurance flight at subsonic speed.
  - It is equipped with a MEMS (Micro-Electro-Mechanical Systems)-based Inertial Navigation System (INS) for navigation along with the Flight Control Computer (FCC) for guidance and control.
  - The vehicle is programmed for fully autonomous flight and their check-out is done using a laptop-based Ground Control Station (GCS).
  - Abhyas system is equipped with Radar Cross-Section (RCS) and infrared signatures which can be used to simulate a variety of aircraft for the practice of anti-aircraft warfare and also for the testing designed to target aerial targets.
- **Utility:**
  - It will be used as a target for the evaluation of various missile systems.
    - It offers a realistic threat scenario for practice of weapon systems.

### 6) VL-SRSAM

Vertical Launch Short Range Surface to Air Missile (VL-SRSAM) was successfully flight-tested by Defence Research & Development Organisation (DRDO) and the Indian Navy from an Indian Naval Ship at Integrated Test Range (ITR), Chandipur off the coast of Odisha.

- **About:**
  - VL-SRSAM has been designed and developed jointly by three facilities of the Defence Research and Development Organisation for deployment of Indian Naval warships.
  - The missile has the capability of neutralizing various aerial threats at close ranges including sea-skimming targets.

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- Sea skimming is a technique many anti-ship missiles and some fighter or strike aircraft use to avoid radar and infrared detection.
- **Design:**
  - The missile has been designed to strike high-speed airborne targets at the range of 40 to 50 km and at an altitude of around 15 km.
  - Its design is based on Astra missile which is a Beyond Visual Range Air to Air missile.
    - Astra ("weapon") is India's first air-to-air all weather beyond-visual-range active radar homing air-to-air missile, developed by the Defence Research and Development Organization.
    - A Beyond-Visual-Range missile (BVR) is an air-to-air missile that is capable of engaging at ranges of 20 nautical miles or beyond.
- **Features:**
  - Cruciform wings: They are four small wings arranged like a cross on four sides and give the projective a stable aerodynamic posture.
  - Thrust Vectoring: It is the ability to change the direction of the thrust from its engine, control the angular velocity and the attitude of the missile.
    - Thrust is the force which moves an aircraft through the air.
  - Canisterised system: The inside environment is controlled, thus making its transport and storage easier and improving the shelf life of weapons.

#### 7) Prithvi-II

India successfully conducted the night trial of surface-to-surface nuclear-capable short-range ballistic missile Prithvi-II.

- Earlier, Intermediate Range Ballistic Missile Agni-IV was tested which can travel as far as 4,000 km.
- **About:**
  - Prithvi-II is an indigenously developed Surface-to-Surface Missile Short-Range Ballistic Missile (SRBM), which has a range of around 250 km-350km and can carry a one tonne payload.
  - Prithvi II class is a single-stage liquid-fueled missile that has warhead mounting capability of 500 kg-1000kg.
  - The missile is a proven system and is capable of striking targets with a very high degree of precision.
  - The state-of-the-art missile uses an advanced inertial guidance system with manoeuvring trajectory to hit its target.

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- It was initially developed for the Indian Air Force as its primary user and was later inducted into the Indian Army as well.
- While the missile was inducted into India's Strategic Forces Command for the first time in 2003, it was the first missile developed under the IGMDP.
- **Developed by:**
  - Defence Research and Development Organisation (DRDO) of India under its Integrated Guided Missile Development Programme (IGMDP).

**What are the Prithvi Missiles?**

- The Prithvi missile system comprises various tactical Surface-to-Surface Short-Range Ballistic Missiles (SRBM).
- Its development began in 1983, and it was India's first indigenous ballistic missile.
- It was first test-fired in 1988, from Sriharikota, SHAR Centre.
  - It has a range of from 150 to 300 km.
- The naval variant of Prithvi I and Prithvi III class missiles have the code-name Dhanush.
- The propulsion technology was likely based on the Soviet SA-2 surface-to-air missile.
  - Soviet SA-2 Surface-to-Air Missile:
    - Developed in the mid-1950s, the Soviet SA-2 surface-to-air missile was the first effective Soviet Union surface-to-air missile.
    - Developed as a missile for the battlefield, it could carry a nuclear warhead in its role as a tactical nuclear weapon.
- The Prithvi I missiles have been in service with the Indian Army since 1994.
  - Reportedly, Prahar missiles are replacing with Prithvi I missiles.
- Prithvi II missiles have been in service since 1996.
- Prithvi III having a more extended range of 350 km, was successfully test-fired in 2004.

**8) AGNI - 4 BALLISTIC**

India successfully carried out a night launch of the nuclear-capable Agni-4 ballistic missile from the APJ Abdul Kalam Island in Odisha.

- The successful test reaffirms India's policy of having a 'Credible Minimum Deterrence' Capability.
- The successful test was carried out under the aegis of the Strategic Forces Command.
- The Strategic Forces Command is operationally responsible for all of India's nuclear assets.

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### **Agni-4 Missile**

- **About:**

- The surface to surface Agni-IV missile having 4000 km strike range is a two stage missile.
- It is 20-metre long and weighs 17 tonnes.
- It is equipped with modern and compact avionics to provide a high level of reliability.
- It is an Intermediate Range Ballistic Missile with a range of around 4,000 km. Developed by the Defence Research and Development Organisation (DRDO).

- **Features:**

- It is equipped with state-of-the-art Avionics, 5th generation On Board Computer and distributed architecture.
- It has the latest features to correct and guide itself for in-flight disturbances.
- The most accurate Ring Laser Gyro based Inertial Navigation System (RINS) and supported by the highly reliable redundant Micro Navigation System (MINGS), ensures the vehicle reaches the target within two digit accuracy.

### **9) PARAM ANANTA**

The Centre for Development of Advanced Computing (C-DAC) and IIT Gandhinagar have unveiled India's latest supercomputer called 'Param Ananta'.

#### **About Param Ananta Supercomputer**

- This development is in line with phase two of the central government's National Supercomputing Mission (NSM) which is a joint initiative of the Ministry of Electronics and Information Technology (MeitY) and Department of Science and Technology (DST).
- Computing power: 838 teraflops computing power capacity.
  - The high power supercomputer can process 838 lakh crore calculations per second.
- Indigenously developed: Manufactured and assembled under 'Make in India'.
- Ranking: The supercomputer will rank behind C-DAC's Param Siddhi-AI, which was the 102nd most powerful supercomputer in the world with peak performance capability of 3.3 petaflops.

#### **Applications**

- Help in Research and development activities.
- Its use will include artificial intelligence (AI), machine learning (ML), and data science, computational fluid dynamics (CFD), bio-engineering for genome sequencing and DNA

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studies, computational biology and bioinformatics used in prediction and detection of gene networks.

- It can help atomic and molecular sciences to comprehend the binding of drugs to a particular protein.
- Multiple applications from various scientific domains such as Weather and Climate, Bioinformatics etc

#### **What is a Supercomputer?**

- The supercomputer is a computer with a high-level computational capacity compared to a general-purpose computer.
- The performance of a supercomputer is measured in floating-point operations per second (FLOPS) instead of million instructions per second (MIPS).
- They are expensive and are employed for specialised applications that require immense amounts of mathematical calculations (number crunching).
  - For example, weather forecasting requires a supercomputer.
  - Other uses of supercomputers include scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting).
- USA's Frontier supercomputer, run by the Oak Ridge Leadership Computing Facility, was officially ranked as the most powerful supercomputer in the world.
  - It outperformed Fugaku, the second most powerful supercomputer.

#### **National Supercomputing Mission**

- It is an important initiative by the Government of India to boost indigenous efforts to be in the forefront of supercomputing capability for socio-economic development of the nation.
- The mission was jointly steered by the Ministry of Electronics and IT and Department of Science & Technology.
- It is being implemented through two leading organisations – Centre for Development of Advanced Computing (C-DAC) and the Indian Institute of Science (IISc), Bangalore with an objective to meet the increasing computing demands of the scientific and research community.
- This initiative supports the government's vision of "Digital India" and "Make in India" and will place India at the forefront of the global supercomputing map.
- It aims to deploy 24 facilities with a combined computing power of more than 64 petaFLOPS.
  - The computing power of supercomputers is measured in floating-point operations per second or FLOPS.

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- One petaFLOP is equal to 1,000,000,000,000,000 (one quadrillion) FLOPS, or one thousand teraFLOPS.
- The four major pillars of the NSM, namely, Infrastructure, Applications, R&D, HRD, have been functioning efficiently to realise the goal of developing indigenous supercomputing eco system of the nation.

#### 10) SAMUDRAYAAN MISSION

The Ministry of Earth Sciences (MoES) has launched India's first manned ocean mission "Samudrayaan" in Chennai.

- With this Unique Ocean Mission, India joined the elite club of nations such as the US, Russia, France, Japan, and China to have niche technology and vehicles to carry out subsea activities.

#### Key Points

##### ▪ About:

- It is India's first unique manned ocean mission that aims to send men into the deep sea in a submersible vehicle for deep-ocean exploration and mining of rare minerals.
- It will send three persons in a manned submersible vehicle MATSYA 6000 to a depth of 6000 metres into the sea for deep underwater studies.
  - Submarines go only about 200 metres.
- It is a part of the Rs 6000-crores Deep Ocean Mission.

##### ▪ MATSYA 6000:

- It is an indigenously developed manned submersible vehicle.
- It will facilitate the MoES in conducting deep ocean exploration of resources such as gas hydrates, polymetallic manganese nodules, hydro-thermal sulfides, and cobalt crusts which are located at an approximate depth between 1000 and 5500 metres.
  - Polymetallic nodules, also called manganese nodules, are mineral concretions on the sea bottom formed of concentric layers of iron and manganese hydroxides around a core.

##### ▪ Significance:

- This will open up more growth avenues to explore ocean resources for clean energy, drinking water, and blue economy.
- Developed countries have already carried out similar ocean missions. India is the 1<sup>st</sup> country among the developing nations to carry out a deep ocean mission.

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▪ **Other Related Initiatives:**

- India-Norway Task Force on Blue Economy for Sustainable Development.
- Sagarmala Project.
- O-SMART.
- Integrated Coastal Zone Management.
- National Fisheries Policy.

**11) ADITYA PROJECT**

The Indian Space Research Organisation (ISRO) is preparing for its first scientific expedition to study the Sun, Aditya-L1. It would be placed into a point in space known as the L1 Lagrange point.

- Aditya L1 will be ISRO's 2<sup>nd</sup> space-based astronomy mission after AstroSat, which was launched in 2015.
- Aditya 1 was renamed as Aditya-L1. The Aditya 1 was meant to observe only the solar corona.

**Key Points**

- **Launch Vehicle:** Aditya L1 will be launched using the Polar Satellite Launch Vehicle (PSLV) XL with 7 payloads (instruments) on board.
- **Objective:** Aditya L1 will study the Sun's corona (Visible and Near infrared rays), Sun's photosphere (soft and hard X-ray), chromosphere (Ultra Violet), solar emissions, solar winds and flares, and Coronal Mass Ejections (CMEs), and will carry out round-the-clock imaging of the Sun.
- **Challenges:** The distance of the Sun from Earth (approximately 15 crore kms on average, compared to the only 3.84 lakh kms to the Moon). This huge distance poses a scientific challenge.
  - Due to the risks involved, payloads in earlier ISRO missions have largely remained stationary in space; however, Aditya L1 will have some moving components which increases the risks of collision.
  - Other issues are the super hot temperatures and radiation in the solar atmosphere. However, Aditya L1 will stay much farther away, and the heat is not expected to be a major concern for the instruments on board.

**Importance:**

- Evolution of every planet, including Earth and the exoplanets beyond the Solar System, is governed by its parent star i.e the Sun in our case. The Solar weather and environment affects the weather of the entire system. Therefore, it is important to study the Sun.

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- Effects of Variation in Solar Weather System: Variations in this weather can change the orbits of satellites or shorten their lives, interfere with or damage onboard electronics, and cause power blackouts and other disturbances on Earth.
- Knowledge of solar events is key to understanding space weather.
- To learn about and track Earth-directed storms, and to predict their impact, continuous solar observations are needed.
- Many of the instruments and their components for this mission are being manufactured for the first time in the country.

## TELESCOPE

### 1) INTERNATIONAL LIQUID-MIRROR TELESCOPE

#### What is international liquid-Mirror Telescope?

- It is world's first liquid-mirror telescope that was commissioned for astronomy. Other liquid-telescopes were previously built either to track satellites or were used for military purposes.
- International Liquid-Mirror Telescope (ILMT) was set up at the Devasthal Observatory campus, which is owned by Aryabhata Research Institute of Observational Sciences (ARIES), Nainital in Uttarakhand.
- ILMT will be the third telescope facility at Devasthal that has become world's pristine sites for obtaining astronomical observations.

#### When will it be operational?

ILMT is set to commence its full-scale scientific operations in October 2022. It will work along with 3.6-metre Devasthal Optical Telescope (DOT), which is India's largest telescopes in operation.

#### How is ILMT different?

- Liquid-mirror telescopes are stationary telescopes which is used to image a strip of the sky at a given point of time at night as opposed to the conventional telescope which is steered to point towards celestial source of interest in sky for observations. The liquid-mirror telescope will survey and capture all possible celestial objects ranging from stars, galaxies, asteroids, supernovae explosions to space debris.
- Conventional telescopes comprise of highly polished glass mirrors, either single or a combination of curved ones. These glasses are steered in a controlled fashion to focus on targeted celestial object on specific nights. This light is then reflected to create images. While the liquid-telescope is made up of mirrors with reflective liquid. In ILMT, mercury has been used as reflective liquid.



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- Conventional telescopes help in observing specific stellar sources for fixed hours in accordance with study requirement and time allotted by respective telescope time allotment committee. While, ILMT will help in capturing images of sky on all nights between two successive twilights.

**Countries that developed ILMT**

India, Canada, Belgium, Poland and Uzbekistan are the main countries to collaborate on setting up the ILMT. It was designed and built at Advanced Mechanical and Optical Systems Corporation and Centre Spatial de Liège in Belgium.

**2) THIRTY METER TELESCOPE (TMT)**

The design of **back-end instruments** and other aspects of the **Thirty Meter Telescope (TMT)** project being installed at **Maunakea in Hawaii** has been developed by close collaboration between the **2020 Physics Nobel Laureate Prof. Andrea Ghez and Indian astronomers.**

**Key Point:**

- The Thirty-meter telescope (TMT) project is an international partnership between the **USA, Canada, Japan, China, and India.**
- It will allow deeper exploration into space and **observe cosmic objects** with unprecedented sensitivity.
- **Other Global Projects with Indian Collaboration:**
  - **The Laser Interferometer Gravitational-Wave Observatory (LIGO) Project**
    - The Indian scientists contributed in several aspects such as **designing algorithms for analysis of signals from gravitational waves**, estimating energy and power radiated from black holes etc.
    - Now **LIGO-India** is a planned advanced gravitational-wave observatory to be located in India as part of the worldwide network.
  - **CERN Project:**
    - India became a **full Associate Member** of world's largest particle **Physics laboratory CERN** in 2017, thereby **getting full access** to data generated there.
    - The contribution of Indian scientists there is mainly in building the **Large Hadron Collider (LHC)** and construction of two significant CERN experiments, **CMS and ALICE.**
  - **Facility for Antiproton and Ion Research (FAIR):**
    - FAIR is coming up at **Darmstadt, Germany** for **studying the building blocks of matter and the evolution of the Universe.**

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- FAIR is a sophisticated **accelerator complex** that will **use the high energy and ion beams to mimic the condition inside the core** of the stars and early phase of the universe.
- The role of Indian scientists would be to build **NUSTAR** (Nuclear Structure, Astrophysics and Reactions), **CBM** (Compressed Baryonic Matter) and **PANDA** (Antiproton Annihilation at Darmstadt).
- **Square Kilometre Array (SKA):**
  - India has joined **nine other countries** to build the **world's largest and most sophisticated radio telescope** called Square Kilometre Array (SKA).
  - The **core of the telescope will be based in Karoo desert in South Africa**. Since the **total detection area** of the receiver dishes would exceed **1 square kilometer**, it is called Square Kilometre Array.
- **International-Thermonuclear-Experimental-Reactor (ITER):**
  - The International-Thermonuclear-Experimental-Reactor (ITER) is focused around **creating an environment mimicking the Sun** in laboratory conditions using **nuclear fusion**.
  - India's scientists and institutions such as **Institute for Plasma Research, Ahmedabad** are playing an important role in this.

### 3) VAINUBAPU TELESCOPE

1. The Vainu Bappu Observatory is an astronomical observatory owned and operated by the Indian Institute of Astrophysics. It is located at Kavalur in the Javadi Hills, near Vaniyambadi in Tirupathur district in the Indian state of Tamil Nadu. It is 200 km south-west of Chennai and 175 km south-east of Bangalore.
2. The Vainu Bappu Observatory of the Indian Institute of Astrophysics traces its origin back to 1786 when William Petrie set up his private observatory at his garden house at Egmore, Madras, which eventually came to be known as the Madras Observatory. Later it was moved to Kodaikanal and functioned there as the Kodaikanal Observatory since 1899.
3. However, Kodaikanal had very few nights available for observation and hence astronomers searched for a new site after India's independence. M.K. Vainu Bappu who took over as the director of the Kodaikanal Observatory in 1960, found a sleepy little hamlet called Kavalur in the Javadi Hills as a suitable site for establishing optical telescopes for observing celestial objects. This came to be known as Kavalur Observatory.

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4. Observations began in 1968 with a 38 cm telescope made in the backyard of the Kodaikanal Observatory.
5. The first telescope was of 38 cm (15-inch) aperture, with which astronomical observations were started in 1968 at Kavalur Observatory. The 75 cm (30-inch) telescope has been completely designed and fabricated at the workshops of the Indian Institute of Astrophysics. In 1972 a 1-metre (40-inch) telescope made by Carl Zeiss Jena was installed at Kavalur.
6. Vainu Bappu started the 2.3-metre (93-inch) aperture telescope, designed and built within the country. Bappu died in 1982 and would not see the completion of the telescope. On 6 January 1986, the observatory was renamed as Vainu Bappu Observatory and the 2.3-metre telescope as Vainu Bappu Telescope. The telescope is so powerful that it can easily resolve a 25 paise coin kept forty kilometres away. Deep sky observations are carried out with this telescope using a variety of focal plane instruments. The equatorially mounted horse-shoe-yoke structure of the telescope is ideally suited for low latitudes and permits easy observation near the north celestial pole. The telescope has a F/3.25 paraboloid primary of 2.3 m diameter with the prime focus image scale of 27 arcsec/mm and a Cassegrain focus image scale of 6.7 arcsec/mm. This telescope has been operated as a national facility and attracts proposals from all over the country and sometimes from outside India.

#### 4) DIFFERENCE BETWEEN HUBBLE & JAMES WEBB TELESCOPE

##### What is the Difference between Hubble & James Webb Telescope?

- **Wavelength:**
  - The James Webb Space Telescope would be observing infrared radiations most primarily covering between 0.6 to 28 microns.
  - Hubble's work involved watching the ultraviolet and the visible spectrum of light. It observes the range of 0.8 to 2.5 microns.
- **Orbits:**
  - Webb Telescope would not be orbiting the Earth. It would be orbiting the sun from 1.5 million kilometres away from the Earth.
  - Hubble orbits the Earth at an altitude of 575 kilometres from it.
- **Vision:**
  - As per NASA, Hubble can see the smallest and the newest of all galaxies.
  - Webb would be able to see the Newborn galaxies as well.
  - Webb's near and mid-infrared instruments would be helpful in studying the first formed galaxies and exoplanets.

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**JAMES WEBB SPACE TELESCOPE**

- The telescope is the result of an international collaboration between NASA, the European Space Agency (ESA) and the Canadian Space Agency which was launched in December 2021.
- It is currently at a point in space known as the Sun-Earth L2 Lagrange point, approximately 1.5 million km beyond Earth's orbit around the Sun.
  - The Lagrange Point 2 is one of the five points in the orbital plane of the Earth-Sun system.
  - Named after Italian-French mathematician Joseph-Louis Lagrange, the points are in any revolving two-body system like Earth and Sun, marking where the gravitational forces of the two large bodies cancel each other out.
  - Objects placed at these positions are relatively stable and require minimal external energy or fuel to keep themselves there, and so many instruments are positioned here.
- It's the largest, most powerful infrared space telescope ever built.
- It's the successor to Hubble Telescope.
- It can see backwards in time to just after the Big Bang by looking for galaxies that are so far away that the light has taken many billions of years to get from those galaxies to our telescopes

**HUBBLE SPACE TELESCOPE**

- The Hubble Space Telescope is named after the astronomer Edwin Hubble, whose contribution in the field of astronomy and cosmology are remarkable
- It is a large space telescope and was launched in 1990 and is still operational. It is expected to decay by 2030-2040
- Hubble features a 2.4-meter mirror, and its four main instruments include ultraviolet, visible, and near-infrared regions of the electromagnetic spectrum
- It is the only telescope that has been designed in a manner that it can be serviced by astronauts in space. Till date 5 Space Shuttle missions have been conducted to repair and upgrade the parts of the telescope
- The telescope has been built by NASA, along with contributions from the European Space Agency (ESA)
- It is one of the largest space telescopes which can perform versatile missions. However, with the ongoing construction of the Thirty Meter Telescope, HST will no longer with the largest light-vision telescope in the world.

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**5) ASTROSAT**

- AstroSat is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously.
- The payloads cover the energy bands of Ultraviolet (Near and Far), limited optical and X-ray regime (0.3 keV to 100keV).
- One of the unique features of AstroSat mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.
- AstroSat with a lift-off mass of 1515 kg was launched on September 28, 2015 into a 650 km orbit inclined at an angle of 6 deg to the equator by PSLV-C30 from Satish Dhawan Space Centre, Sriharikota. The minimum useful life of the AstroSat mission is expected to be 5 years.
- The science data gathered by five payloads of AstroSat are telemetered to the ground station at MOX. The data is then processed, archived and distributed by Indian Space Science Data Centre (ISSDC) located at Bylalu, near Bengaluru.

**The scientific objectives of AstroSat mission are:**

- To understand high energy processes in binary star systems containing neutron stars and black holes;
- Estimate magnetic fields of neutron stars;
- Study star birth regions and high energy processes in star systems lying beyond our galaxy;
- Detect new briefly bright X-ray sources in the sky;
- Perform a limited deep field survey of the Universe in the Ultraviolet region.

**ASTROSAT detects a rare galaxy**

- India's first multi-wavelength satellite, which has five unique X-ray and ultraviolet telescopes working in tandem, AstroSat, has detected extreme-UV light from a galaxy, called AUDFs01, 9.3 billion light-years away from Earth," Inter-University Centre for Astronomy and Astrophysics (IUCAA) said.
- The discovery was made by an international team of astronomers led by Dr Kanak Saha, associate professor of astronomy at the IUCAA, and published on August 24 by 'Nature Astronomy', the release said.
- This team comprised scientists from India, France, Switzerland, the USA, Japan and The Netherlands.
- Saha and his team observed the galaxy, which is located in the Hubble Extreme Deep field, through AstroSat.

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- Earlier, NASA’s Hubble Space Telescope (HST), a significantly larger than UVIT (UV imaging telescope), did not detect any UV emission (with energy greater than 13.6 eV) from this galaxy because it is too faint, it said.
- AstroSat/UVIT was able to achieve this unique feat because the background noise in the UVIT detector is much less than the ones on HST.

## HEALTH

### 1. CORONA

1. Recently, the Lancet published a study titled “Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China”.
2. The study highlighted the high mortality due to the 2019 novel coronavirus (2019-nCoV infection) which caused clusters of severe respiratory illness similar to severe acute respiratory syndrome (SARS) coronavirus.
3. It also pointed out that there are major gaps in the knowledge of the origin, epidemiology, duration of human transmission and clinical spectrum of the disease.
4. Findings of the Study
5. Most of the infected patients were men.
6. Less than half had underlying diseases (diabetes, hypertension and cardiovascular ailments).
7. 66% of patients had been exposed to Huanan seafood market.
8. Researchers collected and analysed data by real-time Reverse transcription-polymerase chain reaction (RT-PCR).
9. RT-PCR is a laboratory technique combining reverse transcription of RNA into DNA and next-generation sequencing.

### Coronavirus:

1. Coronaviruses are a specific family of viruses, with some of them causing less-severe damage, such as the common cold and others causing respiratory and intestinal diseases.
2. A coronavirus has many “regularly arranged” protrusions on its surface, because of which the entire virus particle looks like an emperor’s crown, hence the name “coronavirus”.
3. It is an RNA virus with ribonucleic acid (RNA) as its genetic material instead of deoxyribonucleic acid (DNA). That means the virus blends with its host’s DNA and can mutate rapidly.
4. Due to this property of rapid mutation, coronaviruses can be quite different from one another.

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5. These can affect humans as well as mammals including pigs, cattle, cats, dogs, martens, camels, hedgehogs and some birds.
6. There are four common disease-causing coronaviruses, while the two other are the Severe Acute Respiratory Syndrome (SARS) coronavirus and the Middle East Respiratory Syndrome (MERS) coronavirus, both of which can cause severe respiratory diseases.
7. In the newly identified coronavirus, a direct link with the disease has not been established yet. It was speculated that it was related to the SARS epidemic of 2002.
8. World Health Organisation (WHO) has said that further investigations and research are required to determine the source, modes of transmission and extent of infection caused by the new virus.

## 2. MONKEYPOX

Recently, the US started surveillance on people travelling from Nigeria, who may have had contact with the individuals infected with Monkeypox.

### Key Points:

1. It is a viral zoonotic disease (transmission from animals to humans) and is identified as a pox-like disease among monkeys hence it is named Monkeypox. It is endemic to Nigeria.
2. It is caused by monkeypox virus, a member of the Orthopoxvirus genus in the family Poxviridae.
3. The natural host of the virus remains undefined. But the disease has been reported in many animals.
4. Animals known to be sources of Monkeypox virus include monkeys and apes, a variety of rodents (including rats, mice, squirrels and prairie dogs) and rabbits.

### Outbreaks:

1. It was first reported in 1958, in monkeys in the Democratic Republic of Congo (DRC) and in humans in 1970, also in the DRC.
2. In 2017, Nigeria experienced the largest documented outbreak, 40 years after the last confirmed case.
3. Subsequently, the disease has been reported in many West and Central African countries.

### Symptoms:

1. Infected people break out in a rash that looks a lot like chicken pox. But the fever, malaise, and headache from Monkeypox are usually more severe than in chicken pox infection.

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2. In the early stage of the disease, Monkeypox can be distinguished from smallpox because the lymph gland gets enlarged.

#### Transmission:

1. Primary infection is through direct contact with the blood, bodily fluids, or cutaneous or mucosal lesions of an infected animal. Eating inadequately cooked meat of infected animals is also a risk factor.
2. Human-to-human transmission can result from close contact with infected respiratory tract secretions, skin lesions of an infected person or objects recently contaminated by patient fluids or lesion materials.
3. Transmission can also occur by inoculation or via the placenta (congenital monkeypox).

#### Vulnerability:

It spreads rapidly and can cause one out of ten deaths if infected.

#### Treatment and Vaccine:

1. There is no specific treatment or vaccine available for Monkeypox infection. In the past, the anti-smallpox vaccine was shown to be 85% effective in preventing Monkeypox.
2. But the world was declared free of smallpox in 1980 so the vaccine isn't widely available anymore.
3. Currently, there is no global system in place to manage the spread of Monkeypox, with each country struggling to contain any outbreak whenever it occurs.

#### Way Forward:

1. Improved surveillance and response, raise awareness of the disease and avoid contact with wild animals, especially monkeys.
2. Any animals that might have come into contact with an infected animal should be quarantined, handled with standard precautions and observed for monkeypox symptoms for 30 days.
3. It is important to refocus attention on other diseases. There is a drop in the number of reported cases of endemic diseases as people are not seeking care in health facilities, owing to Covid-19.

### 3. BLACK AND WHITE FUNGUS DISEASES

#### Black fungus:

A number of Covid-19 patients are developing a serious fungal infection known as Mucormycosis also called black fungus.



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**Mucormycosis:**

1. It is a serious but rare fungal infection caused by a group of molds called mucormycetes, which is abundant in the environment.
2. It mainly affects people who have health problems or take medicines that lower the body's ability to fight germs and sickness.
3. The types of Mucormycosis are: Rhinocerebral (Sinus and Brain), Pulmonary (Lung), Gastrointestinal, Cutaneous (Skin), and disseminated Mucormycosis.

**Transmission:**

1. It occurs through inhalation, inoculation, or ingestion of spores from the environment.
2. Mucormycosis does not spread between people or between people and animals.

**Symptoms:**

1. These include pain and redness around eyes and/or nose, fever, headache, coughing, shortness of breath, bloody vomits, and altered mental status.
2. Warning signs can include toothache, loosening of teeth, blurred or double vision with pain.

**Prevention:**

Avoiding areas with a lot of dust like construction or excavation sites, avoiding direct contact with water-damaged buildings and flood water after hurricanes and natural disasters and avoiding activities that involve close contact to soil.

**Treatment:**

1. Mucormycosis needs to be treated with prescription antifungal medicine.
2. In some cases, it can require surgery.

**White fungus**

1. As the central government asks states to notify black fungus or mucormycosis an epidemic, an infection called white fungus or Candidiasis has also been found to affect some people.
2. Covid-19 patients are more prone to white fungus as it affects the lungs and similar symptoms are created like that of coronavirus.
3. Black fungus is a serious but rare fungal infection caused by a group of molds called mucormycetes, which is abundant in the environment.

**Key Points:**

1. White Fungus or Candidiasis is a fungal infection caused by a yeast (a type of fungus) called Candida.

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2. Candida normally lives on the skin and inside the body, in places such as the mouth, throat, gut, and vagina, without causing any problems.
3. Candida can cause infections if it grows out of control or if it enters deep into the body (for example, the bloodstream or internal organs like the kidney, heart, or brain).
4. The most common species that causes infection is Candida albicans.

#### Cause:

1. This infection can be caused due to low immunity, or if people come in contact with things that contain these moulds like water, etc.
2. Children and women are more at risk of contracting the fungal infection.
3. Like the black fungus, white fungus is also more likely to afflict people with compromised immune systems, pre-existing medical conditions, AIDS, a recent kidney transplant or diabetes.

#### Symptoms:

1. People experience symptoms similar to Covid if it reaches the lungs such as chest infection, despite testing negative for the virus.
2. White fungus affects the lungs as well as other parts of the body including the nails, skin, stomach, kidney, brain, private parts and mouth.

#### Diagnosis and Treatment:

1. CT scans or X-Rays can reveal the condition.
2. Patients with the white fungus are currently being treated with known anti-fungal medication.

#### Prevention:

1. Special caution is required of moulds in water that can lead to infection.
2. Proper sanitation is very important.

#### 4.OMICRON CORONA

1. The World Health Organization has declared the recently-discovered B.1.1.529 strain of Covid-19, to be a variant of concern.
2. The virus was first detected in Southern Africa and it is renamed Omicron.
3. Omicron is placed in the most-troubling category of Covid-19 variants, along with the globally-dominant Delta plus its weaker rivals Alpha, Beta and Gamma.
4. This variant has a large number of mutations. Some of them are cause for serious concern because they may allow the new variant to evade immunity obtained from a past infection or via a vaccine.
5. However, there are no reliable estimates of just how much more transmissible the Omicron variant is compared to previous strains of the virus

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6. Apart from South Africa, Omicron has been detected in Israel in people coming from Malawi, Botswana, Belgium and Hong Kong.

**Nomenclature:**

1. The WHO has decided to name the variants after the letters of the Greek alphabet, to avoid the countries that first detected them being stigmatised.
2. WHO selected the name Omicron, instead of Nu or Xi, the two letters between Mu and Omicron. This is because:
3. Xi happens to be a popular surname in China (avoiding ‘causing offence to any cultural, social, national, regional, professional or ethnic groups).
4. Nu could have been confused with the word ‘new’.

**Situation in India:**

1. Seroprevalence studies indicate that a large proportion of the population has already been exposed to the virus providing some level of protection to subsequent infections.
2. Further, the immunisation campaign has gained momentum.
3. Approximately 44% of Indian adults have been fully vaccinated and 82% have received at least one dose.
4. Scientists believe that prior infection followed by one or two doses of vaccination may have a larger protective effect than two doses of the vaccination alone.

**Variants of Concern:**

1. A variant for which there is evidence of an increase in transmissibility, more severe disease (e.g., increased hospitalizations or deaths), significant reduction in neutralization by antibodies generated during previous infection or vaccination, reduced effectiveness of treatments or vaccines, or diagnostic detection failures.
2. The new Variants could kick off new wave(s) of epidemic transmission.
3. The WHO currently lists 5 variants of concern:
  - Omicron (B.1.1.529), identified in southern Africa in November 2021
  - Delta (B.1.617.2), which emerged in India in late 2020 and spread around the world
  - Gamma (P.1), which emerged in Brazil in late 2020
  - Beta (B.1.351), which emerged in South Africa in early 2020
  - Alpha (B.1.1.7), which merged in Britain in late 2020.

**Way Forward:**

1. Scientific approach to Travel Ban: India should take a risk-based and scientific approach when considering travel curbs in light of the variant.

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2. Reinforcing Public Health Measures: New emerging variants signify public health measures are still important.
3. For example, distancing, mask-wearing, avoiding crowded spaces, and good ventilation.
4. Lesson Learnt: An important lesson the pandemic has taught us in India is the critical importance of biomedical research and capacity building – for saving lives and economic growth.

#### 5. NORO VIRUS

1. A highly contagious virus named Norovirus has been detected in Kerala.
2. It is a group of viruses that leads to gastrointestinal illness.
3. It causes inflammation of the lining of the stomach and intestines, in addition to severe vomiting and diarrhoea.
4. Norovirus is resistant to many disinfectants and can heat up to 60°C. Therefore, merely steaming food or chlorinating water does not kill the virus. The virus can also survive many common hand sanitisers.

#### Transmission:

1. A person can be infected with different varieties of norovirus several times in their lives, but developing immunity to one type doesn't provide protection against other varieties.
2. The virus can be transferred from an infected to a healthy individual through contaminated surfaces or food.
3. The virus can primarily be transmitted from oral-faecal.
4. Disease outbreaks typically occur aboard cruise ships, in nursing homes, dormitories, and other closed spaces.
5. Vulnerable Group:
6. The virus can affect people across all age groups but is known to cause serious symptoms in children, the elderly and people with comorbidities.

#### Symptoms:

Diarrhoea, Vomiting, Stomach ache, Gastrointestinal problems etc are the symptoms.

#### Treatment:

While there is no specific treatment available to cure the virus, generic medications for diarrhoea and vomiting can help cure the disease.

#### Status:

1. There are 685 million cases annually, of which 200 million are detected among children younger than five years.

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- Nearly 50,000 children die every year due to diarrhoea caused by the virus.

#### 6. EPIDEMICS THAT THREATENED THE WORLD

The World Health Organisation (WHO) has released a list of “Ten threats to global health in 2019”.

##### Ten Threats and India:

##### Air pollution, climate change:

- Nine out of 10 people are breathing polluted air across the world.
- India, with 18% of the world’s population, sees 26% of the global premature deaths and disease burden due to air pollution.

##### Noncommunicable diseases:

- Noncommunicable diseases, such as diabetes, cancer, and heart disease, are collectively responsible for over 70% of all deaths worldwide, or 41 million people.
- This includes 15 million people dying prematurely, aged between 30 and 69.
- India has been named as the “diabetes capital of the world”. India’s current estimated cancer burden — over 1.5 million new cases — is predicted to nearly double in coming 20 years.

##### Global influenza pandemic:

- WHO has said that the world may face another influenza pandemic. But, the only thing we don’t know is when it will hit and how severe it will be.
- Until January 13, 1,694 cases of swine flu had been reported in India this year, with 49 deaths. In 2018, 14,992 cases and 1,103 deaths were reported countrywide.

##### Fragile, vulnerable settings:

- More than 1.6 billion people (22% of the global population) live in places where challenges such as drought, famine, conflict, and population displacement and weak health services have left them without access to basic care.
- The massive distress in India’s farm sector has engendered waves of internal migration for work. This migrant population often live in unhygienic conditions with very little access to basic care.
- Natural calamities routinely bring health crises like the Kerala floods last year were followed by a leptospirosis outbreak.

##### Antimicrobial Resistance (AMR):

- The ability of bacteria, parasites, viruses, and fungi to resist antibiotics threatens our ability to fight with them.
- Drug resistance is driven by the overuse of antimicrobials in people and in animals, especially those used for food production, as well as in the environment.

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3. AMR is also a result of the rampant over-the-counter sale of medications without the prescription of a registered medical practitioner.
4. India, China, and the Russian Federation accounted for 47% of the global incidence of MDR-TB (Multidrug-Resistant- Tuberculosis) in 2016. India has an AMR policy but the implementation is poor.

#### **Weak primary healthcare:**

1. Primary health care is usually the first point of contact people have with their health care system, and ideally should provide comprehensive, affordable, community-based care throughout life.
2. Many countries do not have adequate primary health care facilities. This neglect may be due to a lack of resources in low- or middle-income countries and possibly also due to focus on single disease programmes in the past few decades.
3. In India, the primary care arm of Ayushman Bharat, with a proposed 1,53,000 health and wellness centers, has received less attention than Pradhan Mantri Jan Arogya Yojana (i.e. The insurance aspect of Ayushman Bharat).
4. Rural health statistics for 2017, in India, show around 8,000 posts of doctors in primary health centers are vacant (against a requirement of almost 27,000), and almost 2000 of the total 25,000 Primary Health Centres' have no doctors at all.

#### **Vaccine hesitancy:**

1. Vaccine hesitancy – the reluctance or refusal to vaccinate despite the availability of vaccines – threatens to reverse progress made in tackling vaccine-preventable diseases.
2. Vaccination prevents 2-3 million deaths a year, and a further 1.5 million could be avoided if global coverage of vaccinations is improved.

#### **Dengue:**

1. Dengue, a mosquito-borne disease that causes flu-like symptoms and is lethal and kills up to 20% of those with severe dengue.
2. WHO estimates 40% of the world is at risk of dengue, with around 390 million infections annually.
3. Dengue is endemic to India and its season is lengthening significantly. Until November 25, 2018, India saw 89,974 dengue cases and 144 deaths.

#### **HIV:**

1. According to the WHO, nearly a million people every year die due to HIV/AIDS. Since the beginning of the epidemic, more than 70 million people

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have acquired the infection, and about 35 million people have died. Today, around 37 million worldwide live with HIV.

2. India has launched a test and treat policy, made HIV treatment the right of every individual. India has also enacted the HIV/AIDS Act, 2018 which makes anti-retroviral therapy a legal right for Indians with HIV/AIDS.

**Ebola, other high threat pathogens:**

1. WHO's identifies diseases and pathogens that have the potential to cause a public health emergency but lack effective treatments and vaccines.
2. This list includes Ebola, Zika, Nipah, Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS) and disease X, which represents the need to prepare for an unknown pathogen that could cause a serious epidemic.
3. While India saw no case of Ebola, but several Indian states battled Zika in October-November 2018, and at least 17 people died of Nipah infection Kerala over April and May.

**7. REOVIRIDAE**

1. Reoviridae is a family of double-stranded RNA viruses. Member viruses have a wide host range, including vertebrates, invertebrates, plants, protists and fungi. They lack lipid envelopes and package their segmented genome within multi-layered capsids. Lack of a lipid envelope has allowed three-dimensional structures of these large complex viruses (diameter ~60–100 nm) to be obtained, revealing a structural and likely evolutionary relationship to the cystovirus family of bacteriophage. There are currently 97 species in this family, divided among 15 genera in two subfamilies. Reoviruses can affect the gastrointestinal system (such as rotaviruses) and respiratory tract. The name "reo-" is an acronym for "respiratory enteric orphan" viruses. The term "orphan virus" refers to the fact that some of these viruses have been observed not associated with any known disease. Even though viruses in the family Reoviridae have more recently been identified with various diseases, the original name is still used.
2. Reovirus infections occur often in humans, but most cases are mild or subclinical. Rotaviruses, however, can cause severe diarrhea and intestinal distress in children, and lab studies in mice have implicated orthoreoviruses in the expression of coeliac disease in pre-disposed individuals. The virus can be readily detected in feces, and may also be recovered from pharyngeal or nasal secretions, urine, cerebrospinal fluid, and blood. Despite the ease of finding reoviruses in clinical specimens, their role in human disease or treatment is still uncertain.

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3. Some viruses of this family, such as phyto-reoviruses and oryza-viruses, infect plants. Most of the plant-infecting reoviruses are transmitted between plants by insect vectors. The viruses replicate in both the plant and the insect, generally causing disease in the plant, but little or no harm to the infected insect.

#### Structure:

Reoviruses are non-enveloped and have an icosahedral capsid composed of an outer (T=13) and inner (T=2) protein shell. Ultrastructure studies show that virion capsids are composed of two or three separate layers which depends on species type. The innermost layer (core) has T=1 icosahedral symmetry and is composed of 60 different types of structural proteins. The core contains the genome segments, each of them encode a variety enzyme structure which is required for transcription. The core is covered by capsid layer T=13 icosahedral symmetry. Reoviruses have a unique structure which is contains a glycolysated spike protein on the surface.

#### Genome:

The genomes of viruses in family Reoviridae contain 10–12 segments which are grouped into three categories corresponding to their size: L (large), M (medium) and S (small). Segments range from about 0.2 to 3 kbp and each segment encodes 1–3 proteins (10–14 proteins in total). Proteins of viruses in the family Reoviridae are denoted by the Greek character corresponding to the segment it was translated from (the L segment encodes for  $\lambda$  proteins, the M segment encodes for  $\mu$  proteins and the S segment encodes for  $\sigma$  proteins).

#### Life cycle:

1. Viruses in the family Reoviridae have genomes consisting of segmented, double-stranded RNA (dsRNA). Because of this, replication occurs exclusively in the cytoplasm, and the virus encodes several proteins which are needed for replication and conversion of the dsRNA genome into positive-sense RNAs.
2. The virus can enter the host cell via a receptor on the cell surface. The receptor is not known but is thought to include sialic acid and junctional adhesion molecules (JAMs). The virus is partially uncoated by proteases in the endolysosome, where the capsid is partially digested to allow further cell entry. The core particle then enters the cytoplasm by a yet unknown process where the genome is transcribed conservatively causing an excess of positive-sense strands, which are used as messenger RNA templates to synthesize negative-sense strands.
3. The genome of the rotavirus is divided into 11 segments. These segments are associated with the VP1 molecule which is responsible for RNA synthesizes. In early events, the selection process occurs so that the entry of the 11 different RNA segments go in the cell. This procedure is performed by newly synthesized RNAs. This event ensures that one



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each of the 11 different RNA segments is received. In late events, the transcription process occurs again but this time is not capped unlike the early events. For virus different amounts of RNAs are required therefore during the translation step there is a control machinery. There are the same quantities of RNA segments but different quantities of proteins. The reason for this is that the RNA segments are not translated at the same rate.

4. Viral particles begin to assemble in the cytoplasm 6–7 hours after infection. Translation takes place by leaky scanning, suppression of termination, and ribosomal skipping. The virus exits the host cell by monopartite non-tubule guided viral movement, cell to cell movement, and existing in occlusion bodies after cell death and remaining infectious until finding another host.

#### **Multiplicity reactivation:**

Multiplicity reactivation (MR) is the process by which two or more virus genomes, each containing inactivating genome damage, can interact within an infected cell to form a viable virus genome. McClain and Spendlove demonstrated MR for three types of reovirus after exposure to ultraviolet irradiation. In their experiments, reovirus particles were exposed to doses of UV-light that would be lethal in single infections. However, when two or more inactivated viruses were allowed to infect individual host cells MR occurred and viable progeny were produced. As they stated, multiplicity reactivation by definition involves some type of repair. Michod et al. reviewed numerous examples of MR in different viruses, and suggested that MR is a common form of sexual interaction in viruses that provides the benefit of recombinational repair of genome damages.

#### **Taxonomy:**

The family Reoviridae is divided into two subfamilies based on the presence of a "turret" protein on the inner capsid. From ICTV communications: "The name Spinareovirinae will be used to identify the subfamily containing the spiked or turreted viruses and is derived from 'reovirus' and the Latin word 'spina' as a prefix, which means spike, denoting the presence of spikes or turrets on the surface of the core particles. The term 'spiked' is an alternative to 'turreted' that was used in early research to describe the structure of the particle, particularly with the cypoviruses. The name Sedoreovirinae will be used to identify the subfamily containing the non-turreted virus genera and is derived from 'reovirus' and the Latin word 'sedo', which means smooth, denoting the absence of spikes or turrets from the core particles of these viruses, which have a relatively smooth morphology."

### **8. PARVOVIRUS**

Nearly 2,000 pet and stray dogs in Amravati city were affected by canine parvovirus virus last month with veterinarians cautioning pet owners against a severe outbreak.

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**What is Parvovirus?**

1. It is a highly contagious viral disease affecting puppies and dogs.
2. It affects the intestinal tract of canines with puppies being more susceptible.
3. Bloody diarrhoea, vomiting, drastic weight loss, dehydration and lethargy are some of the symptoms.
4. The virus has reported a 90 per cent mortality rate.

This virus was discovered in 1967 and has rapidly become a serious threat to canine health. This is primarily due to the fact that the virus is hard to kill, can live for a long time in the environment, and is shed in large quantities by infected dogs.

**How does the virus spread in dogs?**

Through direct contact with an infected dog or by indirect contact with a contaminated object, including the hands and clothing of people who handle infected dogs.

**What's causing increase in the number of cases?**

1. The recent rise in cases of Parvovirus in pets is due to the Covid-19 pandemic that compelled many pet owners to avoid timely vaccination of their dogs.
2. Also, due to the non-implementation of the animal birth control programme, dog vaccination and rabies in the last three years has led to rising parvovirus cases in street dogs in the city.

**Treatment:**

Parvovirus has no cure and inoculating a puppy or a dog gives them a fighting chance against the infection.

**9. TOMATO FLU**

Recently, some parts of Kerala reported Tomato Flu among children under five years of age.

**What is Tomato Flu?**

1. The infection has been named 'tomato flu' because of the red, painful blisters that appear on a patient's body and gradually enlarge to the size of a tomato.
2. The 'tomato flu' is caused by Coxsackievirus A 16.
3. It belongs to the Enterovirus family.
4. The enteroviruses are an ancient and important group of RNA viruses.
5. Humans are the only hosts for the enteroviruses (NPEVs).
6. The infectious disease is caused by intestinal viruses and is rare in adults as they usually have immune systems strong enough to defend them from the virus.

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**Transmission:**

1. Tomato flu is very contagious and children are at increased risk of exposure to tomato flu as viral infections are common in this age group and spread is likely to be through close contact.
2. If the outbreak of tomato flu in children is not controlled and prevented, transmission might lead to serious consequences by spreading in adults as well.

**Symptoms:**

1. The primary symptoms observed in children with tomato flu are like those of chikungunya, which include high fever, rashes, and intense pain in joints.
2. As with other viral infections, further symptoms include fatigue, nausea, vomiting, diarrhoea, dehydration, swelling of joints, body aches, and common influenza-like symptoms, which are similar to those manifested in dengue.

**Treatment:**

1. This flu is a self-limiting one and there is no specific drug for this.
2. The treatment for tomato flu is similar to the treatment of chikungunya, dengue and hand, foot, and mouth disease.
3. Patients are advised to isolate, rest, plenty of fluids, and hot water sponge for the relief of irritation and rashes.

**10. WEST NILE FEVER**

1. Recently, a 47-year-old man in Thrissur, Kerala died due to West Nile Virus (WNV). This has caused the Kerala health department to be on alert.
2. Malappuram's 6-year-old boy also died of the same infection, earlier in 2019.
3. WNV was first reported in the state of Alappuzha in 2006. Later in 2011, it was also reported in Ernakulam, Kerala.

**What is WNV?**

1. The West Nile Virus is a flavivirus related to the viruses that are also responsible for causing St. Louis encephalitis, Japanese encephalitis, and yellow fever.
2. It is a mosquito-borne, single-stranded RNA virus.

**Global Prevalence:**

1. Along all major bird migratory routes, WNV outbreak sites are found.
2. Africa, Europe, the Middle East, North America, and West Asia are the regions where the virus is commonly found.

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3. Usually, WNV infections peak during the period when mosquito vectors are most active and the ambient temperature is high enough for virus multiplication for most of the countries.

**Prevalence in India:**

1. In Mumbai in the year 1952, the antibodies against WNV were first detected in humans.
2. Since then, the virus activity has been reported in southern, central, and western India.
3. In Andhra Pradesh and Tamil Nadu, WNV was isolated from *Culex vishnui* mosquitoes.
4. In Maharashtra, it was isolated from *Culex quinquefasciatus* mosquitoes.
5. In Karnataka, it has been isolated from humans.
6. Further, WNV neutralizing antibodies were found to be present in human serum collected from Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Odisha, Rajasthan and Assam.
7. In 1977, 1978 and 1981, serologically confirmed cases of WNV infections were reported in Vellore and Kolar districts, and in West Bengal in 2017.
8. During an acute encephalitis outbreak in Kerala, the complete genome sequence of WNV was isolated in 2013.
9. The association of WNV with eye infection in Tamil Nadu had been clearly established during an epidemic of mysterious fever in the first half of 2010.

**Origin:**

1. WNV was first isolated in a woman in the West Nile district of Uganda in 1937.
2. It was identified in birds in the Nile delta region in 1953. Before 1997, WNV was not considered pathogenic for birds.
3. Human infections attributable to WNV have been reported in many countries for over 50 years.

**Transmission Cycle:**

1. Principal vector for transmission is the *Culex* species of mosquitoes.
2. Birds act as the reservoir host of the virus.
3. Infected mosquitoes transmit WNV between and among humans and animals, including birds.
4. When a mosquito feeds on infected birds, they become infected.
5. The virus circulates in the blood of those infected mosquitoes for a few days, eventually getting into the mosquito's salivary glands.
6. The virus may get injected into humans and animals during later blood meals (when mosquito bites). Therein, WNV can multiply and possibly cause illness.

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7. WNV can also get transmitted from an infected mother to her child through blood transfusion or via exposure to the virus in laboratories.
8. No instance of transmission by contact with infected humans or animals has been reported.
9. It does not spread “through eating infected animals, including birds.
10. Generally, the incubation period for WNV disease is 2-6 days. However, this may range from 2-14 days, and can also be several weeks in people whose immunity is compromised.
11. According to the World Health Organization (WHO), no human-to-human transmission of WNV through casual contact has been reported till date.

#### **Symptoms:**

1. In 80% of the infected people, the disease is asymptomatic.
2. In the rest of the 20% cases, West Nile fever or severe WNV is observed with symptoms such as fever, headache, fatigue, body aches, nausea, rash, and swollen glands.
3. Severe infection may even cause neurological diseases like West Nile encephalitis or meningitis or West Nile poliomyelitis or acute flaccid paralysis.
4. Also, there are reports of WNV-associated Guillain-Barré syndrome and radiculopathy.
5. Around 1 in 150 individuals with WNS is likely to develop a more severe form of disease.
6. It may take several weeks or months to recover from severe illness.
7. Nervous system damage can last forever.
8. In persons with co-morbidities and immuno-compromised persons (such as transplant patients), the disease may turn out to be fatal.

#### **Measures of Prevention:**

1. The establishment of an active animal health surveillance system to detect new cases in birds and horses should be essentially established.
2. As WNV outbreaks in animals precede human cases, it is necessary to provide early warning for veterinary and human public health authorities.
3. The European Centre for Disease Control and Prevention (ECDC) has suggested that 28-day blood donor deferral or nucleic acid testing of prospective donors who have visited or lived in an affected area should be implemented by the European Union (EU).
4. Besides, testing for WNV infection must be done for the donors of organs, tissues and cells, who are living in or returning from an affected area.

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**Treatment:**

1. As of now, no treatment/vaccine for WNV is available.
2. Only supportive treatments can be provided to neuroinvasive WNV patients.

**Transmission Cycle:**

1. Principal vector for transmission is the culex species of mosquitoes.
2. Birds act as the reservoir host of the virus.
3. Infected mosquitoes transmit WNV between and among humans and animals, including birds.
4. When a mosquito feeds on infected birds, they become infected.
5. The virus circulates in the blood of those infected mosquitoes for a few days, eventually getting into the mosquito's salivary glands.
6. The virus may get injected into humans and animals during later blood meals (when mosquito bites). Therein, WNV can multiply and possibly cause illness.
7. WNV can also get transmitted from an infected mother to her child through blood transfusion or via exposure to the virus in laboratories.
8. No instance of transmission by contact with infected humans or animals has been reported.
9. It does not spread "through eating infected animals, including birds.
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#### Measures of Prevention:

1. The establishment of an active animal health surveillance system to detect new cases in birds and horses should be essentially established.
2. As WNV outbreaks in animals precede human cases, it is necessary to provide early warning for veterinary and human public health authorities.
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4. Besides, testing for WNV infection must be done for the donors of organs, tissues and cells, who are living in or returning from an affected area.

#### Treatment:

1. As of now, no treatment/vaccine for WNV is available.
2. Only supportive treatments can be provided to neuroinvasive WNV patients.

#### 11. BIRD FLU

1. The first human death was recorded due to Bird Flu in India this Year. This was caused by H5N1 Avian Influenza Virus.
2. Earlier, China reported the first human infection of H10N3 bird flu.

#### Key Points:

1. A disease caused by avian influenza (AI) Type A viruses found naturally in wild birds worldwide.
2. AI viruses are broadly classified as low pathogenic AI (LPAI) and highly pathogenic AI (HPAI) viruses, based on their pathogenicity. H5N1 strains come under HPAI viruses.
3. The virus can infect domestic poultry including chickens, ducks, turkeys and there have been reports of H5N1 infection among pigs, cats, and even tigers in Thailand zoos.

#### Impact:

1. Outbreaks can lead to devastating consequences for the country, particularly the poultry industry.
2. Farmers might experience a high level of mortality in their flocks, with rates often around 50%.

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#### Infection in Humans:

1. The most common route of virus transmission is direct contact with infected birds, either dead or alive, or contact with contaminated surfaces or air near the infected poultry.
2. Human-to-human transmission of the H5N1 virus is very rare.
3. Children and adults below 40 were seen to be the most affected and mortality was high in 10-19 years olds.

#### Symptoms in Humans:

1. Range from mild to severe influenza-like illnesses such as fever, cough, sore throat, muscle aches, nausea, abdominal pain, diarrhea, vomiting.
2. People can also develop severe respiratory illness (e.g., difficulty breathing, pneumonia, acute respiratory distress, viral pneumonia) and altered mental status, seizures etc.

#### Prevention and Eradication:

1. Strict biosecurity measures and good hygiene are essential in protecting against disease outbreaks.
2. If the infection is detected in animals, a policy of culling infected and contact animals is normally used in an effort to rapidly contain, control and eradicate the disease.
3. WHO's global laboratory system, the Global Influenza Surveillance and Response System (GISRS), identifies and monitors strains of circulating influenza viruses, and provides advice to countries on their risk to human health and available treatment or control measures.

#### Status of Bird Flu in India:

1. Fresh cases of bird flu were reported in different states of India between December 2020-January 2021 causing alarm across the country.
2. Previously in 2019, India was declared free from Avian Influenza (H5N1), which had also been notified to the World Organization for Animal Health (OIE).
3. The OIE is an intergovernmental organisation responsible for improving animal health worldwide. It is headquartered in Paris, France.

#### 12. SCRUB TYPHUS BACTERIA

1. An outbreak of Scrub Typhus (also known as Bush Typhus), a bacterial disease, has caused 5 deaths and 600 infections in Nagaland's Noklak district bordering Myanmar.
2. The North East Region is also suffering from an outbreak of diseases like malaria, Japanese encephalitis and Covid-19 pandemic.
3. The cattles have also been affected by African swine fever.



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**Key Points:**

1. **Caused By:** *Orientia tsutsugamushi* (Bacteria)
2. **Spread:** Through bites of Larval Mites of family trombiculid, also called Chiggers.
3. **Symptoms:** Fever, headache, body aches, and sometimes rash.
4. **Occurrence:** Rural areas of Southeast Asia, Indonesia, China, Japan, India, and northern Australia.
5. **Treatment:** Antibiotics. No vaccine available.

