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UPSC CSE 2022

SCIENCE & TECHNOLOGY



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BIOTECHNOLOGY

e-DNA

Context

- Researchers from two teams have independently shown that environmental DNA (e-DNA) can potentially identify and monitor terrestrial animals.

What is e DNA?

- Environmental DNA or eDNA is **DNA that is collected from a variety of environmental samples such as soil, seawater, snow or air, rather than directly sampled from an individual organism.**
- As various organisms interact with the environment, DNA is expelled and accumulates in their surroundings from various sources.
- Example sources of eDNA include, **feces, mucus, gametes, shed skin, carcasses and hair.**
- **Thus, in a nutshell:** Animals shed DNA through their breath, saliva, fur or faeces into the environment. These samples are called e-DNA.

Significance

- With eDNA, all pathogens can be monitored in an environment regardless of where they come from.
- An integrated eDNA monitoring program could cost-effectively provide advanced warning of human, livestock and wildlife diseases.

eDNA metabarcoding

- eDNA metabarcoding is a novel method of assessing biodiversity wherein samples are taken from the environment via water, sediment or air from which DNA is extracted, and then amplified using general or universal primers in polymerase chain reaction and sequenced using next-generation sequencing to generate thousands to millions of reads. From this data, species presence can be determined, and overall biodiversity assessed. It is an interdisciplinary method that brings together traditional field-based ecology with in-depth molecular methods and advanced computational tools.

GM CROPS

Context

- Recently, the world's first genetically modified (GM) rubber plant was planted on the outskirts of Guwahati, Assam.

About

- Genetically modified crops (GM crops) are plants used in agriculture, the DNA of which has been modified using genetic engineering methods.
- GM crops were first introduced in the U.S. in the mid-1990s.

The debate around GM Crops

Merits

Reduced input burden

- Since genetically modified crops require minimal pesticides, fertilizers or insecticides the cost of input is greatly reduced.

Disease resistant and Sustainability

- Through genetic modifications the genetically modified crops are made resistant to diseases. This enhances their sustainability and yield.

Environmental Protection

- According to an Oklahoma State University report, the increase of GM animals and crops often requires less time, tools and chemicals, and may help with reducing greenhouse gas emissions, soil erosion and environmental pollution.

Longer Shelf life

- Genetically modified foods have a longer shelf life. This enhances the ease of transportation and storage.

Affordability

- Due to reduced burden of inputs and longer shelf life hence reduced wastages, the prices of the output will be low.
- This increases the affordability.

Fortification

- According to the Food and Agricultural Organization of the United Nations, some GM foods have been engineered to become more nutritious in terms of vitamin or mineral content.
- This not only helps people get the nutrients they need, but also plays a significant role in fighting against malnutrition in third-world countries.

Decreased Use of Pesticides

- It has been proven that genetically modified crops do not need pesticides to become stronger against various types of insects or pests that may destroy them.

Demerits

Gene Transfer

- A constant risk of genetically modified foods is that an organism's modified genes may escape into the wild.
- Experts warn that genes from commercial crops that are resistant to herbicides may cross into the wild weed population, thus creating super-weeds that have become impossible to kill.

Antibiotic resistance

- Genetically modified crops have inbuilt antibiotic properties due to their inbuilt mechanisms for disease control.
- This can result in superbugs which can disrupt the health care sector.

Carcinogen exposure risk

- There are researches which show that crops tolerant to commercial pesticides greatly increase the risk of cancer development in rats.
- Genetically modified crops can also pose serious threats to human health.

Lower Level of Biodiversity

- When we remove a certain pest that is harmful to crops, we could also be removing a food source for a certain species.
- In addition, genetically modified crops could prove toxic to some organisms, which can lead to their reduced numbers or even extinction.

Gene Spilling

- It is unclear what effects, if there are any, the genetic pollution resulting from inadequate sequestering of genetically modified crop populations would have on the wild varieties surrounding them.

Exploitation

- Some countries may use genetic engineering of foods as a very powerful weapon against their enemies.

Widening Gap of Corporate Sizes

- This disadvantage can possibly happen between food-producing giants and their smaller counterparts.

- Larger companies might have more political power and might be able to influence safety and health standards.

New Diseases

- As previously mentioned, genetically modified foods can create new diseases.

Economic Concerns

- Consumer advocates are worried that this will raise seed prices to very high levels that third-world countries and small farmers cannot afford them, thus widening the gap between the rich and the poor.

EMBRYO SELECTION WITH POLYGENIC SCORES

Context

- A special report published in the New England Journal of Medicine raises serious questions about the benefits, risks and ethics of a new service offered by companies called ESPS or "**embryo selection based on polygenic scores.**"

What is ESPS?

- ESPS allows in vitro fertilization patients to select embryos with the goal of choosing healthier and even smarter children.
- Polygenic scores are a "weighted average of the contributions of all of the genes we have information on in the genome, to try to predict whether one person has a higher or lower rate of a disease or some trait."
- Thus, parents are tempted to use polygenic scores to pick embryos predicted to have specific traits they treasure, hoping to produce kids who are taller, smarter, or less likely to develop cancer or heart disease.

Benefits

- It allows parents to give the child genes that they do not carry. Individuals 'tailor-made' to show desirable characteristics.
- In a nutshell, ESPS is the drive to create the population of perfect people.
 1. Prevents Genetic Diseases:
 2. Optimized chance of a successful pregnancy:
 3. It can increase human lifespan for up to 30 years.
 4. Right to Genetic Determinism: Parents can set their own limits for genetically engineering their baby. The government does not have the right to control means of reproduction.

Gain of Function Research

Context

- The term 'gain of function research' has recently cropped up in the debate about the origins of the Covid-19 pandemic, which has killed over 34 lakh people worldwide.

About

- 'Gain of function' is a field of research focused on growing generations of microorganisms, under conditions that cause mutations in a virus.
- These experiments are termed 'gain of function' because they involve manipulating pathogens in a way that they gain an advantage in or through a function, such as increased transmissibility, virulence, immunogenicity, and host tropism.
- Such experiments allow scientists to better predict emerging infectious diseases, and to develop vaccines and therapeutics.

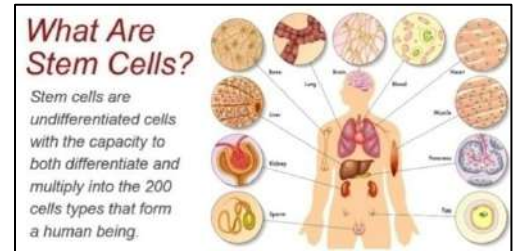
STEM CELL RESEARCH

Context

- Indian stem cell and developmental biologist Prof. Maneesha S Inamdar has been part of the WHO Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing.

About

- Stem cells are the body's raw materials – cells from which all other cells with specialized functions are generated.
- No other cell in the body has the natural ability to generate new cell types.**
- They are **found in both embryonic and adult organisms.**
- They serve as a repair system for the body



Embryonic stem cells

- Embryonic stem cells supply new cells for an embryo as it grows and develops into a baby.
- These stem cells are said to be pluripotent, which means they can change into any cell in the body.

Adult stem cells

- Adult stem cells supply new cells as an organism grows and to replace cells that get damaged.
- Adult stem cells are said to be multipotent, which means they can only change into some cells in the body, not any cell, for example:
- Blood (or 'haematopoietic') stem cells can only replace the various types of cells in the blood. Skin (or 'epithelial') stem cells provide the different types of cells that make up our skin and hair.

- Helps us understand the basic biology of how living things work and what happens in different types of cell during disease.
- Therapy – to replace lost or damaged cells that our bodies can't replace naturally.
- Grow new cells in a laboratory to replace damaged organs or tissues
- Correct parts of organs that don't work properly
- Research causes of genetic defects in cells
- Research how diseases occur or why certain cells develop into cancer cells
- Test new drugs for safety and effectiveness

Autosomal DNA

Context

- A technique based on 'autosomal DNA' has been used for the first time to identify the great-grandson and closest living relative of Sitting Bull, a prominent 19th century Native American leader.

About

- Autosomal DNA is a term used in genetic genealogy to describe DNA which is inherited from the autosomal chromosomes.
- An autosome is any of the numbered chromosomes, as opposed to the sex chromosomes.
- Humans have 22 pairs of autosomes and one pair of sex chromosomes (the X chromosome and the Y chromosome).
- Autosomes are numbered roughly in relation to their sizes.

Bio-methanation Technology

In News

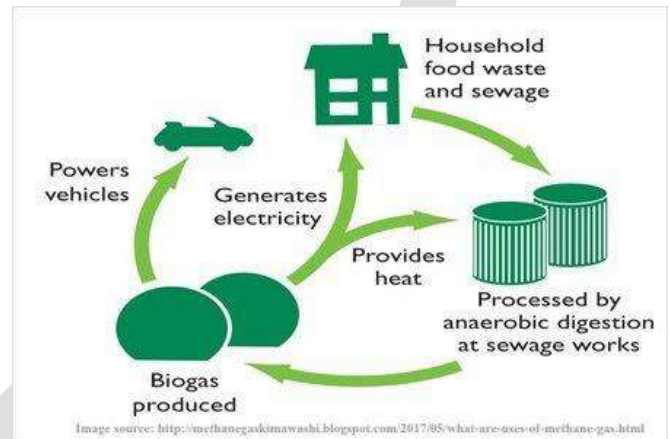
- A new high rate bio-methanation technology for the integrated treatment of sewage and organic solid waste and concomitant generation of biogas and bio manure can treat groundwater and wastewater and convert it to potable water. It can be used for sewage and organic solid waste treatment with decentralized applications in various parts of India.
- Solid and liquid wastes are major challenges faced by big cities as also for the rapidly urbanizing areas, and sustainable technologies are needed for tackling them.
- An integrated treatment of sewage along with organic solid waste in India could help evolve a sustainable technology to overcome the solid and liquid waste disposal issues.

About

- Bio-methanation is a process by which **organic material is microbiologically converted under anaerobic conditions to biogas.**
- Three main physiological groups of microorganisms are involved: **fermenting bacteria, organic acid oxidizing bacteria, and methanogenic archaea.**

Biogas

- Biogas mainly consists of methane (about 60-75%), carbon dioxide (about 25-40%) besides small quantities of NH₃ and H₂S and has a Calorific Value of about 5000 kcal /m³.
- Biogas can be utilized either for cooking / heating applications, or for generating motive power or electricity through dual-fuel, gas engines, low pressure gas turbines or steam turbines.



Advantages of Anaerobic Digestion / Biomethanation

- Generation of gaseous fuel;
- Can be done on a small-scale;
- No external power requirement unlike aerobic treatment;
- Enclosed system enables all the gas produced to be collected for use. Green house gases
- Emission to the atmosphere is avoided;
- Free from bad odour, rodent and fly menace, visible pollution and social resistance;
- Modular construction of plant and closed treatment needs less land area; and
- Production of biogas and high grade soil conditioner.

Precision-Guided Sterile Insect Technique (pgSIT)

Context

- Leveraging advancements in CRISPR-based genetic engineering, researchers have created a system that restrains populations of mosquitoes that infect millions each year with debilitating diseases.

About

- The “precision-guided sterile insect technique” (pgSIT), **alters genes linked to male fertility – creating sterile offspring – and female flight in Aedes aegypti**, the mosquito species responsible for spreading diseases including dengue fever, chikungunya and Zika.
- The pgSIT uses CRISPR to sterilise male mosquitoes and render female mosquitoes (which spread disease) flightless.
- The system is self-limiting and is not predicted to persist or spread in the environment, two safety features that should enable acceptance for this technology.
- The scientists say pgSIT eggs can be shipped to a location threatened by mosquito-borne disease or developed at an on-site facility that could produce the eggs for nearby deployment.

- Once the pgSIT eggs are released in the wild, sterile pgSIT males will emerge and eventually mate with females, driving down the wild population as needed.



CSIR – National Environmental Engineering Research Institute (NEERI)

ICMR approved the use of Saline Gargle RT-PCR test developed by CSIR NEERI for COVID-19 detection

Salient features and Advantages

- ✓ Nasopharyngeal swab, oropharyngeal swab and viral transport medium NOT required.
- ✓ Skilled health care workers for sample collection NOT required.
- ✓ Non-invasive sampling and patient friendly.
- ✓ Waste generation during sample collection is minimised.
- ✓ Self sampling is possible.
- ✓ Fast sampling is possible.
- ✓ Long queues of patients/persons at sample collection centre can be minimised.
- ✓ No RNA extraction kit required. Simple room temperature incubation in buffer, followed by heating for few minutes is good enough to give reasonably good RNA template for Direct RT-PCR.
- ✓ Saves time and money.

www.neeri.res.in @Csir Neeri @CSIR_NEERI @csirneeri

ANTI-BACTERIAL FABRIC

Context

- Union Minister for MSME Narayana Rane launched the unique anti-bacterial fabric developed by Kumarappa National Handmade Paper Institute, Jaipur, under Khadi and Village Industries Commission (KVIC).

About

- The fabric is treated with anti-bacterial agent extracted from cow dung which prevents bacterial growth in the fabric.
- This innovative fabric could be great use in hospitals and other medical facilities.

INDIA'S FIRST IVF CALF BORN

Context

- With the birth of first IVF calf of a Buffalo breed namely Banni in the country, India's OPU - IVF work has reached to next level.

About

- In vitro fertilization (IVF) is used clinically in cattle and humans.
- In vitro fertilisation (IVF) is a **process of fertilisation where an egg is combined with sperm in vitro ("in glass")**.
- The process involves monitoring and stimulating a female's ovulatory process, removing an ovum or ova (egg or eggs) from her ovaries and letting sperm fertilise them in a culture medium in a laboratory.
- After the fertilised egg (zygote) undergoes embryo culture, it is implanted in the female.
- IVF is a type of **assisted reproductive technology used for infertility treatment and gestational surrogacy**.

- A fertilised egg may be implanted into a surrogate's uterus, and the resulting child is genetically unrelated to the surrogate.

Biotech-PRIDE

Context

- Recently, Promotion of Research and Innovation through Data Exchange) Guidelines [Biotech-PRIDE] was released.

About

- Biotech-PRIDE is developed by **Department of Biotechnology (DBT), Ministry of Science and Technology.**
- Bio-Grid will be a National Repository for biological knowledge, information and data and will be responsible for enabling its exchange, developing measures for safety, standards and quality for datasets and establishing detailed modalities for accessing data.
- The Biotech PRIDE will be **implemented through Indian Biological Data Centre (IBDC) at Regional Centre for Biotechnology** supported by Department of Biotechnology.

End-to-End Genome Sequencing

Context

- Recently, a preprint titled "**The complete sequence of the human genome**" was posted in the online repository bioRxiv.
- In this preprint, scientists reported the most complete sequencing of the human genome until now.

Gene Sequencing

- DNA sequencing is a laboratory technique used to determine the exact sequence of bases (A, C, G, and T) in a DNA molecule.
- The DNA base sequence carries the information a cell needs to assemble protein and RNA molecules.

Background

- The Human genome project announced in 1990 announced a complete human genome but about 15% of it was incomplete.

IndiGau

Context

- Union Minister of Science & Technology released "IndiGau"

About

- IndiGau is **India's first Cattle Genomic Chip for the conservation of pure varieties of indigenous cattle breeds** like, Gir, Kankrej, Sahiwal, Ongole etc.
- This chip will have practical utility in the Governments schemes to achieve the goal of conservation of our own breeds with better characters and help towards doubling of farmers' income by 2022.
- The manufacturing of this chip is **in synergy with Rashtriya Gokul Mission.**
- This indigenous chip was developed by the concerted efforts of scientists of National Institute of Animal Biotechnology (NAIB), Hyderabad, and an **autonomous institution under the aegis of the Department of Biotechnology.**

Importance of conserving Indigenous Breeds

- **Crossbreds are more productive** but their tendency to wilt under Indian conditions of low input and harsh climate and susceptibility to tropical diseases warrants the conservation and development of indigenous breeds.
- The annual loss in milk production of cattle and buffaloes due to thermal stress in 2020 is about 3.2 million tonnes of milk.

- Indigenous cattle are well known for their quality of **heat tolerance and ability to withstand extreme climatic conditions.**
- So, the urgency for protection and conservation of indigenous breeds cannot be over emphasised.
- For instance breeds like **Punganur, Vechur and Krishna Valley** are rapidly declining and require immediate attention.

Rashtriya Gokul Mission

- Rashtriya Gokul Mission (RGM) was launched in December 2014 for development and conservation of indigenous breeds through selective breeding in the breeding tract and genetic up-gradation of nondescript bovine population.
- Rashtriya Gokul Mission will be **implemented through the “State Implementing Agency (SIA viz Livestock Development Boards).**
- The scheme comprises of two components namely National Programme for Bovine Breeding (NPBB) and National Mission on Bovine Productivity (NMBP).

Objectives

- The Rashtriya Gokul Mission has the following objectives:
 1. To undertake breed improvement programme for indigenous cattle breeds so as to improve the genetic make-up and increase the stock.
 2. To enhance milk production and productivity of indigenous bovines.
 3. To upgrade nondescript cattle using elite indigenous breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar, Red Sindhi.
 4. To distribute disease-free high genetic merit bulls of indigenous breeds for natural service.

Initiatives under Rashtriya Gokul Mission

- **Awards** for encouraging farmers/breeder societies to rear Indigenous breeds of bovines:
- **Gopal Ratna awards:** for farmers maintaining the best herd of Indigenous Breed and practicing best management practices.
- **Kamdhenu awards:** for best managed Indigenous herd by Institutions/Trusts/ NGOs/ Gaushalas or best-managed Breeders’ societies.
- **National Kamdhenu Breeding Centre:**to develop and conserve Indigenous Breeds in a holistic and scientific manner.
- **Gokul Gram:** These are integrated cattle development centers, ‘Gokul Grams’ to develop indigenous breeds including up to 40% nondescript breeds (belonging or appearing to belong to no particular class or kind).
- **E-Pashu Haat:** An e-market portal connecting breeders and farmers, for quality- disease-free bovine germplasm.
- **National Bovine Genomic Center for Indigenous Breeds (NBGC-IB)** for selection of breeding bulls of high genetic merit at a young age using highly precise gene-based technology.
- **Advanced Reproductive Technology:** In-vitro Fertilization (IVF)/ Multiple Ovulation Embryo Transfer (MOET) and sex-sorted semen technique to improve the availability of disease-free female bovines.
- **Pashu Sanjivni:** to estimate bovine productivity by registration of bovine animals in milk production.

Gene Bank

Context

- Union Agriculture Minister inaugurated the world's second-largest refurbished gene bank at the National Bureau of Plant Genetic Resources (NBPGR), Pusa, New Delhi.
- The National Gene Bank established in the year 1996 to preserve the seeds of Plant Genetic Resources (PGR) for future generations, has the capacity to preserve about one million germplasm in the form of seeds.

About

- Gene banks are a type of biorepository that preserves genetic material.
- For plants, this is done by in vitro storage, freezing cuttings from the plant, or stocking the seeds (e.g. in a seedbank).

- For animals, this is done by the freezing of sperm and eggs in zoological freezers until further need.
- Genetic material in a 'gene bank' is preserved in a variety of ways, such as **freezing at -196° Celsius in liquid nitrogen**, being placed in artificial ecosystems, and put in controlled nutrient mediums.
- **Svalbard Global Seed Vault** is located on the **Norwegian island of Spitsbergen in the remote Arctic Svalbard archipelago**

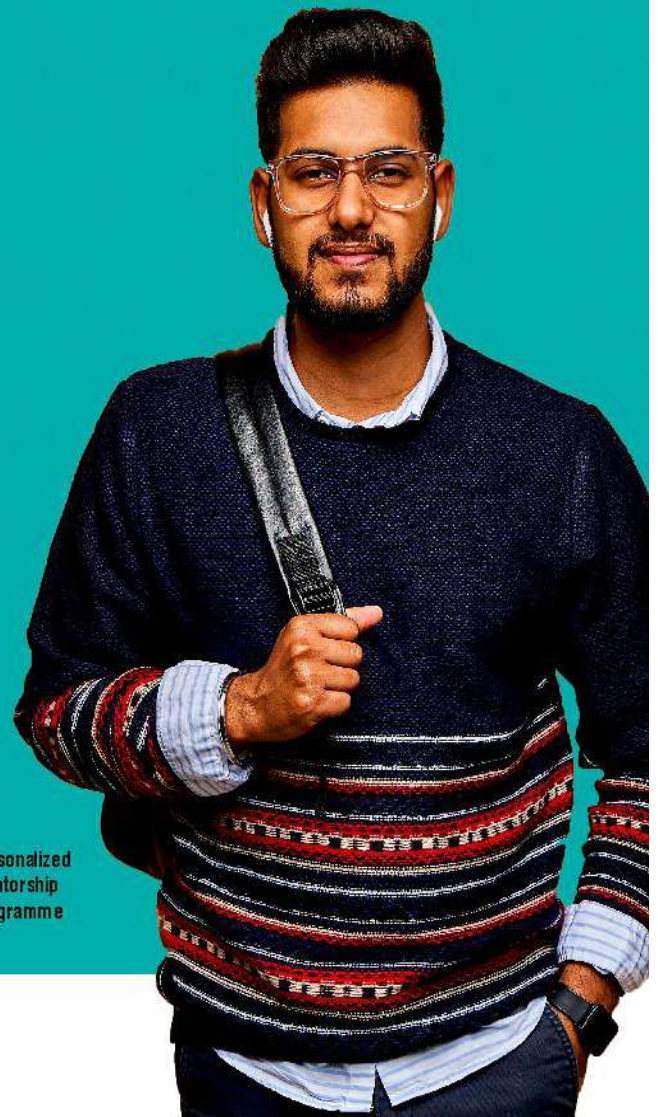


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NANOTECHNOLOGY

International Conference on Nanotechnology for Better Living

Context

- Union Minister of State Science & Technology inaugurated a five-day International Conference on Nanotechnology for Better Living at National Institute of Technology (NIT), Srinagar.
- This is the 7th Edition of the Conference and is being held **under the aegis of Materials Research Society of India** in association with Anna University, SKUAST-K, NIT Mizoram, SSM College of Engineering, IIT Madras, SKIMS, M G University Kerela, and in collaboration with Nanoscale Research Facility (NRF), IIT Delhi.

Nanotechnology

- Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.
- Nanotechnology is the understanding and control of matter at the nanoscale, at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications.
- In the International System of Units, the prefix "nano" means one-billionth, or 10^{-9} ; therefore one nanometer is one-billionth of a meter.

Few examples and applications of Nanotechnology

- Nanotechnology and nanomaterials can be applied in all kinds of industrial sectors. They are usually found in these areas:

Electronics

- Carbon nanotubes are close to replacing silicon as a material for making smaller, faster and more efficient microchips and devices, as well as lighter, more conductive and stronger quantum nanowires. Graphene's properties make it an ideal candidate for the development of flexible touchscreens.

Energy

- A new semiconductor developed by Kyoto University makes it possible to manufacture solar panels that double the amount of sunlight converted into electricity. Nanotechnology also lowers costs, produces stronger and lighter wind turbines, improves fuel efficiency and, thanks to the thermal insulation of some nanocomponents, can save energy.

Biomedicine

- The properties of some nanomaterials make them ideal for improving early diagnosis and treatment of neurodegenerative diseases or cancer.
- They are able to attack cancer cells selectively without harming other healthy cells.
- Some nanoparticles have also been used to enhance pharmaceutical products such as sunscreen.

Environment

- Air purification with ions, wastewater purification with nanobubbles or nanofiltration systems for heavy metals are some of its environmentally-friendly applications.
- Nanocatalysts are also available to make chemical reactions more efficient and less polluting.

Food


- In this field, nanobiosensors could be used to detect the presence of pathogens in food or nanocomposites to improve food production by increasing mechanical and thermal resistance and decreasing oxygen transfer in packaged products.

Textile


- Nanotechnology makes it possible to develop smart fabrics that don't stain nor wrinkle, as well as stronger, lighter and more durable materials to make motorcycle helmets or sports equipment.

Nanotechnology, up close


Advantages



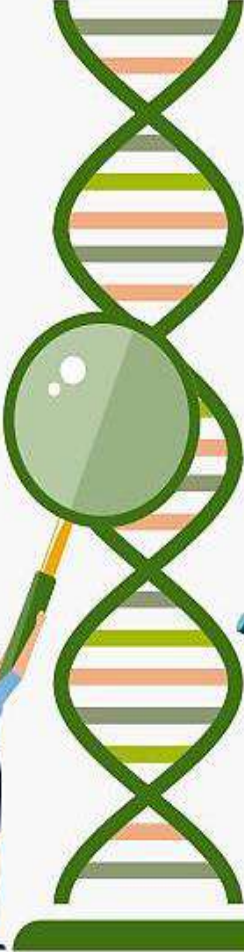
Promoting renewable energies
It enables new ways to obtain and store energy. It also makes **solar panels cheaper** and more efficient.




It extends the limits of electronics
Unlike silicon microchips, nanochips will make it possible to build **very precise circuits** at an atomic level.




It allows a more effective medicine
Arteries can be unblocked, cells can be selectively attacked, **damaged genes can be repaired** and faster and more precise surgeries can be performed.




Disadvantages



It threatens the environment
This type of technology could **cause negative effects on the environment** by generating new toxins and pollutants.



It has an impact on the job market
The obsolete materials and changes in production processes could **destroy jobs**, but this technology could create others.



It compromises the safety
The properties of this technology could **facilitate espionage**, the production of nanoweapons and smart bullets.



UPSC CSE PRELIMS TEST SERIES

2022

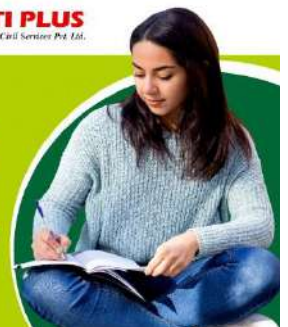
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IT & COMPUTER

MILLIMETRE WAVE BAND IN 5G

Context

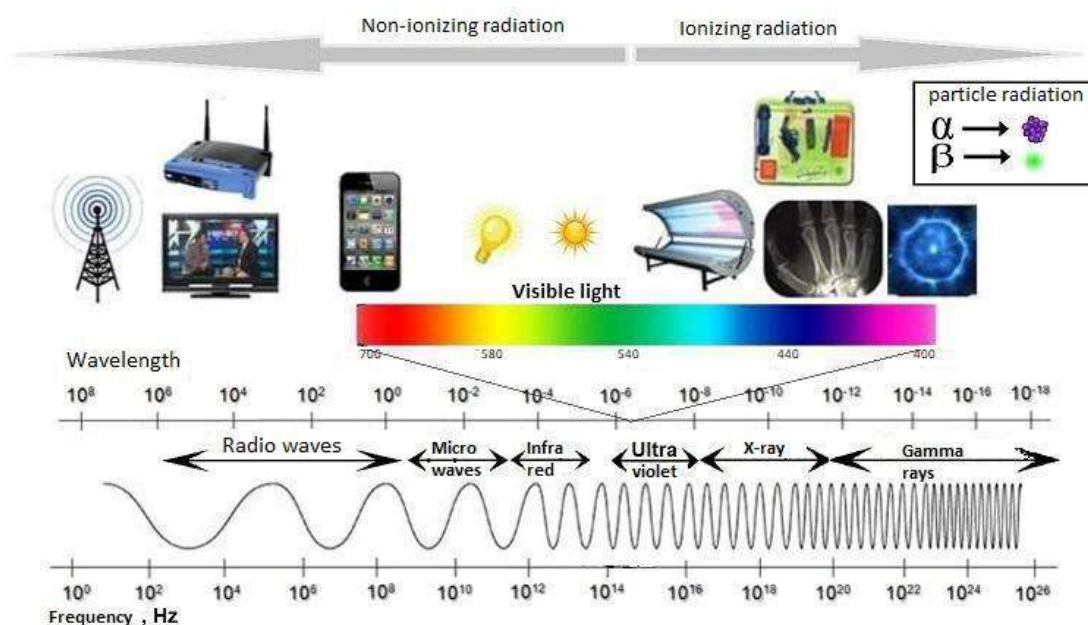
- The Satcom Industry Association-India (SIA), has voiced concerns over the Government's plan to include the Millimetre Wave (mm Wave) bands in the 5G spectrum auction.

Decoding Spectrum and Bands in Telecommunication

What is Spectrum?

- Spectrum refers to the invisible radio frequencies that wireless signals travel over.
- Those signals are what enable us to make calls from our mobile devices, tag our friends on Instagram, call an Uber, and do everything on our mobile devices.
- The frequencies we use for wireless are only a portion of what is called the electromagnetic spectrum.

The electromagnetic spectrum



Bands

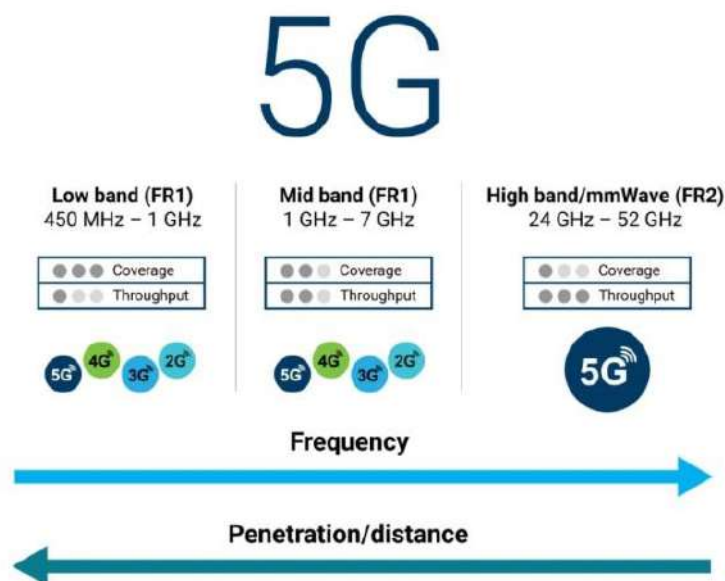
- Portions of electromagnetic spectrum are grouped in "bands" depending on their wavelengths – the distance over which the wave's shape repeats.
- The full electromagnetic spectrum ranges from three Hz (extremely low frequency) to 300 EHz (gamma rays).
- The portion used for wireless communication sits within that space and ranges from about 20 KHz to 300 GHz.
- Different bands have slightly different characteristics. For the purposes of wireless communication, we can think of spectrum in three categories: low-, mid-, and high-band spectrum.
- These spectrum frequencies are transmitted between cell sites and our mobile devices.
- Low-band spectrum (under 3 GHz)** travels longer distances with minimal signal interruption. Today's wireless networks are built primarily on low-band spectrum.
- High-band spectrum (above 24 GHz)** travels much shorter distances – think meters, not miles – compared to low-band spectrum, but offers high capacity and ultra-fast speeds.
- Mid-band spectrum (between 3 and 24 GHz)** blends the characteristics of both low- and high-band spectrum – providing a mix of coverage and capacity.

5 G

- 5G is the **fifth generation of cellular technology**. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks.
- 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.
- 5G wireless technology is meant to deliver **higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users.**
- **Network Standard:** MIMO

Comparison	2G	3G	4G	5G
Introduced in year	1993	2001	2009	2018
Technology	GSM	WCDMA	LTE, WiMAX	MIMO, mm Waves
Access system	TDMA, CDMA	CDMA	CDMA	OFDM, BDMA
Switching type	Circuit switching for voice and packet switching for data	Packet switching except for air interference	Packet switching	Packet switching
Internet service	Narrowband	Broadband	Ultra broadband	Wireless World Wide Web
Bandwidth	25 MHz	25 MHz	100 MHz	30 GHz to 300 GHz
Advantage	Multimedia features (SMS, MMS), internet access and SIM introduced	High security, international roaming	Speed, high speed handoffs, global mobility	Extremely high speeds, low latency
Applications	Voice calls, short messages	Video conferencing, mobile TV, GPS	High speed applications, mobile TV, wearable devices	High resolution video streaming, remote control of vehicles, robots, and medical procedures

Bands in 5 G



About Millimetre Wave Band in 5g

- Millimetre Wave band or mmWave is a particular segment of radio frequency spectrum that ranges between 24 GHz and 100 GHz.

Advantages

Seamless data transfer

- This spectrum, has a short wavelength, and is apt to deliver greater speeds and lower latencies.
- This in turn makes data transfer efficient and seamless as the current available networks work optimally only on lower frequency bandwidths.

Cover greater distances

- 5G services can be deployed using lower frequency bands.
- They can cover greater distances and are proven to work efficiently even in urban environments, which are prone to interference.

Data speeds

- But, when it comes to data speeds, these bands fail to hit peak potential needed for a true 5G experience.
- So, mmWave is that quintessential thing in 5G for mobile service providers.

Concern

Disrupt of the satellite communication Industry

- 27.5-31 GHz and 17.7-21.2 GHz bands have been preserved for satellite-based broadband services as per the International Telecommunication Union (ITU).
- The 24.25-27.5 GHz band particularly had been the subject of controversy due to out-of-band emissions into the passive satellite band used for weather satellites at 23.6-24 GHz.

Denial of advanced broadband services

- Offering excessive spectrum resources in the upcoming 5G auction will result in Indian citizens being denied the benefits of high-demand, advanced satellite broadband services.

Loss in Economy

- It will result in a massive loss to the Indian economy, along with the loss of foreign direct investment (FDI) and employment generation benefits.

NATIONAL SUPERCOMPUTING MISSION (NSM)

Context

- As per the ministry of science and technology's annual year-end review: Under the National Super-Computer Mission (NSM), four new Supercomputers have been installed since July 2021 at IIT-Hyderabad, NABI-Mohali, CDAC-Bengaluru and IIT Kanpur.

About NSM

- It is a first of its kind Mission to boost the country's computing power.
- The mission was set up to provide the country with supercomputing infrastructure to meet the increasing computational demands of academia, researchers, MSMEs, and startups by creating the capability design, manufacturing, of supercomputers indigenously in India.

Agencies involved

- The National Super Computing Mission is steered jointly by the Ministry of Electronics and IT (MeitY) and Department of Science and Technology (DST).
- It is being implemented by the Centre for Development of Advanced Computing (C-DAC), Pune and the Indian Institute of Science (IISc), Bengaluru.

Target

- The target of the mission was set to establish a network of supercomputers ranging from a few Tera Flops (TF) to Hundreds of Tera Flops (TF).
- Plus, three systems with greater than or equal to 3 Peta Flops (PF) in academic and research institutions of National importance across the country by 2022.

Supercomputers

- Supercomputer, are a class of extremely powerful computers.
- They refer to the fastest high-performance systems available at any given time.

- Such computers have been used primarily for scientific and engineering work requiring exceedingly high-speed computations.
- Common applications for supercomputers include testing mathematical models for complex physical phenomena or designs, such as climate and weather, evolution of the cosmos, nuclear weapons and reactors, new chemical compounds (especially for pharmaceutical purposes), and cryptology.

Supercomputers in India

- India is ranked 23rd in the world in terms of number of supercomputers.
- Cray XC40-based Pratyush is the fastest supercomputer in India. Mihir ranks 67 in the world.
- **The first supercomputer of India** assembled indigenously, called **Param Shivay**, was installed in IIT (BHU).
- By this year, the government aims to install 73 indigenously supercomputers across the country.

OPEN-SOURCE SOFTWARE

In News

- The open-source software repository service GitHub is in the news after it was used to create and share an offensively named app that sexually harassed Muslim women in India.
- The app used pictures of the women stolen from their social media handles and invited “users” to bid for them.

About

- The term open source refers to something people can modify and share because its design is publicly accessible.
- In a nutshell, Open source software is software with source code that anyone can inspect, modify, and enhance.



Closed vs Open Source

- Some software has source code that only the person, team, or organization who created it – and maintains exclusive control over it – can modify.
- This kind of software is called "proprietary" or "closed source" software.
- Open source software is different. Its authors make its source code available to others who would like to view that code, copy it, learn from it, alter it, or share it.
- Open source licenses affect the way people can use, study, modify, and distribute software.

Web 3.0

Context

- The concept of Web3, also called Web 3.0, used to describe a potential next phase of the internet, created quite a buzz in 2021.

Details

- **About:** Web 3.0 is the upcoming third generation of the internet where websites and apps will be able to process information in a smart human-like way through technologies like machine learning (ML), Big Data, decentralized ledger technology (DLT), etc.
- **Aim:** It aims to create a level of transparency, where smart contracts will control user data and transactions instead of centralised organizations.
- **Significance:** Data will be interconnected in a decentralized way, which would be a huge leap forward to our current generation of the internet (Web 2.0), where data is mostly stored in centralized repositories.

Closing Thoughts

- The new internet will provide a more personal and customized browsing experience, a smarter and more human-like search assistant, and other decentralized benefits that are hoped will help to establish **a more equitable web.**
- This will be achieved by empowering each individual user to become a sovereign over their data.

Global Cyber Security Index (GCI) 2020

In News

- According to a United Nations Report, India has jumped 37 places to 10th position in the Global Cyber Security Index (GCI) 2020.
- Breaking into the top 10 list, India also ranks fourth in the Asia-Pacific region.
- The top rank in the GCI was achieved by the US with a score of 100.

About GCI

- The GCI is a composite index created, analyzed and published by the International Telecommunication Union (ITU) - a specialized agency of the United Nations.
- It measures the commitment to cyber-security of its 194 member countries to raise cyber-security awareness.
- The latest report is the fourth GCI edition by the ITU, the first version of which was launched six years ago.
- Each country's development or engagement is assessed along five pillars - (i) Legal measures, (ii) Technical measures, (iii) Organizational measures, (iv) Capacity development, and (v) Cooperation- and then aggregated into a composite score.

METAVERSE

Context

- Facebook has renamed itself as Meta.

What is Metaverse actually?

- Metaverse is a parallel, virtual, world where users can have different identities, possessions and characters.
- In the complex explanation, Metaverse is supposed to be the post-Internet world, a decentralised computing platform.
- The metaverse is being envisioned as a new world order really, where your services could be offered virtually in exchange for other virtual assets, or Cryptocurrencies.
- Interoperability is key to metaverse's success.

INDIA INTERNET GOVERNANCE FORUM (IIGF)

Context

- India Internet Governance Forum (IIGF) event will be conducted jointly by Ministry of Electronics and IT, NIXI and Multistakeholder Group from 8th to 11th of November, 2021.

Details

- The India Internet Government Forum is an initiative associated with the UN Internet Governance Forum (UN-IGF).
- The theme of IIGF 2021 is 'Empower India through Power of Internet'.
- The event will witness enlightening discussions on the road to Digitization in India.
- India Internet Governance Forum(IIGF) has been constituted in conformance to IGF-Paragraph 72 of the Tunis Agenda of the UN-based Internet Governance forum (IGF).
- The Internet Governance Forum (IGF) is a multi-stakeholder platform bringing representatives together from various groups to discuss public policy issues related to the Internet.
- Through an open and inclusive process, IIGF brings together all stakeholders in the Global Internet governance ecosystem, including government, industry, civil society, academia - as equal participants of the larger Internet Governance discourse.

RADIO OVER INTERNET PROTOCOL (ROIP)

Context

- In view of a much needed solution for providing effective long range Marine communication, the Radio over Internet Protocol (ROIP) System at Syama Prasad Mookerjee Port, Kolkata (SMP, Kolkata), was inaugurated.

About

- ROIP system is being introduced as a marine communication mode, for the first time in any Major Indian Port.
- Radio over Internet Protocol, or RoIP, is similar to Voice over IP (VoIP), but augments two-way radio communications rather than telephone calls.

CRISP M TOOL

Context

- Union Minister of Rural Development & Panchayati Raj, Giriraj Singh, launched the “Climate Resilience Information System and Planning (CRISP-M) tool” through a virtual event.

About

- A New CRISP-M tool has been launched in order to integrate the climate information in the “Geographic Information System (GIS) based watershed planning” under the MGNREGA.
- This tool will help in embedding climate information in GIS based planning as well as implementation of Mahatma Gandhi NREGA (MGNREGA).
- This tool was developed with the help of British Government and all the stakeholders. They supported the Rural Development Ministry in developing the tool.
- This tool will open up new possibilities for rural communities in dealing with the climate change issues.
- This tool will be used in seven states namely, Bihar, Uttar Pradesh, Jharkhand, Chhattisgarh, Madhya Pradesh, Odisha and Rajasthan, for developing climate resilience.

FOSS4GOV INNOVATION CHALLENGE

Context

- The government has extended the last date of participation and submission in FOSS4Gov Innovation Challenge till 15th of September.

About

- The **Ministry of Electronics & Information Technology (MeitY)** had announced #FOSS4Gov Innovation Challenge to accelerate adoption of Free and Open Source Software (FOSS) in Government and build Indian FOSS Ecosystem.
- Through this challenge, the government invites innovators, start-ups, working professionals, academics and students in India to showcase their existing FOSS based innovations and/or build new, implementable, open source product innovations in Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) with possible applications for Govtech in Health, Education, Agriculture, Urban Governance etc.

ADAPTIVE REFRESH RATE

Context

- The recent iPhone 13 Pro range is offering a 120Hz high-refresh-rate display which Apple is calling ProMotion.

Refresh Rate

- Simply put, **refresh rate means how many times the image on a screen can be updated** or “refreshed” every second – much faster than your eye can detect.
- A 60Hz TV can refresh the screen 60 times per second, while a 120Hz on the iPhone 13 Pro can refresh the screen 120 times per second. The higher the refresh rate, the more times per second the screen is refreshing its pixels.

Adaptive Refresh Rate

- When a display has an adaptive refresh rate the refresh rate changes from **10Hz to 120Hz** depending on the content being played.
- So, a static website will be played at a 10Hz refresh rate and a game at a 120Hz refresh rate.
- This means there is little chance of under delivering or over delivering refresh rate.

Pegasus spyware

In News

- Amnesty International, the Forensic Architecture and the Citizen Lab recently launched a database documenting attacks against human rights defenders using the spyware Pegasus.

About

- Pegasus is spyware that can be installed on devices running some versions of IOS, Apple etc.
- It was developed by **the Israeli cyber-arms firm NSO Group.**
- Pegasus is capable of reading text messages, tracking calls, collecting passwords, mobile phone tracking, accessing the target device's microphone(s) and video camera(s), and gathering information from apps.

QSim

Context

- Minister of State for Electronics & Information Technology, launched QSim – Quantum Computer Simulator Toolkit.
- **Aim:** To enable Researchers and Students to carryout research in Quantum Computing in a cost effective manner.

About

- QSim is an outcome of the project **“Design and Development of Quantum Computer Toolkit (Simulator, Workbench) and Capacity Building”.**
- This is one of the first initiatives in the country to address the common challenge of advancing the Quantum Computing research frontiers in India.
- This project is being executed collaboratively by IISc Bangalore, IIT Roorkee and C-DAC with the support of Ministry of Electronics and Information Technology (MeitY).

QSim - Feature Highlights

- **Intuitive UI:** QSim offers a robust QC allowing students / researchers to create Quantum programs, visualize the instant circuit generation and simulated outputs.
- **Simulate noisy Quantum logic circuits:** Helps simulate Quantum circuits with and without noise and test how well various algorithms work with imperfect quantum components.
- **Pre-loaded Quantum algorithms**
- **Integrated with HPC:** The quantum simulations are performed on powerful HPC resources allowing multiple users to submit jobs simultaneously with different QuBit configurations.

QSim - Offering Models

- PARAM SHAVAK QSim - Standalone system with Quantum Simulator in a box
- PARAM QSim Cloud - Available on cloud using HPC infrastructure PARAM SIDDHI AI (developed and deployed under NSM program)

Eutelsat Quantum

Context

- Recently, the European Space Agency (ESA) launched the world's first commercial fully reprogrammable satellite called Eutelsat Quantum.

Details

- Eutelsat Quantum, is the first commercial fully flexible software-defined satellite in the world.

What is a reprogrammable satellite?

- A re-programmable satellite allows the user to change the communications as per need, in real time.
- The traditional models do not have this feature; they are designed and “hard-wired” on Earth.
- Even while orbiting in a fixed position at 35,000 kilometers above Earth, the satellite can be reprogrammed.
- Because it can be reprogrammed in orbit, it can respond to changing demands for data transmission and secure communications during its 15-year lifetime.

How will Eutelsat Quantum benefit us?

- The Eutelsat Quantum weighs 3.5 tonnes and consists of eight communication beams.
- Each of the beams can be modified to make changes to the coverage area and its telecommunications signal.
- As the changes can be done in minutes, this satellite can be used in providing mobile coverage in moving objects successfully.
- The satellite can detect and characterise any rogue emission, enabling it to respond dynamically to accidental interference or intentional jamming.
- The Eutelsat Quantum will be covering the geographical area from West Africa to Asia in a 15 years period of time.

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SPACE TECHNOLOGY

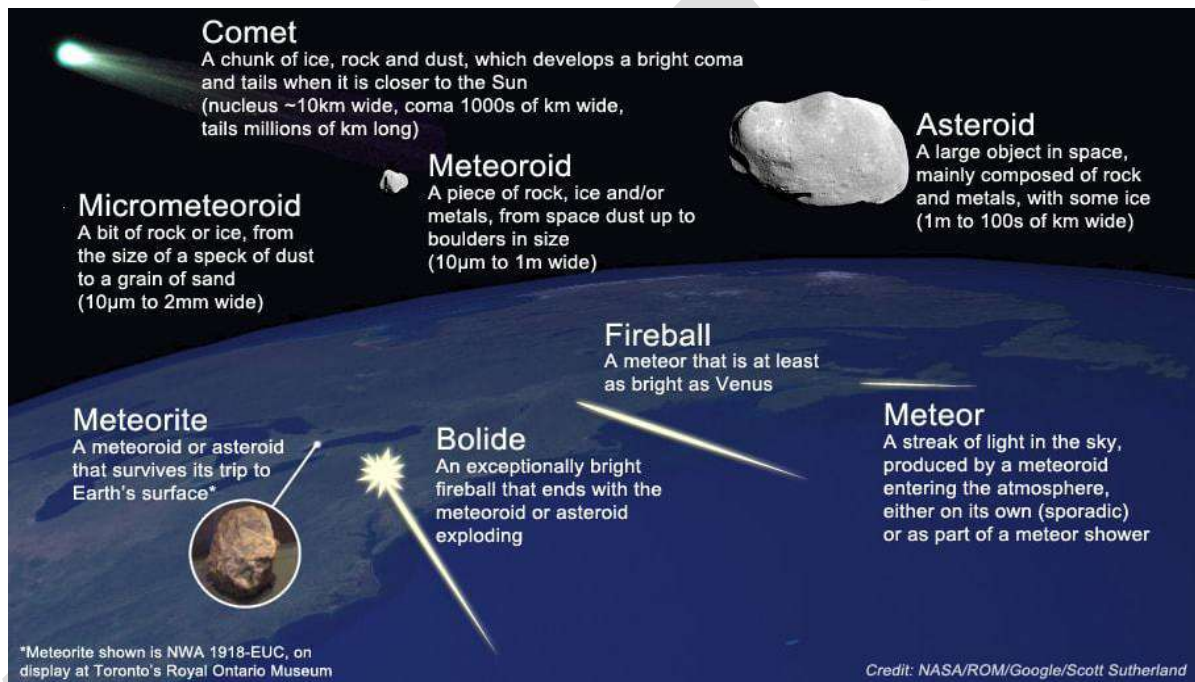
METEORITES

Context

- A piece of the Winchcombe meteorite that touched down in the town of Winchcombe in the UK in February 2021 will be displayed at the National History Museum.
- It is a **Carbonaceous Meteorite**.

Significance of meteorites

- Meteorites date back to the birth of the solar system nearly 4.5 billion years ago.
- Therefore examining it offer scientists **clues about the:**
 1. **beginning of the solar system and the Earth.**
 2. **Age and composition of the Solar System.**
 3. **Geologic history of Earth and the Moon**
 4. **Stellar evolution:** Some meteorites contain grains of dust (“stardust”) that were produced by stars before the formation of our Solar System. Studies of these presolar grains can increase our understanding of star formation and evolution.
 5. **History of life:** Meteorites may have brought to Earth the components necessary for life – organic compounds that can be transported great distances inside space rocks.



Perseid Meteor Shower

Context

- Perseid Meteor shower lighted up the skies from August 11 to 13.

About

- Perseid meteors get its name from the point at which they appear to hail in the constellation Perseus of the northern sky.
- The meteor shower is said to be the leftover debris of the Comet Swift-Tuttle.

Sutter's Mill Meteorite

Context

- Researchers have discovered carbon dioxide-rich liquid water inside a meteorite called Sutter's Mill from an asteroid that formed 4.6 billion years ago.

About

- This finding suggests that the meteorite's parent asteroid formed beyond Jupiter's orbit before being transported into the inner solar system.
- It further provides key evidence for the dynamics of the Solar System's formation.

CO₂-rich Liquid Water in an Ancient Meteorite

Water is found throughout the Solar System as solid ice and plays a key role in its evolution

Water is preserved as H₂O or hydroxyl molecules in carbonaceous chondrites that make up meteorites...

...but has not been found as a liquid in these samples

The Sutter's Mill meteorite

Transmission electron microscopy with cryo-stage of aqueously altered sample

Synchrotron-based X-ray computed nanotomography

Discovery of tiny inclusions filled with CO₂-rich liquid water!

This indicates that the Sutter's Mill meteorite's parent body formed outside the CO₂ snow line in the early Solar System with CO₂-rich ice in it

Key implications:

- Sutter's Mill's parent body formed in the outer Solar System
- It was transported inwards due to Jupiter's orbital instability, providing evidence of the Solar System's dynamic evolution

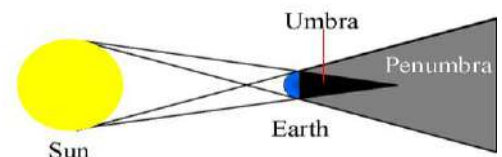
LUNAR ECLIPSE

Context

- Stargazers across the world witnessed a Total Lunar Eclipse, Blood Moon and a Flower Moon on May 26.

Earth's Three Shadows

- Earth's shadow can be divided into three parts:
 1. Umbra - the darker, central part.
 2. Penumbra - the outer part.
 3. Antumbra - the partly shaded area beyond the umbra.



Types of lunar eclipses:

1. Penumbral Lunar Eclipse

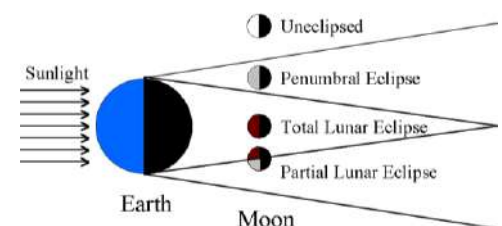
- The Moon passes through Earth's penumbral shadow.

2. Partial Lunar Eclipse

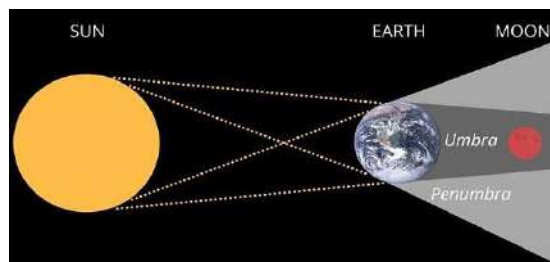
- A partial lunar eclipse happens when **part of the Moon** enters Earth's umbral shadow.
- In a partial eclipse, Earth's shadow appears very dark on the side of the Moon facing Earth.

3. Total Lunar Eclipse

- Total eclipses of the Moon happen at Full Moon when the Sun, Earth, and Moon are aligned to form a line.
- During a total lunar eclipse, **Earth's umbra completely covers the Moon.**
- The astronomical term for this **type of alignment is syzygy.**
- Lunar eclipses are safe to see with the naked and unaided eye.



- About 35% of all lunar eclipses in a calendar year are total lunar eclipses.
- On average, a total lunar eclipse can be seen from any given location every 2.5 years.
- **Note:** A lunar eclipse usually lasts for a few hours. At least two partial lunar eclipses happen every year, but total lunar eclipses are rare.



Flower Moon

- The term comes from the use by the Native American tribes as it is the time of year when spring flowers appear in abundance.

Blood Moon

- A total lunar eclipse is sometimes called a Blood Moon, because of the reddish tinge the Full Moon takes on when fully eclipsed.
- Blood Moon is not a scientific term.

NEO-01 AND SPACE DEBRIS

Context

- Recently, China launched a **low Earth orbit robot prototype** called 'NEO-01'.
- It can **scoop up space debris** left behind by other spacecraft with a big net.

Details

- NEO-01, was launched on **Long March 6 rocket**.
- NEO-01 will use **a net to capture space debris** and then burn it with its **electric propulsion system**.
- The NEO-01, will also peer into deep space to observe small celestial bodies.
- The 30kg robot will pave the way for future technologies capable of mining on asteroids.

Kessler syndrome

- This is an idea proposed by NASA scientist Donald Kessler in 1978.
- It says if there is too much space junk in orbit, it could result in a chain reaction where more and more objects will collide and create new space junk in the process, to the point where Earth's orbit became unusable – a Domino Effect.
- 12 fragmentation events have already taken place every year for the past two decades.



Initiatives taken to tackle the problem

Inter-Agency Space Debris Coordination Committee

- IADC is an inter-governmental forum whose aim is to co-ordinate efforts to deal with debris in orbit around the Earth founded in 1993.

NORAD

- North American Aerospace Defense Command, is an initiative of the U.S. and Canada that shares selective debris data with many countries.

ClearSpace-1 Mission

- In this a "chaser" with its four robotic arms will grab the leftover of 2013 craft known as VESPA (Vega Secondary Payload Adapter) and drag it down to Earth's atmosphere where both will burn up.
- To be launched in 2025.

ELSA-d, Mission

- ELSA-d (End-of-Life Services b), will test technologies to capture an object in low-Earth orbit and move it to a lower altitude, where it will eventually burn up harmlessly in Earth's atmosphere.

Starship

- Space X Starship – the passenger-carrying spacecraft once ready can collect and de-orbit space junk apart as well.

'Project NETRA'

- It is an early warning system in space to detect debris and other hazards to Indian satellites.

Other

- ISRO's GSLV employs passivation of the Cryogenic Upper Stage at the end of its useful mission.
- ISRO's communication satellites are designed with adequate propellant margins for re-orbiting at the end of their useful life to a higher graveyard orbit.
- Successful example: INSAT-2C

Positron and positron excess phenomenon

Context

- Researchers have resolved the mystery of the antimatter counterpart of the electrons called Positron and Positron Excess Phenomenon.

Antimatter

- Antimatter is the opposite of normal matter.
- More specifically, the sub-atomic particles of antimatter have properties opposite those of normal matter.
- The electrical charge of those particles is reversed.
- Antimatter was created along with matter after the Big Bang, but antimatter is rare in today's universe.

Understanding Positron

- Atoms of normal matter have particles that are known as electrons (-ve), protons (+ve) and neutrons (no charge) inside of them.
- In the case of antimatter, the electrical charge is reversed relative to matter.
- Anti-electrons (called positrons) behave like electrons but have a positive charge.
- So, a Positron is an antimatter counterpart to an electron.
- It has the equal or same mass as an electron.
- Antiprotons, as the name implies, are protons with a negative charge.
- Antimatter is NOT antigravity.
- These antimatter particles (which are called "antiparticles") have been generated and studied at huge particle accelerators such as the Large Hadron Collider operated by CERN (the European Organization for Nuclear Research).

Yaogan satellites

Context

- China launched the eighth group of three Yaogan-30 satellites into orbit on a Long March 2C rocket.

About

- Yaogan satellites are a series of reconnaissance satellites launched by China.
- The first Yaogan 1 satellite was launched in 2006.
- Yaogan satellites are optical remote sensing satellites.
- Uses: disaster prevention and reduction, surveying land resources, road network design, urban planning, and crop yield estimation, electromagnetic environment surveys, and related technical tests.
- Yaogan-30 satellites would be used for electromagnetic environment surveys and other related technical tests.
- A small satellite for the Internet of Things (IoT) called Tianqi-12 satellite was also aboard the flight. It would serve the purpose of data connectivity to China.

Unicorn

Context

- Scientists have discovered the smallest-known black hole in the Milky Way galaxy and nicknamed it 'the Unicorn.'

About

- 'The Unicorn' falls into a "mass gap" between the largest-known neutron stars.
- The black hole is roughly three times the mass of our sun.
- Luminous red giant star orbits with the black hole in a so-called binary star system named V723 Mon.
- V723 Mon is in the **Monoceros constellation** – which translates to unicorn.
- The black hole is located about 1,500 light years.
- By way of comparison, the closest star to our solar system, Proxima Centauri, is 4 light years away.

Sun Halo Phenomenon

Context

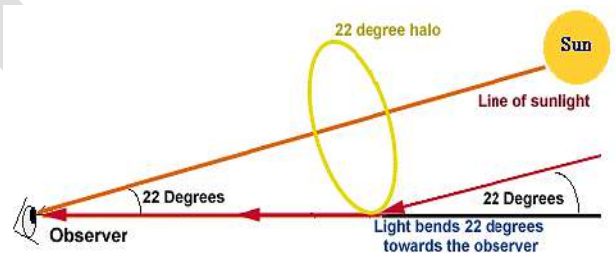
- Recently, people in Bengaluru witnessed a bright rainbow ring around the sun or Sun Halo.

Halo

- A halo is a ring of light surrounding the sun or moon.
- Halos form when light from the sun or moon is refracted by ice crystals associated with thin, high-level clouds (like cirrostratus clouds).
- Light undergoes two refractions as it passes through an ice crystal and the amount of bending that occurs depends upon the ice crystal's diameter.

22 Degree Circular Halo

- It is a rare optical and atmospheric phenomenon called '**22 degree circular halo**'.
- A 22 degree halo develops when light enters one side of a columnar ice crystal and exits through another side.
- The light is refracted when it enters the ice crystal and once again when it leaves the ice crystal.
- The two refractions bend the light by 22 degrees from its original direction, producing a ring of light observed at 22 degrees from the sun or moon.



NASA-ESA Solar orbiter (SolO)

Context

- NASA and European Space Agency's Sun-watching spacecraft has captured the first solar eruption.

Details

- The Solar Orbiter caught sight of coronal mass ejection, or CME.
- The CME was captured by NASA instrument, the Solar Orbiter Heliospheric Imager (SoloHI) onboard the spacecraft.
- SoloHI watches **the solar wind, dust, and cosmic rays that fill the space between the Sun and the planets.**
- Two more imagers on Solar Orbiter -- ESA's Extreme Ultraviolet Imager and Metis -- also captured views of the CME.
- NASA's STEREO-A spacecraft, short for Solar Terrestrial Relations Observatory, also caught a glimpse from its COR2 detector, which blocks out the Sun's bright disk to see otherwise faint phenomena in the solar wind.

Solar Orbiter

- The Solar Orbiter (SolO) is a Sun-observing satellite, developed by the European Space Agency (ESA). SolO is intended to

1. perform detailed measurements of the inner heliosphere and nascent solar wind, and
2. perform close observations of the polar regions of the Sun, which is difficult to do from Earth.

Both will serve answer to the question "How does the Sun create and control the heliosphere?"

Solo was launched on 10 February 2020.

CME

- A coronal mass ejection (CME) is a significant release of plasma and accompanying magnetic field from the solar corona. They often follow solar flares. The plasma is released into the solar wind.

GAGANYAAN MISSION

Context

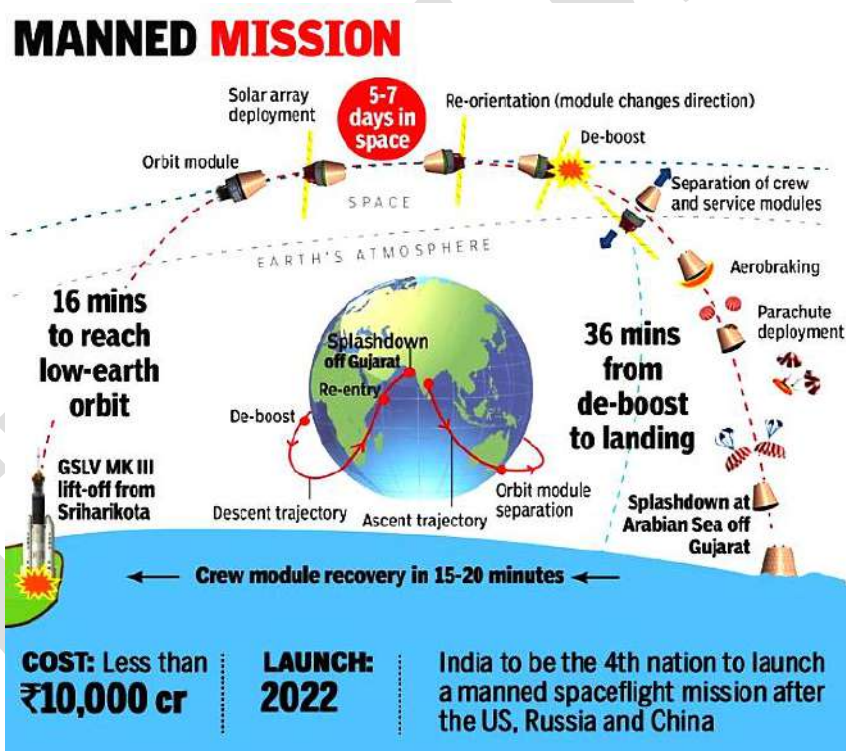
- ISRO successfully conducted a 25-second qualification test for its liquid propellant-based Vikas engine to be used under the Gaganyaan mission.

About

- Gaganyaan is an Indian crewed orbital spacecraft that is intended to send 3 astronauts to space for a minimum of seven days by 2023, as part of the Indian Human Spaceflight Programme.
- It will be for the **first time that India** will launch its manned mission to space, **making the country fourth in line** to have sent a human to space.

Launch Vehicle

- **GSLV Mk-III (Geosynchronous Satellite Launch Vehicle) the three-stage heavy-lift launch vehicle** will be used for carrying the orbital module.
- **Note:** This three-stage heavy lift launch vehicle, named **GSLV MkIII-M1**, was used for launching Chandrayaan-2.



GSLV Mk III is designed to carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO) or about 10 tons to Low Earth Orbit (LEO). The powerful cryogenic stage of GSLV Mk III enables it to place heavy payloads into LEO's of 600 km altitude.

- The launcher uses two S200 solid rocket boosters to provide the huge amount of thrust required for lift off.

Placement

- The spacecraft **will be placed in a low earth orbit of 300-400 km**.
- The human spaceflight will take 16 minutes to reach the orbit where it will stay for five to seven days.
- The **capsule will rotate around the Earth every 90 minutes**, and astronauts will be able to witness sunrise and sunset. The three astronauts will be able to see India from space every 24 hours, while they conduct experiments on micro-gravity.

Suit

- With the ability to hold one oxygen cylinder, the suit will allow the astronaut to breathe in space for 60 minutes.

Return

- For its return, the capsule will take 36 hours, and will land in the Arabian Sea, just off the coast of Gujarat.

Vyommitra

- ISRO has also developed a **female half humanoid robot named Vyommitra**, a combination of two Sanskrit words Vyoma (space) and Mitra (friend), which will be sent on the first unmanned Gaganyaan flight.
- Vyommitra will **help in simulating human functions in space and will also interact with the environment control life support system.**

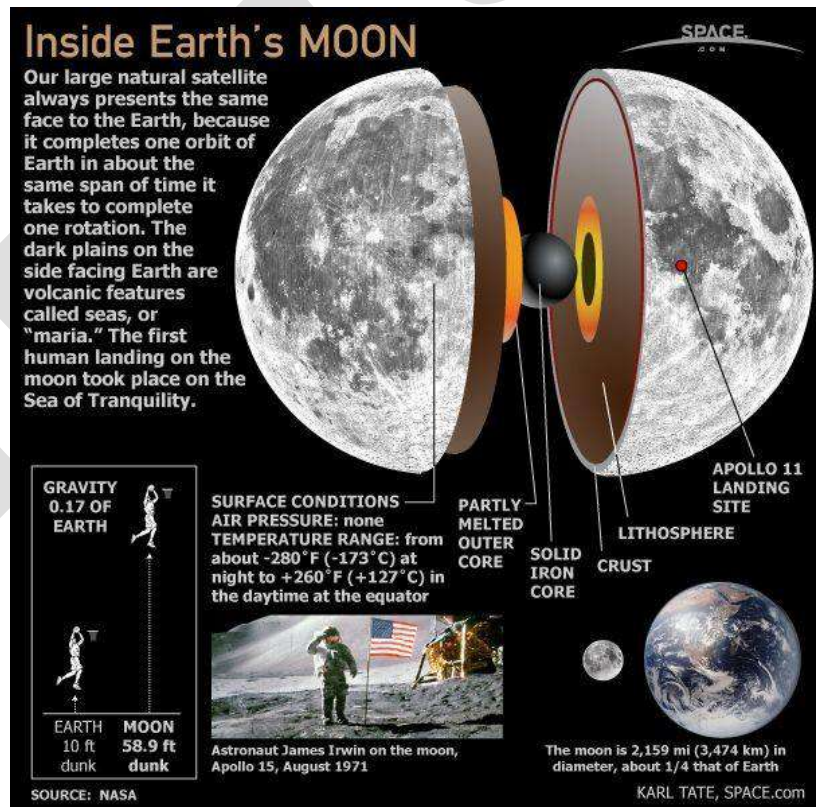
CHANDRAYAAN 3

Context

- The Indian Space Research Organisation (ISRO) is targeting the launch of **third lunar mission** Chandrayaan-3 by middle of the next year.

Details

- **About:** Chandrayaan-3 is a lander-and rover-specific mission, which will demonstrate India's capability of soft landing on a celestial body, with the rover.
- **Mandate:** It will then communicate with Earth via the existing orbiter from Chandrayaan-2 and take images 100 km from Moon's orbit. The orbiter has an estimated lifespan of seven years.
- **Objective:** The unique exploration of Chandrayaan-3 aims at studying not just one area of the Moon but all the areas combining the exosphere, the surface as well as the sub-surface in a single mission.
- **Significance:** With Chandrayaan-1, ISRO achieved immense success as the 'Moon Impact Probe' by Chandrayaan-1 lunar remote sensing orbiter detected water in vapor form in trace amounts. With Chandrayaan-3, India aims to further the study of the lunar surface, focussing on the South Pole or dark side of the Moon that has not seen sunlight in billions of years, which is believed to have ice and vast mineral reserves.



Why exploring the Moon is imperative?

- The Moon is the closest cosmic body at which space discovery can be attempted and documented.
- Further, Moon is a promising test-bed to showcase technologies required for deep-space missions.
- Exploring the Moon will enhance our understanding of the celestial body clearly, stimulating the advancement of technology, promoting global alliances and inspiring future generations of explorers and scientists.

Why Lunar South Pole of the Moon is targeted for exploration?

- The Moon provides the best linkage to Earth's early history and civilization.
- The exploration **will offer an undisturbed historical record of the inner Solar system environment.**
- The Lunar South pole is especially interesting **because the lunar surface area that remains in shadow is much larger than that at the North Pole.**
- Further, there could be a **possibility of the presence of water in permanently shadowed areas around it.**
- In addition, the South Pole region has craters that are cold traps and contain a fossil record of the early Solar System.

SMALL SATELLITE LAUNCH VEHICLE

Context

- ISRO indicated that its indigenous new launch rockets, called the Small Satellite Launch Vehicle (SSLV), will have its much-delayed, maiden development flight this April.

Launch vehicle

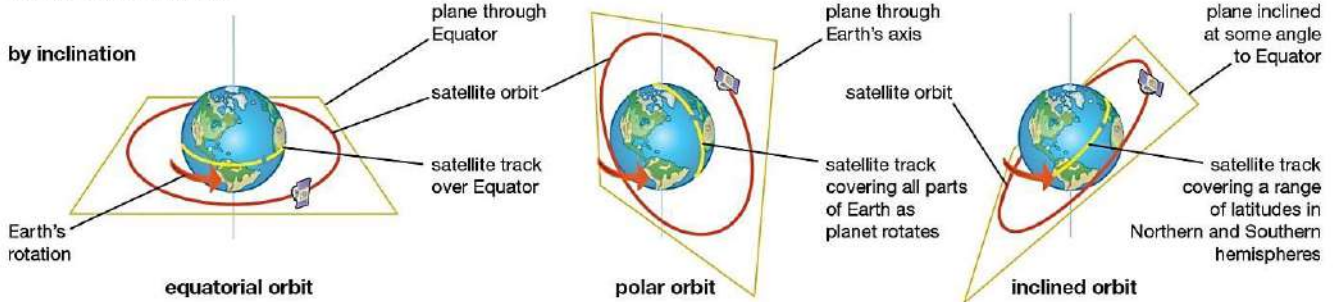
- A launch vehicle or carrier rocket is a rocket-propelled vehicle used to carry a payload from Earth's surface to space, usually to Earth orbit or beyond.



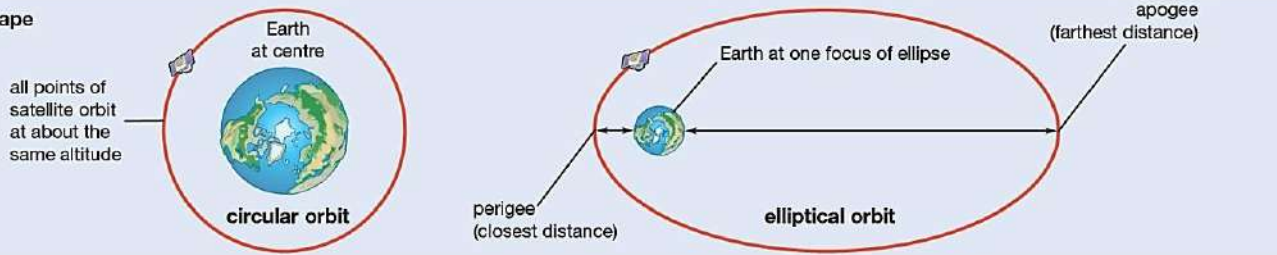
About:

- The Small Satellite Launch Vehicle (or SSLV) is a **small-lift launch vehicle** being developed by the Indian Space Research Organisation (ISRO).
- **Aim:** The SSLV was developed with the aim of launching small satellites commercially at drastically reduced price and higher launch rate as compared to Polar Satellite Launch Vehicle (PSLV).
- **Capacity and Features:** It has a payload **capacity to deliver 600 kg.** SSLV is a **three-stage, all-solid launch vehicle** that can carry a payload weighing **500 kilograms to the polar orbit, 500 kilometers above Earth's surface and a 300-kilogram payload into Sun Synchronous Polar Orbit.** It has the **capability to support multiple orbital drop-offs.** The SSLV is the smallest vehicle at 110-ton mass at ISRO. It can carry satellites weighing up to 500 kg to a low earth orbit while the tried and tested PSLV can launch satellites weighing in the range of 1000 kg.

Types of Earth orbit



by shape



by altitude



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ALTIMETERS

Context

- The US Federal Aviation Administration (FAA) has warned that the new 5G technology could interfere with instruments such as altimeters.

About

- An altimeter or an **altitude meter** is **an instrument used to measure the altitude of an object above a fixed level.**
- So, in aviation it measures how far above the ground an airplane is travelling.
- In addition to altitude, altimeter readouts are also used to facilitate automated landings and to help detect dangerous currents called wind shear.
- Concern:** Altimeters operate in the 4.2-4.4 GHz range and the concern is that the auctioned frequencies sit too close to this range.



DARK MATTER

Context

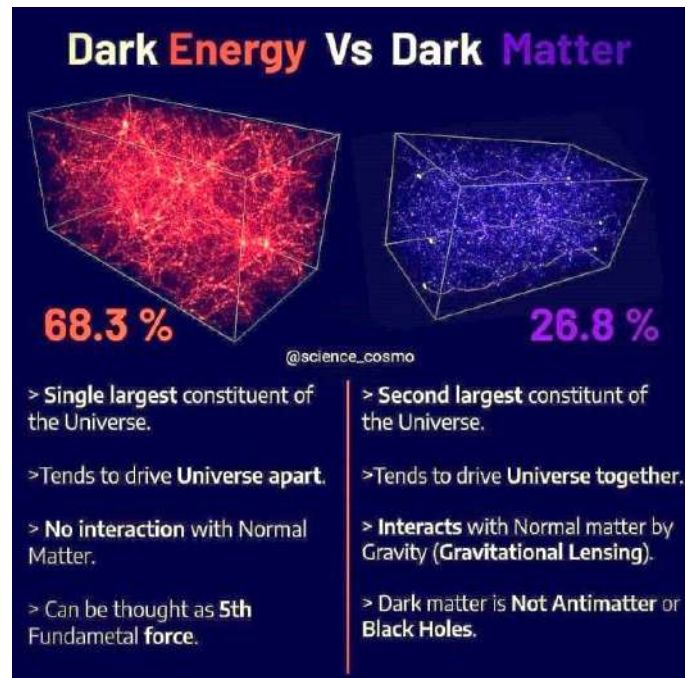
- Scientists are investigating how the shape of dark matter halo affects the motion of stars in stellar bars (found at the centre of some galaxies).

About

- Dark energy is the name given to the mysterious force that's causing the rate of expansion of our universe to accelerate over time, rather than to slow down.
- Dark matter is a component of the universe whose presence is discerned from its gravitational attraction rather than its luminosity.

Features

- Unlike normal matter, **dark matter does not interact with the electromagnetic force.**
- This means it **does not absorb, reflect or emit light, making it extremely hard to spot.**
- In fact, researchers have been able to infer the existence of dark matter only from the gravitational effect it seems to have on visible matter.



GRAVITATIONAL WAVES

Context

- Gravitational waves revealed the first known mergers of a black hole and neutron star.
- Until now, all identified sources of gravitational waves were two of a kind: either two black holes or two neutron stars, spiraling around one another before colliding and coalescing.

Gravitational Waves

- A gravitational wave is an invisible (yet incredibly fast) ripple in space.
- Gravitational waves travel at the speed of light (186,000 miles per second).
- These waves squeeze and stretch anything in their path as they pass by.

What causes gravitational waves?

- The most powerful gravitational waves are created when objects move at very high speeds. Some examples of events that could cause a gravitational wave are:
 - when a star explodes asymmetrically (called a supernova)
 - when two big stars orbit each other
 - when two black holes orbit each other and merge.
 - But these types of objects that create gravitational waves are far away.
 - And sometimes, these events only cause small, weak gravitational waves.
 - The waves are then very weak by the time they reach Earth. This makes gravitational waves hard to detect.

How do we know that gravitational waves exist?

- In 2015, scientists detected gravitational waves for the very first time.
- They used a very sensitive instrument called LIGO (Laser Interferometer Gravitational-Wave Observatory).
- These first gravitational waves happened when two black holes crashed into one another.
- The collision happened 1.3 billion years ago. But, the ripples didn't make it to Earth until 2015!

How are gravitational waves detected?

- When a gravitational wave passes by Earth, it squeezes and stretches space.
- LIGO can detect this squeezing and stretching.
- Each LIGO observatory has two “arms” that are each more than 2 miles (4 kilometers) long.
- A passing gravitational wave causes the length of the arms to change slightly.
- The observatory uses lasers, mirrors, and extremely sensitive instruments to detect these tiny changes.



Neutron Stars

- Neutron stars are formed when a massive star runs out of fuel and collapses.
- The very central region of the star – the core – collapses, crushing together every proton and electron into a neutron.
- If the core of the collapsing star is between about 1 and 3 solar masses, these newly-created neutrons can stop the collapse, leaving behind a neutron star. Once formed, they no longer actively generate heat, and cool over time.
- Neutron stars are the smallest and densest currently known class of stellar objects.
- Since neutron stars began their existence as stars, they are found scattered throughout the galaxy in the same places where we find stars. And like stars, they can be found by themselves or in binary systems with a companion.
- Many neutron stars are undetectable because they simply do not emit enough radiation. A handful of neutron stars have been found sitting at the centers of supernova remnants quietly emitting X-rays.
- In binary systems, some neutron stars can be found accreting materials from their companions, emitting electromagnetic radiation powered by the gravitational energy of the accreting material.
- The two general classes of non-quiet neutron stars are – pulsars and magnetars.

WHITE DWARF

Context

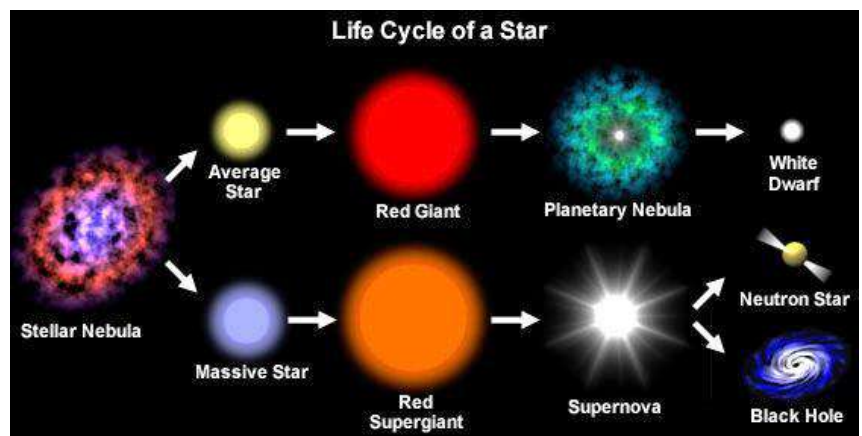
- Only a smidge bigger than the moon, a newfound white dwarf is the smallest of its kind known.

About

- A white dwarf is what stars like the Sun become after they have exhausted their nuclear fuel.
- Near the end of its nuclear burning stage, this type of star expels most of its outer material, creating a planetary nebula and only the hot core of the star remains.
- This core becomes a very hot white dwarf, with a temperature exceeding 100,000 Kelvin.
- The white dwarf then cools down over the next billion years or so.
- A typical white dwarf is half as massive as the Sun, yet only slightly bigger than Earth.
- A white dwarf is 200,000 times as dense as earth and it is one of the densest collections of matter, surpassed only by neutron stars.

Composition

- Usually, white dwarfs are composed of carbon and oxygen (CO white dwarf).
- Neon Magnesium Helium white dwarf may also form.



EnVision Mission

Context

- The European Space Agency (ESA) announced that it has selected EnVision as its next orbiter that will visit Venus sometime in the 2030s.

The mission

- EnVision is an ESA led mission with contributions from NASA. It is likely to be launched sometime in the 2030s.
- Once launched on an Ariane 6 rocket, the spacecraft will take about 15 months to reach Venus.
- The spacecraft will carry a range of instruments to study the planet's atmosphere and surface, monitor trace gases in the atmosphere and analyse its surface composition.
- A radar provided by NASA will help to image and map the surface.

Questions that the Mission seeks to get answers to

- How Earth and Venus evolved so differently from each other considering that they are roughly of the same size and composition.
- Is Venus still geologically active?
- Could it have once hosted an ocean and even sustained life?
- What lessons can be learned about the evolution of terrestrial planets in general, as we discover more Earth-like exoplanets?

About Venus

- For those on Earth, Venus is the second-brightest object in the sky after the moon.
- It appears bright because of its thick cloud cover that reflects and scatters light.
- Venus, which is the second closest planet to the Sun, is called the Earth's twin because of their similar sizes.
- The planet's thick atmosphere traps heat and is the reason that it is the hottest planet in the solar system, despite coming after Mercury, the closest planet to the Sun.
- Surface temperatures on Venus can go up to 471 degrees Celsius, which is hot enough to melt lead.
- Further, Venus moves forward on its orbit around the Sun but spins backwards around its axis slowly.
- This means on Venus the Sun rises in the west and sets in the East.
- One day on Venus is equivalent to 243 Earth days because of its backward spinning, opposite to that of the Earth's and most other planets.
- Venus also does not have a moon and no rings.

Previous Missions

- Because of the planet's harsh environment, no humans have visited it and even the spacecraft that have been sent to the planet have not survived for a very long time.
- So far, spacecraft from several nations have visited the planet.
- The first such spacecraft was the Soviet Union's Venera series (the spacecraft, however, could not survive for long because of the planet's harsh conditions), followed by NASA's Magellan Mission that studied Venus from 1990-1994.
- As of now, Japan's Akatsuki mission is studying the planet from Orbit.

Future Missions

- DAVINCI+ and VERITAS are part of NASA's Discovery Program, which began in 1992.
- The two selections are a part of the ninth Discovery Program and were made from proposals submitted in 2019.

DAVINCI+

- DAVINCI+ is short for 'Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging' and is the first US-led mission to the planet's atmosphere since 1978.
- It will try to understand Venus' composition to see how the planet formed and evolved.

- It will pass through the planet's thick atmosphere and make observations and take measurements of noble gases and other elements.
- It will also try to return the first high resolution photographs of a geological feature that is unique to Venus.
- This feature, which is called "tesserae" may be comparable to Earth's continents.
- The presence of tesserae's may suggest that Venus has tectonic plates like Earth.

Veritas

- VERITAS is short for 'Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy'.
- It will map the planet's surface to determine its geologic history and understand the reasons why it developed so differently from Earth.

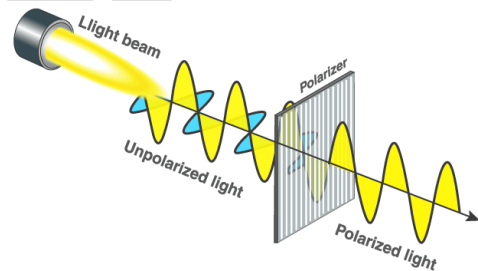
PASIPHAE SURVEY

Context

- An ambitious sky-survey project named as Pasiphae is set to peep into the unknown regions of the sky.

About Pasiphae

- Polar-Areas Stellar-Imaging in **Polarization High-Accuracy Experiment (PASIPHAE)** is an international collaborative sky surveying project.
- **Aim:** To study the polarization in the light coming from millions of stars.
- A light wave that is vibrating in more than one plane is referred to as unpolarized light. Polarized light waves are light waves in which the vibrations occur in a single plane. A polarimeter is an optical instrument with which one can accurately measure the angle by which the polarization of light is rotated.
- The survey will use two high-tech optical polarimeters to observe the northern and southern skies, simultaneously.
- It will focus on capturing starlight polarization of very faint stars that are so far away that polarization signals from there have not been systematically studied yet.
- The distances to these stars will be obtained from measurements of the GAIA satellite.
- By combining these data, astronomers will perform a maiden magnetic field tomography mapping of the interstellar medium of very large areas of the sky using a novel polarimeter instrument known as **WALOP (Wide Area Linear Optical Polarimeter)**.
 1. Interstellar medium (ISM) is the matter and radiation that exist in the space between the star systems in a galaxy.
 2. Tomography is the representation of a cross section of solid object using X-rays.



Why is PASIPHAE important?

- Since its birth about 14 billion years ago, the universe has been constantly expanding, as evidenced by the presence of **Cosmic Microwave Background (CMB) radiation which fills the universe**.
- The Cosmic Microwave Background (CMB) is the cooled remnant of the first light that could ever travel freely throughout the Universe. This 'fossil' radiation, the furthest that any telescope can see, was released soon after the 'Big Bang'. Scientists consider it as an echo or 'shockwave' of the Big Bang.
- Immediately after its birth, the universe went through a short inflationary phase during which it expanded at a very high rate, before it slowed down and reached the current rate.
- However, so far, there have only been theories and indirect evidence of inflation associated with the early universe.
- **Consequence of the inflationary phase** - A tiny fraction of the CMB radiation has its imprints in the form of a specific kind of polarization (known scientifically as B-mode signal).
- All previous attempts to detect this signal met with failure mainly due to the difficulty posed by our galaxy, the Milky Way, which emits copious amounts of polarized radiation.
- Besides, it contains a lot of dust clouds that are present in the form of clusters.
- When starlight passes through these dust clouds, they get scattered and polarised.
- In a nutshell, the galactic emission is so bright that the polarisation signal of CMB radiation is lost.

What is WALOP?

- It is an instrument, when mounted on two small optical telescopes, will be used to detect polarised light signals emerging from the stars along high galactic latitudes.
- Photometry, in astronomy, is the measurement of the brightness of stars and other celestial objects (nebulae, galaxies, planets, etc.). Such measurements can yield large amounts of information on the objects' structure, temperature, distance, age, etc.

NEW SHEPHARD ROCKET SYSTEM

Context

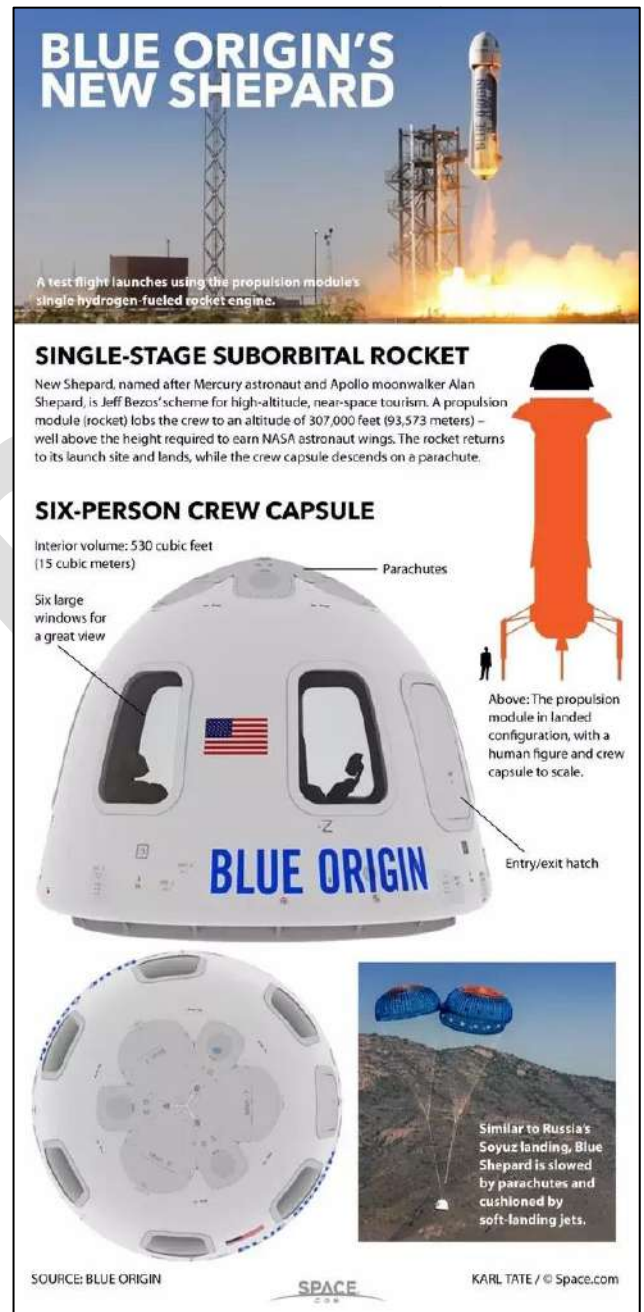
- Recently, Jeff Bezos's space company called Blue Origin concluded the online auction for the first seat on New Shepard, a rocket system meant to take tourists to space.

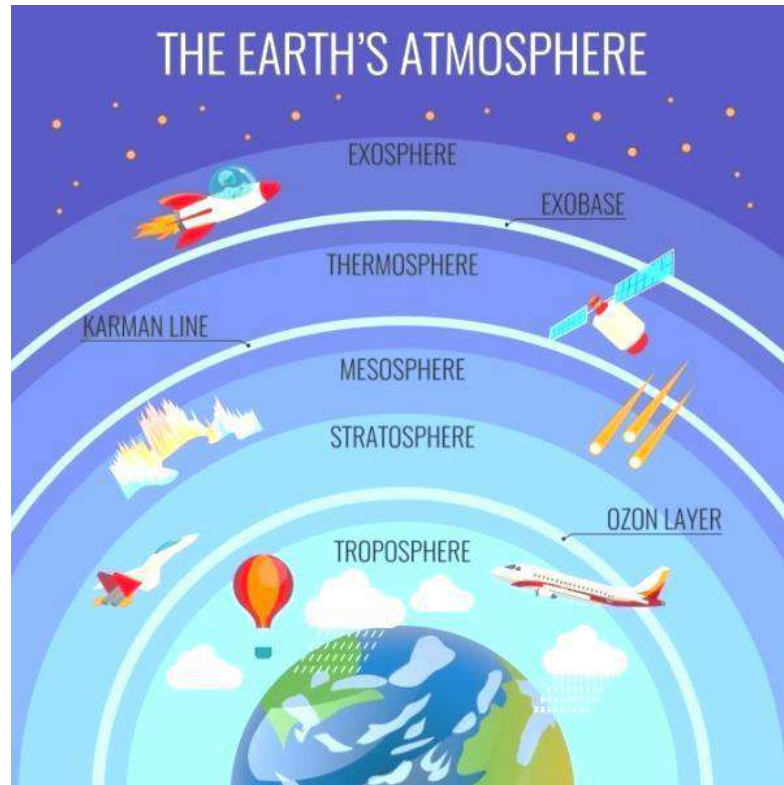
What is New Shepard?

- New Shepard has been named after astronaut Alan Shepard – the first American to go to space
- It offers flights to space over 100 km above the Earth and accommodation for payloads.
- Essentially, it is a rocket system that has been designed to take astronauts and research payloads past the Karman line – the internationally recognized boundary of space.
- The idea is to provide easier and more cost-effective access to space meant for purposes such as academic research, corporate technology development and entrepreneurial ventures among others.
- New Shepard will also allow space tourists to experience microgravity by taking them 100 km above the Earth.

How does it work?

- The rocket system consists of two parts, the cabin or capsule and the rocket or the booster.
- The capsule is fully autonomous and does not require a pilot.
- The system is a fully reusable, vertical takeoff and vertical landing space vehicle that accelerates for about 2.5 minutes before the engine cuts off.
- After separating from the booster, the capsule free falls in space lands back with the help of parachutes, while the booster performs an autonomously controlled vertical landing back to Earth.
- The Kármán line is an attempt to define a boundary between Earth's atmosphere and outer space.
- The Fédération Aéronautique Internationale (FAI), an international standard-setting and record-keeping body for aeronautics and astronautics, defines the Kármán line as the altitude of 100 kilometres above Earth's mean sea level. **Not all organizations recognize this definition.** The US Air Force and NASA define the boundary as 50 miles (80 km) above sea level. The line is approximately at the turbopause, above which atmospheric gases are not well-mixed. **International law does not define the edge of space, or the limit of national airspace.**





NEUTRINOS

Context

- Scientists have shown that the geometry of space-time can cause neutrinos to oscillate.

Neutrino: a fundamental particle of weak interaction

- A neutrino is a sub-atomic particle that is very similar to an electron, but has no electrical charge.
- They are subject to weak force. Thus, the gravitational interaction is extremely weak, and neutrinos do not participate in the strong interaction.
- Neutrinos typically pass through normal matter unimpeded and undetected.
- About 100 trillion neutrinos pass through our bodies every second!
- The neutrino has a **very little mass, a zero charge and a spin $\frac{1}{2}$** .
- Neutrinos were first detected in 1959 and they are the second most abundant particle in the world after Photon.

Sources of Neutrinos

- Neutrinos are created by various radioactive decays; the following list is not exhaustive, but includes some of those processes:
 - beta decay of atomic nuclei or hadrons,
 - natural nuclear reactions such as those that take place in the core of a star
 - artificial nuclear reactions in nuclear reactors, nuclear bombs, or particle accelerators
 - during a supernova
 - during the spin-down of a neutron star
 - when cosmic rays or accelerated particle beams strike atoms.

Detection

- A neutrino is able to react with an atom of gallium-71, converting it into an atom of the unstable isotope germanium-71.
- The germanium is then chemically extracted and concentrated.
- Neutrinos were thus detected by measuring the radioactive decay of germanium.

India-based Neutrino Observatory

- In Theni district in Tamil Nadu, the India-based Neutrino Observatory is proposed to be set up.
- It is a particle physics research project under construction to primarily study atmospheric neutrinos in a 1,200 meters (3,900 ft) deep cave under a mountain.
- The main experiment proposed at INO is the **Iron-Calorimeter Detector**.

Why does INO need the mountain?

- The mountain consists of 1km of solid rock that filters away most of the charged particles from the cosmic rays.
- The filtered set consists of a part of the incident cosmic ray protons and practically all the neutrinos.

Why does the experiment have to be underground?

- If the detector was placed at the surface of the mountain, it would pick up billions of cosmic ray muons every hour and about 10 neutrino events per day.
- After placing inside the rock, it would detect only 300 muon events per hour and about 10 neutrino events per day of which 3 will be the desired muon neutrino events.

CHINA'S 'ARTIFICIAL SUN'

Context

- **China's Experimental Advanced Superconducting Tokamak (EAST)**, which mimics the energy generation process of the sun, set a new record after it ran at 216 million degrees Fahrenheit (120 million degrees Celsius) for 101 seconds.
- For another 20 seconds, the "artificial sun" also achieved a peak temperature of 288 million degrees Fahrenheit (160 million degrees Celsius), which is over ten times hotter than the sun.


What is China's 'artificial sun' EAST?

- The Experimental Advanced Superconducting Tokamak (EAST) reactor is an **advanced nuclear fusion experimental research device**.
- The **purpose of the artificial sun is to replicate the process of nuclear fusion**, which is the same reaction that powers the sun.

Apart from the EAST, China is currently operating the HL-2A reactor as well as J-TEXT. In December 2020, HL-2M Tokamak, China's largest and most advanced nuclear fusion experimental research device, was successfully powered up for the first time.

- EAST first became operational in 2006. The EAST project is **part of the International Thermonuclear Experimental Reactor (ITER) facility**, which will become the world's largest nuclear fusion reactor when it becomes operational in 2035.
- ITER project includes the contributions of several countries, **including India**, South Korea, Japan, Russia and the United States.

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How does the 'artificial sun' EAST work?

- The EAST Tokamak device is designed to replicate the nuclear fusion process carried out by the sun and stars.

Nuclear Fission	Nuclear Fusion
<ul style="list-style-type: none"> A heavy nucleus breaks up to form two lighter ones. It involves a chain reaction, which can lead to dangerous meltdowns. The heavy nucleus is bombarded with neutrons. There is established, decades-old technology to control fission. Nuclear waste, a byproduct of fission, is <u>an environmental challenge</u>. Raw material like plutonium or uranium is scarce and costly. 	<ul style="list-style-type: none"> Two nuclei combine to form a heavier nucleus. There is no chain reaction involved. Light nuclei have to be heated to extremely high temperature. Scientists are still working on a controlled fusion reactor that offers more energy than it consumes. There is no nuclear waste. Raw materials are very easily sourced. Fusion reactions have energy densities many times greater than nuclear fission.

Significance

- The sun's core only reaches about 15 million degrees Celsius, which means the reactor was able to touch temperatures that are 10 times hotter than that.
- Once mastered, nuclear fusion could potentially provide unlimited clean energy and very low costs.

ARTIFICIAL MOON BY CHINA

Context

- China has now built an artificial moon facility that will simulate lunar conditions and the environment for scientists to test new tech and future missions.

About the project

- Features in the Research Facility**
 - This "first of its kind in the world", facility is located in the eastern city of Xuzhou, in Jiangsu province.
 - It can replicate low gravity environments for as long as one wants, making China less dependent on zero-gravity planes to train astronauts, and environments to test new rovers and technologies.
 - The facility, will use powerful magnetic fields inside a 2-foot-diameter (60 centimeters) vacuum chamber to make gravity disappear.
- The mini-moon**
 - The mini-moon is about two feet in diameter and the artificial surface has been made with rocks and dust that are as light as those on the moon.
- Note:** The gravity on the Moon is not zero, it is one-sixth as powerful as the gravity on Earth due to the magnetic field.

Significance

- This project will aid scientists in resolving technical challenges and determining whether certain buildings may survive on the surface of the moon. It will also aid in the evaluation of the feasibility of human settlement on the moon.

Gamma-ray bursts (GRBs)

Context

- Researchers derived the spectrum of the very-high-energy gamma-ray afterglow emission of a relatively nearby gamma-ray burst.

About

- Gamma-ray bursts (GRBs) are immensely energetic explosions that have been observed in distant galaxies.
- They are the brightest and most energetic electromagnetic events known to occur in the universe.
- Bursts can last from ten milliseconds to several hours.
- After an initial flash of gamma rays, a longer-lived "afterglow" is usually emitted at longer wavelengths (X-ray, ultraviolet, optical, infrared, microwave and radio)
- The intense radiation of most observed GRBs is released during processes like creation or merging of neutron stars or black holes.
- All observed GRBs have originated from outside the Milky Way galaxy.
- GRBs were first detected in 1967 by the Vela satellites.

Deep Space Atomic Clock

Context

- NASA's Deep Space Atomic Clock, which launched on a satellite in June 2019, outperformed all other clocks in space during its first year in orbit around Earth.

Space navigation

- To navigate the solar system today, space probes listen for signals from antennas on Earth and then bounce those signals back.
- Ultraprecise, refrigerator-sized atomic clocks on the ground measure that round trip time – which can take hours – to pinpoint a spacecraft's location.

DSAC

- The Deep Space Atomic Clock (DSAC) is a miniaturized, ultra-precise mercury-ion atomic clock for precise radio navigation in deep space.
- DSAC could simply measure how long it takes a signal from Earth to arrive and calculate its own position.
- The Deep Space Atomic Clock (DSAC) is as stable as a ground clock.
- DSAC is so stable because it keeps time using electrically charged atoms, or ions, rather than neutral atoms.
- It is expected that a DSAC would incur no more than 1 microsecond of error in 10 years of operations.
- It is expected to improve the precision of deep space navigation, and enable more efficient use of tracking networks. The project is managed by NASA's Jet Propulsion Laboratory.

Fast Radio Bursts

Context

- A radio telescope in Canada has detected 535 fast radio bursts, quadrupling the known tally of these brief, highly energetic phenomena in one go.

About

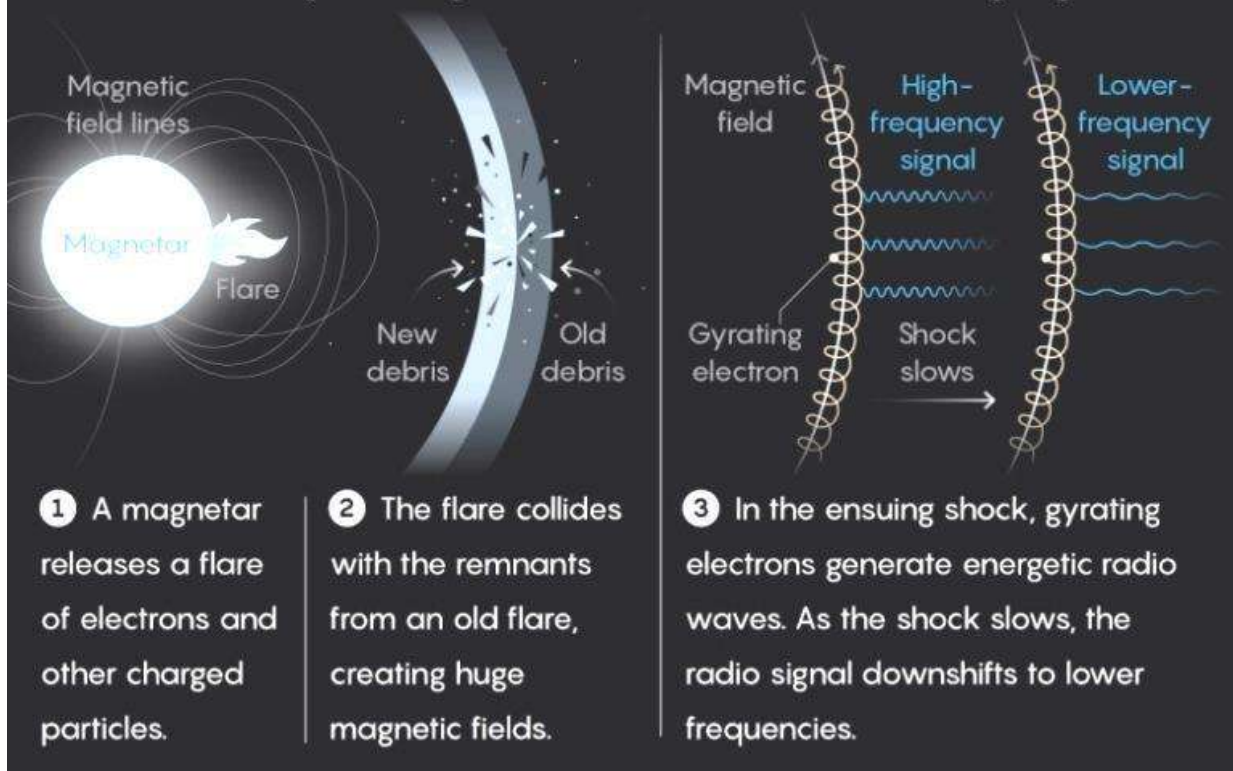
- Fast radio bursts are bright, unresolved (pointsource-like), broadband (spanning a large range of radio frequencies), millisecond flashes found in parts of the sky.
- The first FRB was discovered in 2007.

Origin

- The exact origin and cause of the FRBs is still the subject of investigation; proposals for their origin range from a rapidly rotating neutron star and a black hole, to extraterrestrial intelligence.
- Many theories suggest the bursts originate from neutron stars, which are corpses of stars that died in catastrophic explosions known as supernovas

How Fast Radio Bursts Work

Fast radio bursts are brief, energetic blips of radio waves that originate far across the universe. At least one repeats, which has added to the challenge of explaining what might be creating them. A new model accounts for past observations and predicts specific features that should be seen going forward.



Shenzhou-12

Context

- Recently, China launched Shenzhou-12, or Divine Vessel in first crewed mission since 2016.

Details

- Shenzhou-12 is the third of 11 missions – four of which will be crewed – needed to complete China's first full-fledged space station called **Tiangong**.
- Construction of the space station began with the launch of Tianhe, the first and largest of three modules. The station is expected to be completed by 2022.
- Tiangong will be a space station placed in low Earth orbit between 340 and 450 km above the surface.
- Shenzhou-12 spacecraft was launched on a Long March-2F rocket in Jiuquan Satellite Launch Center in China's Gobi Desert.
- The flight marks the seventh crewed Chinese spaceflight and the seventh crewed flight of the Shenzhou program.
- The spacecraft carried three members of the People's Liberation Army Astronaut Corps (PLAAC) on the first flight to the Tianhe core module.
- The trio is expected to stay in space for three months as part of the country's space station mission.

Note: China is the third country after the former Soviet Union and the United States to carry out a manned mission on its own.

MARS 2020 MISSION

Context

- Indian-origin Vandii Verma drives Perseverance rover on Mars, says it's incredible.

About

- Perseverance, nicknamed Percy, is a car-sized Mars rover designed to explore the crater Jezero on Mars as part of NASA's Mars 2020 mission.
- NASA named the landing site Octavia E. Butler Landing.
- The rover also carried the mini-helicopter Ingenuity to Mars, that made the first powered flight on another planet on 19 April 2021.



Broad Objectives of Mars 2020 Mission

- Looking for habitability:** identify past environments that were capable of supporting microbial life.
- Seeking biosignatures:** seek signs of possible past microbial life in those habitable environments, particularly in specific rock types known to preserve signs over time.
- Caching samples:** collect core rock and regolith ("soil") samples and store them on the Martian surface.
- Preparing for humans:** test oxygen production from the Martian atmosphere.

SOLAR STORM

Context

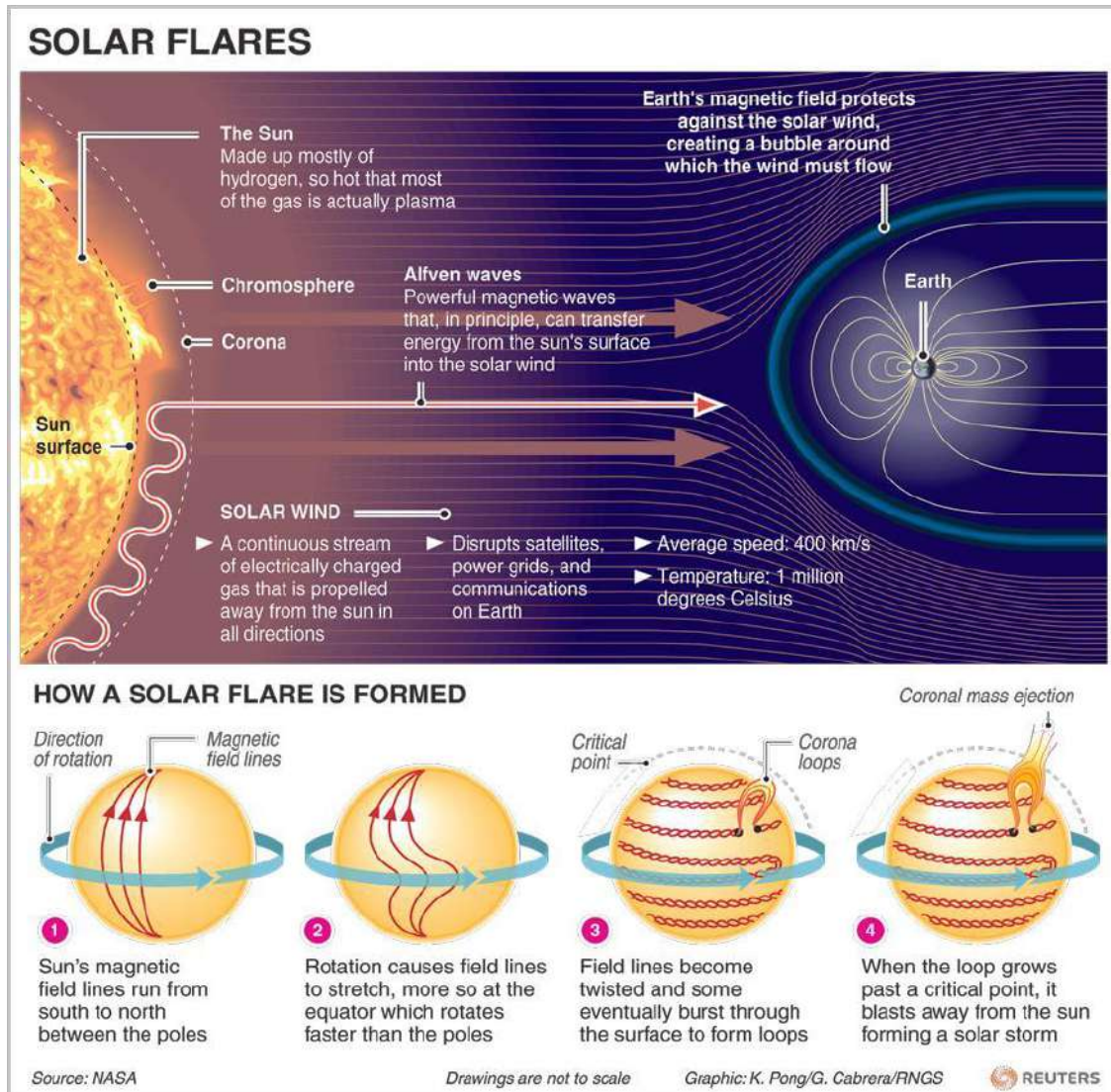
- A fierce solar storm is moving towards the Earth at a speed of 1.6 million kilometers per hour.
- It is feared that this storm may hit the Earth today, due to which there may be a power failure around the world.

About

- NASA has classified this flare as an X1.5-class flare.
- X-class denotes the most intense flares, while the number provides more information about its strength.
- An X2 is twice as intense as an X1, an X3 is three times as intense, etc.

Impact

- Satellite signals can be interrupted due to this collision.
- It can also have a direct effect on radio signals, communication and weather.
- It can cause interference in GPS navigation, mobile phone signals and satellite TV, current in power lines can be increased.
- Note:** However, this is rarely the case because the Earth's magnetic field acts as a protective shield.
- A solar storm in March 1989 caused a nine-hour blackout Hydro-Québec's electricity transmission system in Canada.
- Due to the solar storm, people living at the North or South Pole will be able to see a view of beautiful celestial lighting (auroras) at night.



Landsat 9

Context

- US space agency NASA has cleared the launch of Landsat 9 by Atlas V rocket.

About

- Landsat 9 is a powerful **Earth-observing satellite**.
- It is a **joint NASA and US Geological Survey (USGS) mission** that will continue the legacy of monitoring Earth's land and coastal regions that began with the first Landsat satellite in 1972.
- The rocket will take Landsat 9 to its orbit 438 miles above Earth.
- Landsat 9 will join its sister satellite, Landsat 8 that was launched in 2013, in orbit in collecting images from across the planet every eight days.
- This calibrated data will continue the Landsat programme's critical role in monitoring the health of Earth and helping people manage essential resources, including crops, irrigation water, and forests.
- It will also **study the boundaries of Earth's magnetic field**, to see how energy from the Sun can break through our planet's magnetic shield, and study how quickly their atmospheres are escaping.

LUCY MISSION

Context

- NASA is poised to send its first spacecraft called LUCY to study Jupiter's Trojan asteroids to glean new insights into the solar system's formation 4.5 billion years ago.

About

- The probe is called Lucy after an ancient fossil.
- Aim:** Its mission is to investigate the group of rocky bodies circling the Sun in two swarms, one preceding Jupiter in its orbital path and the other trailing behind it.
- After receiving boosts from Earth's gravity, Lucy will embark on a 12-year journey to eight different asteroids -- one in the Main Belt between Mars and Jupiter and then seven Trojans.
- Whatever Lucy finds will give us vital clues about the formation of our solar system.

Fossil

- Lucy (Australopithecus), a fossilized hominid of the species *Australopithecus afarensis*.
- Researchers discovered Lucy the fossil in Ethiopia in 1974.

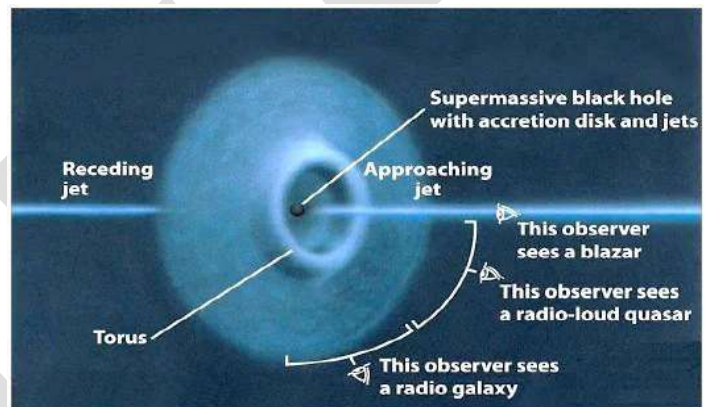
BLAZAR

Context

- Blazar 3.5 billion light-years from Earth provides better understanding of physics powering their massive optical fare.

About

- Blazars are one of the most luminous and energetic objects in the universe powered by material falling onto a super-massive black hole at the center of the host galaxy.
- The luminosity being because of their jet composed of ionized matter traveling at nearly the speed of light towards an observer (the Earth).



SCIENCE TECHNOLOGY AND INNOVATION (STI) HUBS

Context

- The Department of Science and Technology (DST) will be setting up 75 Science Technology and Innovation (STI) Hubs in different parts of the country, exclusively for Scheduled Castes (SCs) and Scheduled Tribes (STs).

Significance

- This will not only promote scientific talent but also contribute to socio-economic development of these communities.
- The training and skill development program es under the STI Hubs will build the Science Technology and Innovation (STI) Capacities and Capabilities among SC/ST population.
- The STI Hubs also improve the Indigenous Knowledge Systems (IKS) through inputs of S&T and converting them to appropriate technologies for creating better livelihood options.

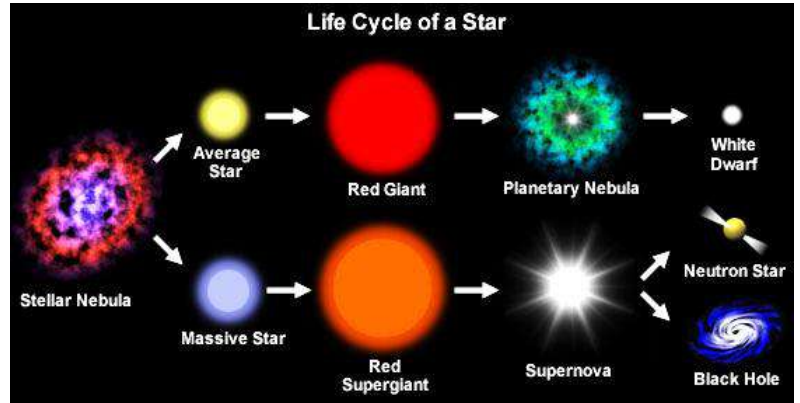
WHITE DWARF

Context

- An international team has reported a unique phenomenon in a white dwarf about 1,400 light years from Earth.

About

- A white dwarf is what stars like the Sun become after they have exhausted their nuclear fuel.
- Near the end of its nuclear burning stage, this type of star expels most of its outer material, creating a planetary nebula.
- Only the hot core of the star remains.
- This core becomes a very hot white dwarf, with a temperature exceeding 100,000 Kelvin.
- The white dwarf then cools down over the next billion years or so.
- Recently, soft X-ray and extreme ultraviolet observations have become a powerful tool in the study the composition and structure of the thin atmosphere of these stars.
- A typical white dwarf is half as massive as the Sun, yet only slightly bigger than Earth.
- White dwarfs are one of the densest collections of matter, surpassed only by neutron stars.



Composition

- Usually, white dwarfs are composed of carbon and oxygen (CO white dwarf).
- Neon Magnesium Helium white dwarf may also form.

Blue Straggler

Context

- Indian scientists conducted first ever comprehensive analysis of Blue stragglers.

About

- Blue stragglers are a class of star observed in old, dense stellar systems such as globular clusters.
- They stand out because old stellar populations are expected to be devoid of blue (high-mass) stars which possess very short lifespans.
- The blue stragglers in an old stellar population must therefore have formed long after the system as a whole.
- They are bigger and bluer than the rest of the stars.

INSPIRES at-1 CubeSat

Context

- INSPIRESat-1 CubeSat, developed under the International Satellite Program in Research and Education (INSPIRE), is ready for launch, the Indian Institute of Space Science and Technology (IIST) has said.

About

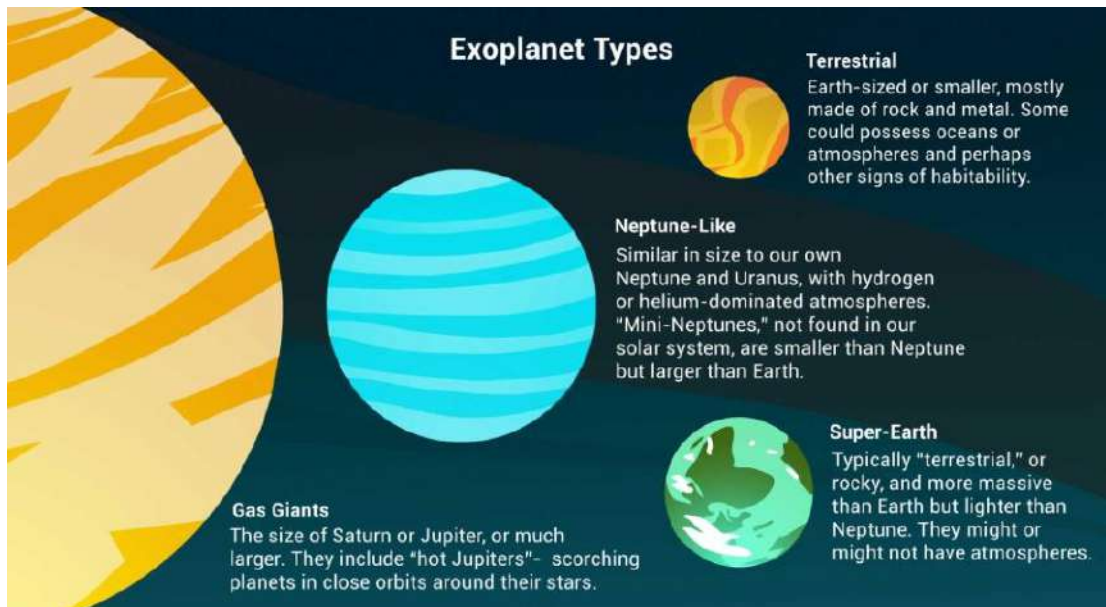
- INSPIRESat-1 is a collaborative effort by the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder in the U.S., the National Central University, Taiwan, and the Nanyang Technological University in Singapore, apart from the IIST.
- The satellite, which will be placed in a low earth orbit, is equipped with a Compact Ionosphere Probe for studying the earth's ionosphere.
- A constellation of earth and space-weather observation satellites is envisaged under the INSPIRE programme.
- The small satellite that weighs less than 10 kg will be launched aboard an upcoming Polar Satellite Launch Vehicle (PSLV) mission of the Indian Space Research Organisation (ISRO).

- A CubeSat (U-class spacecraft) is a type of miniaturized satellite for space research that is made up of multiple cubic modules of 10 cm × 10 cm × 10 cm size.

HYCEAN WORLDS

Context

- A study published in The Astrophysical Journal identifies a new class of exoplanets – Hycean worlds – that could support life different from that on Earth.



Details

- These planets are about 2.6 times the size of Earth, have temperatures about 200 degrees Celsius and planet-wide oceans. These could support microbial underwater life.
- Exoplanets are planets that orbit a star other than our sun. The prefix exo comes from the Greek and means outside; these worlds are far, far outside our own solar system.

Inspiration 4

Context

- Entrepreneur Elon Musk's SpaceX announced that 'Inspiration4', **its first all-civilian, non-governmental spaceflight, is on track for launch on September 15.**

Details

- The mission involves circling the Earth for three days, and then splashing down into the Atlantic Ocean.
- Inspiration4 will orbit the Earth at 575km, higher than the International Space Station (408km) and the Hubble space telescope (547km).

Significance

- In this journey data will be collected on ECG (electrocardiograph) activity, movement, sleep, heart rate and rhythm, blood oxygen saturation, cabin noise and light intensity, which will help in assessing behavioural and cognitive changes over the journey.
- The travelers will undergo balance and prescription tests just before and after their journey to assess their response to the change in gravity.
- Immune system function will also be monitored by collecting blood.
- Their organ systems will also be monitored by an AI-powered ultrasound device.
- Thus, the journey will present an opportunity for collecting large amounts of health data that will aid in planning future crewed space missions.

Tianzhou-3

Context

- Tianzhou-3 cargo spacecraft docks with China space station module

About

- Tianzhou 3 is a mission of the Tianzhou-class uncrewed cargo spacecraft.
- Like previous Tianzhou missions, the spacecraft was launched from Wenchang Satellite Launch Center in Hainan, China on a Long March 7 launch vehicle.
- Tianzhou 3 is the second cargo resupply mission to the Tianhe core module (TCM) of the under-construction Tiangong space station, carrying over six tons of supplies.
- Tiangong is a space station being constructed by China in low Earth orbit between 340 and 450 km above the surface.
- Being China's first long-term space station, it is the goal of the "Third Step" of the China Manned Space Program.

VIPER

Context

- VIPER to look for answers on lunar South Pole on how did frozen water arrive on Moon.

About

- VIPER (Volatiles Investigating Polar Exploration Rover) is a lunar rover developed by NASA (Ames Research Center), and currently planned to be delivered to the surface of the Moon in November 2023.
- The rover will be tasked with prospecting for lunar resources in permanently shadowed areas in the lunar south pole region, especially by mapping the distribution and concentration of water ice.
- VIPER will be carried aboard Astrobotic's Griffin lander as part of NASA's Commercial Lunar Payload Services (CLPS) initiative.
- Nasa has selected Nobile Crater as the potential site for landing the rover and exploring the possibility of resources.
- Nobile is an impact crater that was formed through a collision with another smaller celestial body and is almost permanently covered in shadows, allowing ice to exist there.

Why the South Pole?

- The Moon's South Pole is one of the coldest areas in our solar system and scientists have thus far only studied the region using remote sensing instruments, including those on Nasa's Lunar Reconnaissance Orbiter and the Lunar Crater Observation and Sensing Satellite.
- Data from these observations have led to the conclusion that the South Pole on the Moon could be home to ice and other potential resources that exist in permanently shadowed areas of the Moon.
- Scientists aim to study the origin and distribution of water on the Moon and prepare to harvest the resources 2,40,000 miles from the Earth that could be used to safely send astronauts farther into outer space.
- VIPER team aims to address how frozen water and other resources arrived on the Moon in the first place and plans to identify where they came from, how they remained preserved for billions of years, how they escape, and where they go.

Artemis Program

- Artemis program plans to send the next man and first woman to the lunar surface by the year 2024.
- The last time NASA sent humans to the Moon was in 1972, during the Apollo lunar mission.

CMEs and ADITYA L-1 MISSION

Context

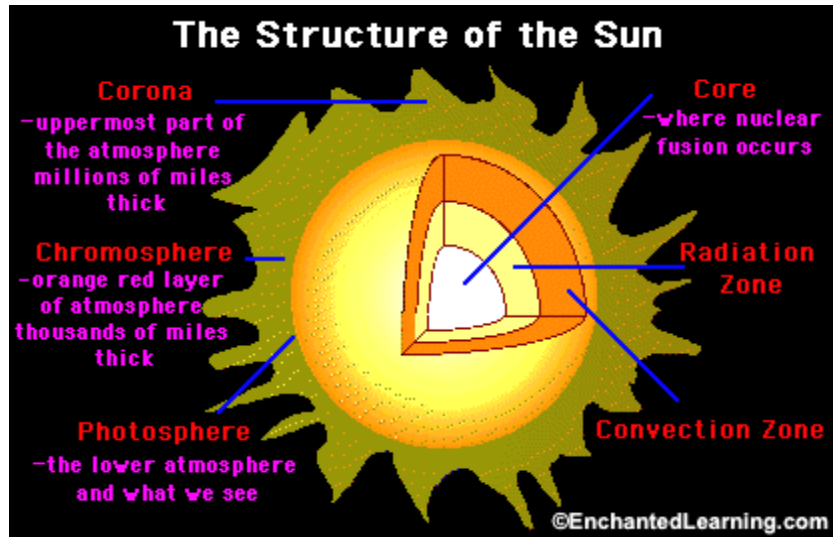
- A recent study has shown how conditions and events in the solar atmosphere like coronal mass ejections influence the accuracy of space weather prediction, which is crucial for the health of our satellites.
- This understanding will aid the interpretation of data from the upcoming Aditya-L1, India's first solar mission.

The coronal mass ejections (CMEs)

- The outer solar atmosphere, the corona, is structured by strong magnetic fields.
- Where these fields are closed, often above sunspot groups, the confined solar atmosphere can suddenly and violently release bubbles of gas and magnetic fields called coronal mass ejections.

Impact

- Coronal mass ejections, along with solar flares of other origin, can disrupt radio transmissions and cause damage to satellites and electrical transmission line facilities, resulting in potentially massive and long-lasting power outages.



About ADITYA L1 Mission

- It is India's first solar mission planned by the Indian Space Research Organisation (ISRO).
- The Aditya-1 mission was conceived as a **400kg class satellite** carrying one payload, the Visible Emission Line Coronagraph (VELC) and was planned to launch in a 800 km low earth orbit.
- The satellite carries additional six payloads with enhanced science scope and objectives.
- **Aditya-1 was meant to observe only the solar corona.**
- **Aditya-L1** with additional experiments can now provide observations of **Sun's Corona (soft and hard X-ray, Emission lines in the visible and NIR), Chromosphere (UV) and photosphere (broadband filters).**
- In addition, particle payloads will study the particle flux emanating from the Sun and reaching the L1 orbit, and the magnetometer payload will measure the variation in magnetic field strength at the halo orbit around L1.
- These payloads have to be placed outside the interference from the Earth's magnetic field and **could not have been useful in the low earth orbit.**

Roman Space Telescope

In News

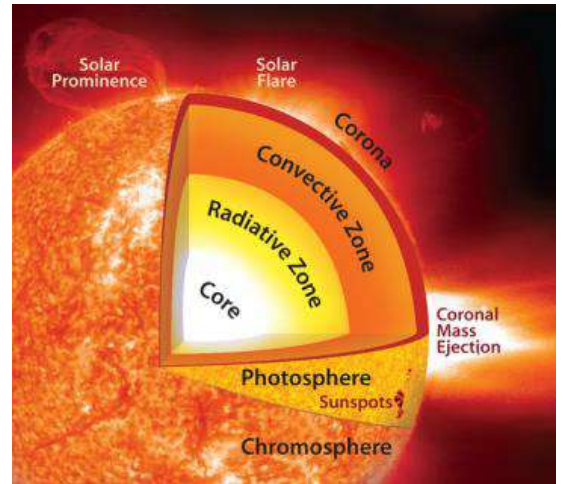
- The Roman Space Telescope will survey the sky up to thousands of times faster than can be done with Hubble.

About

- The Nancy Grace Roman Space Telescope is a NASA infrared space telescope currently under development.
- It is based on an existing 2.4 m wide field of view primary mirror and will carry two scientific instruments.
- It will be able to supersede Hubble, providing a panoramic field of view at least 100 times greater than Hubble's at similar image sharpness, or resolution.

Objective

- The telescope will look at answers pondering scientists on Earth for decades including how galaxies form and evolve over cosmic time? How did the largest structures in the universe assemble? How did the Milky Way galaxy come to be in its current form?
- Roman will give us the ability to see faint objects and view galaxies over long intervals of cosmic time.
- That will allow us to study how galaxies assembled and transformed.
- It will try to understand the evolution of galaxies not only of the Milky Way but in its neighboring regions as well.
- Roman's infrared detectors are ideal for capturing light emerging from those galaxies and can pick up signals from distant and fainter galaxies.
- Right now, with telescopes like Hubble, we can sample tens of high-redshift galaxies. With Roman, we'll be able to sample thousands.



CHANG'E-5 LUNAR MISSION

Context

- On December 16, 2020, China's Chang'e-5 lunar mission delivered to Earth nearly 2 kg of rocky fragments and dust from the Moon.
- The team has modelled the potential contributions from specific craters: **Aristarchus, Kepler, Copernicus, Harding, and Harpalus.**
- Now, scientists presented the early-stage findings that use geological mapping to link 'exotic' fragments in the collected samples to features near the landing site.

About Chang'e 5

- It is the fifth lunar exploration mission of the Chinese Lunar Exploration Program, and China's first lunar sample-return mission.
- The mission comprised of a lunar orbiter, a lander and an ascent probe that lifted the lunar samples back into orbit and returned them back to Earth.
- The Chang'e 5 landing site is in the Northern Oceanus Procellarum near a huge volcanic complex, Mons Rümker, located in the northwest lunar near side.
- The Chang'e 5 landing site, named Statio Tianchuan, is within the Procellarum KREEP Terrain, with elevated heat-producing elements, thin crust, and prolonged volcanism.
- This area is characterized by some of the youngest mare basalts on the Moon (~1.21 billion years old), with elevated titanium, thorium, and olivine abundances, which have never been sampled by Apollo or Luna mission.
- Chang'e-5 will help scientists understand what was happening late in the moon's history, as well as how Earth and the solar system evolved.

Indian Astronomical Observatory

Context

- The Indian Astronomical Observatory (IAO) is becoming one of the promising observatory sites globally, said a recent study.

About

- The Indian Astronomical Observatory (IAO), located in Hanle near Leh in Ladakh, has one of the world's highest located sites for optical, infrared and gamma-ray telescopes.
- It is operated by the Indian Institute of Astrophysics, Bangalore.
- It is currently the ninth highest optical telescope in the world, situated at an elevation of 4,500 meters (14,764 ft).

- The Indian Astronomical Observatory **stands on Mt. Saraswati, Digpa-ratsa Ri, Hanle in south-eastern Ladakh** union territory.
- The Observatory has two active telescopes. These are the 2.01 meter optical-infrared **Himalayan Chandra Telescope** (HCT) and a **High Altitude Gamma Ray Telescope (HAGAR)**.

Landsat 9

Context

- US space agency NASA has cleared the launch of Landsat 9 by Atlas V rocket.

About

- Landsat 9 is a powerful **Earth-observing satellite**.
- The Landsat 9 satellite is a **joint NASA and US Geological Survey (USGS) mission** that will continue the legacy of monitoring Earth's land and coastal regions that began with the first Landsat satellite in 1972.
- The rocket will take Landsat 9 to its orbit 438 miles above Earth.
- Landsat 9 will join its sister satellite, Landsat 8 that was launched in 2013, in orbit in collecting images from across the planet every eight days.
- This calibrated data will continue the Landsat programme's critical role in monitoring the health of Earth and helping people manage essential resources, including crops, irrigation water, and forests.
- It will also study the boundaries of Earth's magnetic field, to see how energy from the Sun can break through our planet's magnetic shield, and study how quickly their atmospheres are escaping.

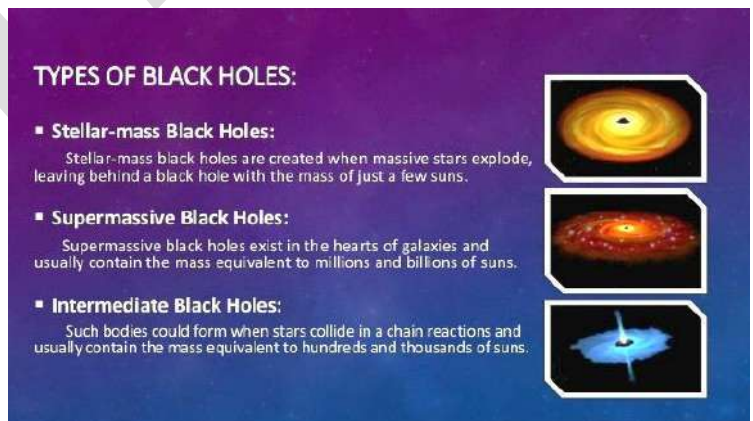
M87*

Context

- In 2019, astronomers of the Event Horizon Telescope captured the first ever image of a supermassive black hole (M87*) which was located at the centre of a galaxy Messier 87 (M87).

About

- A black hole is a place in space **where gravity pulls so much that even light cannot get out**.
- The gravity is so strong because matter has been squeezed into a tiny space. This can happen when a star is dying.
- Because no light can get out, people can't see black holes. **They are invisible**.
- Space telescopes with special tools can help find black holes. The special tools can see how stars that are very close to black holes act differently than other stars.



DART MISSION

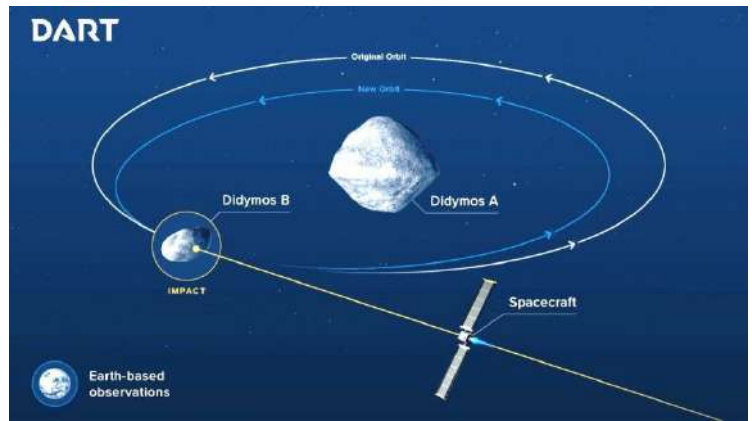
Context

- NASA is supposed to launch the agency's first planetary defense test mission named the Double Asteroid Redirection Test (DART).

About

- DART is a spacecraft designed to impact an asteroid as a test of technology.
- DART is a planetary defense-driven test of technologies **for preventing an impact of Earth by a hazardous asteroid**.
- DART will be the **first demonstration of the kinetic impactor technique** to change the motion of an asteroid in space.
- The binary near-Earth asteroid (65803) **Didymos is the target for the DART demonstration**.

- Didymos is the twin-asteroid system. Didymos is a binary near-Earth asteroid.
- The DART spacecraft will achieve the kinetic impact deflection by deliberately crashing itself into the moonlet at **a speed of approximately 6.6 km/s**, with the aid of an onboard camera (named DRACO).
- The collision will change the speed of the moonlet in its orbit.



Hera

- Hera will arrive at the Didymos system in 2027 to measure the impact crater produced by the DART collision and study the change in the asteroid's orbital trajectory.

STARLINK INTERNET SERVICES

Context

- Ministry of Communications has said that Starlink Internet Services is not licensed to offer satellite-based internet services in India as being advertised to the public.

About

- Starlink is a satellite internet constellation operated by SpaceX providing satellite Internet access to most of the Earth.
- The constellation consists of over 1600 satellites in mid-2021, and will eventually consist of many thousands of mass-produced small satellites in low Earth orbit (LEO), which communicates with designated ground transceivers.

James Webb Space Telescope

Context

- NASA has launched the \$8 billion James Webb Space Telescope (JWST) on December 25, 2021.

About

- The James Webb Space Telescope (JWST or "Webb") is a joint **NASA-ESA-CSA space telescope** that is planned to succeed the Hubble Space Telescope as NASA's flagship astrophysics mission.
- JWST will study various phases in the history of the universe, from the formation of solar systems to the evolution of our own Solar System.
- The **telescope must be kept very cold** in order to observe in the infrared without interference, so it will be deployed in space near the Sun-Earth **L2 Lagrange point**.
- Also a large sunshield made of silicon-coated and aluminium-coated Kapton will keep its mirror and instruments below 50 K (-223.2 °C).

Note

- A Lagrange point is a location in space where the combined gravitational forces of two large bodies, such as Earth and the sun or Earth and the moon, equal the centrifugal force felt by a much smaller third body.
- The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" without coming in the influence of gravitational field of any other body (example Earth or Sun).

SPACE TOURISM

Context

- Billionaire Japanese entrepreneur Yusaku Maezawa reached **the International Space Station (ISS)** for a 12-day trip, during which time he will complete 100 tasks in space, including playing a game of badminton.

Space Tourism

- Space tourism is another niche segment of the aviation industry that seeks to give tourists the ability to become astronauts and experience space travel for recreational, leisure, or business purposes.
- Companies including Virgin Atlantic, SpaceX, XCOR Aerospace, Jeff Bezos's Blue Origin and Armadillo Aerospace are working on providing space tourism services to people.

International Space Station Programme

- Launched in 1998 and involving **Russia, the United States, Canada, Japan, and the European Space Agency**.
- **China and India are not members** of ISSP.
- The ownership and use of the space station is established by intergovernmental treaties and agreements.
- The station serves as a microgravity and space environment research laboratory in which scientific research is conducted in astrobiology, astronomy, meteorology, physics, and other fields

Context

- In an astronomical milestone for NASA, their Parker Solar Probe flew into the Sun's corona (where the temperature is roughly two million degrees Fahrenheit) becoming the first spacecraft ever to do so.

About

- The Parker Solar Probe is a NASA space probe **launched in 2018 with the mission of making observations of the outer corona of the Sun**.
- It will approach to within 9.86 solar radii from the center of the Sun, and by 2025 will travel, at closest approach, as fast as 690,000 km/h, or 0.064% the speed of light.
- The Parker Solar Probe mission design **uses repeated gravity assists at Venus to** incrementally decrease its orbital perihelion to achieve a final altitude (above the surface) of approximately 8.5 solar radii.

Science Goals

- The goals of the mission are:
 1. Trace the flow of energy that heats the corona and accelerates the solar wind.
 2. Determine the structure and dynamics of the magnetic fields at the sources of solar wind.
 3. Determine what mechanisms accelerate and transport energetic particles.

NHP Bhuvan Portal

Context

- ISRO, Dr. K. Sivan also launched the NHP –Bhuvan portal of NRSC.

About

- NHP-Bhuvan Portal is a repository of information on the initiatives undertaken by NRSC under NHP with a facility to download the reports and knowledge products being developed by NRSC.
- **National Remote Sensing Centre (NRSC)**, Indian Space Research Organization (ISRO), Hyderabad is one of **the Implementing Agency under the National Hydrology Project (NHP)**.
- It is carrying out hydrological studies using satellite data and geospatial techniques.

NRSC

- NRSC under ISRO manages data from aerial and satellite sources.
- NRSC is mostly financed by State and Central Government funds but also do commercial business by selling satellite images and provide Consultancy to various government, private organisations.

National Hydrology Project

- It was started in 2016 as a **Central Sector Scheme with 100% grant** to implementing agencies on pan India basis.
- It is an initiative of the **Ministry of Jal Shakti and is supported by the World Bank.**
- **Timeline:** 8 years from 2016-17 to 2023-24.
- **Implementing Agencies:** 49 (including 12 from Central Government and 37 from States)
- **Project Components:** Water Resources Monitoring Systems; Water Resources Information Systems; Water Resources Operations and Planning Systems and Institutional Capacity Enhancement.

NEOWISE

Context

- NASA's NEOWISE Asteroid-Hunting Space Telescope Gets Two-Year Mission Extension.

About

- The NEOWISE mission uses a space telescope to hunt for asteroids and comets, including those that could pose a threat to Earth.
- Launched in 2009 as the **Wide-Field Infrared Survey Explorer, or WISE**, the space telescope was originally designed to survey the sky in infrared, detecting asteroids, stars and some of the faintest galaxies in space.
- In 2013, the telescope was taken out of hibernation and re-purposed for the NEOWISE project as an instrument to study near-Earth objects, or NEOs, as well as more distant asteroids and comets.
- During its primary mission, NEOWISE detected more than 158,000 minor planets.

Fengyun-3E (FY-3E)

Context

- China successfully launched a new **meteorological satellite, called Fengyun-3E(FY-3E).**

About

- Fengyun-3E(FY-3E) is designed with a lifespan of eight years.
- It will mainly obtain the atmospheric temperature, humidity and other meteorological parameters for numerical prediction applications, improving China's weather forecast capacity.
- It will also monitor the global snow cover, sea surface temperature, natural disasters and ecology to better respond to climate change and prevent and mitigate meteorological disasters.

Palomar 5

Context

- Astronomers discovered a Supra-Massive Black Hole Population in a "Fluffy" Star Cluster called Palomar 5 in our Galaxy.

About

- Palomar 5 is a globular cluster discovered by Walter Baade in 1950.
- A globular cluster is a spherical collection of stars. Globular clusters are very tightly bound by gravity, giving them their spherical shapes and high concentrations of stars toward their centers.

Planetary Conjunction

Context

- Mars, Venus, Moon are set to align on July 12-13.

About

- Conjunction is an apparent aligning, meeting or passing of two or more celestial bodies.



Types of Conjunctions

- As seen from a planet that is superior, if an inferior planet is on the opposite side of the Sun, it is in **superior conjunction** with the Sun.
- An **inferior conjunction** occurs when the two planets lie in a line on the same side of the Sun.
- In an inferior conjunction, the superior planet is "in opposition" to the Sun as seen from the inferior planet.
- A **triple conjunction** is an astronomical event where two planets or a planet and a star meet each other three times in a short period, either in opposition or at the time of inferior conjunction, if an inferior planet is involved.
- The lining-up of three planets is a particular case of **syzygy**.

What are Superior and Inferior Planets?

- In the Solar System, a planet is said to be inferior or interior with respect to another planet if its orbit lies inside the other planet's orbit around the Sun.
- In this situation, the latter planet is said to be superior to the former.
- In the reference frame of the Earth, in which the terms were originally used, the inferior planets are Mercury and Venus, while the superior planets are Mars, Jupiter, Saturn, Uranus and Neptune.
- Dwarf planets like Ceres or Pluto and most asteroids are 'superior' in the sense that they almost all orbit outside the orbit of Earth.

Orbital vs. Suborbital Flight

Context

- Recently, 6 people on Virgin Galactic's VSS Unity Spaceship took a trip to the edge of space known as Super-orbital Flight.

About

- The main difference between orbital and suborbital flight is the speed at which a vehicle is traveling.
- An orbital spacecraft must achieve what is known as orbital velocity, whereas a suborbital rocket flies at a speed below that.
- Orbital velocity is the speed that an object must maintain to remain in orbit around a planet.
- To orbit 125 miles (200 kilometers) above Earth, a spacecraft must travel at 17,400 mph (28,000 km/h).
- Suborbital flight, in contrast, requires much lower speeds. A suborbital rocket doesn't have the power to achieve orbit.
- Instead, it will fly up to a certain height that depends on its speed, and then come back down once its engines are shut off.
- To reach 125 miles above Earth, a suborbital vehicle needs to fly at a relatively sedate 3,700 mph (6,000 km/h).

Hubble Telescope

Context

- NASA plans to fix a glitch that has stopped the Hubble space telescope from being used for science work for more than a month.

About

- The Hubble Space Telescope was launched into low Earth orbit in 1990 and remains in operation.
- Hubble and its four main instruments **observe in the ultraviolet, visible, and near-infrared regions of the electromagnetic spectrum**.
- It has recorded some of the most detailed visible light images, allowing a deep view into space.
- Many Hubble observations have led to breakthroughs in astrophysics, such as **determining the rate of expansion of the universe**.

Space Rice

Context

- China has harvested the first batch of Space rice from seeds that went to a 23-day lunar voyage with China's Chang'e-5.
- After being exposed to cosmic radiation and zero gravity, these seeds were harvested at the space breeding research centre of the South China Agricultural University.
- The seeds are now 1 centimeter long, reports said.

What is space rice?

- Rice seeds exposed to the environment in Space may mutate and produce higher yields once planted on Earth.
- China has been taking seeds of rice and other crops to Space since 1987.
- More than 200 Space plant varieties, including cotton and tomatoes, have been approved for planting.

PDS 70

Context

- Scientists for the first time have spotted a moon-forming region around a planet beyond our solar system.

About

- The researchers used the ALMA observatory in Chile's Atacama desert to detect the disc of swirling material accumulating around one of two newborn planets seen orbiting a young star called PDS 70, located a relatively close 370 light years from Earth.
- The orange-colored star PDS 70, roughly the same mass as our Sun, is about 5 million years old.



STELLAR MID-LIFE CRISIS

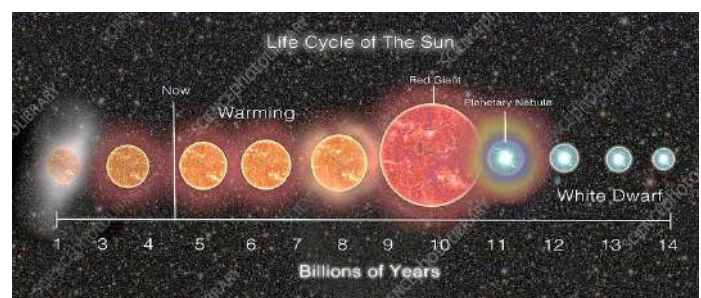
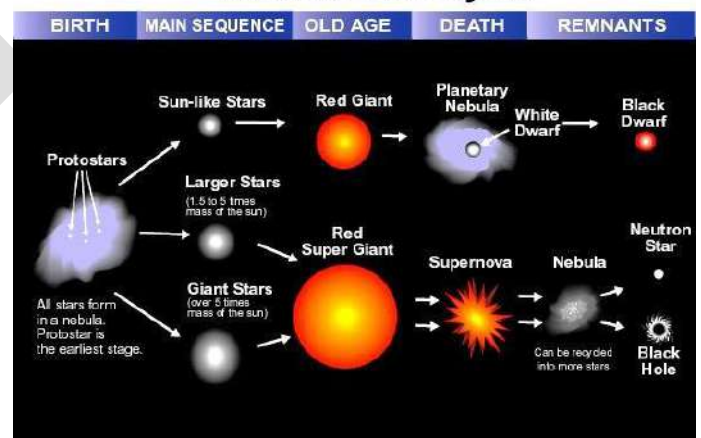
Context

- A team of astronomers from India and Nepal have detected that stars also go through a midlife crisis.

What happens when stars reach midlife?

- Spread over billions of years, the development leads to a **decline in the numbers of sunspots, flares, outbursts, and similar phenomena in the atmospheres of stars.**
- These developments are directly linked to the strength of their magnetic fields.
- At about the age of the Sun the magnetic field generation mechanism of stars suddenly becomes sub-critical or less efficient.
- This leads to two activity states a low activity mode and an active mode.
- A middle-aged star like the Sun can often switch to the low activity mode.
- The recent findings suggesting that the Sun maybe transitioning to a magnetically inactive future.

The Star Life Cycle



Cassini Spacecraft

In News

- NASA's Cassini spacecraft has detected an unusually high concentration of methane, along with carbon dioxide and dihydrogen, in the moons of Saturn by flying through their plumes.

Cassini

- Cassini, is a collaboration among NASA, the European Space Agency (ESA), and the Italian Space Agency (ASI) to send a space probe to study the planet Saturn and its system, including its rings and natural satellites.
- The Flagship-class robotic spacecraft comprised both NASA's Cassini space probe and ESA's Huygens lander, which landed on Saturn's largest moon, Titan in 1997.
- Cassini was the fourth space probe to visit Saturn and the first to enter its orbit.

Discrete Mars Auroras

Context

- The UAE's Hope spacecraft, which is orbiting Mars since February 2021, has captured images of glowing atmospheric lights in the Red Planet's night sky, known as discrete auroras.

What causes an aurora on Earth?

- Auroras are caused **when** charged particles ejected from the Sun's surface – called the **solar wind** – **enter the Earth's atmosphere** **and** interact with different gases in the atmosphere at the poles to cause a display of light.
- Northern Lights - Aurora borealis are seen from the US (Alaska), Canada, Iceland, Greenland, Norway, Sweden and Finland.
- Aurora australis or southern lights are visible from Antarctica, Chile, Argentina, New Zealand and Australia.



So, how are Martian auroras different?

- Unlike auroras on Earth, which are seen only near the north and south poles, discrete auroras on Mars are seen all around the planet at night time.
- Unlike Earth, which has a strong magnetic field, the Martian magnetic field has largely died out.
- This is because the molten iron at the interior of the planet– which produces magnetism– has cooled.
- However, the Martian crust, which hardened billions of years ago when the magnetic field still existed, retains some magnetism.
- So, in contrast with Earth, which acts like one single bar magnet, magnetism on Mars is unevenly distributed.
- These disjointed fields channel the solar wind to different parts of the Martian atmosphere, creating "discrete" auroras over the entire surface of the planet.
- Studying Martian offer clues as to why the Red Planet lost its magnetic field and thick atmosphere – that are among the essential requirements for sustaining life.

What is the Hope orbiter studying?

- The Hope Probe, the Arab world's first mission to Mars, took off from Earth in July 2020.
- The primary objective of the mission is to study Martian weather dynamics.

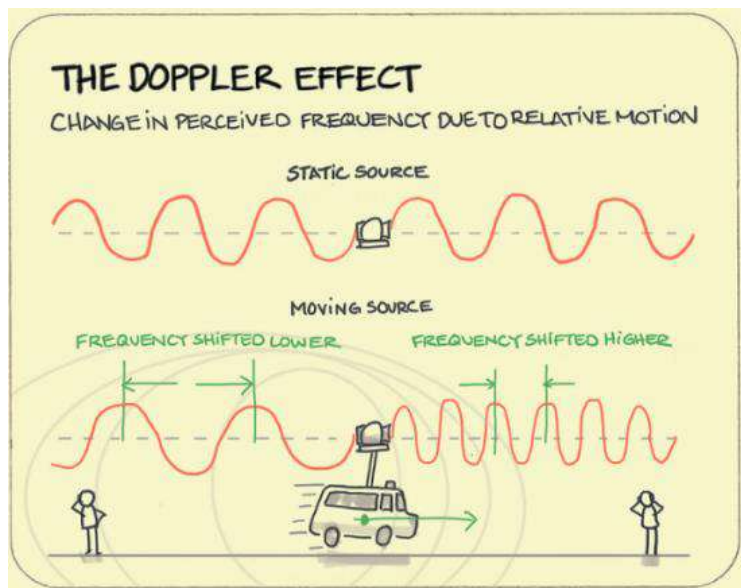
Doppler Radar

Context

- The India Meteorological Department's (IMD) only Doppler radar in Mumbai, which surveys weather patterns and forecast, stopped working again on Wednesday afternoon, when the city was witnessing rainfall.

Decoding Doppler Effect

- Doppler Effect is the **change in frequency of a wave in relation to an observer** who is moving relative to the wave source.
- A Doppler Radar works on the same principle.
- A common example of Doppler shift is the change of pitch heard when a vehicle sounding a horn approaches and recedes from an observer.



NEA Scout

Context

- NASA announced that its new spacecraft, named NEA Scout, has completed all required tests and has been safely tucked inside the Space Launch System (SLS) rocket.

What is NEA Scout?

- Near-Earth Asteroid Scout, or NEA Scout, is **a small spacecraft, about the size of a big shoebox.**
- Its main **mission is to fly by and collect data from a near-Earth asteroid.**

Nauka Module

Context

- Pirs, a Russian module on the International Space Station (ISS) used as a door for cosmonauts to go out on spacewalks, was detached from ISS.
- In its place, Russia's space agency Roscosmos will be attaching a significantly larger module called Nauka.

What does Russia's new Nauka module do?

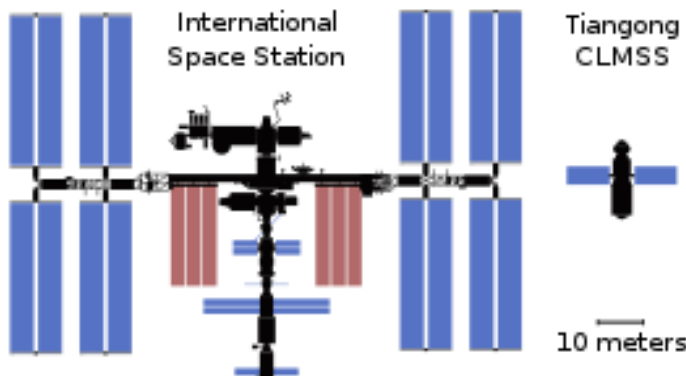
- Nauka will primarily serve as a research facility.
- On the ISS, Nauka will be attached to the critical **Zvezda module, which provides all of the space station's life support systems** and serves as the structural and functional centre of the Russian Orbital Segment (ROS).

About ISS

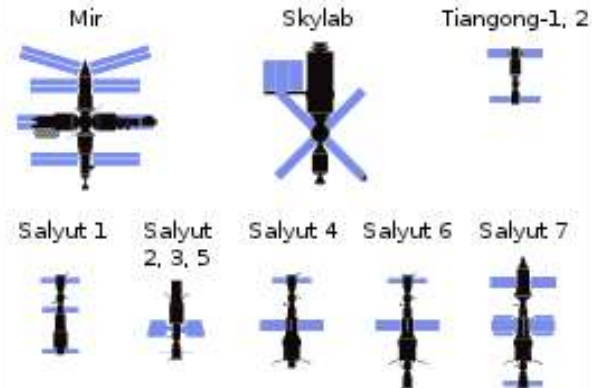
- The International Space Station (ISS) is a modular space station (**habitable artificial satellite**) in **low Earth orbit.**
- It is a multinational collaborative project involving five participating space agencies: **NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).**
- The station serves as a **microgravity and space environment research laboratory** in which scientific research is conducted in astrobiology, astronomy, meteorology, physics, and other fields.
- The **first piece of the International Space Station was launched in 1998** after which more pieces were added.
- The first crew arrived on ISS in November, 2000 after which the space station has been continuously occupied.
- ISS flies at an **altitude between 220km and 410 km** above the earth. This is the low-earth orbit.
- With the naked eye, the ISS can be seen** from nearly every area of Earth at different points in time.

- It travels around the Earth at an average speed of 27,700 kilometre per hour. It therefore **completes 15.5 orbits per day. Therefore, it orbits Earth every 90 minutes.**
- Space Stations prior to ISS

Current orbital stations



Past orbital stations



EOS-03

Context

- Earth observation Geo-imaging satellite "EOS-03" is scheduled for launch in third quarter of 2021.
- This is the **first developmental flight of SmallSatellite Launch Vehicle or SSLV.**

About

- It would enable near-real time monitoring of natural disasters like floods & cyclones.
- EOS-03 is capable of **imaging the whole country 4-5 times daily.**
- In addition to natural disasters, EOS-03 would also **enable monitoring of water bodies, crops, vegetation condition, forest cover changes etc.**
- The first earth observation satellite was launched in 2020 along with nine customer satellites.
- The EOS-1 was intended for applications in agriculture, forestry and disaster management support.

First SSLV Developmental Flight

- SSLV is ideal for on-demand, quick turn-around launch of small satellites.
- SSLV is a three-stage, all-solid launch vehicle that can carry a payload weighing **500 kilograms to the polar orbit, 500 kilometers above Earth's surface and a 300-kilogram payload into Sun Synchronous Polar Orbit.**

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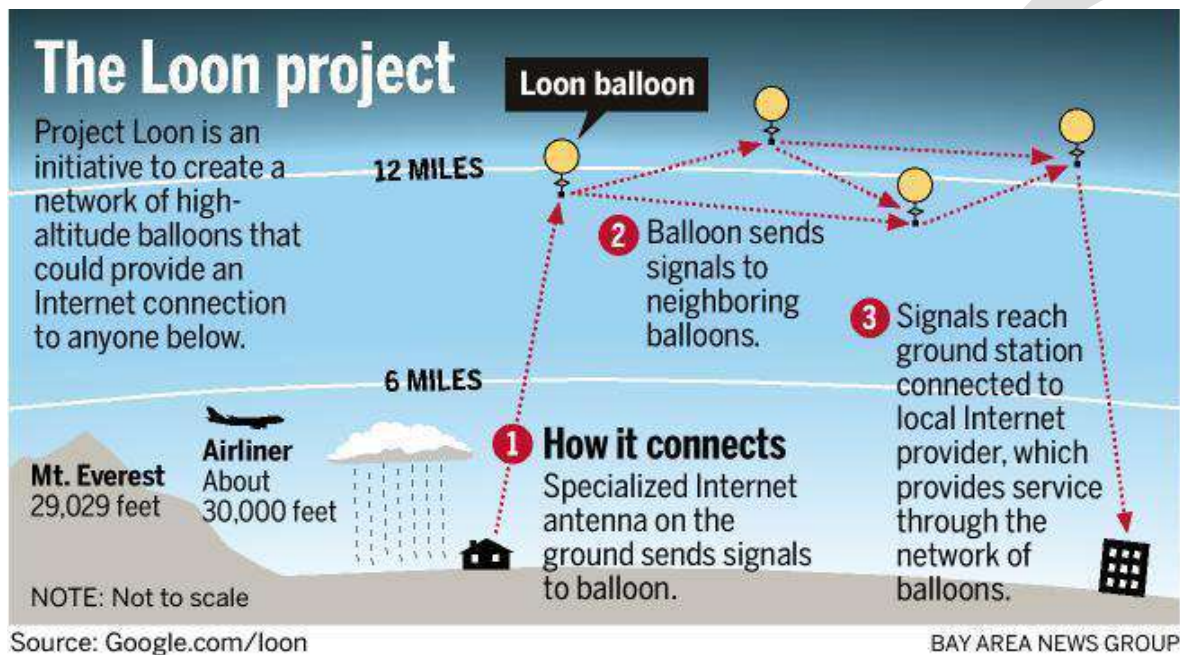
Internet via Balloon

Context

- Florida's Republican governor called on the administration of President Joe Biden to greenlight a plan to transmit the Internet to people in Cuba via high-altitude balloons when their government has blocked access.

About

- For years, Alphabet – the parent company of Google – worked to perfect an Internet-balloon division service called Loon. It shut down that project, saying it wasn't commercially viable.
- Prior to the shutdown, Loon balloons had been providing service in mountainous areas in Kenya.



CST-100 Starliner

Context

- The launch of Boeing's uncrewed Starliner Orbital Flight Test-2 (OFT-2), which was supposed to lift off has been postponed.
- The spacecraft, which is called the Crew Space Transportation-100 (CST-100), is part of an uncrewed test flight to the International Space Station (ISS).
- The mission is part of NASA's Commercial Crew Program.

What is the CST-100 Starliner and what is its purpose?

- The Boeing CST-100[a] Starliner is a **class of reusable crew capsules expected to transport crew to the International Space Station (ISS) and other low-Earth orbit destinations.**
- It is manufactured by Boeing for its participation in NASA's Commercial Crew Program.
- The Boeing Starliner holds a crew of up to seven people and is being designed to be **able to remain in-orbit for up to seven months with reusability of up to ten missions.**
- It is designed to be compatible with the **Atlas V, Delta IV, Falcon 9, and Vulcan Centaur launch vehicles.**
- The Starliner, will take roughly 24 hours to reach the ISS, after which it will dock there.

NASA's Commercial Crew Program

- NASA's commercial crew program is a partnership between SpaceX, Boeing and NASA to fly astronauts to the International Space Station.
- Unlike previous human spaceflight programs, NASA is a customer buying flights from commercial providers.
- The program is helping to lower the cost of spaceflight and create new a commercial market for humans in space.

- It will also ease NASA's burden of transporting astronauts and it would be able to focus on greater scientific research and building spacecraft and rockets meant for deep space exploration missions.

Context

- ISRO to send Bhutan's INS-2B satellite into space by year-end

About

- The development of the INS-2B satellite of Bhutan is being underway by four Bhutanese engineers who were trained at ISRO's UR Rao Satellite Centre in Bengaluru from December 28 to February 25, 202

Indo-Bhutan space cooperation

- India and Bhutan have been engaged in space cooperation with a ground Earth station for South Asia Satellite (SAS) that was inaugurated in Thimphu, Bhutan during Prime Minister Narendra Modi's visit in August 2019.
- The SAS was launched by India as a gift to the countries in the South Asia region, including Bhutan.

SAS

- South Asia Satellite (designated GSAT-9), formerly known as SAARC Satellite, is a **geostationary communications and meteorology satellite** operated by the Indian Space Research Organisation for the South Asian Association for Regional Cooperation (SAARC) region.
- The satellite is a part of his neighbourhood first policy.
- **Afghanistan, Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka are the users** of the multi-dimensional facilities provided by the satellite.
- The South Asia Satellite provides crucial information on tele-medicine, tele-education, banking and television broadcasting opportunities.
- It is also equipped with remote sensing state of the art technology which enables collection of real-time weather data and helps in observations of the geology of the South Asian nations.

Gamma Irradiation Technology

In News

- Union Minister Dr Jitendra Singh Says, Gamma Irradiation Technology For Food Preservation Has Already Been Shared With Private Players.
- At present 26 Gamma Radiation Processing Plants are operational in the country in private, semi government and government sector for irradiation of various products.

About

- The gamma irradiation process **uses Cobalt 60 radiation to kill microorganisms** on a variety of different products in a specially designed cell.
- Gamma radiation is generated by the decay of the radioisotope Cobalt 60, with the resultant high energy photons being an effective sterilant.

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Active Galactic Nuclei (AGN)

Context

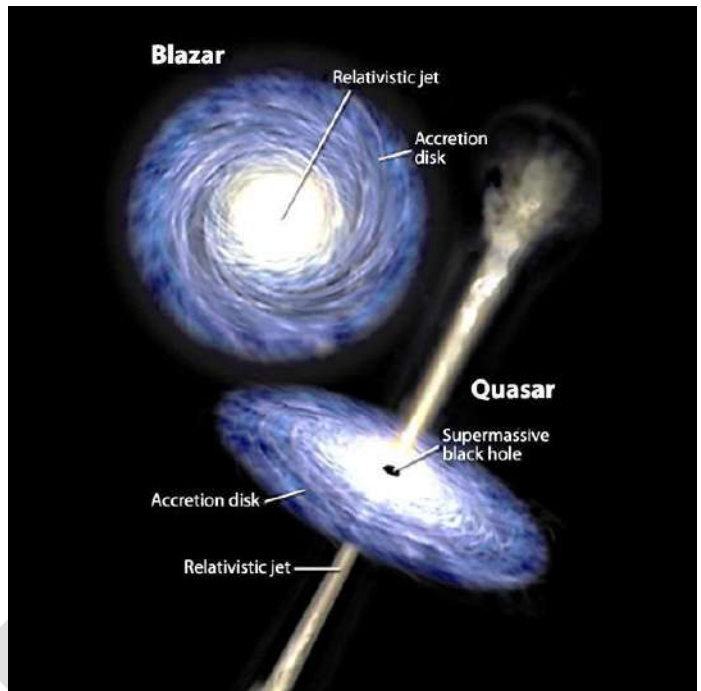
- Indian researchers have discovered three super-massive black holes from three galaxies merging together to form a triple active galactic nucleus.

Super-Massive Black Hole & AGN

- At the center of most galaxies, there's a massive black hole.
- The concentration of matter here is so dense that even light can't escape from it.
- They have mass of millions or even billions of Suns.
- The black hole accretes gas, dust, and stellar debris around it.
- As these material falls towards the black hole, their gravitational energy gets converted to light forming active galactic nuclei (AGN).
- 15 % of AGN emit charged particles called jets travelling at speeds close to the speed of light.

Details

- An Active Galactic Nucleus (AGN) is a **compact region at the center of a galaxy that has a much-higher-than-normal luminosity over at least some portion of the electromagnetic spectrum.**
- Such excess non-stellar (not from star) emission has been observed in the radio, microwave, infrared, optical, ultra-violet, X-ray and gamma ray wavebands.
- A galaxy hosting an AGN is called **an "active galaxy"**.
- Numerous subclasses of AGN have been defined based on their observed characteristics; the most powerful AGN are classified as quasars.
- A blazar is an AGN with a jet pointed toward the Earth, in which radiation from the jet is enhanced by relativistic beaming.



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HEALTH

Lumpy Skin Disease

Context

- Bihar government issued an advisory about the likely spread of lumpy skin disease (LSD).

About

- Lumpy skin disease (LSD) is an infectious disease in cattle caused by a virus of the family Poxviridae, (**capripox virus**) also known as **Neethling virus**.
- Virus is transmitted through arthropod vectors, direct contact, contaminated feed and water and repeated use of needles on different animals can all spread the disease.
- **It is controlled through vaccination**, control of animal movements and culling infected animals..

EBOLA

Context

- Recently, Democratic Republic of the Congo (DRC) declared the end of the 12th Ebola outbreak.

About

- Ebola **virus disease** is a fatal illness **affecting humans and other primates**.
- It was first **discovered in 1976** near the Ebola River (Democratic Republic of Congo).
- The virus is **transmitted to people from wild animals** (such as fruit bats, porcupines and non-human primates).
- It then spreads in the human population through **direct contact with the blood, secretions, organs or other bodily fluids of infected people**.
- **Symptoms:** Fever, Aches and pains, Loss of appetite, abdominal pain, diarrhea, and vomiting.
- **Eventually:** Damages the **immune system and organs**, uncontrollable bleeding and death.
- There's no cure for Ebola. **Vaccine: not available. Investigational vaccine:** rVSV-ZEBOV
- **Treatment:** Fluids and electrolytes, Oxygen, Blood transfusions etc

Emergency Use Listing (EUL)

Context

- Bharat Biotech International is about to apply for an emergency-use listing (EUL) for its covid vaccine, Covaxin.

About

- The EUAL is a risk-based procedure for assessing and listing unlicensed vaccines, therapeutics and in vitro diagnostics (IVDs) for use primarily **during public health emergencies of international concern (PHEIC)** but also in other public health emergencies if appropriate.
- The **World Health Organization (WHO)** developed the Emergency Use Assessment and Listing (EUAL) mechanism in response to the **2014 - 2016 Ebola Virus Disease (EVD) outbreak**.
- WHO's **cutoff for efficacy of covid-19 vaccines is 50%**. WHO EUL will make those inoculated with Covaxin eligible to enter regions such as the European Union.

WHO BioHub System

Context

- The World Health Organization (WHO) and the Swiss Confederation signed a Memorandum of Understanding to launch the first WHO BioHub Facility as part of the WHO BioHub System, which was announced in November 2020.

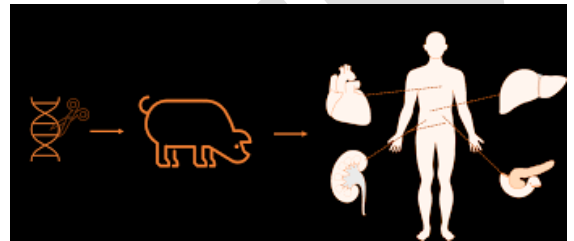
About

- Based in Spiez, Switzerland, the facility will serve as a centre for the safe receipt, sequencing, storage and preparation of biological materials for distribution to other laboratories
- This is to inform risk assessments, and sustain global preparedness against these pathogens.
- Currently, most pathogen sharing is done bilaterally between countries and on an ad hoc basis which can be slow, and leave some countries without access to the benefits and tools.
- The BioHub will enable Member States to share biological materials with and via the BioHub under pre-agreed conditions, including biosafety, biosecurity, and other applicable regulations.
- This will ensure timeliness and predictability in response activities.

XENOTRANSPLANTATION

Context

- In a first, doctors in the USA transplanted a genetically altered pig heart into a patient. This process is referred to as xenotransplantation .



About

- Xenotransplantation is any procedure that involves the transplantation, implantation or infusion into a human recipient of either -
 - (a) live cells, tissues, or organs from a nonhuman animal source, or
 - (b) human body fluids, cells, tissues or organs that have had ex vivo contact with live nonhuman animal cells, tissues or organs.
- Such cells, tissues or organs are called xenografts or xenotransplants.

Nipah Virus

Context

- Recently, Nipah Virus antibodies in bats were found from Mahabaleshwar cave in Maharashtra.

About

- The Nipah virus (NiV) is a type of RNA virus in the genus Henipavirus.
- **Symptoms** : fever, cough, headache, shortness of breath, and confusion, coma and even death.
- The virus normally circulates among specific types of fruit bats.
- It can both spread between people and from other animals to people.
- Spread typically requires direct contact with an infected source.
- As of 2021 there is neither vaccine nor specific treatment.
- Preventive measures include avoiding exposure to bats and sick pigs, and not drinking raw date palm sap.
- The disease **was first identified in 1998** in Malaysia. The disease is named after a village in Malaysia, Sungai Nipah.

Peter Pan Syndrome

Context

- A special court in Mumbai has granted bail to a 23-year-old accused of sexually assaulting a minor. During the hearing, the accused had told the court he suffered from “Peter Pan Syndrome”

About

- Peter Pan Syndrome is a psychological condition that is used to describe an adult who is socially immature.
- People develop behaviors like living life carefree, finding responsibilities challenging in adulthood, and basically, “never growing up” – suffer from Peter Pan Syndrome.
- Peter Pan Syndrome is not recognized by the World Health Organization.
- It is not listed in the Diagnostic and Statistical Manual of Mental Disorders.

Wendy Syndrome

- People suffering from Wendy Syndrome as often seen “making decisions, tidying up messes, and offering one-sided emotional support”.

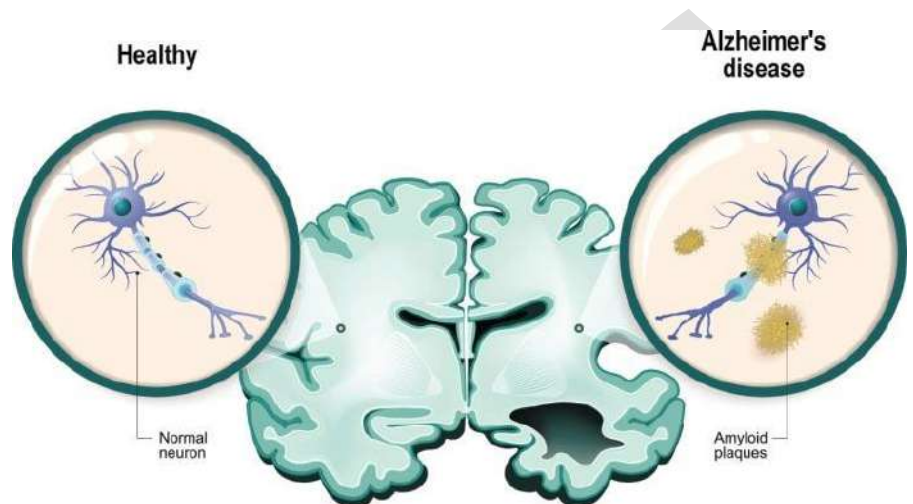
Aducanumab

Context

- The U.S. Food and Drug Administration approved Aduhelm (aducanumab) for the treatment of Alzheimer’s.

Alzheimer

- Alzheimer’s is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills, and eventually, the ability to carry out simple tasks.
- While the specific causes of Alzheimer’s disease are not fully known, it is characterized by changes in the brain—including amyloid plaques and neurofibrillary, or tau, tangles—that result in loss of neurons and their connections.
- These changes affect a person’s ability to remember and think.
- Alzheimer’s disease is most common in people over the age of 65. It can also affect people in 30s and 40s.



H10N3

Context

- The first human case of a rare strain of bird flu known as H10N3 has been reported in a 41-year-old man in eastern China.
- Until now, no human case of H10N3 has been reported elsewhere.

About

- Little is known about the virus, which appears to be rare in birds.

Bird flu

- Bird flu or avian flu, is caused by influenza viruses that spread between birds.
- It can often spread easily between birds, but very rarely causes disease in humans.
- Symptoms resemble those of normal flu – fever, cough, muscle aches, sore throat – but it can develop into a serious respiratory illness.
- Other strains of bird flu, including H5N1 and H7N9, have caused hundreds of deaths in humans since the first cases were reported in 1997.

BIPOLAR AIR DISINFECTANT AND PURIFIER

Context

- An air disinfection and purifying device called “Bipolar Air Disinfectant and Purifier”, was launched.

Details

- The new Bipolar Air Disinfectant & Purifier device can inactivate pathogens like SARS-COV-2 (COVID19), Norovirus, Influenza, Legionella virus, Rhinovirus, Varicella zoster virus, TB bacteria, Staphylococcus bacteria, E Coli bacteria, Pseudomonas bacteria, Bacillus cereus bacteria, fungi and molds.

- With this device, the company has introduced **the first Make in India Bipolar Ionization technology in the country.**

How Does Bipolar Ionization Work?

- **Bipolar ionization works by introducing positive and negative ions into the air.**
- The ionization causes **production of clusters of hydroxyl (OH) radicals, which are formed on the surface of microbes, removing hydrogen from the microbes' cell walls,** thereby inactivating potentially infectious particles.

HAVANA SYNDROME

Context

- Recently, the US Federal Bureau of Investigation (FBI) has said that dealing with the issue of Havana Syndrome is a top priority and that it will keep investigating the cause and how to protect staff.

What is Havana Syndrome?

- Havana Syndrome refers to a set of mental health symptoms that are said to be experienced by US intelligence and embassy officials in various countries.
- It typically involves **symptoms such as hearing certain sounds without any outside noise being present, nausea, vertigo and headaches, memory loss and issues with balance.**
- According to studies **microwave weapons "a main suspect"**
- Victims may have been subjected to high-powered microwaves that either damaged or interfered with the nervous system.
- It was said to have **built a pressure inside the brain that generated the feeling of a sound being heard.**

SWADESH PROJECT

In News

- DBT-National Brain Research Centre (DBT-NBRC) have **recently developed project SWADESH, a unique brain initiative focusing on certified neuroimaging, neurochemical, neuropsychological data and analytics that are made accessible to researchers for managing brain disorders.**

About

- SWADESH is the first large-scale multimodal neuroimaging database designed specifically for Indian population with big-data architecture and analytics for various disease categories under one platform.
- To strengthen Alzheimer's disease (AD) research and help scientific community come up with promising treatments.
- SWADESH proposes a big-data architecture that manages and analyzes six modules, namely neurodegenerative [AD, mild cognitive impairment (MCI), and Parkinson's disease (PD)], neuropsychiatric (schizophrenia and bipolar disorder), neurodevelopmental (autism and epilepsy), COVID-19-related disorders, other disorders, and healthy subjects.

Norovirus

Context

- Kerala health minister issued guidelines after norovirus, a highly contagious stomach bug that causes a range of symptoms, was confirmed in the state's Wayanad district.

About

- Norovirus is an **animal-borne disease transmitted through contaminated water and food.**
- Norovirus causes **gastrointestinal illness, including inflammation of the lining of the stomach and intestines, severe vomiting and diarrhoea.**
- Norovirus does not significantly affect healthy people but it can be serious in young children, the elderly and people with comorbidities.

- Norovirus is **easily transmitted through close contact** with people who have been infected, or by touching contaminated surfaces. It can also be spread by eating food that has been prepared or handled by someone with the stomach bug.
- The virus is spread through the excrement and vomit of an infected person.
- There **are currently no licensed vaccines for noroviruses.**

NOBEL PRIZE FOR PHYSIOLOGY OR MEDICINE 2021

Context

- American scientists David Julius and Ardem Patapoutian have won the 2021 Nobel Prize for Physiology or Medicine for their discoveries of receptors for temperature and touch.

Experiment

- Dr. Julius has been studying the different compounds in chili peppers and spider venom to understand how our bodies sense heat and chemical irritants.
- Decoding the neuroscience of pain can help develop new targets for pain therapy.
- Dr. Patapoutian helped **discover a novel class of sensors in our skin and internal organs that respond to cold and other mechanical stimuli.**

Findings

- They detailed how **capsaicin, or the chemical compound in chili peppers**, causes the burning sensation.
- They created a library of DNA fragments to understand the corresponding genes and finally discovered a new **capsaicin receptor and named it TRPV1.**
- This discovery paved the way for the identification of many other temperature-sensing receptors.
- They identified another new receptor called **TRPM8, a receptor that is activated by cold.**
- They explained that **this new receptor is specifically expressed in a subset of pain-and-temperature-sensing neurons.**
- They further studied if these receptors can be activated by mechanical stimuli.
- They poked cells and identified a cell line that produced an electric signal in response.
- They identified a single gene, which when silenced made the cells insensitive to the poking.
- They named this new **mechanosensitive ion channel Piezo1.**

Significance

- This knowledge [of the TRPV1, TRPM8 and Piezo channels] is being used to develop treatments for a wide range of disease conditions, including chronic pain.

miSHERLOCK

In News

- A team of researchers based at Harvard University's Wyss Institute and MIT have unveiled a quick and inexpensive testing platform capable of distinguishing between major SARS-CoV-2 variants called miSHERLOCK

Details

- The platform, called miSHERLOCK is fully self-contained from sample preparation to test readout.
- It is built around the CRISPR-based diagnostic tool called SHERLOCK.
- It requires no external equipment or instruments, and is eventually meant to be constructed by the user from 3-D printable parts and battery-powered electronics.

RESEARCH & DEVELOPMENT

TARDIGRADES AND QUANTUM ENTANGLEMENT

In News

- An international team of researchers have performed the first ever experiment successfully 'quantum entangling' a multi-celled organism.
- The team, says it's managed to place a tardigrade in a state of quantum entanglement between a pair of superconducting qubits.

Tardigrades

- Tardigrades also known as water bears or moss piglets, are a phylum of **eight-legged segmented micro-animals**.

Habitat

- They have been **found everywhere in Earth's biosphere, from mountain tops to the deep sea and mud volcanoes, and from tropical rainforests to the Antarctic**. Tardigrades are prevalent in mosses and lichens and feed on plant cells, algae, and small invertebrates.



Physiology

- Tardigrades are among the **most resilient animals known**, with individual species **able to survive extreme conditions** – such as exposure to extreme temperatures, extreme pressures (both high and low), air deprivation, radiation, dehydration, and starvation – that would quickly kill most other known forms of life. Tardigrades **have survived exposure to outer space**.
- Tardigrades are one of the few groups of species that are **capable of suspending their metabolism (cryptobiosis)**.
- Many species of tardigrade **can survive in a dehydrated state up to five years**, or longer in exceptional cases.

Quantum Entanglement

- Quantum entanglement is a physical phenomenon that occurs **when a pair or group of particles is generated, interact, or share spatial proximity in a way such that the quantum state of each particle of the pair or group cannot be described independently of the state of the others**, including when the particles are separated by a large distance.
- Measurements of physical properties such as position, momentum, spin, and polarization performed on entangled particles can, in some cases, be found to be perfectly correlated.
- Quantum entanglement has direct application in Quantum Computing.

The Recent Experiment

- The researchers managed to put a tardigrade in a state where it was directly **connected to the qubits** in such a way that anything that happens to the water bear or the qubits would simultaneously affect all three.
- This is a fundamental property of quantum computing.

Qubits

- In quantum computing, a qubit or quantum bit is the **basic unit of quantum information**.
- An ordinary computer chip uses bits. These are like tiny switches that can either be in the off position – represented by a zero – or in the on position – represented by a one.
- Rather than just being on or off, **qubits can also be in what's called 'superposition'** – where they're both on and off at the same time, or somewhere on a spectrum between the two. A qubit allows for uncertainty.
- The other thing that qubits can do is called entanglement. In entanglement, two particles are linked together, even if they're physically separate.

'THE INGENIOUS TINKERERS': ATAL INNOVATION MISSION (AIM)

Context

- Atal Innovation Mission (AIM) NITI Aayog released the **second edition of 'Innovations for You'** and another compendium titled '**The Ingenious Tinkerers**'.

About

- The second edition of 'Innovations for You' is a **compendium of innovations focused on agriculture featuring 70 start-ups supported by Atal incubation Centers (AICs) of AIM.**
- 'The Ingenious Tinkerers' is a compilation of the top innovations created by young student innovators who participated in the ATL Marathon - which invites school students to address a problem that they see or face on a day-to-day basis.

Atal Innovation Mission

- The Atal Innovation Mission (AIM) is a **flagship initiative set up by the NITI Aayog** to promote innovation and entrepreneurship across the length and breadth of the country.
- AIM's objectives **are to create and promote an ecosystem of innovation and entrepreneurship across the country** at school, university, research institutions, MSME and industry levels.

Atal Innovation Mission: Initiatives

- Atal Tinkering Labs**-As mentioned, these are to create a problem-solving mindset across schools in India.
- Atal Incubation Centers**-These would help in fostering world-class startups and would also add some dimension to the incubator model.
- Atal New India Challenges**-These are charged to foster product innovations and align them as per the requirements of various sectors/ ministries.
- Mentor India Campaign**-It would create a national mentor network in public sectors, corporates and institutions in order to support the initiatives of Atal Innovation Mission.
- Atal Community Innovation Center**-This would create a community-centric innovation module and provide with ideas in the unserved /underserved regions of India.
- This would bring about an innovation and research in MSME industry.

Atal Tinkering Labs

- The objective of this scheme is to foster curiosity, creativity and imagination in young minds and inculcate skills such as design mind - set, computational thinking, adaptive learning, physical computing, rapid calculations, measurements etc.
- Young children will get a chance to work with tools and equipment to understand what, how and why aspects of STEM (Science, Technology, Engineering and Math).

Key Features of ATL

- ATL is a work space where young minds can give shape to their ideas through hands on do-it-yourself mode; and learn innovation skills.
- Young children get a chance to work with tools and equipment to understand the concepts of STEM (Science, Technology, Engineering and Math).
- ATL contains educational and learning 'do it yourself' kits and equipment on - science, electronics, robotics, open source microcontroller boards, sensors and 3D printers and computers.
- In order to foster inventiveness among students, ATL can conduct different activities ranging from regional and national level competitions, exhibitions, workshops on problem solving, designing and fabrication of products, lecture series etc. at periodic intervals.
- AIM provides a grant-in-aid that includes a **one-time establishment cost of Rs. 10 lakh and operational expenses of Rs. 10 lakh for a maximum period of 5 years to each ATL.**

AmbiTag

Context

- IIT Punjab has developed a first-of-its-kind IoT device – AmbiTag.

About

- It records real-time ambient temperature during the transportation of perishable products, vaccines and even body organs and blood.
- That recorded temperature further helps to know whether that particular item transported from anywhere in the world is still usable or perished because of temperature variation.
- This information is particularly critical for vaccines including Covid-19 vaccine, organs and blood transportation.
- Shaped as a USB device, AmbiTag continuously records the temperature of its immediate surroundings from -40 to +80 degrees in any time zone for a full 90 days on a single charge.
- The device generates an alert when the temperature goes beyond a pre-set limit.
- It can also monitor the temperature of animal semen during transit.

SOLID STATE BATTERIES

Context

- Shareholders of California-based QuantumScape Corp, have approved a multibillion-dollar pay package for Chief Executive Officer Jagdeep Singh, subject to the company meeting some performance milestones.

About

- A solid-state battery is a battery technology that uses solid electrodes and a solid electrolyte, instead of the liquid or polymer gel electrolytes found in lithium-ion or lithium polymer batteries.

Advantages of solid state batteries

- higher cell energy density (by eliminating the carbon anode),
- lower charge time (by eliminating the need to have lithium diffuse into the carbon particles in conventional lithium-ion cells),
- ability to undertake more charging cycles and thereby a longer life, and
- improved safety.

Materials used

- Materials proposed for use as solid electrolytes in solid-state batteries include ceramics (e.g., oxides, sulfides, phosphates), and solid polymers.

Uses

- Solid-state batteries have found use in pacemakers, RFID and wearable devices.

Energetic choices

Solid-state batteries have several pluses over traditional lithium-ion batteries



Front Edge Technology battery powers a light-emitting diode.

Credit: Front Edge



Lithium-ion battery

Cre

Solid-state

- Higher cost
- + Higher energy storage
- + Lighter
- Nascent technology
- + Nonflammable
- + Performs well at high temperatures

Lithium-ion

- + Lower cost
- Lower energy storage
- Heavier
- + Proven technology
- Flammable
- Decreased battery life at higher temperature

UNESCO SCIENCE REPORT

Context

- Latest edition of UNESCO Science Report was published.
- Title: **'The race against time for smarter development'**.
- This year the report focuses on the need to develop countries of all income levels, prioritizing their transition to digital and 'green' economies.

About

- The UNESCO Science Report (USR) is a flagship publication of UNESCO and is published once every five years.
- The first report in this series was published in 1993 by the name of World Science Report.
- It is an oft-cited report on science, technology and innovation (STI). Every edition has a chapter on India.
- The chapter provides an overview of STI developments in India, with suggestions and recommendations.

Highlights and Suggestions

- **Stagnant Gross Domestic Expenditure on Research (GERD):**
It is at 0.7% of the GDP for years. In absolute terms, research expenditure has increased though. India has one of the lowest GERD/GDP ratios among the BRICS nations.
- **Research Intensity:**
India's research intensity has been declining since 2014. R&D in the government sector has been in steady decline since 2015. The share of private business enterprises in it has shot up to 42%. Number of researcher in India, has increased from 157 million in 2011 to 216 million in 2015.
- **Finance and IP:**
Level of domestic investment in R&D is inadequate. India needs to find new ways to finance research projects and to amend existing IP rules to do away with compulsory licenses on vaccines and drugs.
- **Technology:**
India has not adopted industry 4.0 technologies and job losses due to automation are not a serious threat now. Non-availability of well-trained scientists and engineers is a constraint in percolation of technologies. For enhancing technology, spillovers and valorisation of research, linkage between laboratories and manufacturers must be enhanced. For future competitiveness of Indian industry, a pool of technologies related to Fourth Industrial Revolution is essential.
- **Renewable Energy:**
Only a few Indian states have made progress on meeting renewable energy targets. The Report suggests for incentives to promote use of electric and hybrid vehicles.
- **Employment:**
Job opportunities for science, technology, engineering & medicine (STEM) graduates have not increased. However, employability of STEM graduates has increased to 49% in 2019 from 34% in 2014. It is serious issue because every other graduate is unemployable.
- **Research Publications:**
Indian researchers are publishing between 1.5 and 1.8 times the global average on smart-grid technologies, photovoltaics, biofuels and biomass and wind turbine technologies, complementing the government's push to expand green energy sources. There is an increase in scientific publications by Indian researchers on cutting-edge technologies.
- **Policies:**
There is a 'silo approach' in policy making. It's important to establish a single institution to facilitate coordination in innovation policies.
- **Some promising initiatives:**
Atal Innovation Mission, the Prime Minister's Research Fellows scheme; The 'Impacting Research Innovation and Technology' fund etc. The proposed National Research Foundation can be a big boost for academic research.

41st SCIENTIFIC EXPEDITION TO ANTARCTICA

Context

- India has successfully launched the 41st Scientific Expedition to Antarctica with the arrival of the first batch of its contingent at the southern white continent.

Details

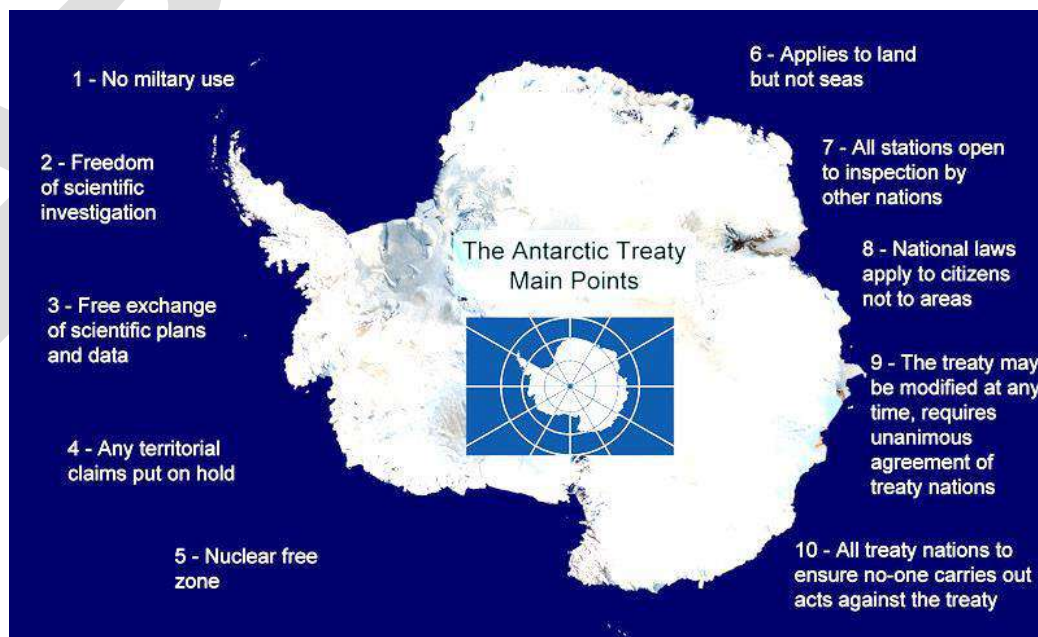
- The 41st expedition has two major programs.
- The first program encompasses geological exploration of the Amery ice shelf at Bharati station.
- This will help explore the link between India and Antarctica in the past.
- The second program involves reconnaissance surveys and preparatory work for drilling of 500 meters of ice core near Maitri.
- It will help in improving the understanding of Antarctic climate, westerly winds, Sea-ice and greenhouse gases from a single climate archive for past 10,000 years.

Indian Antarctic Program

- The Indian Antarctic Program is a multi-disciplinary, multi-institutional program under the control of the National Centre for Polar and Ocean Research, Ministry of Earth Sciences.
- It was **initiated in 1981** with the first Indian expedition to Antarctica.
- The program gained global acceptance with India's signing of the Antarctic Treaty and subsequent construction of the **Dakshin Gangotri Antarctic research base in 1983**, superseded by the **Maitri base from 1989**.
- The newest base **commissioned in 2012 is Bharati**.
- Under the program, atmospheric, biological, earth, chemical, and medical sciences are studied by India.
- As of today, Maitri and Bharati are fully operational.
- The National Centre for Polar and Ocean Research (NCPOR), Goa – an **autonomous institute** under the Ministry of Earth Sciences – manages the entire Indian Antarctic program.

The Antarctic Treaty

- The Antarctic Treaty was signed in Washington on 1 December 1959 by the twelve nations (**Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, United Kingdom, United States and USSR**).
- The Treaty now has 52 signatories. India became a member of this treaty in 1983.
- Headquarters:** Buenos Aires, Argentina.
- The Treaty, applies to the area south of 60° South latitude.



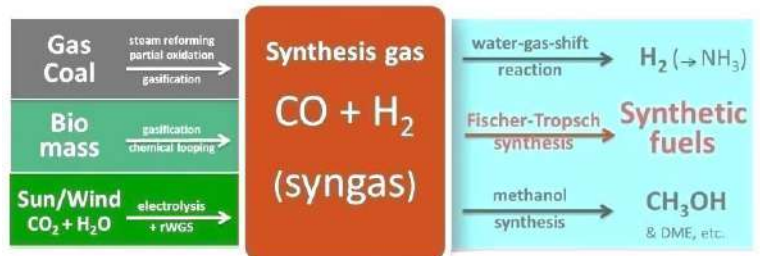
Fluidized Bed Gasification Technology

Context

- Bharat Heavy Electricals Limited (BHEL) has developed the fluidized bed gasification technology suitable for high ash Indian coals to produce syngas and then convert syngas to methanol with 99% purity.
- This technology will help the country move towards the adoption of clean technology and promote the use of methanol as a transportation fuel (blending with petrol), thus reducing crude oil imports.

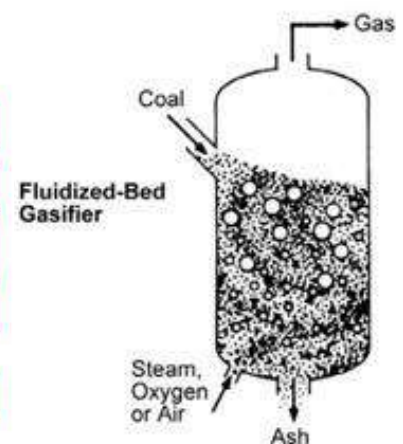
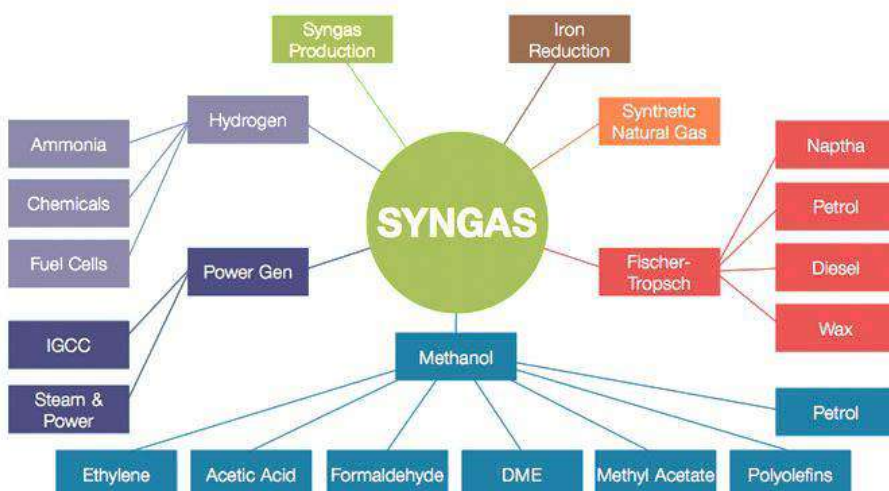
Gasification

- Gasification is a technological process that can convert any carbonaceous (carbon-based) raw material such as coal into fuel gas, also known as synthesis gas (syngas for short).
- The broad process of converting coal into methanol consists of conversion of coal to synthesis (syngas) gas, syngas cleaning and conditioning, syngas to methanol conversion, and methanol purification.



What is fluidized bed gasification?

- Fluidized-bed gasifiers suspend feedstock particles/coal in an **oxygen-rich gas** so the resulting bed within the gasifier acts as a fluid.
- These gasifiers employ back-mixing, and efficiently mix feed coal particles with coal particles already undergoing gasification.
- To sustain fluidization, or suspension of coal particles within the gasifier, coal of small particles sizes (<6 mm) is normally used.
- **Note:** Fluidization is a process similar to liquefaction whereby a granular material is converted from a static solid-like state to a dynamic fluid-like state. This process occurs when a fluid (liquid or gas) is passed up
- The gasifiers normally operate at moderately high temperature to achieve an acceptable carbon conversion rate (e.g., 90-95%).
- However, the **operating temperatures are usually less than the ash fusion temperature** so as to avoid clinker formation and the possibility of de-fluidization of the bed.
- This, in turn means that fluidized-bed gasifiers are best suited to relatively reactive coals, low rank coals, and other fuels such as biomass.



GLOBAL INNOVATION INDEX 2021

Context

- India has climbed 2 spots and has been ranked 46th by the World Intellectual Property Organization (WIPO) in the Global Innovation Index 2021 rankings.

Published by

- The GII report is published by WIPO in partnership with the Portulans Institute, with support of corporate network partners, such as the Confederation of Indian Industry, Brazilian National Confederation of Industry, Ecopetrol Group (Colombia), and the Turkish Exporters Assembly.

India's performance

- India has been on a rising trajectory, over the past several years in the Global Innovation Index (GII), from a rank of 81 in 2015 to 46 in 2021.
- Lauding India's efforts, the GII report said that selected middle-income economies are changing the innovation landscape, starting with China; Turkey, Vietnam, India, and the Philippines now pulling their weight.

TOP THREE INNOVATION ECONOMIES BY INCOME GROUP

Incomes	Countries (top three)
High income	Switzerland, Sweden, USA
Upper middle income	China, Bulgaria, Malaysia
Lower middle income	Vietnam, India, Ukraine
Low income	Rwanda, Tajikistan, Malawi

Source: Global Innovation Index 2021 by World Intellectual Property Organization

MICROFLIER

Context

- North-Western University engineers have created an electronic microchip with the capability of flight.

About

- About the size of a grain of sand, the new flying microchip (or "microflier") does not have a motor or engine.
- Instead, it catches flight on the wind – much like a maple tree's propeller seed – and spins like a helicopter through the air toward the ground.
- These microflier as the "smallest-ever human-made flying structures".

Women's Involvement in Science and Engineering Research (WISER) program

Context

- Women's Involvement in Science & Engineering Research (WISER) program was launched recently.

Key facts

- This is a first-of-its-kind programme, launched to promote women in the field of research and development by lateral entry.
- It was launched by Indo-German Science & Technology Centre (IGSTC) to encourage women researchers in R&D projects.
- This programme was launched in addition to the ongoing flagship 2+2 program of the IGSTC.

- This program of IGSTC is a joint initiative of Department of Science & Technology (DST), India and Federal Ministry of Education & Research (BMBF) of Germany.

Features of the programme

- This programme will support women scientists who are holding regular or long-term research positions in academia or research institutes or industry.
- Women can involvement in this program through lateral entry. There is no requirement of break-in-career or any age limit. This programme will enable easy participation.

Oxyjani

Context

- Indian researchers have designed a robust, mobile group oxygen concentrator called Oxyjani.

About

- OxyJani is based on the principles of Pressure Swing Adsorption (PSA) technology.
- The team **replaced lithium zeolites (LiX)** which is usually used in oxygen concentrators, **with sodium zeolites which does not generate toxic solid waste and can be manufactured in India.**
- The concentrator is capable of delivering a range of solutions, conversion of medical air to medical oxygen, and is an entirely off-grid solution including all modules that can facilitate deployment in rural areas.
- Moreover, the **waste from the 13X zeolite plant can be potentially a good agricultural input material.**
- The device is in the range of 30-40 litres per minute (l/min)., which is potentially useful for ICU uses too.

NBDriver

Context

- Researchers at the Indian Institute of Technology (IIT) Madras have developed an Artificial Intelligence-based mathematical model called NBDriver (neighbourhood driver) to identify cancer-causing alterations in cells.

About

- In this study, the main goal was to discover patterns in the DNA sequences -- made up of four letters, or bases, A, T, G and C surrounding a particular site of alteration.
- The underlying hypothesis was that these patterns would be unique to individual types of mutations -- drivers and passengers.

Driver Mutation

- A driver mutation is an alteration that gives a cancer cell a fundamental growth advantage for its neoplastic transformation.

Passenger mutations

- Passenger mutations can be defined as mutations that do not directly drive cancer initiation and progression, as opposed to driver mutations, such as mutations in oncogenes, TSGs or repair genes.

AMLEX

Context

- IIT Ropar has developed a **first-of-its-kind Oxygen Rationing Device - AMLEX.**

About

- AMLEX is designed to increase the life of medical oxygen cylinders.
- AMLEX supplies a required volume of oxygen to the patient during inhalation and trips when the patient exhales CO₂.
- This process saves oxygen which otherwise unnecessarily get wasted.

EMVÓLIO

Context

- DBT-BIRAC has developed Emvólio, a refrigeration device.

About

- Emvólio is a **portable, battery-powered medical-grade refrigeration device** that improves the efficiency of the immunization by strictly maintaining preset temperature for up to 12 hours, thus enabling the safe and efficient transportation of vaccines to the last mile.

Absorption Spectroscopy

In News

- Researchers from IIT Madras and IISER Kolkata have developed a method to detect minute quantities of chemicals in solution.
- They use a variation of absorption spectroscopy that surpasses the systemic limits imposed by conventional absorption spectroscopy.
- With this technique, they can, in principle, illuminate the insides of cells and detect minuscule quantities of substances present there.

About

- Absorption spectroscopy is a tool to detect the presence of elements in a medium.
- Light is shone on the sample, and after it passes through the sample is examined using a spectroscope.
- Usually in absorption spectroscopy, the principle used is that light because of its wavelike nature, shows diffraction patterns, that is, dark and light fringes, when it scatters off any object.
- A related concept called **the Abbe criterion** sets a natural limit on the size of the object being studied.

Soft Robotic Actuators

Context

- Using porous carbon nanoparticles from waste onion peels, a team of scientists have developed soft robotic actuators.

Actuator

- An "actuator" can be defined as a **device that converts energy (in robotics, that energy tends to be electrical) into physical motion.**

About

- Soft robots or actuators consisting of rubber-like polymer with embedded nanomaterial, which convert a source of energy to mechanical motion have been gaining much interest with targeted applications in areas, including bio-medical, military, and remote space operations.
- Generation of predesigned motion facilitated by their flexibility, affordability, and easy customization are the main reasons for such interest.
- The actuators can act as efficient traps for illuminating low-power near-infrared (NIR) light and can convert a control signal into mechanical motion with bioengineering applications such as drug delivery, wearable and assistive devices, prostheses, and even artificial organs.

MISCELLANEOUS

Zeolite

Context

- Recently, DRDO placed an order with Air India to bring Zeolite from all over the world.
- Purpose: To meet the demand of oxygen supply in the country amidst the COVID-19 pandemic.

About

- Zeolites are **microporous, aluminosilicate minerals** commonly used as commercial adsorbents and catalysts.
- Zeolites have a porous structure that can accommodate a wide variety of cations, such as Na⁺, K⁺, Ca²⁺, Mg²⁺
- Zeolites **occur naturally** but are also produced industrially on a large scale.
- Natural zeolites form where volcanic rocks and ash layers react with alkaline groundwater.

Uranium

Context

- The Maharashtra Anti-Terrorism Squad (ATS) arrested two persons with 7 kg natural uranium.

About

- Uranium occurs **naturally in low concentrations in soil, rock and water** and is commercially extracted from uranium-bearing minerals.

Uses

- In **nuclear power plants, Nuclear Fuel and Nuclear Submarines.**
- As **shield against radiation in medical processes** using **radiation therapy**
- While transporting radioactive materials
- Uranium's high density makes it effective in halting radiation.
- Its high density also makes it useful as **counterweights in aircraft and industrial machinery.**
- Provides **4 % of world renewable energy.**
- Ammunition, military weaponry
- Atomic Bombs
- Target for X-Ray production
- To color glass and silverware

CHARACTERISTICS OF URANIUM

- Uranium is weakly radioactive metal.
- It is malleable, ductile, slightly paramagnetic.
- Strongly electropositive and is a poor electrical conductor.
- Uranium metal has very high density .
- Uranium-235 was the first isotope that was found to be fissile.
- Uranium-235 can be used to make an atomic bomb. The first nuclear bomb used in war relied on uranium fission.

Deep ocean mission

Context

- Chief of the Naval Staff, and the Government stakeholders discussed the modalities to deepen cooperation in "Deep Ocean Mission" which is to be the torchbearer of India's "Blue Economy".
- Establishing a research facility in Goa for marine biology and engineering.
- Undertaking climate change surveys of seas around India.
- Making ocean thermal energy conservation efficacious.
- Generates power from the difference in temperatures.

About

- Deep Ocean mission is an initiative to undertake the deep ocean exploration focused on India's exclusive economic zones and continental shelf.
- It is under **Ministry of Earth Sciences (MoES).**

Objective

- It aims to search for deep-sea resources and minerals, flora and fauna, including microbes, and studying ways to sustainably utilise them.

Deep Ocean Mission includes:

- Developing systems for deepsea mining, launching a manned submersible.
- Deep-ocean exploration, including purchase of a vessel for this.
- Deep-ocean biodiversity studies, bio prospecting.

Components

There are six components to the programme.

(1) Development of Technologies for Deep Sea Mining, and Manned Submersible:

- A manned submersible will be developed to carry three people to a depth of 6000 metres in the ocean with suite of scientific sensors and tools for mining Polymetallic Nodules.

(2) Development of Ocean Climate Change Advisory Services:

- It entails developing a suite of observations and models to understand and provide future projections of important climate variables on seasonal to decadal time scales.

(3) Technological innovations for exploration and conservation of deep-sea biodiversity

- Bio-prospecting of deep-sea flora and fauna including microbes and studies on sustainable utilization of deep-sea bio-resources will be the main focus.
- This component will support the Blue Economy priority area of Marine Fisheries and allied services.

(4) Deep Ocean Survey and Exploration

- To explore and identify potential sources of hydrothermal minerals that are sources of precious metals formed from the earth's crust along the Indian Ocean mid-oceanic ridges.

(5) Energy and freshwater from the Ocean

- Involves studying and preparing detailed engineering design for offshore Ocean Thermal Energy Conversion (OTEC) powered desalination plants.

(6) Advanced Marine Station for Ocean Biology

- Aimed at development of human capacity and enterprise in ocean biology and engineering.

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DIGGING DEEP

Potato-shaped polymetallic nodules are a source of metals such as nickel, cobalt, copper, manganese and iron

HOW WILL IT BE DONE?

- 1 Survey identifies areas where polymetallic nodules are present
- 2 Ship carrying integrated mining system (IMS) will be anchored at site
- 3 Soil tester will be sent down to evaluate seabed soil properties for load bearing and shear strength
- 4 A 12-tonne crawler will be sent to the seabed
- 5 Cameras on crawler send images to the ship

- 6 Pump sucks the nodule, transfers it to a crusher in crawler
- 7 Crushed granules pumped to ship through a buffer
- 8 Minerals segregated in ship and transported to land

WHAT WILL BE MINED?

- > Polymetallic nodules, a rock-like solid mass formed by accumulation of matter within sediments at the bottom of the sea
- > Iron, manganese, nickel, cobalt and copper are found in nodules
- > India to explore polymetallic nodules in the central Indian Ocean basin for 15 years
- > Estimated polymetallic nodule resource potential is 380 million tonnes containing 4.7 million tonnes of nickel, 4.29 million tonnes of copper, 0.55 million tonnes of cobalt and 92.59 million tonnes of manganese

FUTURE

- > Mining equipment tested at 500m depth so far
- > First stage will be conducted by 2019 and with crawler for locomotion trials and pumping system at 6,000m depth
- > Prototype will be ready in 2022 and go through final tests

DEEP OCEAN MISSION

- > Deep Sea Mining through 'Underwater Vehicles' and 'Underwater Robotics'
- > Asserting exclusive rights to explore polymetallic nodules from seabed **over 75,000 sq km of areas in international water**
- > Estimated polymetallic nodules resource potential: **380 million tonnes (MT)**
- > Development of ocean climate change advisory services
- > Technology for sustainable utilisation of marine bio-resources

THESE POLYMETALLIC NODULES CONTAIN

Manganese	92.6 MT
Nickel	4.7
Copper	4.3
Cobalt	1

(*figures are rounded off)

- > Deep ocean survey and exploration
- > Energy from the ocean and offshore-based desalination
- > Krill fishery from southern ocean

Samudrayaan Project under the Deep Ocean Mission

Samudrayaan

"India's own crawler to walk the Ocean bed"

AIM:
Exploration of **polymetallic nodules** (also known as manganese nodules) from Ocean.

ABOUT:

- It is a part of the **Ministry of Earth Sciences' pilot project** for deep ocean mining for rare minerals.
- It proposes to carry three persons in a **submersible vehicle to a depth of 6,000 metres for 72 hours under sea.**
- The project is expected to become a reality by **2021-22.**
- The project has been undertaken by the **National Institute of Ocean Technology (NIOT).**

w.t.g

Black carbon

Context

- Black Carbon has a significant adverse effect on human health and leads to premature mortality, says a new study by Department of Science and Technology.

Findings

- Indo-Gangetic Plain**, experiences very high aerosol loading and trace gas concentrations throughout the year due to prevalence of a subsidence zone (sudden sinking of the Earth's surface).
- The region observed **decadal increasing trends** both in Aerosol Optical Depth and Black Carbon aerosols.
- From 2009 to 2016, correlation between daily all-cause mortality and ambient air quality establish that there is a clear impact of BC aerosols, NO₂ and, PM_{2.5} exposure.
- The effect of pollutants was **more prominent for males**, age group 5-44 and, in winter.
- The adverse effect of air pollutants was not limited to current day of exposure but can extend as high as up to 5 days (Lag effect).
- Mortality rises linearly with an increase in air pollutants level.

Aerosol

- An aerosol is a **suspension of fine solid particles or liquid droplets in air or another gas.**
- Aerosols can be natural or anthropogenic.
- Examples of natural aerosols are fog or mist, dust, forest exudates and geyser steam.
- Examples of anthropogenic aerosols are particulate air pollutants and smoke.

Black Carbon

- Chemically, black carbon (BC) is a component of fine particulate matter (PM ≤ 2.5 μm).
- It is formed through the **incomplete combustion of fossil fuels, biofuel, and biomass.**
- Black carbon is a climate forcing agent contributing to global warming.
- It warms the Earth by absorbing sunlight and heating the atmosphere and by **reducing albedo** when deposited on snow and ice (direct effects) and indirectly by interaction with clouds.
- Black carbon stays in the atmosphere **for only several days to weeks**
- The IPCC have posited that reducing black carbon is one of the easiest ways **to slow down short term global warming.**

Aerosol Optical Depth

- Aerosol Optical Depth (AOD) is the measure of aerosols (e.g., urban haze, smoke particles, desert dust, sea salt) distributed within a column of air from the Earth's surface to the top of the atmosphere.

JivanVayu

Context

- IIT Ropar has developed power free CPAP device "JivanVayu". The device has been manufactured using 3D printing.
- It can be used as a substitute for Continuous Positive Airway Pressure (CPAP) machine.

Details

- This is the nation's first such device which functions even without electricity.
- It is adapted to both kinds of oxygen generation units like CO₂ cylinders and oxygen pipelines in hospitals.
- These provisions are not available in otherwise existing CPAP machines.
- The device is designed to maintain a FiO₂ (fraction of inspired oxygen or FiO₂ is the concentration of oxygen in the gas mixture) of above 40 per cent with a PEEP (positive end-expiratory pressure) of 5-20 cm H₂O.
- Additionally, the device houses a viral filter at the air entrainment end with a viral efficacy of 99.99 per cent.
- The viral filter ensures that the entrained air does not bring in any pathogens from the environment.
- The flow and Positive pressure can be controlled through the regulator at the cylinder end and PEEP valve respectively.

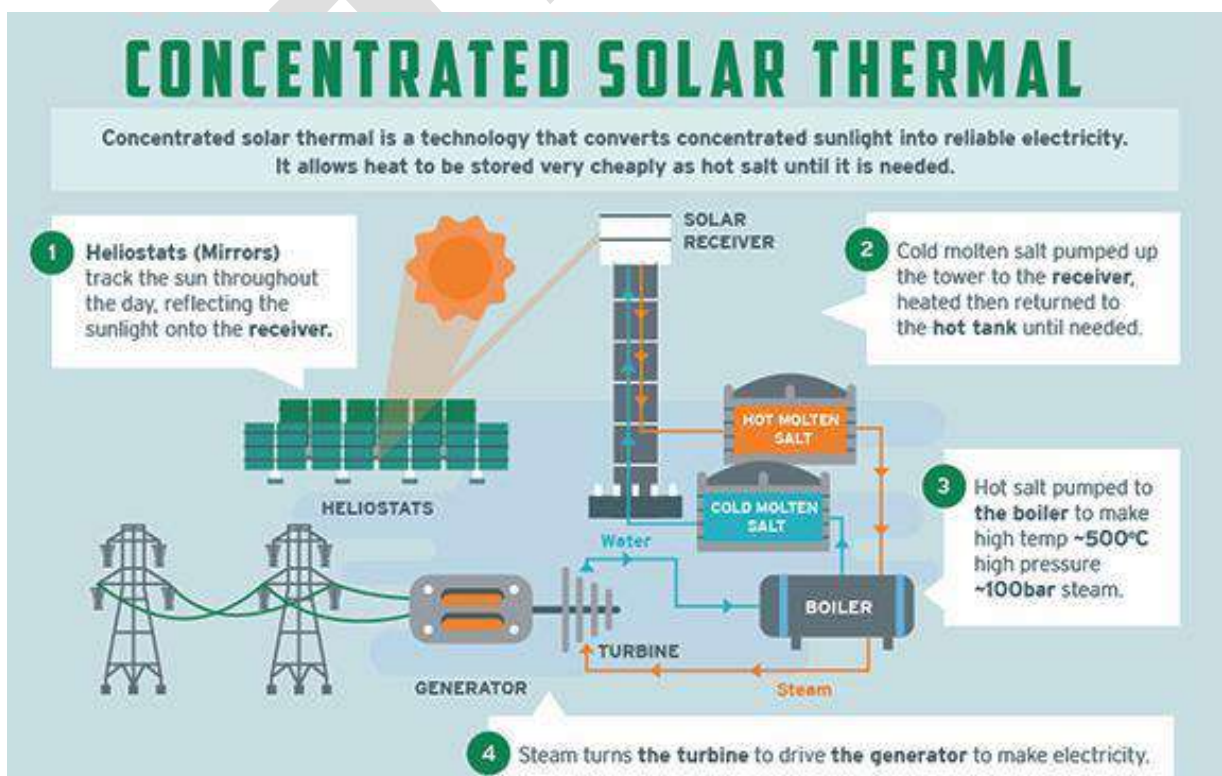
Concentrated Solar Thermal (CST)

Context

- The Ministry of Science & Technology has announced the set up a concentrated solar thermal (CST) based test rig facility at Hyderabad.

About the Rig Facility

- The facility can help the solar industry test capability and performance of solar thermal components like solar receiver tubes, heat transfer fluids, and concentrating mirrors.
- It can conduct simultaneous testing of standard and indigenous solar receiver tubes.



Set up by

- The facility has been set up by the International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI).
- Established in 1997 ARCI is an autonomous institute of the Department of Science & Technology (DST).

Significance

- A majority of the solar thermal Indian companies import solar thermal components, from China and Europe.
- This is an opportunity for indigenous solar thermal components manufacturing players to develop solar thermal technologies for low and medium-temperature applications.

Ultraviolet-C Technology

Context

- Union Minister of State for Science and Technology has said that Ultraviolet-C or UV-C Disinfection Technology will soon be installed in Parliament for the “mitigation of airborne transmission of SARS-COV-2”.

What is UV?

- Ultraviolet (UV) is a type of light or radiation naturally emitted by the Sun.
- **UV is divided into three bands:** UV-C (100-280 nm), UV-B (280-315 nm) and UV-A (315-400 nm).
- UV-A and UV-B rays from the Sun are transmitted through our atmosphere and all UV-C is filtered by the ozone layer.
- UV-B rays can only reach the outer layer of our skin or epidermis and can cause sunburns and are also associated with skin cancer.
- UV-A rays can penetrate the middle layer of your skin or the dermis and can cause aging of skin cells and indirect damage to cells' DNA.
- UV-C radiation from man-made sources has been known to cause skin burns and eye injuries.

Can UV-C kill Coronavirus?

- An in-vitro experiment conducted by Hiroshima University researchers showed that 99.7% of SARS-CoV-2 viral culture was killed when exposed to UV-C irradiation for 30-seconds.

Is it safe for humans?

- Researchers from the IIT-Kanpur, noted that UV-C radiation could be harmful to the skin and eyes of the living beings, therefore the operator of the device must use spectacles with UV-C radiation protection.
- But few studies have shown that far-UVC light (207–222 nm) does not harm mammalian skin.

Right to repair movement

Context

- In recent years, countries around the world have been attempting to pass effective 'right to repair' laws.
- But large tech companies, including Apple, Microsoft, Amazon and Tesla, have been lobbying against the right to repair.

Issue

- The average consumer purchases an electronic gadget, knowing that it will very quickly become obsolete as its manufacturer releases newer, shinier, and more amped up versions of the same device.
- **Result:** Consumer is at the mercy of manufacturers who make repairs inaccessible for most, by dictating who can fix the device and making it an inordinately expensive affair.

Significance of the Movement

- The goal of the movement is to get companies to make spare parts, tools and information on how to repair devices available to customers and repair shops to increase the lifespan of products and to keep them from ending up in landfills.

i-Drone

Context

- Union Health Minister launched the ICMR's drone response and outreach in the north-east (i-Drone).
- The delivery model is aimed at ensuring that life-saving vaccines reach everyone.

About

- This is for the first time that a 'Make in India' drone has been used in South Asia to transport COVID vaccine over an aerial distance of 15 km in 12-15 minutes from the Bishnupur district hospital to **Loktak lake, Karang island in Manipur** for administration at the primary health centre.

Significance

- India is home to geographical diversities and drones can be used to deliver essentials to the last mile.
- This would facilitate vaccine delivery to tough and hard-to-reach terrains.

Present permits

- Currently, the drone-based delivery project has been granted permission for implementation **in Manipur and Nagaland, as well as the Andaman and Nicobar Islands.**
- The Ministry of Civil Aviation, the Directorate General of Civil Aviation and other regulatory authorities have granted permission to fly drones beyond the visual line of sight.

LITHIUM TRIANGLE

Context

- With countries around the world scrambling to reduce emissions, rising global lithium demand and surging prices have drawn increased interest in the so-called '**lithium triangle**' that spans parts of **Argentina, Bolivia and Chile.**

Details

- Lithium has become the new 'white gold' as the demand for high performing rechargeable batteries is rising.
- In Argentina, mining provinces such as **Salta, Jujuy and Catamarca** have moved to strengthen infrastructure, legal security and fiscal stability.



Uses of Lithium

- Lithium metal and its compounds have many uses:
 - lithium stearate is mixed with oils to make all-purpose and high-temperature lubricants
 - lithium hydroxide is used to absorb carbon dioxide in space vehicles
 - lithium is alloyed with aluminium, copper, manganese, and cadmium to make high performance alloys for aircraft
 - Bahnmetall consists of lead containing 0.04% lithium, 0.7% calcium and 0.6% sodium is harder than pure lead and was used for railroad car bearings in Germany.
 - compounds such as LiAlH_4 and organolithium reagents (LiMe , LiPh , etc.) are very important as reagents in organic chemistry
 - lithium metal has the highest specific heat of any solid element and so heat transfer applications
 - various nuclear applications
 - lithium is sometimes used as battery anode material (high electrochemical potential) and lithium compounds are used in dry cells and storage batteries
 - lithium is used in the manufacture of special high strength glasses and ceramics sometimes, lithium-based compounds such as lithium carbonate (Li_2CO_3) are used as drugs to treat manic-depressive disorders.

Lithium Reserves

- Chile has the largest lithium reserves worldwide by a large margin.
- Chile is followed by Australia and Argentina.

Lithium and India

- India does not have enough lithium reserves for manufacturing lithium-ion batteries**, with lithium also having other uses such as in mobile phone batteries, solar panels, aerospace and thermonuclear fusion.
- Almost all-electric vehicles in the country run on imported batteries, mostly from China.
- Recently though, 1,600 tonnes of lithium resources were found in the igneous rocks of the Marlagalla-Allapatna region of Karnataka's Mandya district.

PLANETARIUM INNOVATION CHALLENGE

Context

- MyGov India, under the Ministry of Electronics and Information Technology (MeitY), has launched the Planetarium Innovation Challenge for Indian start-ups and tech entrepreneurs.

About

- The challenge invites applications from start-ups and tech entrepreneurs to develop state-of-the-art technology for our Planetariums.
- The challenge **aims to bring together the tech firms and Start-ups (based out of India) with the potential to build an indigenous planetariums system software using latest technologies including Augmented Reality (A.R.), Virtual Reality (V.R.) and Merged Reality (M.R.).**
- The Innovation Challenge is open to experts from all domains of Planetarium Technology.
- The applicants may include Start-ups, Indian Legal Entities; even Individuals (or Teams) are welcome to submit ideas.
- The first winner, second winner and third winner under the contest will get the cash prizes of Rs.5 lakh, Rs.3 lakh and Rs.2 lakh respectively.

Isothermal Forging Technology

Context

- The Defence Research and Development Organisation (DRDO) has established an **Isothermal forging technology** to produce various stages of high pressure compressor discs from titanium alloy for aeroengines.
- This is a crucial technology for establishing self-reliance in aero engine technology.

What is isothermal forging technology?

- In metallurgy, the process of Forging is termed as shaping metal and increasing its strength by hammering or pressing.
- Forging has different types, among them is isothermal forging technology.
- In Isothermal forging, the die and the workpiece are maintained at the same temperature throughout the forging cycle.
- This technology is widely used to forge titanium-based alloys.
- That is why this technology is best suited for the high-pressure compressors (HPC) discs that are used in aero-engines.
- The fighter jet engine needs components with the highest precision, as a small deformity can lead to huge damage. The isothermal forging technology provides the components with the highest precision.

Tech NEEV/नीव @75

Context

- “Tech NEEV/ नीव @75” was launched as part of Azadi ka Amrit Mahotsav and interacted with successful start-ups including those from the tribal communities on the occasion of Janjatiya Gaurav Diwas.

About

- The Government of India will be setting up 30 Science Technology and Innovation (STI) Hubs in different parts of the country for Scheduled Tribes (STs) by end of 2022.
- **Aim:** To promote scientific talent among tribal communities and for their overall socio-economic development.
- The 75 hour programme includes experience sharing of beneficiaries, community change leaders, societal changemakers conclave and round table discussions by various stakeholders apart from compilation of 75 impactful stories on India’s progress towards Aatma Nirbhar Bharat.

Significance

- The STI Hubs for SCs/STs, will directly benefit 20,000 people through various interventions spreading across farm, non-farm and other allied livelihood sectors.
- It reverberates the importance of Science and Technology in transforming the life of the poorest of the poor and developing affordable technologies.

O-SMART

Context

- The Union Cabinet approved the continuation of the umbrella scheme “Ocean Services, Modelling, Application, Resources and Technology (O-SMART)” of Ministry of Earth Sciences, for implementation during the period from 2021-26 at an overall cost of Rs. 2177 crore.

About

- The O-SMART scheme objectives are: providing forecast and services based on the continuous observation of our oceans, development of technologies and exploratory surveys for sustainable harnessing of our oceanic resources (both living and non-living) and promotion of front-ranking research in ocean sciences.
- The scheme encompasses seven sub-schemes namely Ocean Technology, Ocean Modelling and Advisory Services (OMAS), Ocean Observation Network (OON), Ocean Non-Living Resources, Marine Living Resources and Ecology (MLRE), Coastal Research and Operation and Maintenance of Research Vessels.
- These sub-schemes are being implemented by autonomous/attached institutes of the Ministry, viz. National Institute of Ocean Technology (NIOT), Chennai; Indian National Center for Ocean Information Services (INCOIS), Hyderabad; National Centre for Polar and Ocean Research (NCPOR), Goa, Center for Marine Living Resources and Ecology (CMLRE), Kochi; and National Centre for Coastal Research (NCCR), Chennai as well as involving other national institutes.



GLOBAL INNOVATION INDEX AND INNOVATION COOPERATION ACTION PLAN

Context

- India's Minister for Science & Technology who chaired the 9th BRICS Science & Technology Ministers meet, has called for working towards rightful place for BRICS (Brazil, Russia, India, China, and South Africa) in the Global Innovation Index.
- India is also preparing for the Innovation Cooperation Action Plan 2021-2024 with support from all BRICS countries

Global Innovation Index

- The Global Innovation Index is an annual ranking of countries by their capacity for, and success in, innovation.
- It is published by the **World Intellectual Property Organization, in partnership with Cornell University, INSEAD, and other organisations and institutions.**
- It is based on both subjective and objective data derived from several sources, including the International Telecommunication Union, the World Bank and the World Economic Forum.
- It was **started in 2007** by INSEAD and World Business, a British magazine.
- The index is computed by taking a simple average of the scores in two sub-indices, the Innovation Input Index and Innovation Output Index, which are composed of five and two pillars respectively.
- Each of these pillars describe an attribute of innovation, and comprise up to five indicators, and their score is calculated by the weighted average method.

Innovation Cooperation Action Plan

- All BRICS countries have agreed to the STI-led BRICS Innovation Cooperation Action Plan (2021-24) proposed by India during 12th Meeting of BRICS S&T Steering Committee.
- Indian had proposed the plan to facilitate sharing of experiences of each other's innovation ecosystem and networking of innovators and entrepreneurs.

Titanium alloy

In News

- The Defence Research and Development Organisation (DRDO) has indigenously developed a High Strength Metastable Beta Titanium Alloy that can be used in forging aerospace structures. The metal **contains Vanadium, Iron and Aluminium.**
- These alloys are already being used by many developed nations in recent times as a beneficial substitute for the relatively heavier traditional Nickel-Chromium-Molybdenum structural steels to achieve weight savings.
- The high strength beta titanium alloys are unique due to their higher strength, ductility, fatigue, and fracture toughness making them increasingly attractive for aircraft structural applications.
- An alloy is an admixture of metals, or a metal combined with one or more other elements. For example, combining the metallic elements gold and copper produces red gold, gold and silver becomes white gold, and silver combined with copper produces sterling silver.

I-STEM project

Context

- I-STEM project has been accorded extension for five years, until 2026 and enters its second phase with added features.

About

- I-STEM is a National Portal launched in 2020, which assists researchers to locate the specific facility(ies) they need for their R&D work.
- The goal of I-STEM is to strengthen the R&D ecosystem of the country by connecting researchers with resources, in part by promoting technologies and scientific equipment development indigenously.

Key organization

- It is an initiative of **Office of the Principal Scientific Adviser to the Govt. of India (PSA, GOI)** under the aegis of **Prime Minister Science, Technology and Innovation Advisory Council (PM-STIAC) mission.**

REX MKII

Context

- Recently, an Israeli defense contractor unveiled a remote-controlled armed robot called 'REX MKII' that can patrol battle zones, track infiltrators and open fire.

About

- It is operated by an electronic tablet and can be equipped with two machine guns, cameras and sensors.
- The robot can gather intelligence for ground troops, carry injured soldiers and supplies in and out of battle, and strike nearby targets.
- Proponents say such semi-autonomous machines allow armies to protect their soldiers, while critics fear this marks another dangerous step toward robots making life-or-death decisions.

Maglev Train

Context

- China has unveiled a high-speed maglev train with a designed top speed of 600 kms per hour - world's fastest ground vehicle.

About

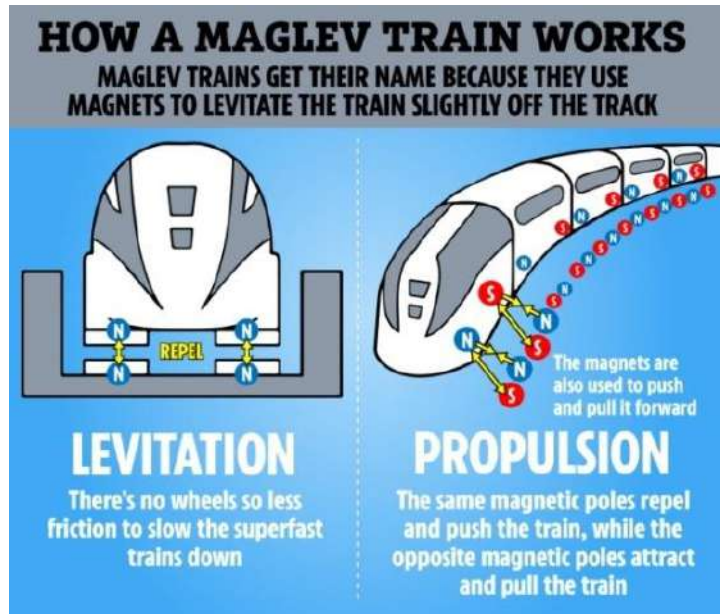
- Maglev, also called **magnetic levitation train or maglev train**, is a floating vehicle for land transportation that is supported by either electromagnetic attraction or repulsion.
- The trains are capable of running about **10 cm above the ground.**
- Maglev system has **no wheels, axles, transmissions, and overhead wires.**
- At present maglev technology has produced trains that can travel **in excess of 500 km (310 miles) per hour.**

Pros

- Extremely fast speed upto 500 km/hr.
- Really quiet operation.
- Less energy upto 30% than normal trains.
- Due to lack of physical contact between train and track, very efficient for maintenance.
- Moving parts are missing. Hence, wear and tear of parts is minimal, and that reduces the maintenance cost.
- Environment friendly, as they don't resort to internal combustion engines.
- Weather proof, which means rain, snow, or severe cold don't really hamper their performance.
- These trains are a lot safe than their conventional counterparts.

Cons

- Expensive tracks compared to the railroad tracks.
- Not compatible with railroad track, and therefore require whole thing to be rebuilt for their entire route.
- High cost incurred on the initial setup.
- Maglev trains are seen as relatively safe. But because of their detached nature, any accidents that could occur on a maglev train could be significantly more severe. The train does not attach to the tracks, so it doesn't have anything to hold on to should there be a malfunction.



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