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Space

Asteroid Apophis

- The USA's NASA space agency has ruled out the possibility of the dreaded asteroid Apophis causing any damage to the Earth for the next 100 years.
    - The "risk list" refers to the Sentry Impact Risk Table maintained by CNEOS, which includes all the asteroids with orbits close to Earth.
    - Apophis is categorized as a PHA.

What are asteroids?

- Asteroids are rocky objects that orbit the Sun, much smaller than planets. They are also called minor planets.
- According to NASA, 994,383 is the count of known asteroids, the remnants from the formation of the solar system over 4.6 billion years ago.

Asteroids are divided into three classes

First

- those found in the main asteroid belt between Mars and Jupiter, which is estimated to contain somewhere between 1.1-1.9 million asteroids.

Second

- Trojans, which are asteroids that share an orbit with a larger planet. NASA reports the presence of Jupiter, Neptune and Mars trojans. In 2011, they reported an Earth trojan as well.

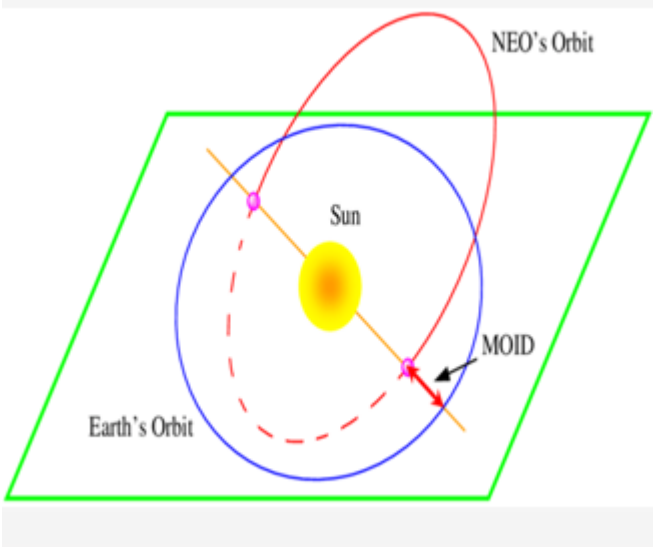
Third

- Near-Earth Asteroids (NEA), which have orbits that pass close by the Earth. Those that cross the Earth's orbit are called Earth-crossers.
- More than 10,000 such asteroids are known, out of which over 1,400 are classified as potentially hazardous asteroids (PHAs).

Potentially Hazardous Asteroids (PHAs)

- All asteroids with a minimum orbit intersection distance **(MOID) of 0.05 au or less** and an absolute magnitude (H) of 22.0 or less are considered PHAs.

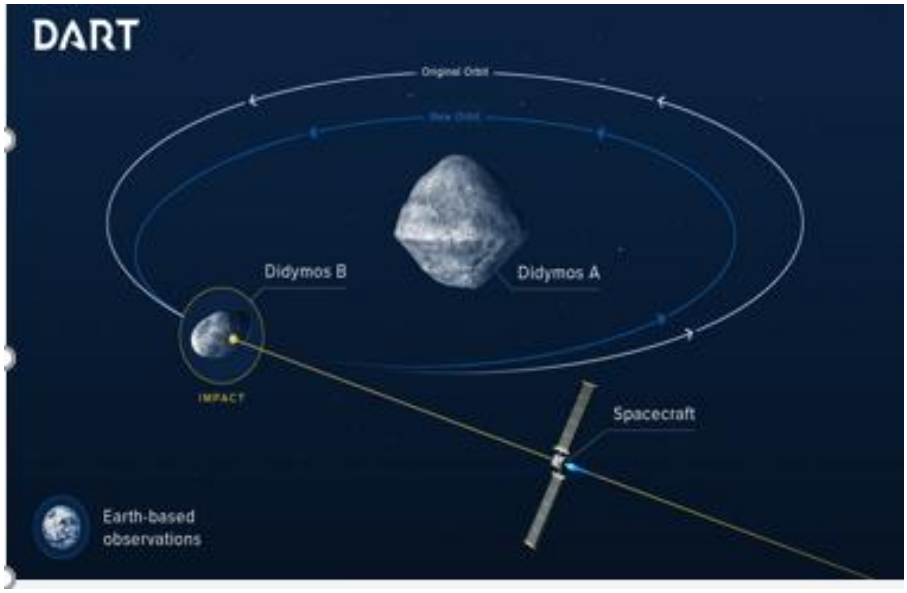
- Minimum Orbit Intersection Distance is a method for calculating the minimum distance between two almost overlapping elliptical orbits.



- An asteroids that can't get any closer to the Earth (i.e. MOID) than 0.05 au (roughly 7,480,000 km or 4,650,000 mi) or are smaller than about 150 m (500 ft) in diameter (i.e. H = 22.0 with assumed albedo of 13%) are not considered PHAs .

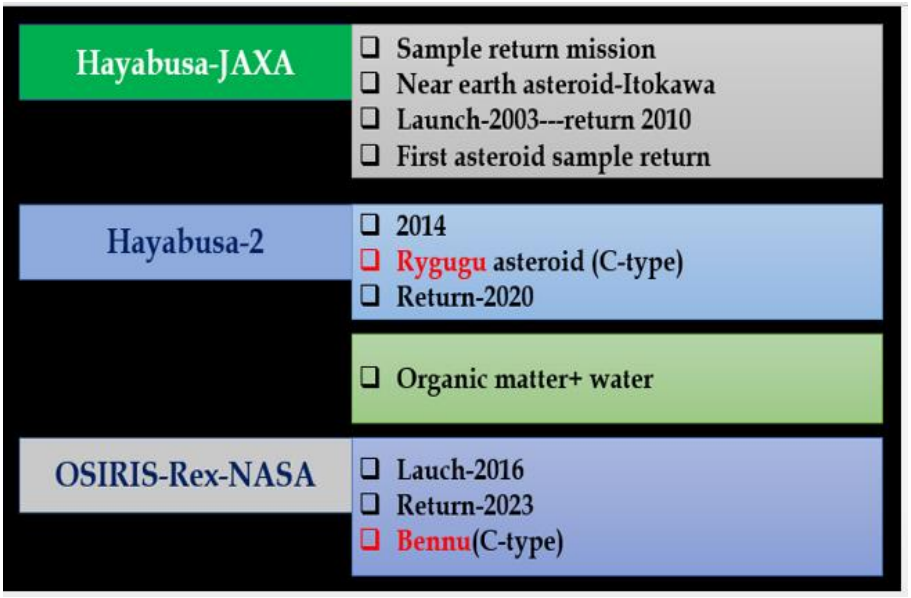
Asteroid Impact Deflection Assessment (AIDA)

- Method of Planetary defence
- Blowing up the asteroid before it reaches Earth,
- Deflecting it off its Earth-bound course by hitting it with a spacecraft (AIDA).



- Joint mission of NASA & ESA
- Deflect the orbit of the smaller body through an impact by one spacecraft.

- NASA is building the Double Asteroid Impact Test (DART) spacecraft for this.
- DART spacecraft will be launch in 2021. It is planned to collide with the target in September 2022.
- ESA's contribution is a mission called Hera, which will perform a close-up survey of the post-impact asteroid
- Flying along with DART will be an Italian-made miniature CubeSat, called LICIACube (Nanosatellite), to record the moment of impact.



Khagolshala Asteroid Search Campaign 2021

- Recently Jawahar Navodaya Vidyalaya students detect asteroids under the Khagolshala Asteroid Search Campaign 2021
    - Eight asteroids detected by sixteen students of Jawahar Navodaya Vidyalayas, under the Khagolshala Asteroid Search Campaign 2021 were conferred the "Provisional Status" by the International Astronomical Search Collaboration
- The campaign is an initiative of the Office of Principal Scientific Adviser, Government of India, and SPACE Foundation.
- It is the India chapter of an international student research program that has got students involved in the search for asteroids.
- High-quality astronomical data sets are distributed to students for analysis and identification of asteroids.
- Students analyse the data using software which then leads to potential discoveries.

- These observations feed into the Near-Earth Object (NEO) data being compiled by NASA and the Jet Propulsion Lab (JPL).
- Space India has established Khagolshala Astronomy and Space Education Labs (ASELs) across 20 Jawahar Navodaya Vidyalayas to date.
- Space India is working with a vision to get the younger generation in the country engrossed in astronomy and space sciences; application, exploration, innovation, and research in these areas.
- The team at Space India works by engaging students through experimentation, observation, and analysis of the universe.
- Students get access to the real-time data from the 'PANSTARRS' (The Panoramic Survey Telescope and Rapid Response System Telescope), located in Hawaii.

SPACE Foundation

- Established in 2001, to popularize science and inculcate scientific temperament among the masses especially students in India.
- SPACE is working to create citizen scientists through various programs on science and astronomy education, and innovation in India.
- These programs have the larger goal of fostering scientific temperament in society, especially among the youth.

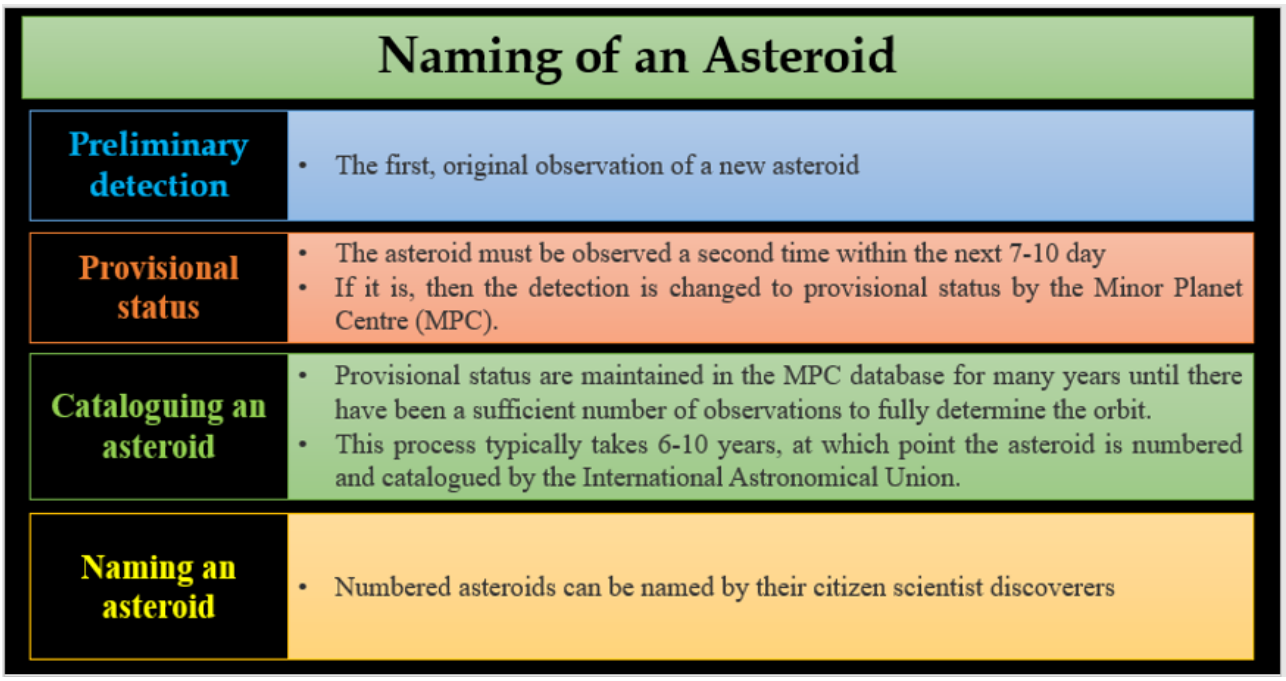
13 May

What are asteroids made of

- C-type-Carbonaceous material
- 75% 0f total
- Mostly water & hardly any metallic element

- S-type-Silicate material
- 17% of total asteroids
- Fe, Nickel, Mg
- Hardly any water but little brighter than C type

- M-type-Metal
- Platinum
- Large amount of platinum on earth come from this asteroid



Asteroid 16 Psyche

- A recent study at National Aeronautics and Space Administration (NASA) has found out that asteroid 16 Psyche, which orbits between Mars and Jupiter, could be made entirely of metal and is worth an estimated 10,000 quadrillion US dollars.
    - Unlike most asteroids that are made up of rocks or ice, scientists believe that Psyche is a dense and largely metallic object thought to be the core of an earlier planet that failed formation.
    - Psyche's shape is like a potato which takes about five earth years to complete one orbit of the sun but only a bit over 4 hours to rotate once on its axis.
    - Images from NASA's Hubble Space Telescope has shown that the surface may mostly comprise iron and nickel, similar to the Earth's core.

Christmas Star

- After nearly 400 years, Saturn and Jupiter – the two largest planets in our solar system – will be brought closest in the night sky by an astronomical event called the "great conjunction" and popularly referred to as the "Christmas Star".

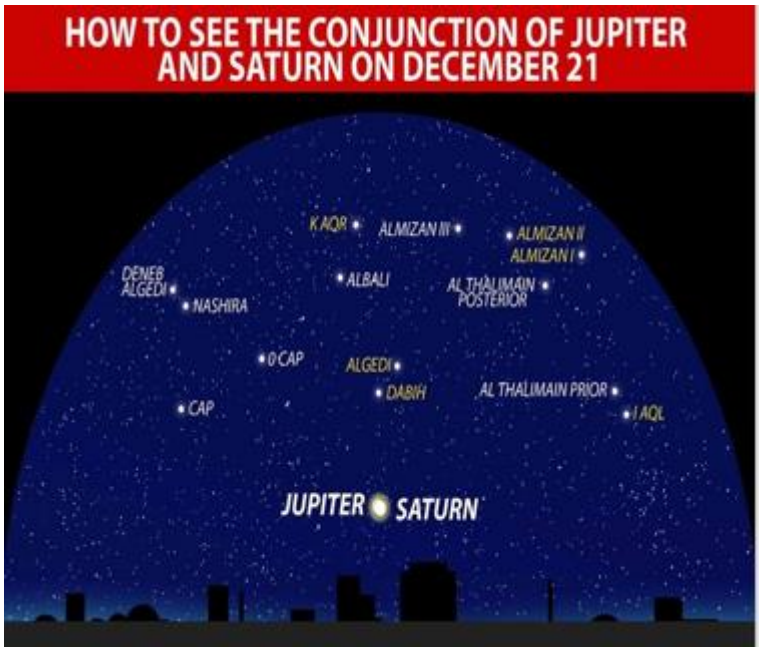
Conjugation

- A conjunction is not unique to Saturn and Jupiter however, it is the name given to any event where planets or asteroids appear to be very close together in the sky when viewed from the Earth

- In June 2005 for instance, as a result of the "spectacular" conjunction, Mercury, Venus and Saturn appeared so close together in the sky that the patch of sky where the three planets were could be covered by a thumb.
- Astronomers use the word "great" for the conjunction of Jupiter and Saturn because of the planets' sizes.

The "Great Conjunction"

- It happens once in about 20 years because of the time each of the planets takes to orbit around the Sun
- Jupiter takes roughly 12 years to complete one lap around the Sun and Saturn takes 30 years.



ISRO successfully launches Brazil's Amazonia 1 satellite, along with 18 other passenger satellites

About

- India's Polar Satellite Launch Vehicle-C51 (PSLV-C51) rocket loaded with 19 satellites from Brazil, USA and India lifted off from the rocket port at Sriharikota
- Amazonia-1 is the optical earth observation satellite.
- It has infrared capabilities that allow it to look at the forest cover regardless of the weather.
- Brazil plans to use the satellite for "alert deforestation" in the region.

- The satellite is also Brazil's first independently designed, built and operated satellite, which country officials hailed after it reached orbit.
- The 18 other satellites include a mix of Indian and American craft. The Indian-built satellites include Satish Dhawan SAT (which studies radiation, space weather and communications), the UNITYsat trio (for radio relay) and a technology demonstrator satellite called Sindhu Netra.
- The 18 'co-passengers' include four of IN- SPACe and 14 of ISRO's commercial arm, New Space India (NSIL).
- An e-copy of the Bhagavad Gita, saved on an SD-card, is also part of the package.

ANTRIX vs NSIL

- In the 2019 Budget-announced the setting up of a New Space India Limited (NSIL), a public sector company that would serve as a marketing arm of ISRO.
- Purpose -market the technologies developed by ISRO and bring it more clients that need space-based services.
- That role was already being performed by Antrix Corporation, another PSU working under the Department of Space, and which still exists.
- NSIL - a demand-driven approach rather than the current supply-driven strategy.
- Instead of just marketing what ISRO has to offer, NSIL would listen to the needs of the clients and ask ISRO to fulfil those.

In-SPACe

- IN-SPACe is supposed to be a facilitator, and also a regulator**.**
- It will act as an interface between ISRO and private parties and assess how best to utilise India’s space resources and increase space-based activities.
- IN-SPACe is the second space organisation created by the government in the last two years.

Earth Observation Satellite EOS-01

- India launched its latest earth observation satellite EOS-01 and nine international customer satellites

By PSLV

- Nine Customer Satellites: These are being launched as part of a commercial agreement with New Space India Limited (NSIL), Department of Space
- Low earth orbit
- Purpose: intended for applications in agriculture, forestry and disaster management support.

EOS-03 Satellite Mission (Failed)

- The rocket was supposed to deposit the satellite in the geostationary transfer orbit, from where the satellite's onboard propulsion system will guide it to a geostationary orbit, 36,000 km from earth's surface.
- By GSLV
- EOS-03 was being sent ahead of EOS-02 which has been delayed by the Covid-19 pandemic.
  EOS-02 was supposed to be launched around March-April this year, but now has been rescheduled for September-October.
- EOS-02 was supposed to ride on ISRO's new SSLV (Small Satellite Launch Vehicle) rocket.
- SSLVs will broaden ISRO's current rocket range that comprises PSLVs and GSLVs, and cater to the increasing demand for launching of small commercial satellites

CMS 01

CMS 01(Dec 2020)- PSLV (C-50)

- Communications satellite envisaged for providing services in extended C Band frequency spectrum.
- The C band is a designation for a portion of the electromagnetic spectrum in the microwave range of frequencies ranging from 4.0 to 8.0 gigahertz (GHz
- Its coverage will include the Indian mainland, and the Andaman & Nicobar and Lakshadweep islands.

- Placed into its specified slot in the Geo-Synchronous Orbit after a series of manoeuvres.
- CMS-01 will replace and enhance the services of GSAT-12.
- GSAT-12, a communication satellite built by ISRO, provides facilities for various communication services like Tele-education, Tele-medicine.

ISRO collaborates to build alternative to Google Maps

- The ISRO has joined hands with MapmyIndia to combine their geospatial expertise and build holistic solutions by leveraging their geoportals.

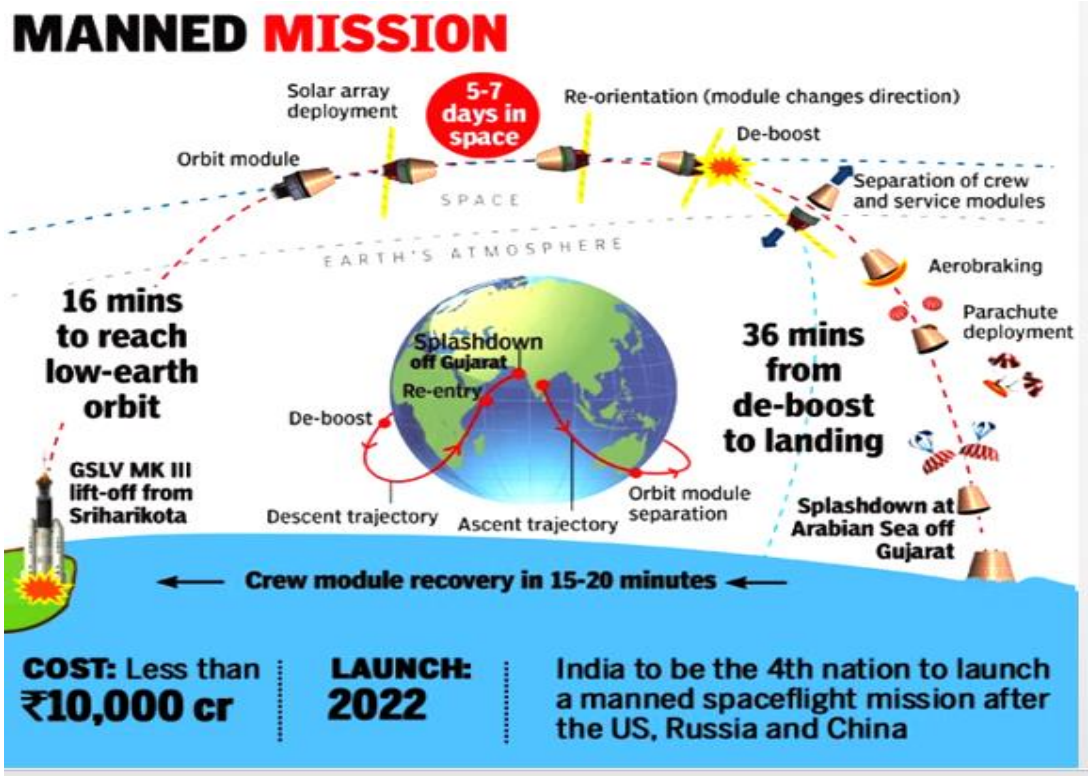
Components

- The collaboration will enable them to jointly identify and build holistic geospatial solutions utilising the ISRO's earth observation datasets such as-
- IRNSS (Indian Regional Navigation Satellite System) called NavIC (Navigation with Indian Constellation, is India's own navigation system, developed by ISRO.
- Bhuvan is the national geo-portal developed and hosted by ISRO comprising geospatial data, services and tools for analysis.
- VEDAS (Visualization of Earth observation Data and Archival System) is an online geo-processing platform using an optical, microwave, thermal and hyperspectral EO data covering applications particularly meant for academia, research and problem solving, according to ISRO.
- MOSDAC (Meteorological and Oceanographic Satellite Data Archival Centre)is a data repository for all the meteorological missions of ISRO and deals with weather-related information, oceanography and tropical water cycles.

Gaganyaan

- Recently, the Union Minister of Science and Technology informed that the human spaceflight module of Gaganyaan will be launched after the second unmanned mission planned in 2022-23.
- First unmanned mission is planned in December 2021.
- Launch by GSLV MKIII.
- In June 2019, the Human Space Flight Centre of the ISRO and the Russian government-owned Glavkosmos signed a contract for the training, which includes Russian support in the selection of candidates, their medical examination, and space training.

- It will circle Earth at a low-earth-orbit at an altitude of 300-400 km from earth for 5-7 days.



SHUKRAYAAN

- French Space Agency CNES announced that it is to participate in ISRO's Venus Mission, SHUKRAYAAN that is to be launched in 2025.

About SHUKRAYAAN

- The mission is to study atmospheric chemistry, compositional variations and dynamics of Planet Venus. Earlier, the mission was scheduled to be launched in 2023
- The satellite is planned to be launched onboard GSLV Mk II rocket.

NISAR

- NASA and ISRO are collaborating on developing an SUV-sized satellite called NISAR.
- The name NISAR is short for NASA-ISRO-SAR.
- SAR here refers to the Synthetic Aperture Radar that NASA will use to measure changes in the surface of the Earth.
- It will be launched in 2022 from the Satish Dhawan Space Center in Sriharikota (Andhra Pradesh) into a near-polar orbit.
- ISRO will provide the spacecraft bus, the second type of radar (called the S-band radar), the launch vehicle and associated launch services.

- NASA will provide one of the radars for the satellite, a high-rate communication subsystem for science data, GPS receivers and a payload data subsystem.
- It will scan the globe every 12 days over the course of its three-year mission of imaging the Earth's land, ice sheets and sea ice to give an unprecedented view of the planet.

Solar Orbiter Mission

- The European Space Agency has released the closest pictures ever taken of the Sun captured by the Solar Orbiter
- It is a cooperative mission between NASA and the European Space Agency (ESA).
- It will observe the Sun with high spatial resolution telescopes and capture observations in the environment directly surrounding the spacecraft to know how the Sun can affect the space environment throughout the solar system.

SOFIA

- NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) confirmed the Water molecules in Clavius Crater in the Moon's southern hemisphere
- it is the first time water has been detected on the sunlit side, showing it is not restricted to the shadowy regions
- Chandrayaan-1 found water molecules in the polar regions.

SOFIA

- SOFIA is a joint project between NASA and the German Aerospace Centre, DLR.
- It features a 100-inch diameter telescope weighing up to 20 tons and is mounted on a modified Boeing 747SP aircraft.

NASA research says the Moon is more metallic than thought before

- Lunar Reconnaissance Orbiter (LRO) spacecraft had found evidence that the Moon's subsurface might have greater quantities of metals such as iron and titanium than thought before.
- The metallic distribution was observed by the Miniature Radio Frequency (Mini-RF) instrument aboard the LRO

Lunar Reconnaissance Orbiter (LRO)

- Lunar Reconnaissance Orbiter is a robotic spacecraft, now orbiting the Moon at an altitude of 50-200 km circular polar Orbit.

- LRO's primary objective is to make fundamental scientific discoveries about the Moon.
- It was launched by NASA in 2009.
- The Miniature Radio-Frequency instrument (Mini-RF) is a synthetic aperture radar (SAR) instrument on the Lunar Reconnaissance Orbiter (LRO).

Significance

- It is known that Earth's crust has lesser amounts of iron oxide than the Moon– a finding that scientists have been trying to explain.
- Now, the new discovery of even greater quantities of metal on the Moon makes their job even more difficult. It really raises the question of what this means for our previous formation hypotheses.
- A possible reason could be that the Moon was created from a material much deeper beneath Earth's surface than was believed before, or that the newly found metal presence could be the result of molten lunar surface cooling down gradually.

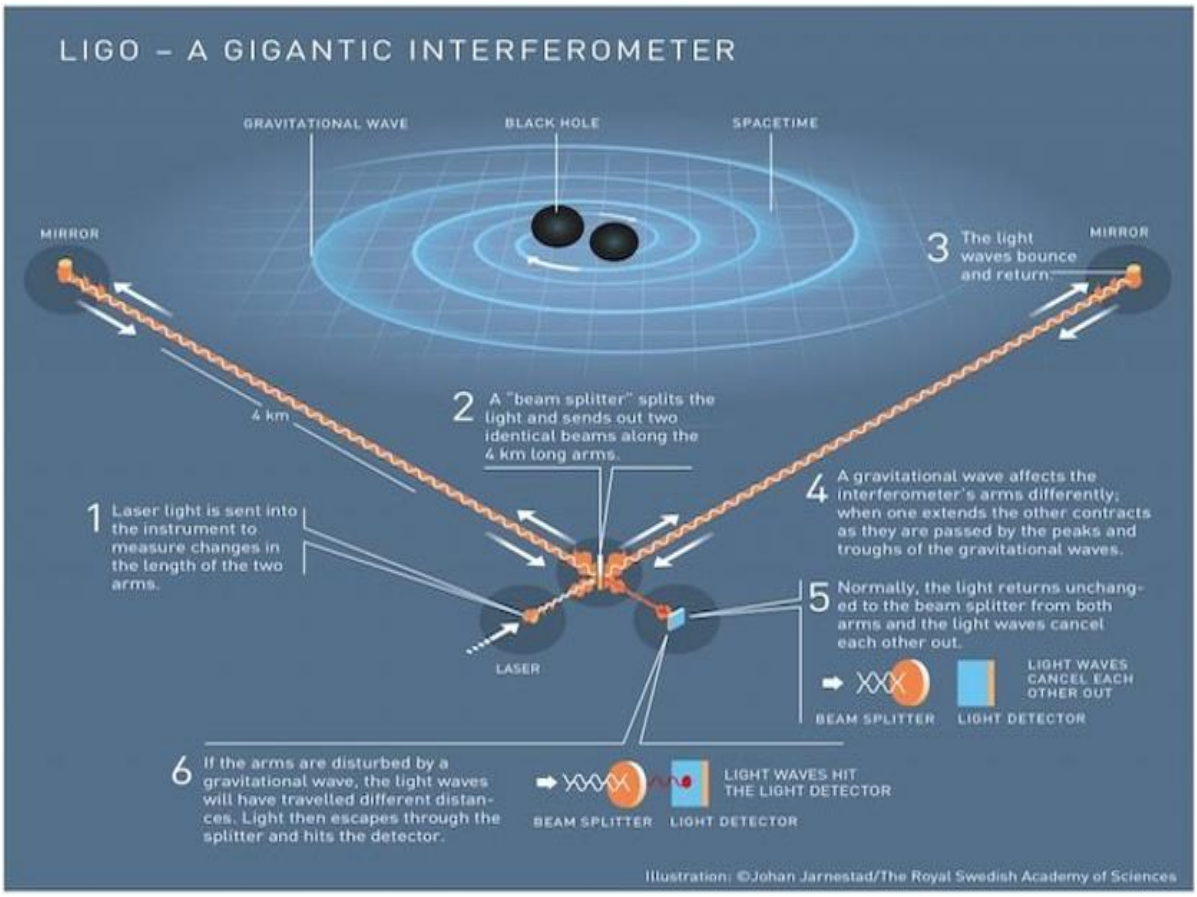
Merger of Two Black Holes with Unequal Masses Detected

- The gravitational wave observatories at Laser Interferometer Gravitational-Wave Observatory (LIGO) have detected a merger of two unequal-mass black holes for the first time.
    - The event, dubbed GW190412, was observed on 12th April, 2019. The event came almost five years after the first ever detection of gravitational wave signals by LIGO detectors.
    - It involved the merger of two black holes weighing approximately 8 and 30 Solar masses, respectively.
    - The new unequal mass system is a unique discovery since all binaries observed previously by the LIGO and Virgo (Italy) detectors consisted of two roughly similar masses.
- Difference between binary blackholes of equal masses and unequal masses:
    - Dominant emission of gravitational waves happens at twice the orbital frequency of the binary blackholes of equal masses and is negligible.
    - In binary blackholes with unequal masses, the emission happens at a frequency that is three times the orbital frequency.

- The LIGO project operates three gravitational-wave (GW) detectors. Two are at Hanford in the State of Washington, north-western USA, and one is at Livingston in Louisiana, south-eastern USA.
- It is a massive observatory for detecting cosmic gravitational waves and for carrying out experiments.

LIGO India

- The LIGO-India project is an international collaboration between the LIGO Laboratory and three lead institutions in the LIGO-India consortium: Institute of Plasma Research, Gandhinagar; IUCAA, Pune; and Raja Ramanna Centre for Advanced Technology, Indore.
- The project, piloted by the Department of Atomic Energy and Department of Science and Technology and is expected to be ready by 2025.
- India's Laser Interferometer Gravitational-Wave Observatory (LIGO) will be set up at Aundha Nagnath, Hingoli District in Maharashtra.



Solar cycle 25

- NASA and the National Oceanic and Atmospheric Administration (NOAA) has announced the commencement of solar cycle 25.
- Like seasons on Earth, the Sun follows a cycle of 11 years, during which solar activities fluctuate between solar minima and maxima.
- Depending on the number of sunspots detected on the Sun, scientists term it is as solar maxima (highest number of sunspots) or solar minima (lowest number of sunspots).

Solar cycle

- The Sun is a huge ball of electrically-charged hot gas.
- This charged gas moves, generating a powerful magnetic field.
- This magnetic field goes through a cycle, called the solar cycle.
- Every 11 years or so, the Sun's magnetic field completely flips.
- This means that the Sun's north and south poles switch places.
- Then it takes about another 11 years for the Sun's north and south poles to flip back again. So far, astronomers have documented 24 such cycles, the last one ended in 2019.

How has the transition between solar cycles 24 and 25 been?

- The Sun's activities were notably lesser during 2019 and early 2020. There were no sunspots for 281 days in 2019 and 181 days in 2020.
- Since December 2019, the solar activities have slowly picked up, corroborating the beginning of the news cycle.
- The panel termed solar cycle 25 to be a weak one, with the intensity similar to that of Solar cycle 24.

Baikal-GVD

- Recently Russian scientists launched one of the world's biggest underwater neutrino telescopes called the Baikal-GVD (Gigaton Volume Detector) in the waters of Lake Baikail, the world's deepest lake situated in Siberia.
- The Baikal-GVD is one of the three largest neutrino detectors in the world along with the IceCube at the South Pole and ANTARES in the Mediterranean Sea.

Purpose

- To study in detail the elusive fundamental particles called neutrinos and to possibly determine their sources.
- The IceCube Neutrino Observatory
- is a neutrino observatory in Antarctica
- The project is a recognized CERN(European Organization for Nuclear Research) experiment.

ANTARES

- The ANTARES collaboration has built an underwater neutrino telescope at 2500m depth in the Mediterranean Sea
- France, Germany, Italy, The Netherlands, Romania, Russia and Spain.

Neutrino

- Proton, neutron, and electron are tiny particles that make up atoms. The neutrino is also a tiny elementary particle, but it is not part of the atom. Such particles are also found to exist in nature.
- Neutrinos are fundamental particles belonging to the lepton family.
- They come in three flavours, one associated with electrons and the others with their heavier cousins the muon and the Tau.
- According to standard model of particle physics, they are mass less.
- However recent experiments indicate that these charge-neutral fundamental particles have finite but small mass which is unknown.
- It interacts very weakly with other matter particles. So weakly that every second trillions of neutrinos fall on us and pass through our bodies unnoticed.
- Neutrinos come from the sun (solar neutrinos) and other stars, cosmic rays that come from beyond the solar system, and from the Big Bang from which our Universe originated. They can also be produced in the lab.

India-based Neutrino Observatory (INO)

- INO Project is aimed at building a world-class underground laboratory with a rock cover to conduct basic research on neutrino.

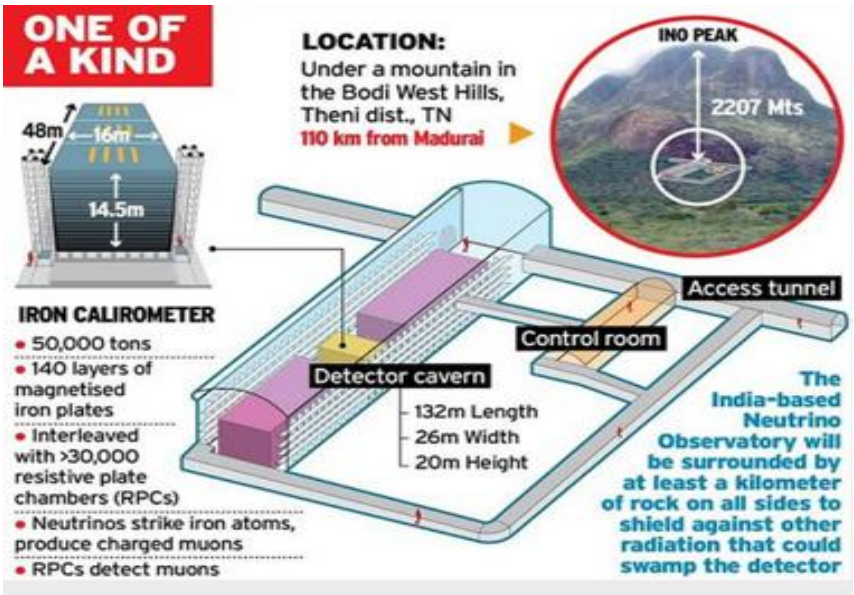
- The Tata Institute of Fundamental Research is the nodal institution. The observatory is to be built jointly with the Department of Atomic Energy and the Department of Science and Technology.
- The observatory will be located underground so as to provide adequate shielding to the neutrino detector from cosmic background radiation.
- The operation of INO will have no release of radioactive or toxic substances. It is not a weapons laboratory and will have no strategic or defence applications.

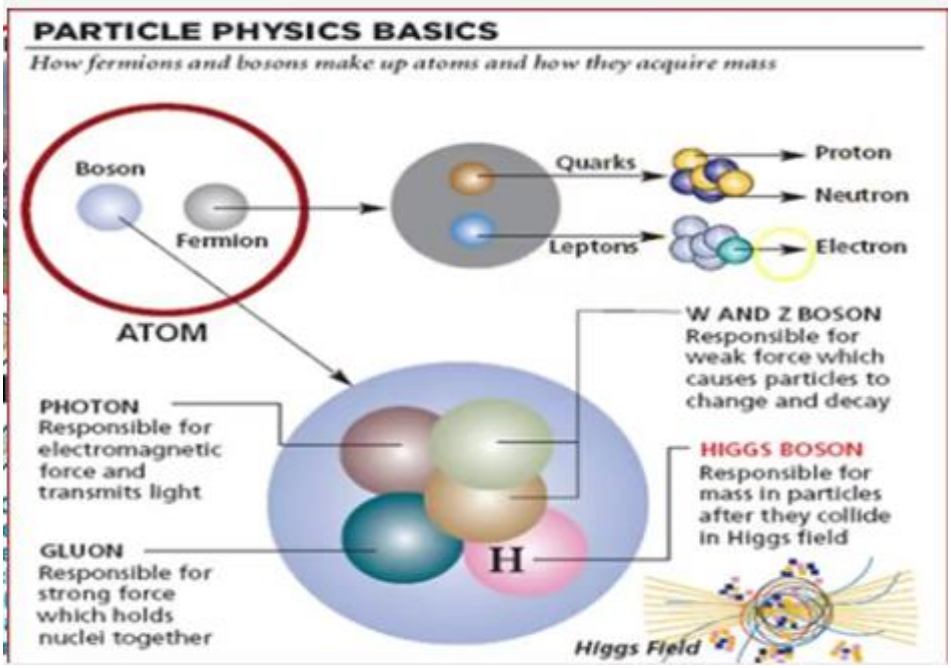
Location factors of INO

- To detect Neutrinos and their reactions, the lab has to be at least 1000 m below surface, to reduce natural cosmic radiation.
- Mountains of South India, are most ideal for this lab, because they've dense rock (mostly gneiss).
- Bodi west hills (TN) is made up of Charnockite (hardest rock known) hence Earthquake risk minimum.

Reason for underground drilling

- The neutrinos interact very weakly with the surroundings.
- Since they interact so weakly, detecting them over other interactions is impossible.
- We need to have a barrier of at least 1 km of earth.



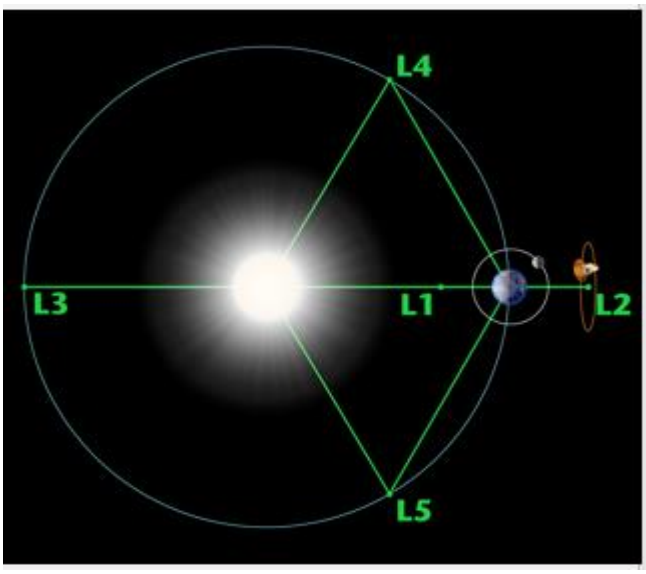


ARIES facility will host the support centre for Aditya-L1

- This role will be played by the ARIES facility (short for Aryabhata Research Institute for observational Sciences) which is situated near Nainital.
- The main aim of this centre is to let every researcher in India perform analysis over scientific data obtained from Aditya-L1.

Aditya L1

- It will be launched using the Polar Satellite Launch Vehicle (PSLV) in XL configuration.
- study the Sun's corona, solar emissions, solar winds and flares, and Coronal Mass Ejections (CMEs), and will carry out round-the-clock imaging of the Sun.



- Aryabhatta Research Institute of Observational Sciences (Estb 1954)
    - ARIES is a leading research institute which specializes in Astronomy, Astrophysics and Atmospheric Sciences.
    - It is an autonomous body under the Department of Science and Technology (DST), Government of India.
    - It is situated at Manora Peak, in Nainital, Uttarakhand.

Aditya-L1 Support Cell

- is a community service centre that has been set up to bring all data on board India's first dedicated solar space mission to a single web-based interface.
- It is a joint effort of Indian Space Research Organisation and Aryabhatta Research Institute of Observational Sciences.

Ingenuity

- NASA successfully flew its tiny helicopter Ingenuity on Mars ,the first powered flight on another planet
    - Ingenuity quickly sent back a black-and-white image from its downward pointing navigation camera, showing its bug-like shadow cast on the surface.

Mars 2020 Mission (Nasa)

Mission Steps

Sample collection

- Rock and soil samples will be collected by Perseverance in cigar size tubes.
- The samples will be collected, the canisters will be sealed, and left on the ground

Mars Fetch Rover (by the European Space Agency)

- Will land and collect all samples from the different locations, and return to the lander.

Mars Ascent Vehicle

- These samples will be transferred to the Mars Ascent Vehicle which will meet with an Orbiter.

Return

- The Orbiter will carry the samples back to Earth.

RESPOND Programme

- ISRO started the RESPOND (Research Sponsored) programme in the 1970s, with the objective of encouraging academia to participate and contribute in various Space related research activities.
- RESPOND is also participating in the National Missions like IMPRINT programme and Uchhatar Avishkar Yojana (UAY).

IMPRINT (IMPacting Research INnovation and Technology)

- Department of Science & Technology and Ministry of education
- Aims to boost research and innovation in India.
- IMPRINT India Programme is joint initiative of Indian Institutes of Technology (IITs) and Indian Institute of Science (IISc).
- It seeks to develop road map for research to solve major engineering and technology challenges in 10 technology domains relevant for country.

Uchhatar Avishkar Yojana (UAY) (Min of Education)

- To promoting innovation of a higher order that directly impacts the needs of the Industry and thereby improves the competitive edge of Indian manufacturing.

- The scheme focuses on a viable industry-academic collaboration where industry shares a part of the cost of research.

Applicability

- The scheme would be applicable to the projects proposed by the Indian Institutes of Technologies initially.
- The projects should have collaboration between the academia and industry – within or outside India.

Funding

- UAY projects are funded jointly by Min of Education, participating Ministries and the Industry in the ratio of 50:25:25.

Crew-2 mission

- Elon Musk-owned commercial rocket firm SpaceX along with the National Aeronautics and Space Administration (NASA) recently launched four astronauts into the International Space Station (ISS).
    - NASA's SpaceX Crew-2 mission consists of the first-ever crew propelled into orbit by a rocket booster recycled from a previous spaceflight.

Crew-2

- The mission consists of four astronauts namely, NASA (2) ,JAXA(1) and ESA (1)
- The four astronauts of the Crew-2 mission will be joining the four members of the Crew-1 mission and spend about five days together on ISS before the Crew-1 team returns to Earth.

International Space station

- Collaboration between the U.S., Russia, the EU, Japan and Canada, and has played host to people from 19 countries since its launch in 1998
- The first segment was launched on November 20, 1998 in a Russian proton rocket named Zarya (which means 'sunrise').

What will Crew-2 do at the ISS?

- Their central focus during this time will be to continue a series of Tissue Chips in Space studies.

Tissue Chips

- are small models of human organs that contain multiple cell types that behave similarly to the human body.

Experiments

- The first experiments were those that studied the dynamics of cells under microgravity.
- Study of how muscles work under long-term stay under low-gravity conditions.
- It also include Janus particles, or particles that have two 'faces' with distinct properties – one side is hydrophobic and avoids water, while the other is hydrophilic and loves water.

Baby Squids and Tardigrades into Space

- NASA will send baby squids and tardigrades (also called water bears) to the International Space Station for conducting various scientific studies
- These animals are part of two separate scientific studies.
    - Behavior of Tardigrades (water bears) in a spaceflight environment.
    - Impact of microgravity conditions on the relationship between bobtail squids and beneficial microbes.
    - The squids are a part of the UMAMI (Understanding of Microgravity on Animal-Microbe Interactions) study which examines the effects of spaceflight on interactions between beneficial microbes and their animal hosts
- Microbes play a crucial role in the normal development of animal tissues and in maintaining human health, and the research will allow scientists to have a better understanding of how beneficial microbes interact with animals when there is a lack of gravity.

Significance

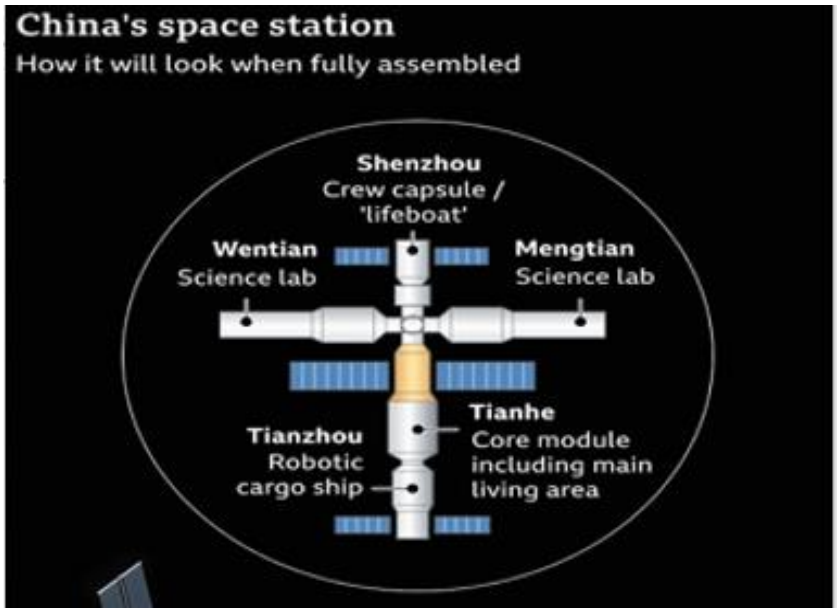
- On Earth, it will help to find ways to protect and even enhance the complex relationship between animals and beneficial microbes, ensuring better human health and well-being.
- In space, the findings will help space agencies develop better measures to protect astronauts from adverse host-microbe alterations on long-duration missions.
- The study on Tardigrades will allow researchers to study their hardiness close up, and possibly identify the genes that allow them to become so resilient. This will help in safer and longer spaceflights.

China rocket debris falls in Indian Ocean

- Debris from the last stage of China's Long March rocket that had last month carried a key component of its under-construction space station fell into the waters of the Indian Ocean west of the Maldives.

Tiangong

- The Long March-5B Y2 rocket was carrying the Tianhe, or Heavenly Harmony, module, which is the first of three key components for the construction of China's space station, which will be completed by the end of next year.
- Tianhe will act "the management and control hub of the space station" which is called Tiangong, or Heavenly Palace.



- The space station, which will be only the second after the International Space Station (ISS), has been designed with a lifespan of 10 years but could last 15 years, or until 2037.
- In past China has sent two previous space stations into orbit. The Tiangong-1 and Tiangong-2 were trial stations though, simple modules that allowed only relatively short stays by astronauts.

What is Space Debris?

- Space debris comes in two types - Natural and Artificial.

Natural space debris

- consists of small pieces of cometary and asteroidal material called meteoroids.

Artificial space debris

- is any non-functional man-made object in space (usually orbiting the Earth).
- Where Does Artificial Space Debris Come From?
- Satellites that have reached the end of their life.
- Satellites and spacecraft that have failed.
- Rocket stages that have launched satellites into space.
- Solid propellant slag.
- Space activity -human waste.
- Deterioration fragments, e.g. peeling paint.
- Fragments from exploding batteries, fuel tanks (not totally empty), etc.
- Fragments from collisions, both accidental and deliberate.

Space Debris

The Remove DEBRIS mission

- is led by the Surrey Space Centre (SSC) at the University Of Surrey, UK, and is co-funded by the European Commission and other partners, including prominent European space companies and institutions.

Project Netra

By ISRO

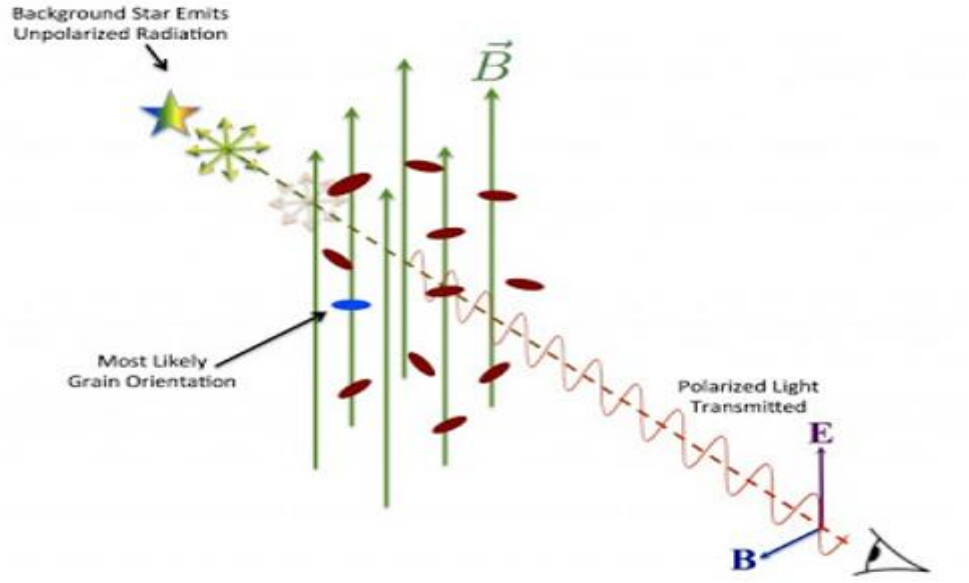
- An early warning system in space to detect debris and other hazards to Indian satellites.
- SSA will first be for low-earth orbits or LEO which have remote-sensing spacecraft.
- Eventual goal is to capture the GEO, or geostationary orbit, scene at 36,000 km where communication satellites operate.

PASIPHAE project (IE)

- Recently the **Wide Area Linear Optical Polarimeter** (WALOP), a vital instrument for the **PASIPHAE Project**, is being developed at Inter-University Centre for Astronomy and Astrophysics (IUCAA), India.

PASIPHAE

- Polar-Areas Stellar-Imaging in Polarisation High-Accuracy Experiment (PASIPHAE) is an international collaborative sky surveying project.
- Scientists aim to study the polarisation in the light coming from millions of stars.



EnVision mission

- European Space Agency (ESA) on Thursday announced that it has selected EnVision as its next orbiter that will visit Venus sometime in the 2030s.
    - EnVision is an ESA led mission with contributions from NASA.
    - It is likely to be launched sometime in the 2030.
- EnVision will follow another ESA-led mission to Venus called 'Venus Express' (2005-2014) that focussed on atmospheric research and pointed to volcanic hotspots on the planet's surface.
- Other than this, Japan's Akatsuki spacecraft has also been studying the planet's atmosphere since 2015.
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Significance of Venus

- Help to find out how Earth and Venus evolved so differently from each other considering that they are roughly of the same size and composition.
- Venus is the hottest planet in the solar system because of the heat that is trapped by its thick cloud cover.
- Scientists speculate about the existence of life on Venus in its distant past and the possibility that life may exist in the top layers of its clouds where temperatures are less extreme.
- Last year, a team of scientists reported that they had found phosphine gas (a chemical produced only through biological processes) in the atmosphere of Venus that triggered excitement in the scientific community that some life forms might be supported by the planet.

Phoshine

- It is a flammable gas that on Earth occurs from the breakdown of organic matter.
- On Earth, this gas is associated with living organisms.
- It can only be made by life—whether human or microbe.
- Used as a chemical weapon during World War I, phosphine is still manufactured as an agricultural.

NASA's Discovery Program- gives scientists a chance to dig deep into their imaginations and find new ways to unlock the mysteries of our solar system. When it began in 1992, the program represented a breakthrough in the way NASA explores space		
Active	Lunar reconnaissance orbiter (2009)	LRO is a robotic spacecraft that set out to map the **lunar** surface
	InSight (2018)	InSight is a **Mars** lander Interior Exploration using Seismic Investigations, Geodesy and Heat Transport, is exploring the deep interior of Mars
Future	Lucy (Oct 2021)	Lucy will visit a main belt asteroid and six **Trojan asteroids**, a unique family of asteroids that **orbit the Sun in front of and behind Jupiter**
	Psyche (2022)	The Psyche mission will explore one of the most intriguing targets in the main **asteroid belt** – a giant metal-rich asteroid, known as 16 Psyche, about three times farther away from the Sun than is the Earth
	MEGANE (2024)	MEGANE spectrometer instrument on the Japanese Aerospace Exploration Agency's **Mars Moons eXploration mission** is a "mission of opportunity" selected by the Discovery Program

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Future	DAVINCI+ (2028-30)	Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging measure the composition of **Venus' atmosphere** to understand how it formed and evolved
	VERITAS (2028-30)	The Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy, or VERITAS, mission will **map Venus' surface to determine** the planet's geologic history and understand why it developed so differently than Earth

New Shephard

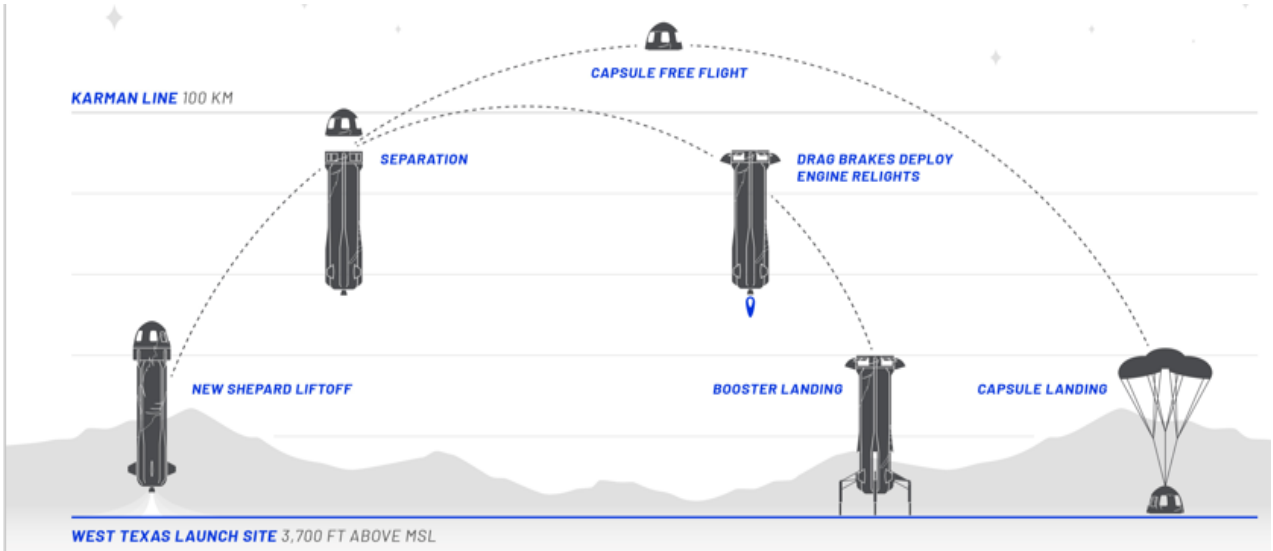
- Recently Blue Origin concluded the online auction for the first seat on New Shephard, a rocket system meant to take tourists to space.

What is New Shephard

- Named after astronaut Alan Shephard – the first American to go to space – and 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.

Significance

- It will also allow space tourists to experience microgravity by taking them 100 km above the Earth.



Suborbital flight

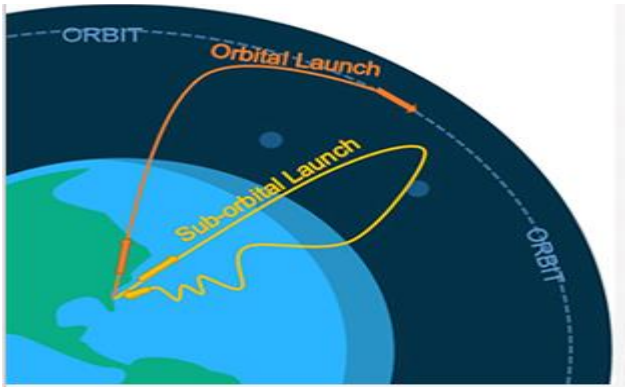
- Recently Virgin Group founder Richard Branson and five others undertook a brief trip to the "edge of space", taking off on the VSS Unity spaceship from New Mexico and reaching an altitude of 85 km from Earth before returning.

Orbital flight

- When an object travels at a horizontal speed of about 28,000 km/hr or more, it goes into orbit once it is above the atmosphere.

Suborbital flight

- Any object travelling slower than 28,000 km/hr must eventually return to Earth.
- If an object travels at 40,000 km/hr, it will achieve what is known as "escape velocity", and never return to Earth.

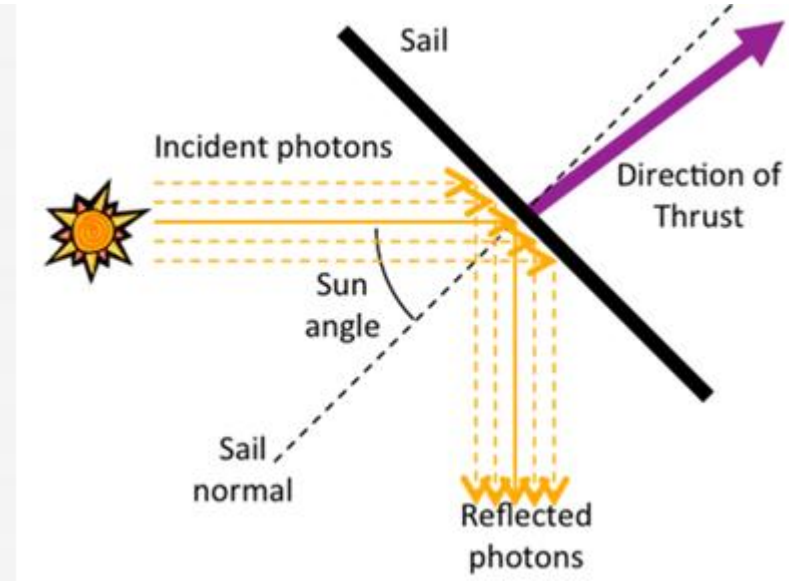


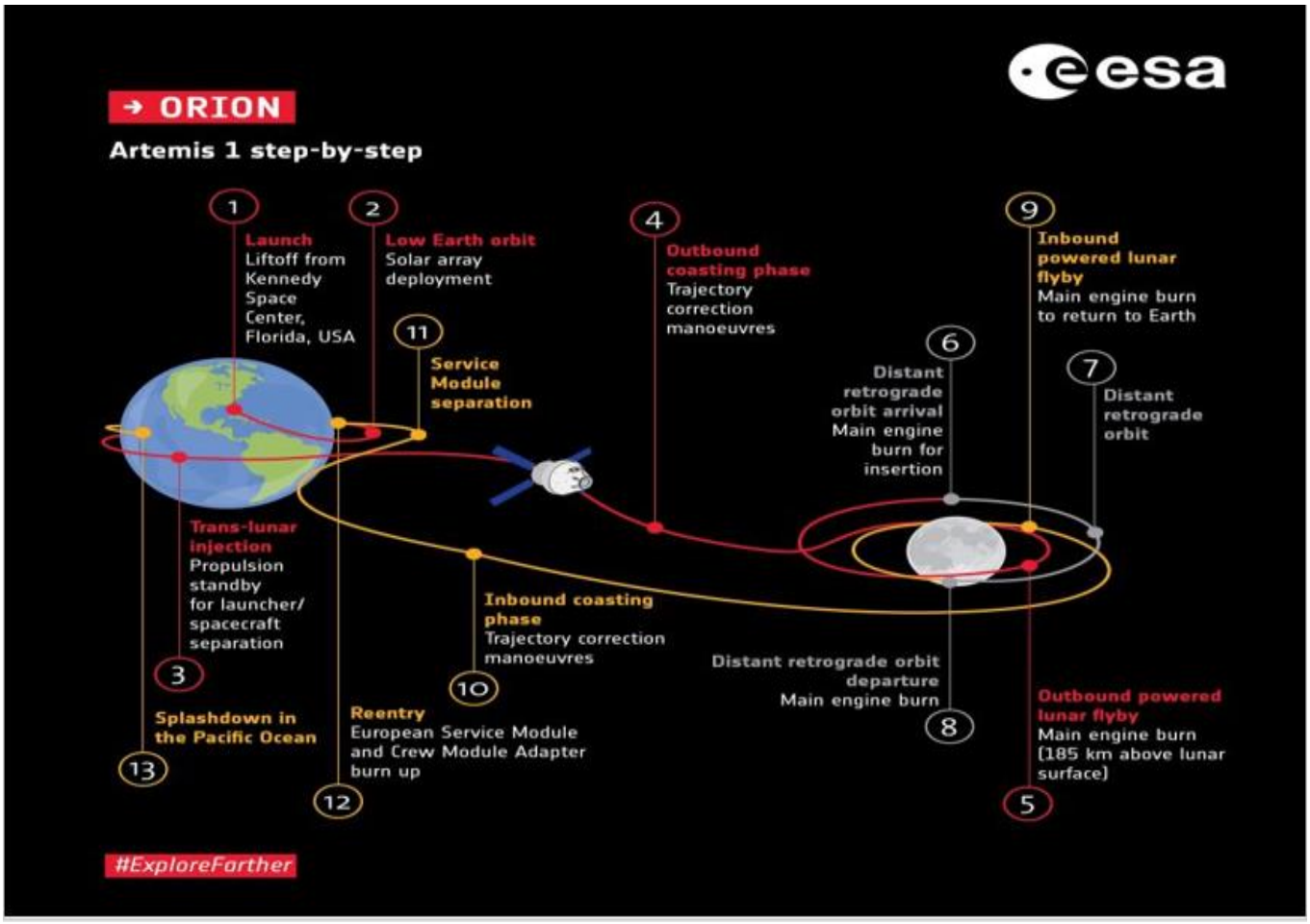
NEA Scout

- Recently 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.
    - It 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.
    - It will also be America's first interplanetary mission using a special solar sail propulsion
    - NEA Scout is one of several payloads that will hitch a ride on Artemis I, which is expected to be launched in November.
    - Artemis I will be an uncrewed test flight of the Orion spacecraft and SLS rocket.
    - Under the Artemis programme, NASA has aimed to land the first woman on the Moon in 2024 and also establish sustainable lunar exploration programs by 2030.

Solar sail propulsion

- This type of propulsion is especially useful for small, lightweight spacecraft that cannot carry large amounts of conventional rocket propellant.
- The large-area sail will generate thrust by reflecting sunlight.



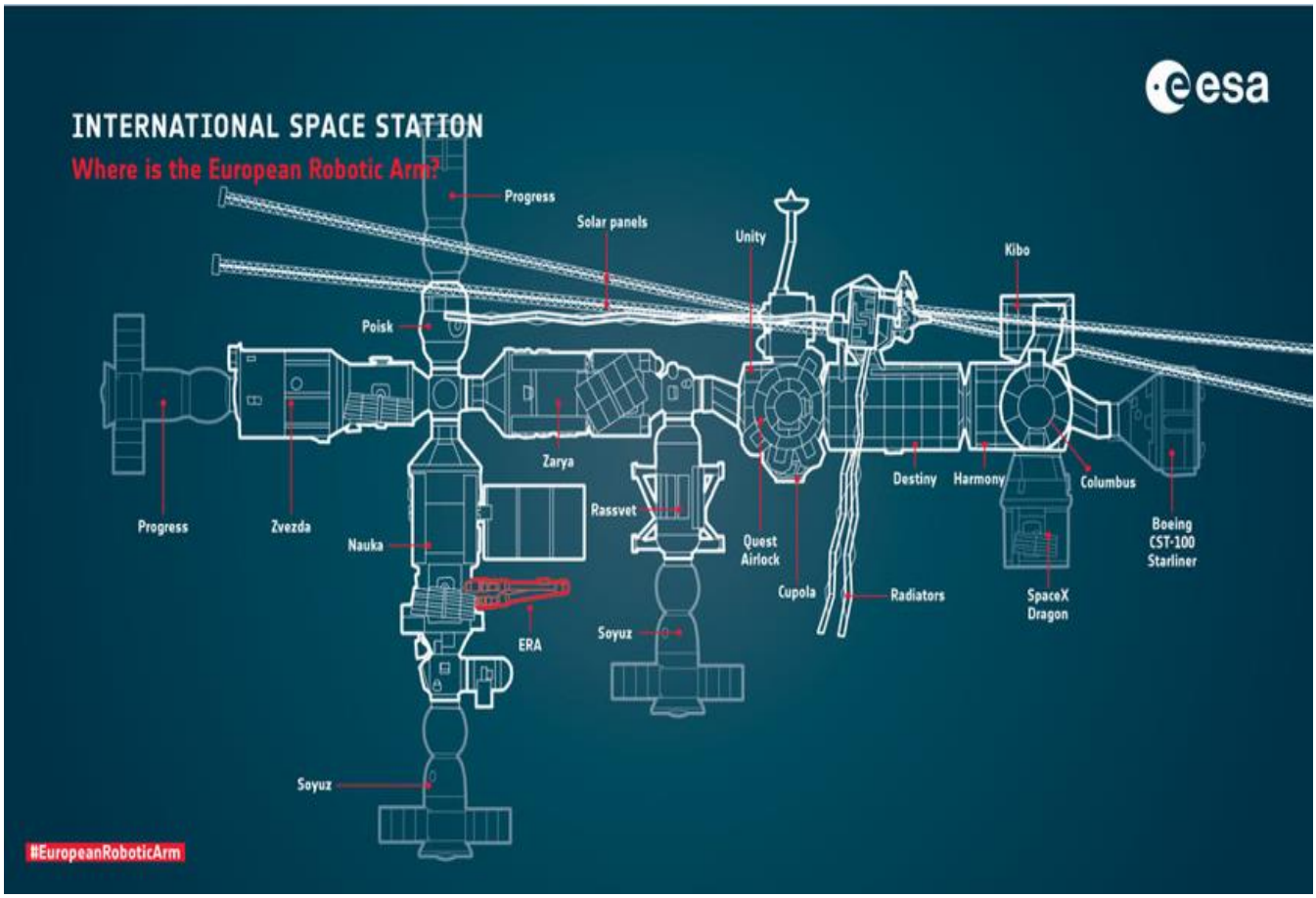


What is Nauka

- Nauka, which was launched from the Baikonur Cosmodrome in Kazakhstan on July 21 using a Proton rocket, is scheduled to be integrated with the ISS.

About Nauka

- Nauka – meaning "science" in Russian – is the biggest space laboratory Russia has launched to date, and will primarily serve as a research facility.
- It is also bringing to the ISS another oxygen generator, a spare bed, another toilet, and a robotic cargo crane built by the European Space Agency (ESA).
- On the ISS, Nauka will be attached to the critical Zvezda module,



James Webb Space Telescope (JWST) Controversy

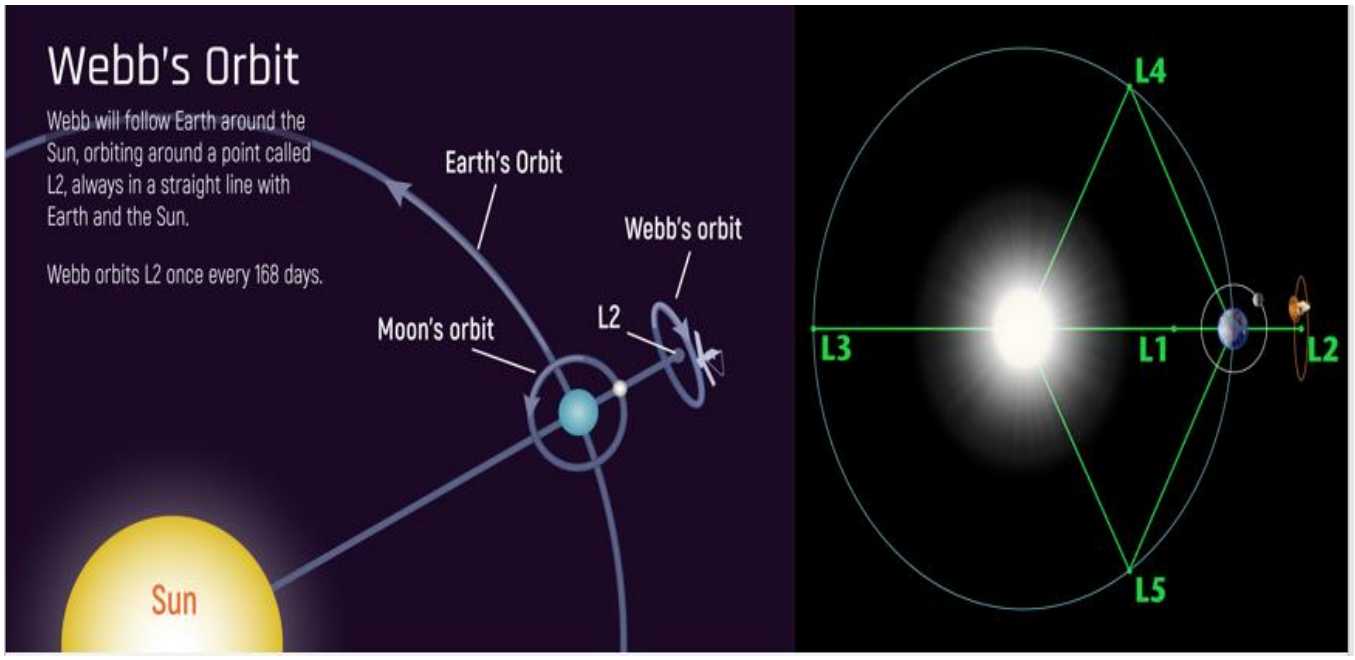
- NASA is set to launch the large infrared James Webb Space Telescope (JWST)
    - But before it launches, NASA has an important decision to make – whether to rename the $8.8-billion telescope.
    - These considerations stem from allegations that NASA's former government-appointed administrator James Webb, after whom JWST is named, had persecuted homosexuals when he had worked for the government.

Hubble Space Telescope (HST) -NASA

- First major optical telescope to be placed in space and has made ground breaking discoveries in the field of astronomy since its launch (into Low Earth orbit in 1990).
- Contribution-Universe expansion (Dark energy), dwarf galaxies, comets etc.

James Webb Space Telescope

- Successor to Hubble.
- It will be a large infrared telescope with a 6.5-meter primary mirror.
- The telescope will be launched on an Ariane 5 rocket from French Guiana in 2021.
- It will study every phase in the history of our Universe, formation of stars etc
- It is an international collaboration between NASA, the European Space Agency (ESA), and the Canadian Space Agency (CSA).



CST-100 Starliner

- The launch of Boeing's uncrewed Starliner Orbital Flight Test-2 (OFT-2) has been postponed once again.

CST-100 Starliner

- 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.

- The Starliner, which is supposed to carry more than 400 pounds of NASA cargo and crew supplies, will take roughly 24 hours to reach the ISS, after which it will dock there
- The spacecraft has been designed to accommodate seven passengers or a mix of crew and cargo for missions to low-Earth orbit.
- The Starliner has an innovative, weldless structure and is reusable up to 10 times with a six-month turnaround time.

NASA's Commercial Crew Program

- To make access to space easier in terms of its cost, so that cargo and crew can be easily transported to and from the ISS, enabling greater scientific research.
- NASA plans to lower its costs by sharing them with commercial partners such as Boeing and SpaceX, and also give the companies incentive to design and build the Commercial Orbital Transportation Services (COTS).

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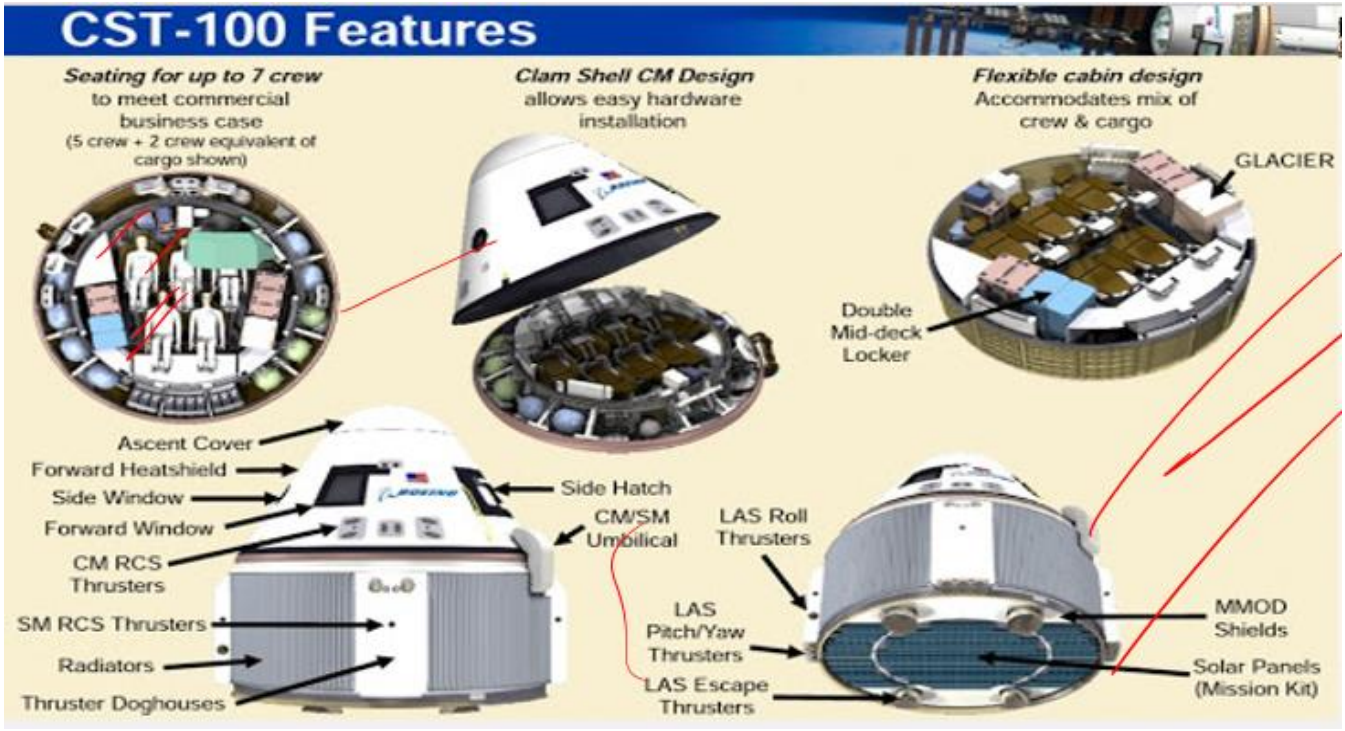


Attempt to collect Mars samples with Perseverance rover (IE)

- NASA's Perseverance rover is exploring the Jezero Crater on Mars and attempting to collect its first rock samples.

Sample collection

- According to data sent to Earth by the rover, no rock samples were collected during the first attempt.
- NASA says that sampling Mars is one of the most complicated tasks and involves drilling holes, collecting and then storing the samples in test tubes.
- The data show a successful drill hole, but no sample in the tube–something we've never seen in testing on Earth.

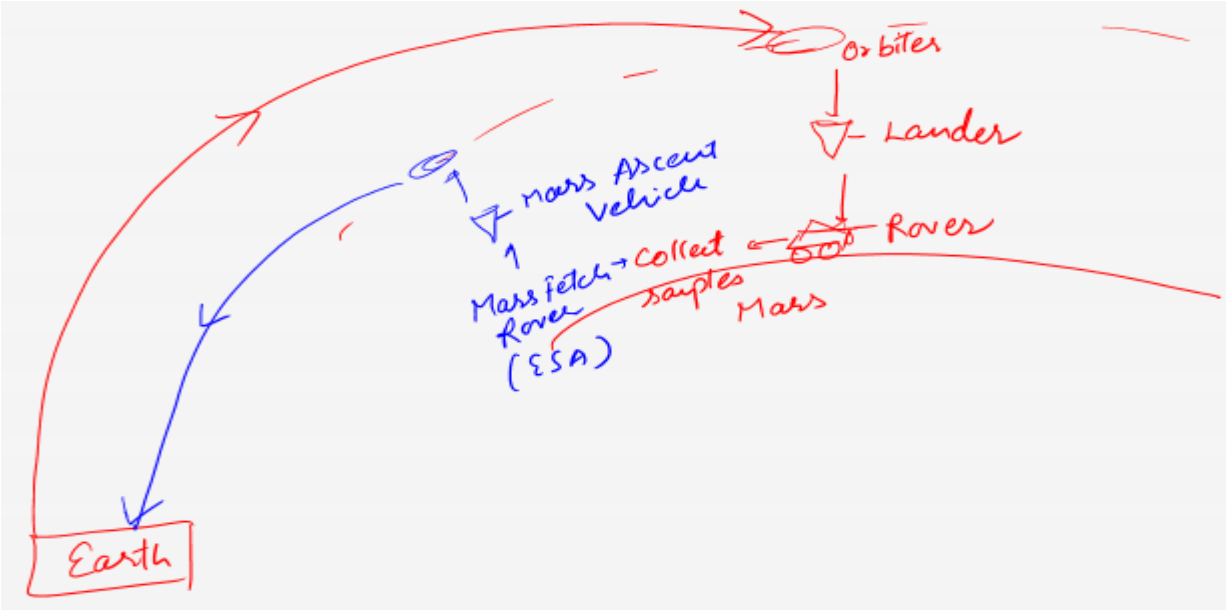
Perseverance rover- Significance

- Perseverance will spend one Mars year (two years on Earth) on the planet during which time it will explore the landing site region.
- The Jezero Crater where it landed was once the site of an ancient river delta — scientists know this because of evidence collected during previous landed and orbital missions that point to wet conditions on the planet billions of years ago.
- If Mars once harboured a warmer atmosphere enabling water to flow in its ancient past (3.5-3.8 billion years ago), and if microbial life had once existed on the Red Planet, it is possible that it exists in "special regions" even today.

- One of the most interesting instruments aboard the rover is called MOXIE, which will produce oxygen from Martian atmospheric carbon dioxide.
- If this instrument is successful, then future astronauts (as of now, no human being has kept foot on Mars) can use it to burn rocket fuel for returning to Earth.
- The rover is also carrying Ingenuity, the first helicopter to fly on Mars that will help collect samples from the surface from locations where the rover cannot reach.

Mars 2020

- is a Mars rover mission forming part of NASA's Mars Exploration Program that includes the rover Perseverance and the small robotic, coaxial helicopter Ingenuity.



Merger of Supermassive Black Holes (IE)

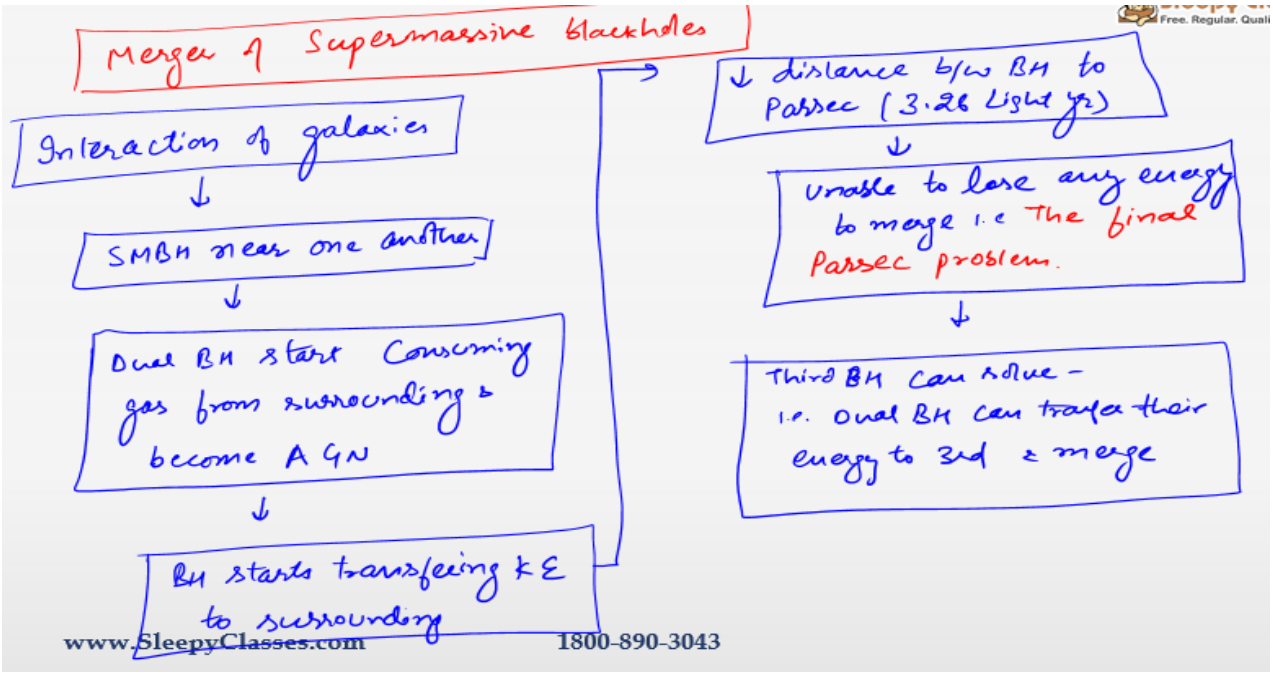
- Indian researchers have discovered three supermassive black holes from three galaxies merging together to form a triple active galactic nucleus (AGN).

About

- Scientists were studying the AGN in the two massive barred spiral galaxies NGC7733 and NGC7734 when they detected unusual emissions from the centre of the latter and a curious movement of a large bright clump within it, having a different velocity than that of NGC7733.
- As the third one was a separate galaxy, the scientists named it NGC7733N.
- All three merging black holes were part of galaxies in the Toucan constellation.

Merger

- According to the researchers, a major factor impacting galaxy evolution is galaxy interactions which happen when galaxies move close to each other and exert tremendous gravitational forces on each other.
- During such galaxy interactions, the respective supermassive black holes can get near each other.
- The dual black holes start consuming gas from their surroundings and become dual AGN.
- If two galaxies collide, their black holes will also come closer by transferring the kinetic energy to the surrounding gas.
- The distance between the blackholes decreases with time until the separation is around a parsec (3.26 light-years).
- The two black holes are then unable to lose any further kinetic energy in order to get even closer and merge. This is known as the final parsec problem.
- The presence of a third black hole can solve this problem.
- The dual merging blackholes can transfer their energy to the third blackhole and merge with each other
- Many AGN pairs have been detected in the past, but triple AGN are extremely rare, and only a handful has been detected before using X-ray observations.
- However, scientist expects such triple AGN systems to be more common in small merging groups of galaxies.



Inspiration4 (IE)

- The first all-civilian mission to orbit Earth on a SpaceX Crew Dragon spacecraft is scheduled to launch on Sept. 15.

About Inspiration4

- It is a spaceflight planned for four people aboard the SpaceX *Resilience* capsule.
- The three-day flight will be the first human spaceflight to orbit Earth with exclusively private citizens on board.
- The flight will be privately operated by SpaceX using a previously-flown Crew Dragon capsule launched to low Earth orbit.
- The mission is a part of an effort to raise millions for the Tennessee-based St. Jude Children's Research Hospital, a paediatric treatment and research facility that focuses on children's catastrophic diseases, particularly leukaemia and other cancers
- It will orbit the Earth at 575 km, higher than the International Space Station (408 km) and the Hubble Space Telescope (547 km)

NASA's InSight Mars Mission

- Nasa's InSight lander has recorded over 500 quakes to date on Mars since its touch down on the Red Planet in November 2018.
- The two recent quakes of magnitude 3.3 and 3.1 originated in a region called Cerberus Fossae.

InSight Mission

- It is a part of NASA's Discovery Program (1992).
- First mission dedicated to looking deep beneath the Martian surface.

CHIME Telescope

- Scientists with the Canadian Hydrogen Intensity Mapping Experiment (CHIME) Collaboration have assembled the largest collection of fast radio bursts (FRBs) in the telescope's first FRB catalog.

CHIME Telescope

- CHIME is an interferometric radio telescope at the Dominion Radio Astrophysical Observatory in British Columbia, Canada.

- The telescope receives radio signals each day from half of the sky as the Earth rotates.

What are FRBs?

- FRBs are oddly bright flashes of light, registering in the radio band of the electromagnetic spectrum, which blaze for a few milliseconds before vanishing without a trace.
- These brief and mysterious beacons have been spotted in various and distant parts of the universe, as well as in our own galaxy.
- Their origins are unknown and their appearance is highly unpredictable.
- But the advent of the CHIME project has nearly quadrupled the number of fast radio bursts discovered to date.
- With more observations, astronomers hope soon to pin down the extreme origins of these curiously bright signals.

Ariel Space Mission

- The Atmospheric Remote-sensing Infrared Exoplanet Large-survey (ARIEL), is a space telescope mission of the European Space Agency's Cosmic Vision program.
- This mission aims at studying the exoplanets, their nature, formation, composition, and evolution over the years.
- The mission is a four year long project and is expected to launch in 2029.

Hope Probe Mission

- Recently, the United Arab Emirates' (UAE's) first-ever interplanetary Hope Probe mission has successfully entered orbit around Mars.

About

- The UAE's Mars Mission called 'Hope' was announced in 2015 with the aim of creating mankind's first integrated model of the Red planet's (Mars) atmosphere.
- 'Hope' was developed by UAE scientists in the USA and was launched in July 2020 from the Tanegashima Space Centre in Japan.

Specification

- The Mars Hope Probe weights just 1.5 tonnes, about the same size as an SUV. It is expected to complete one orbit around the planet every 55 hours.

- The overall life of UAE's Mars mission is around one Martian year, which is about 687 days on Earth.

Sonification Project

- While telescopes offer glimpses of outer space by translating digital data into stunning images, NASA's Chandra X-Ray Center (CXC) has gone a step further by unveiling a new 'sonification' project that transforms data from astronomical images into audio.

How did NASA translate astronomical images into sound?

- NASA's distant telescopes in space collect inherently digital data, in the form of ones and zeroes, before converting them into images. The images are essentially visual representations of light and radiation of different wavelengths in space, that can't be seen by the human eye.
- The Chandra project has created a celestial concert of sorts by translating the same data into sound. Pitch and volume are used to denote the brightness and position of a celestial object or phenomenon.

Stardust 1.O

- Stardust 1.O was recently launched from Maine, the US has become the first commercial space launch powered by biofuel.

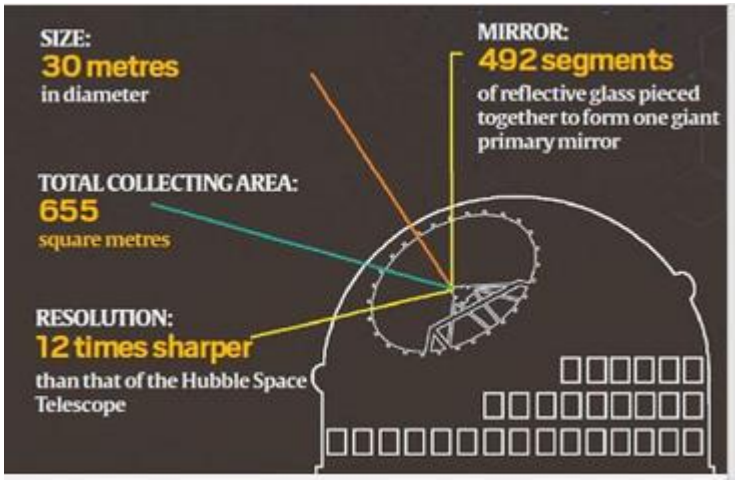
Stardust 1.O

- Stardust 1.O is a launch vehicle suited for student and budget payloads.
- The rocket is manufactured by bluShift, an aerospace company based in Maine that is developing rockets that are powered by bio-derived fuels.
- The rocket is 20 feet tall and has a mass of roughly 250 kg.

Thirty Meter Telescope (TMT)

About

- is an international partnership between the USA, Canada, Japan, China, and India.
- It will allow deeper exploration into space and observe cosmic objects with unprecedented sensitivity.
- Planned location: Mauna Kea on the island of Hawaii in the US state of Hawaii.



Biotechnology

Human Cells Grown in Monkey Embryos

- Researchers at the Salk Institute for Biological Studies in the US have for the first time grown human cells in monkey embryos
- While the results might imply progress for this particular field of research called "chimera research", they have also ignited a debate about how ethical studies of this kind are.

What have the researchers done?

- By integrating human cells into the embryos of macaque monkeys, researchers have created what is called a chimeric tool.

Chimeras

- are organisms that are made up of the cells of two distinct species, in this case humans and monkeys.
- For instance, if this hybrid embryo was placed in the womb of a monkey, it could possibly grow into a new kind of an animal (however this was not the aim of this study).

Past Studies

- Previously, in a 2017 study researchers integrated human cells into pig tissues as they thought that pigs, whose organ size, physiology and anatomy are similar to that of humans, could help them in creating organs that could ultimately be transplanted to humans.

Ethical Concerns

Survivability of hybrid animals

- In 2014, "Geep", a hybrid between a goat and a sheep, was born (unintentional breeding) in an Irish farm.
- Mules are another example of a hybrid animal (intentional breeding) that are the result of mating between a female horse and a male donkey.
- Generally, different species don't cross-breed and if they do, their offspring don't survive for long and are prone to infertility.

Society

- While further research into chimeras might lead to progress, which could mean that they could be used as a source of organs for humans, these chimeras would still be a mix of human and non-human cells, a thought that makes many uncomfortable.
- Further tampering with the genetic code in human beings is more controversial, as any such change can be passed down to future generations.

India

- Production of hybrid animals has been banned in India since 1985.

Rules for the manufacture, use, import, export & storage of hazardous microorganisms, genetically engineered organisms or cells, 1989

- Notified under Environment protection act 1986 implemented by the Ministry of Environment, Forest and Climate Change, Department of Biotechnology and State Governments though various competent authorities.
- Rules regulate Genetically Modified Organism.

Yuan Longping

- The Chinese scientist Yuan Longping, whose development of hybrid rice in the 1970s helped bring an end to famine for millions of people throughout Asia and Africa, died recently.

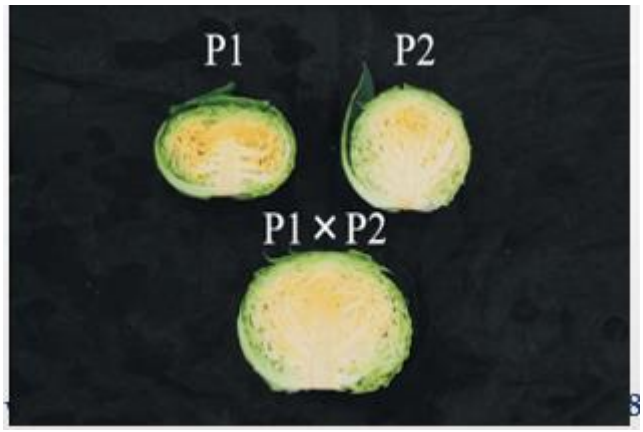
Contribution

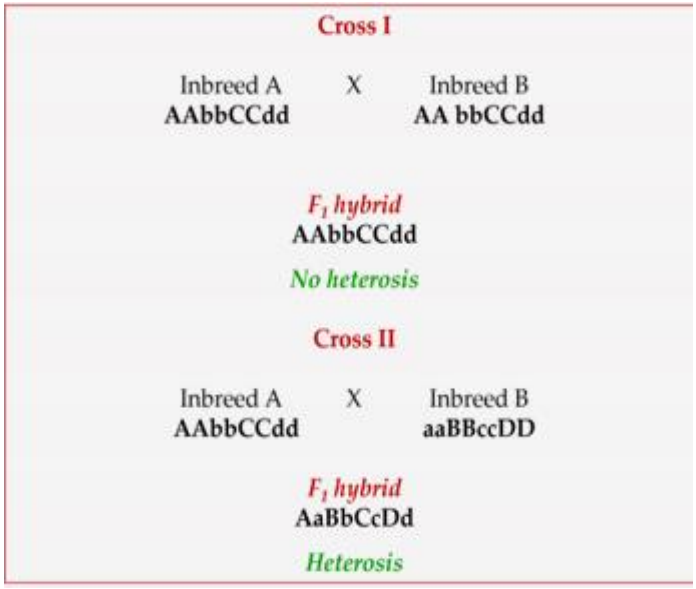
- In 1970s, he developed "the first hybrid rice combination called Nan-you No. 2 which, due to heterosis.

- It typically yielded 20 percent more rice than conventional varieties, transforming Chinese agriculture after years of famine and scarcity.
- Some 10,000 years after Chinese farmers began cultivating rice near the Yangtze River, the country now produces more than 200 million tons of rice a year, more than any other nation.
- He ultimately partnered with the United Nations and the International Rice Research Institute in the Philippines, in addition to teaching farmers in India, Vietnam and elsewhere how to grow hybrid rice.
- In 2004, he was awarded the World Food Prize.

Heterosis

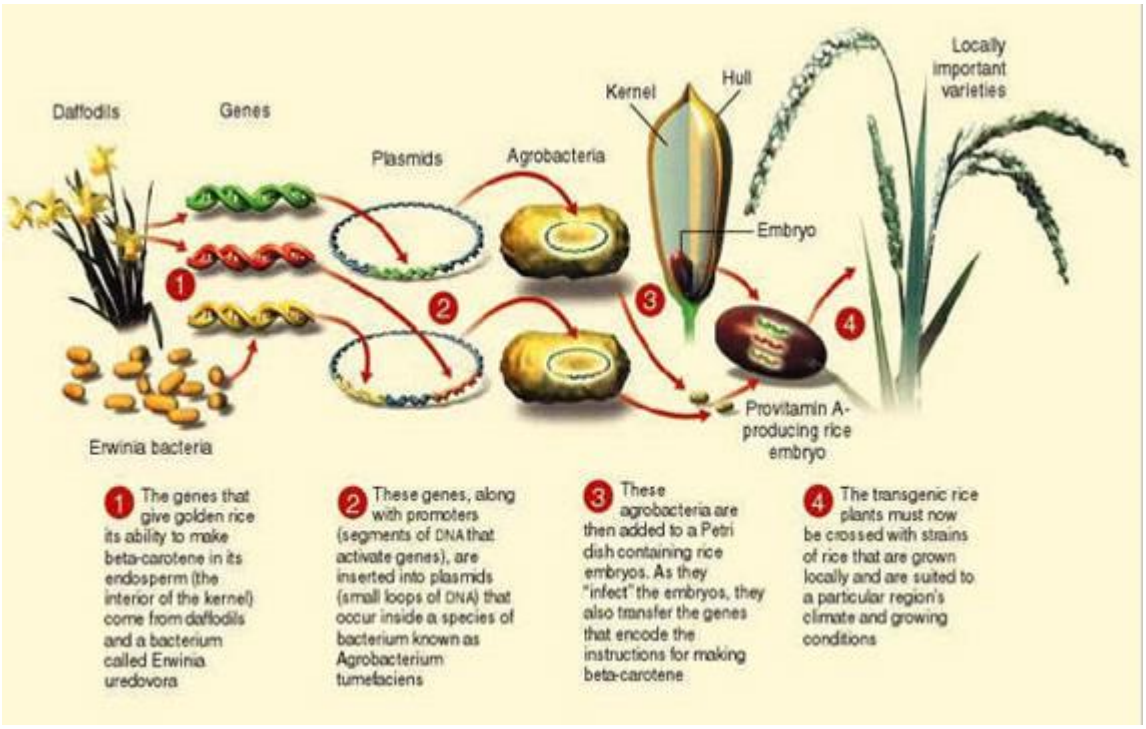
- Often called true heterosis or euheterosis.
- It may be defined as the superiority of an F1 hybrid over both of its parents in terms of yield or some other characters.

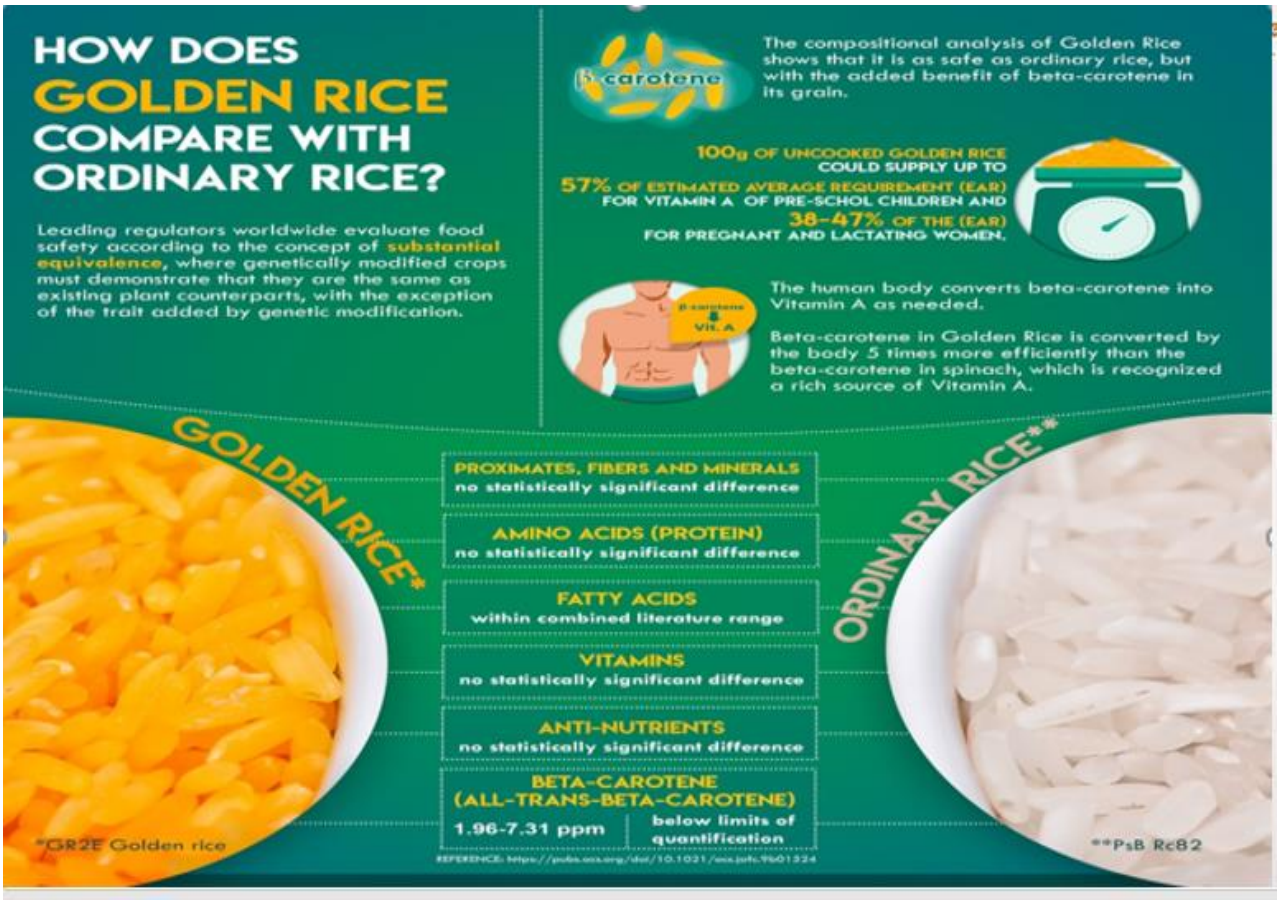




Golden Rice

- Two genes from the daffodil plant and a third from a bacterium.





World's first Nano Liquid Urea

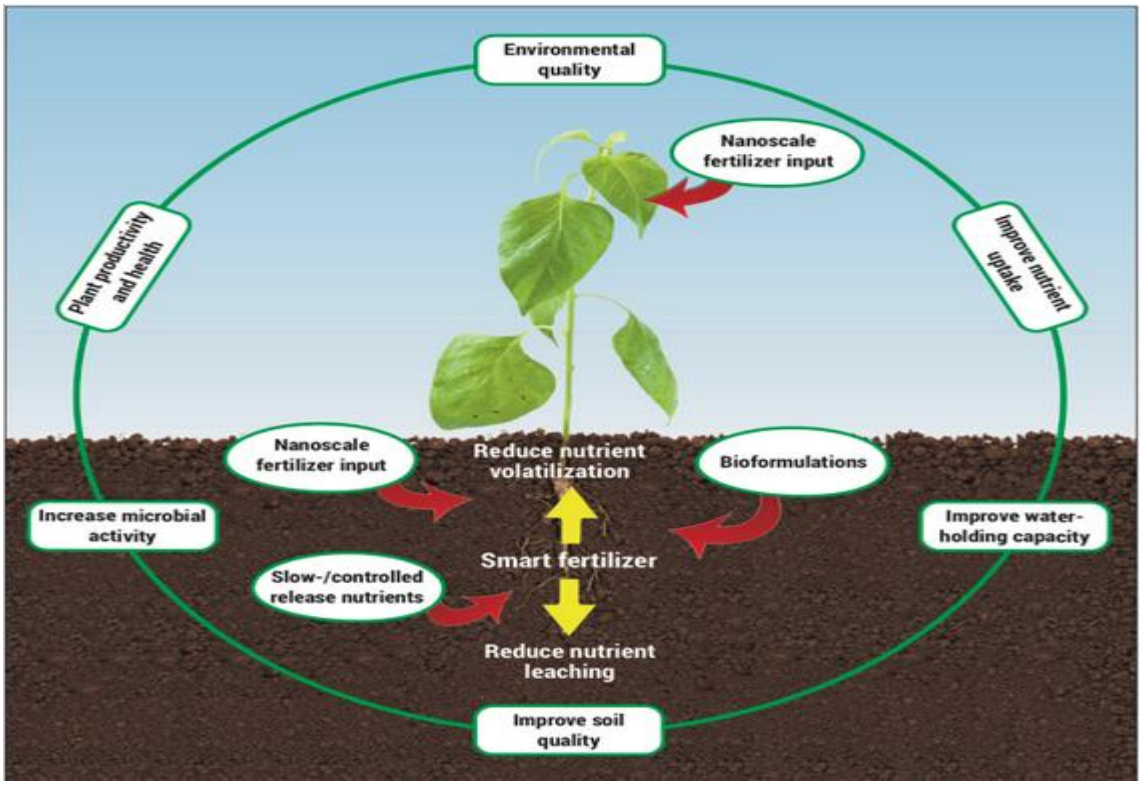
- Indian Farmers Fertiliser Cooperative Limited (IFFCO) on Monday launched the Nano Urea Liquid.
- Indigenously developed at Nano Biotechnology Research Centre, Kalol, Gujrat.

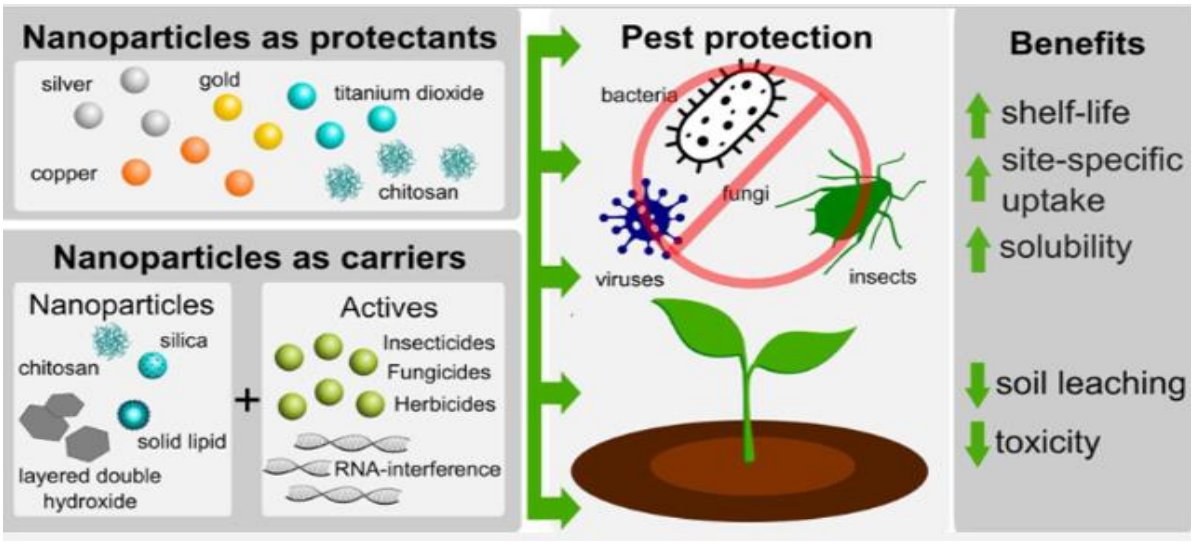
Indian Farmers Fertiliser Cooperative Limited (1967)

- Cooperative societies which is wholly owned by Indian Cooperatives.
- To enable Indian farmers to prosper through timely supply of reliable, high quality agricultural inputs and services in an environmentally sustainable manner.

Nano Urea Liquid-a nutrient to provide nitrogen to plants as an alternative to the conventional urea		
Advantages	Requirement	curtail the requirement of conventional urea by at least 50%
	Impact	Nano Urea liquid (40,000 ppm of nitrogen in a 500 ml bottle)= 1 bag of Conventional urea
	Price	10% cheaper than conventional Urea
	Effectiveness (delivering nitrogen to plants)	conventional Urea-30-40% Nano Urea liquid >80%
	Yield	8% increase (Tested on wheat & rice)

Nano fertilizer-product that is made with nanoparticles or uses nanotechnology to improve nutrient efficiency		
classes	nanoscale fertilizer	nanoparticles which contain nutrients
	nanoscale additives	traditional fertilizers with nanoscale additives
	nanoscale coating	traditional fertilizers coated or loaded with nanoparticles
Application	Nanomaterial coatings (nanomembrane)	May slow the release of nutrients or a porous nanofertilizer may include a network of channels that retard nutrient solubility.
	Encapsulation	encapsulation of beneficial microorganisms can improve plant root health.





Sale of Illegal HTBt Cotton Seeds Doubles

- The illegal cultivation of herbicide tolerant (HT)Bt cotton has seen a huge jump this year, with seed manufacturers claiming that the sale of illegal seed packets has more than doubled from 30 lakh last year to 75 lakh this year.

HTBT Cotton	**Herbicide Tolerant (HT) Bt cotton**
Technique	• Addition of **'Cp4-Epsps' gene** from another soil bacterium, Agrobacterium tumefaciens
Reason	• Herbicide tolerant Bt (HtBt) cotton remains unaffected by glyphosate • **Low cost-** No need of weeding • **Not harmful-** WHO-Not cancer causing
Concerns	**GEAC**-Not approved by GEAC **Seed Act of 1966 and the Cotton Act of 1957** • Prohibit sale of unapproved seeds **Environmental Protection Act** • jail term of five years and a fine of Rs 1 lakh for violation **Other-no accountability of the quality of seed**

Glyphosate	• Non selective Herbicide • Applied to the leaves of plants to kill both broadleaf plants and grasses **Min of Agriculture** • **No person shall use glyphosate except** through Pest Control Operators
GEAC	• **Genetic Engineering Appraisal Committee** • Under **Ministry of Environment, Forest and Climate Change (MoEF&CC).** • **Chaired** by the **Special Secretary/Additional Secretary of MoEF&CC** and co-chaired by a representative from the Department of Biotechnology (DBT).

The functions of GEAC as prescribed in the Rules 1989 are as follows:

> To appraise activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production from the environmental angle.

> To appraise proposals relating to release of genetically engineered organisms and products into the environment including experimental field trials.

> The committee or any persons authorized by it has powers to take punitive action under the Environment Protection Act.

The Debate around Gain-of-Function Research

- The Wuhan Institute of Virology was said to have conducted gain-of-function research on coronaviruses.

Gain-of-function research	• Deliberately **altering an organism** in the lab, altering a gene, or **introducing a mutation** in a pathogen to study its transmissibility, virulence and immunogenicity • Involves **manipulations** that make **certain pathogenic microbes more deadly** or more transmissible • Done by **genetically engineering** the virus and by allowing them to **grow in different growth mediums**, a technique called as **serial passage** **Significance** • Allows researchers to study potential therapies, vaccine possibilities and ways to control the disease better in future.
Loss-of-function' research	• Involves **inactivating mutations**, resulting in a **significant loss of original function**, or no function to the pathogen. • When mutations occur, they alter the structure of the virus that is being studied, resulting in altered functions. • **Some of these significant mutations** might **weaken the virus or enhance its function**

'Dual-use research of concern' (DURC)	• Some forms of **gain-of-function research** reportedly **carry inherent biosafety and biosecurity risks** • This indicates that while the research **may result in benefits for humanity**, there is also the **potential to cause harm** — accidental or deliberate escape of these altered pathogens from labs may **cause even pandemics**.
India	**Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells Rules, 1989** • **Regulate all activities** related to genetically engineered organisms or cells and hazardous microorganisms and products Last year, the **Department of Biotechnology** issued guidelines for the establishment of containment facilities, called '**Biosafety labs', at levels two and three**

First-ever genetically modified rubber planted in Assam

- Recently, the world's first Genetically Modified (GM) rubber plant developed by Rubber Research Institute was planted in Assam.

Rubber plantation		
About	• **Made from the latex** of a tree called **Hevea Brasiliensis** • **An equatorial crop**, but under special conditions, it is also grown in tropical and sub-tropical areas. • The British established the first rubber plantation in India in 1902 on the banks of the river Periyar in Kerala.	
Ideal Conditions	Temperature	• Between 25 °C and 35 °C
	Rainfall	• 200-300 cm daily rainfall followed by bright sunshine is ideal for its growth.
	Other	• Deep, rich and well-drained loamy soil, at an elevation of about 400 meters above the sea level, provides ideal conditions
Ranking	Global	• Thailand, Indonesia, Malaysia, Vietnam, China and India.
	Regional	• Natural rubber is cultivated in 16 states in India • Kerala tops rubber cultivation, followed by Tripura (Source-Business standard-Jan 2021)
Efforts	**National Rubber Policy in March 2019** • Sustainable and Inclusive Development of Natural Rubber • Financial and technical assistance	
	FDI	• 100% **FDI** in plantations of rubber, coffee, tea, cardamom, palm oil tree and olive oil tree

Genetically Modified (GM) rubber plant	
About	• First **GM rubber plant developed by Rubber Research Institute** was planted in Assam.
Technology	• Inserted gene MnSOD, or manganese-containing superoxide dismutaseed
Significance	• **Protect plants from severe cold and drought conditions** • **More suitability to Northeast India as** young rubber plants remains suspended during the winter months

Space Rice

- 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 in November
    - After being exposed to cosmic radiation and zero gravity, these seeds weighing around 40 gram returned and were harvested at the space breeding research centre of the South China Agricultural University in Guangdong province
    - The seeds are now 1 centimeter long.

What is space rice?

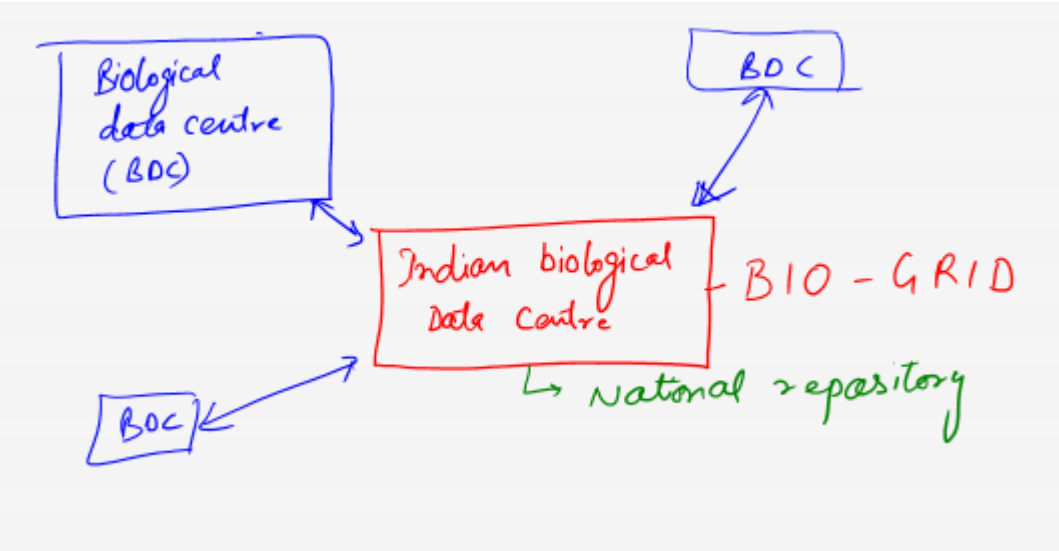
- Rice seeds exposed to the environment in Space may mutate and produce higher yields once planted on Earth.
- China has been taking seeds of rice and other crops to Space since 1987.
- Bloomberg reported more than 200 Space plant **vari**eties, including cotton and tomatoes, have been approved for planting.
- According to China's state media reports, In 2018, the total plantation area for space crops approved in China reached more than 2.4 million hectares.

Biotech-PRIDE (PIB)

- Recently Department of Biotechnology (DBT), Ministry of Science and Technology released Biotech-PRIDE (Promotion of Research and Innovation through Data Exchange) guidelines
- The Minister also launched the website of Indian Biological Data Centre, IBDC.

Biotech-PRIDE Guidelines

- It envisage to bridge other existing biological datasets/data centres with the IBDC, which will be called Bio-Grid.
- This 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
- These guidelines do not deal with generation of biological data per se but is an enabling mechanism to share and exchange information and knowledge generated as per the existing laws, rules, regulations and guidelines of the country



Import of GM food in India (HT)

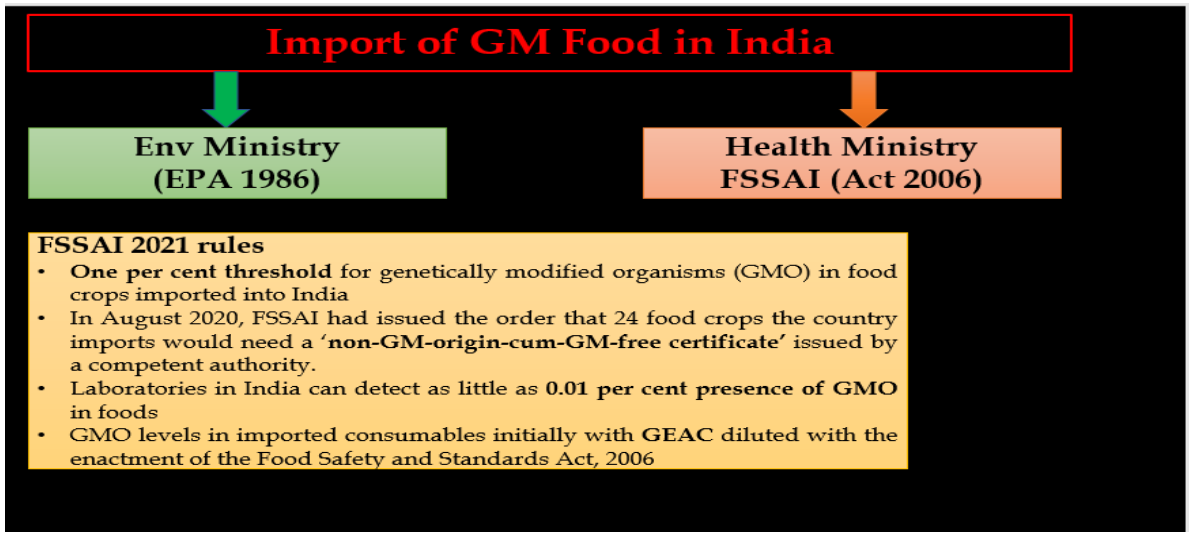
- The poultry industry is demanding a permit for the import of crushed genetically modified (GM) soya seeds for captive consumption of farmers from the Central government.

Import

- Currently India allows import of GM Canola Oil & GM Soyabean
- GM soya bean seeds- Not approved.

Concerns & Demands

- Recently, the prices of soybean, which is used as feed in the poultry industry, has skyrocketed and experts suggest that the import for the particular time frame will stabilise the raw material market.
- Increased cost of production, a misinformed reality about outbreaks of bird flu, Covid-19 restrictions and natural calamities.
- These increased raw material prices directly affect retail chicken prices. As a result of which chicken is sold at ₹250-300/kg in the retail market.
- High speculations in soy contracts on National Commodity and Derivatives Exchange Limited (NCDEX) from the last six months, sector also demands to remove soybean as a commodity from NCDEX.
- GST on soybean should be reduced otherwise the prices for chicken and broiler eggs may increase further.



Food Fortification

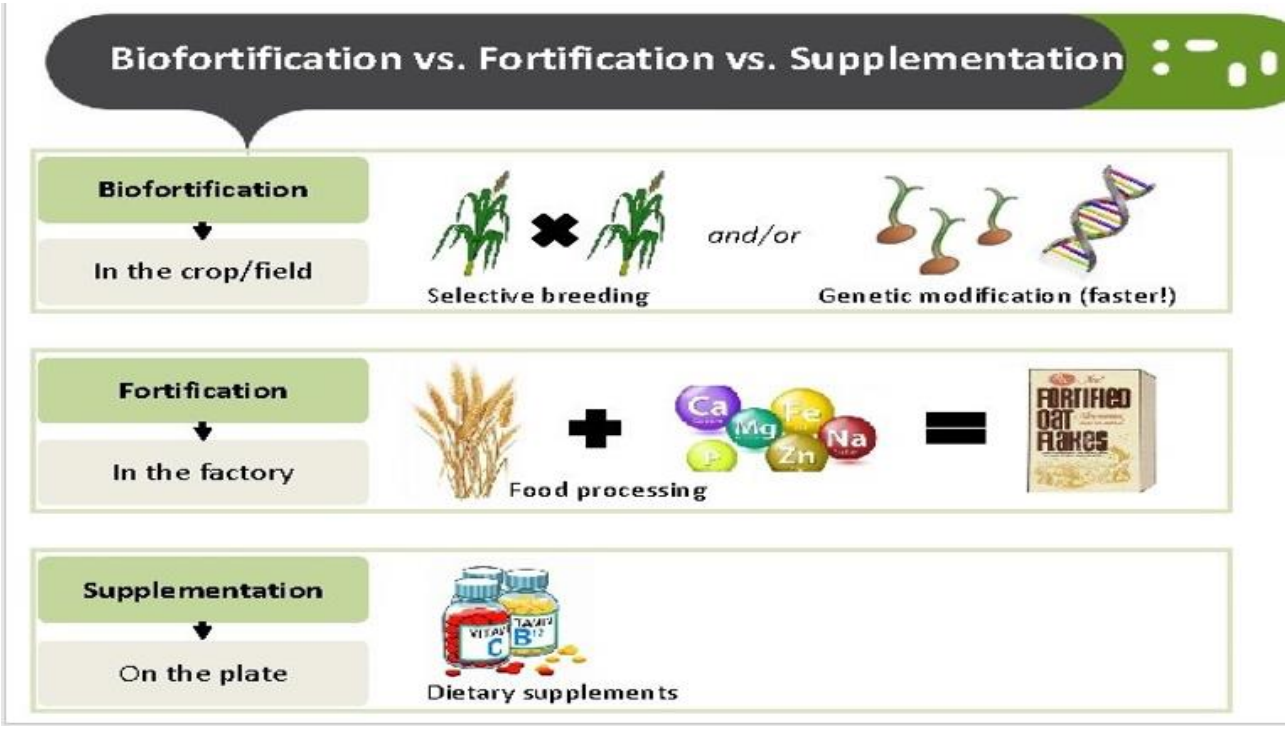
- In a pushback against the Centre's plan to mandatorily fortify rice and edible oils with vitamins and minerals, a group of scientists and activists have written to the Food Safety and Standards Authority of India (FSSAI), warning of the adverse impacts on health and livelihoods.

Food Fortification

- Fortification is a complementary strategy to fight malnutrition under which key vitamins and minerals such as iron, iodine, zinc, vitamins A & D are added to staple foods such as rice, wheat, oil, milk and salt to improve their nutritional content.

Concerns

- Evidence – evidence supporting fortification is inconclusive and certainly not adequate before major national policies are rolled out.
- Hypervitaminosis-Medical journal Lancet and in the American Journal of Clinical Nutrition which show that both anaemia and Vitamin A deficiencies are overdiagnosed, meaning that mandatory fortification could lead to hypervitaminosis.
- Conflict of Interest-many of the studies which FSSAI relies on to promote fortification are sponsored by food companies who would benefit from it, leading to conflicts of interest.
- Absorption-one major problem with chemical fortification of foods is that nutrients don't work in isolation but need each other for optimal absorption. Undernourishment in India is caused by monotonous cereal-based diets with low consumption of vegetables and animal protein.
- Toxicity-Adding one or two synthetic chemical vitamins and minerals will not solve the larger problem, and in undernourished populations can lead to toxicity
- Loss to economy-mandatory fortification would harm the vast informal economy of Indian farmers and food processors including local oil and rice mills, and instead benefit a small group of multinational corporations
- Impact on natural food-Dietary diversity was a healthier and more cost-effective way to fight malnutrition. Once iron-fortified rice is sold as the remedy to anaemia, the value and the choice of naturally iron-rich foods like millets, varieties of green leafy vegetables, flesh foods, liver, to name a few, will have been suppressed by a policy silence.



Advanced Wound Dressing Material Based on Seaweed Agar

- Indian scientist developed advanced Wound Dressing Material Based on Seaweed Agar to treat Diabetic Wounds and Manage Chronic ones at Competitive Cost.

About

- An Indian scientist has developed an advanced wound dressing based on agarose, a natural polymer derived from seaweed agar, for the treatment of infected diabetic wounds and patients suffering from chronic wounds.
- This indigenous dressing will allow cost-effective dressings for chronic wound patients and will also pave the way for business incubation.
- The biodegradable, non-immunogenic wound dressing was developed from sustainable source by adding several additive molecules like iodine and citric acid.

Agar-agar

- is a hydrocolloid extracted from red seaweeds that is widely used as a gelling agent in the food industry.
- In its gelling power, agar is outstanding among the hydrocolloids.

- Among its major properties one can mention its high gel strength at low concentrations, low viscosity in solution, high transparency in solution, thermo-reversible gel and sharp melting/setting temperatures.

Solubility

- Agar-agar is insoluble in cold water, but it swells considerably, absorbing as much as twenty times its own weight of water.
- It dissolves readily in boiling water and sets to a firm gel.

Bio-bank for heart failure (PIB)

- India's first bio-bank for heart failure research inaugurated at Sree Chitra Tirunal Institute for Medical Sciences and technology

National Heart Failure Biobank (NHFB)

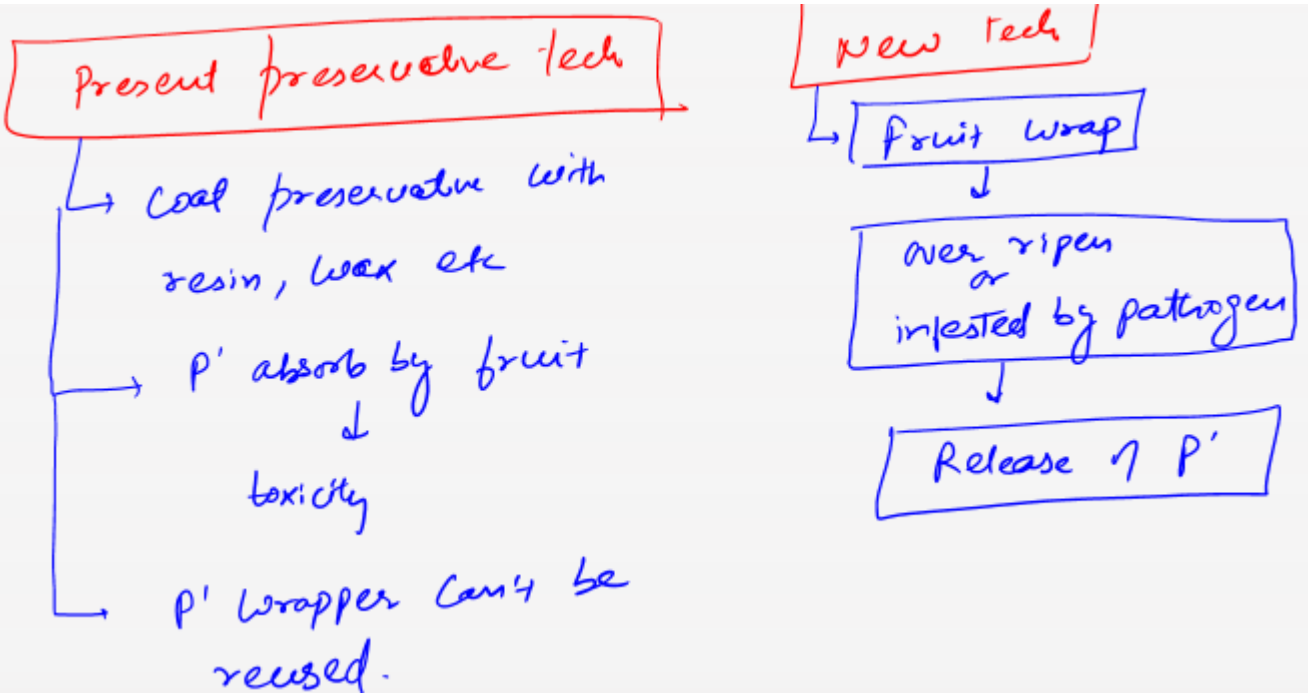
- First heart failure Biobank in the country.
- Samples collected by the biobank will include the blood, serum, tissue samples obtained during open-heart surgery and peripheral blood mononuclear cells (PBMCs) and genomic DNA collected from heart failure patients.
- Consent from patient is needed for sample collection.
- The biobank activity will be supervised by a Technical Advisory Committee (TAC) with a member from the Indian Council of Medical Research(ICMR).

Non-Toxic and Reusable Wrapper to Increase Shelf Life of Fruits (PIB)

- Indian scientist developed Carbon-based non-toxic and reusable wrapper to increase shelf life of fruits.

About

- It is a composite paper made of carbon (graphene oxide) loaded with preservatives that can be used as wrappers to help extend shelf life of fruits.
- Unlike the present preservative dipping technology, where the preservatives are adsorbed by the fruit, causing chronic toxicity to the consumers; here preservatives the wrapper releases the preservative only when needed.
- The wrapper can be reused, which is not possible with the present technology.
- Fruits are highly perishable, hence 50% of fruits produced are wasted, causing huge losses.
- Conventional preservation relies on coating the preservative with the resin, wax, or edible polymer, which may cause chronic health problems.



India to import 1.2 mn tonne GM soyameal (BS)

- India is all set to import 12 lakh tonne of genetically modified soyameal, used as livestock feed, after the environment ministry and DGFT cleared the air on the GM issue.

Reason

- The imports are necessary as skyrocketing prices of soyameal have made the livestock feed costlier, affecting farmers associated with the poultry, dairy and aqua industry.
- Currently, there is no ban on import of soyameal, including GM soyameal. However, the industry wanted clarification on the GM issue before placing the orders.
- Soyameal is a protein-rich solid leftover raw material after extracting oil from soyabean seed.

What government said

- The environment ministry clarified that since the de-oiled cake per se obtained after crushing GM soyabean does not contain any living modified organism, it has no objection to import of soya cake or meal from an environmental angle
- There are three types of GM foods, one with Genetically Modified Organism (GMO), second with Living Modified Organism (LMO) and third with Non-Living Modified Organism (NLMO).
- The soyameal is NLMO. The Environment Ministry has said it has no impact on human and animal health as well as on the environment,

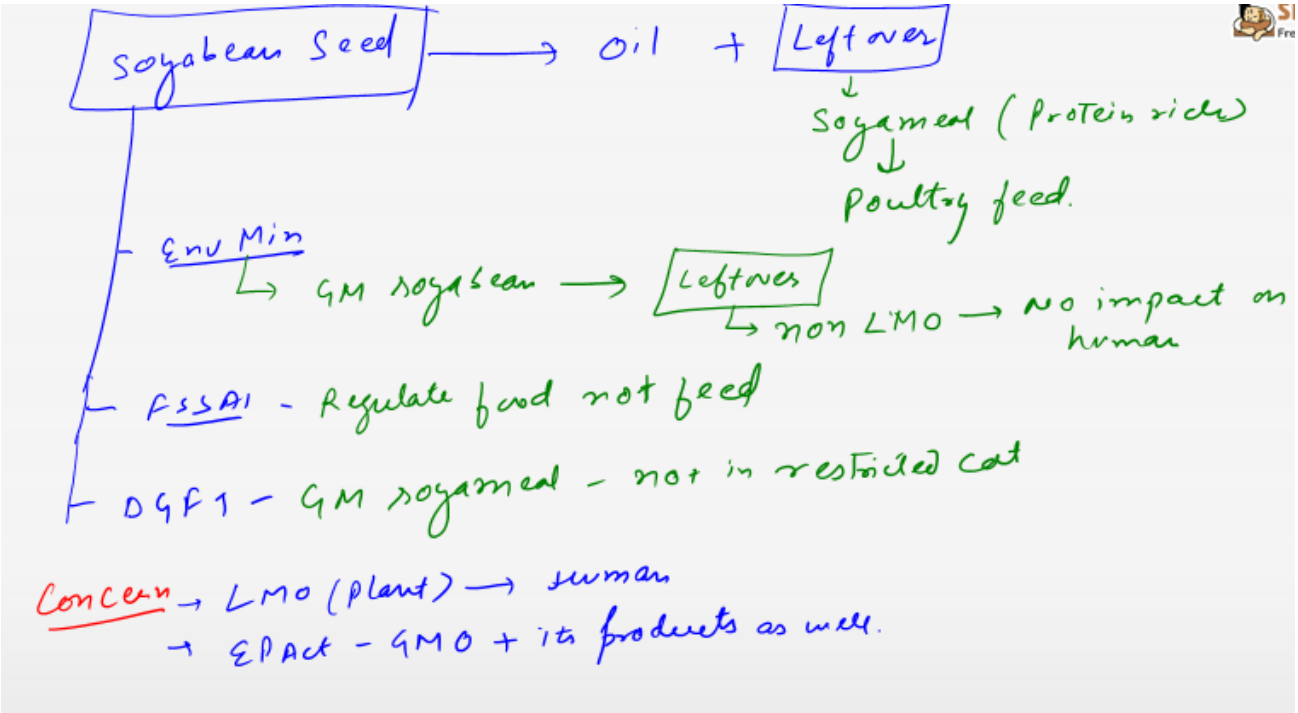
- Food safety regulator FSSAI, which said "it regulates food and not feed. And it does not have any objection.
- Directorate General of Foreign Trade (DGFT) -- a nodal body that administers imports and exports -- said GM soyameal is not in a 'restricted category' and therefore has no concern if imports take place.

Concerns

- Environmental activists have raised concerns about the permission given for something derived from a genetically modified plant to enter the human food chain, given that India's regulatory system has yet to approve GM foods.
- Besides, the 1989 rules of the Environment Protection Act applied not just to GM organisms, but also products and substances thereof.

What is a Living Modified Organism (LMO)?

- A Living Modified Organism (LMO) is defined in the Cartagena Protocol on Biosafety.
- The Protocol also defines the terms 'living organism' and 'modern biotechnology' .
- In everyday usage LMOs are usually considered to be the same as GMOs (Genetically Modified Organisms), but definitions and interpretations of the term GMO vary widely.
- Common LMOs include agricultural crops that have been genetically modified for greater productivity or for resistance to pests or diseases. Examples of modified crops include tomatoes, cassava, corn, cotton and soybeans.



National Gene Bank (PIB)

- Recently Union Agriculture Minister inaugurated the world's second-largest refurbished gene bank at the National Bureau of Plant Genetic Resources

National Gene Bank

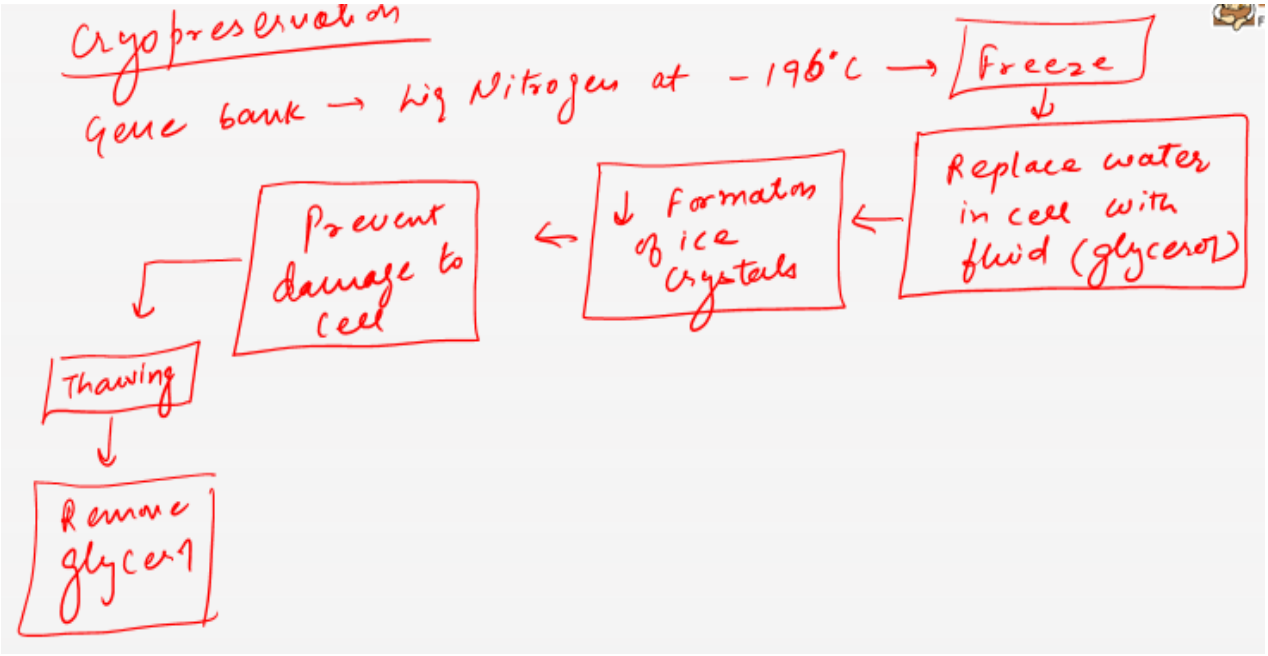
- Gene Banks are a type of biorepository which preserve genetic material. A collection of seed plants, tissue cultures etc.
- Established in the year 1996 to preserve the seeds of Plant Genetic Resources (PGR) for future generations, has the capacity to preserve about one million germplasm in the form of seeds.
- Presently it is protecting 4.52 lakh accessions, of which 2.7 lakh are Indian germplasm and the rest have been imported from other countries.
- Four kinds of facilities, namely, Seed Genebank (- 18°C), Cryogenebank (-170°C to -196°C), In vitro Genebank (25°C) and Field Genebank, to cater to long-term as well as medium-term conservation.
- It stores different crop groups such as cereals, millets, medicinal and aromatic plants and narcotics, etc.

National Bureau of Plant Genetic Resources (NBPGR)

- Under the control of Indian Council of Agricultural Research (ICAR).
- It is a nodal organisation for management of plant genetic resources in India.

Other efforts

- Svalbard Global Seed Vault.
- Located in Norway houses the world’s largest collection of seeds.
- Chang La (Ladakh) seed Vault.
- India’s seed vault located in the Himalayas.
- National Animal Gene Bank.
- Established at the National Bureau of Animal Genetic Resources (NBAGR - Karnal, Haryana), has the objective of conserving the indigenous livestock biodiversity.



Bio-nanocarrier for Visceral Leishmaniasis therapy (PIB)

- Indian researchers have developed a non-invasive, easy to administer, cost-effective, and patient compliant potential therapeutic strategy against Visceral Leishmaniasis, a neglected tropical disease.

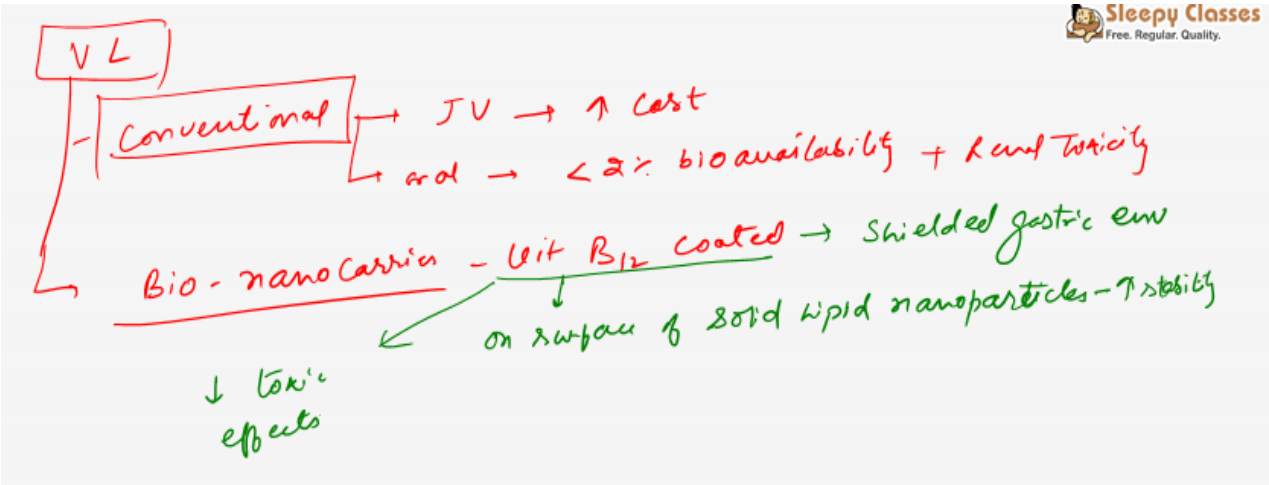
Nanocarrier Based Therapy

- It is based on nano carrier-based oral drugs coated with Vitamin B_{12} enhanced oral bioavailability and efficacy of the therapy by more than 90%.
- The conventional treatment therapy of VL mainly involves painful intravenous administration, which imposes many treatment complications, including prolonged hospitalization, high cost, and high risk of infection.
- Oral drug delivery brings forth massive advantages that can help overcome these barriers. But with oral routes, there are other challenges as more than 90% of orally administered therapeutic drugs have less than 2% bioavailability and potentially high hepatic and renal toxic side effects.

Visceral Leishmaniasis (VL)

- also known as kala-azar.
- is a complex infectious disease transmitted by the bite of female *Phlebotomine* sandflies.
- It is a neglected tropical disease that affects millions annually, making it the second most common parasitic killer after malaria.

- If the disease is not treated, the fatality rate in developing countries can be as high as 100% within 2 years.



Extrusion Technology in Rice Fortification (IE)

- Recently Prime Minister Narendra Modi announced the fortification of rice distributed under various government schemes, including the public distribution system (PDS) and midday meals in schools, by 2024.

Rice Fortification

- The Food Safety and Standards Authority of India (FSSAI) defines fortification as "deliberately increasing the content of essential micronutrients in a food so as to improve the nutritional quality of food and to provide public health benefit with minimal risk to health".

Technologies

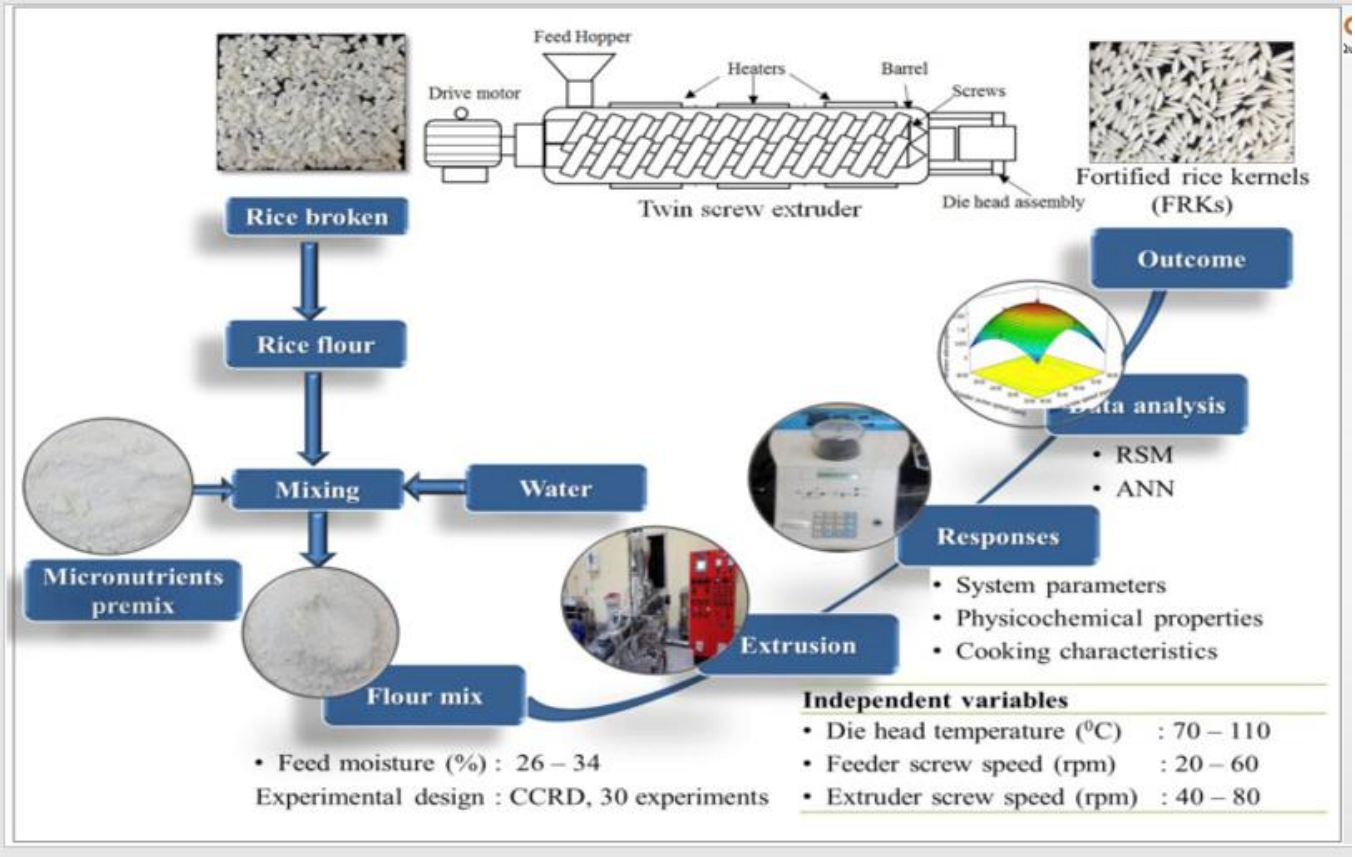
- Various technologies are available for rice fortification, such as coating and dusting.
- For rice fortification in India, 'extrusion' is considered to be the best technology.

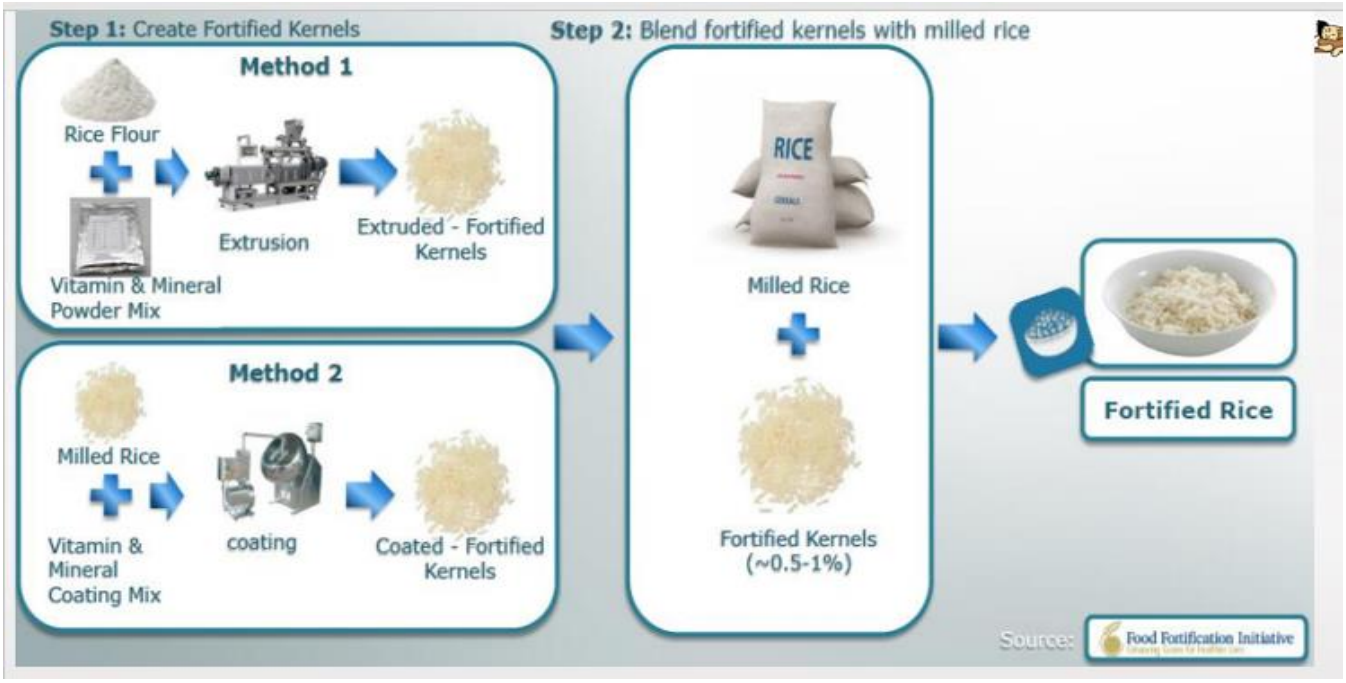
Extrusion technology to produce fortified rice kernels (FRKs)

- In extrusion technology, dry rice flour is mixed with a premix of micronutrients, and water is added to this mixture.
- This mixture then goes into a twin-screw extruder with heating zones, which produces kernels similar in shape and size to rice.
- These kernels are dried, cooled and packaged for use.
- FRK has a shelf life of at least 12 months.

Guidelines

- As per guidelines issued by the Ministry of Consumer Affairs, Food and Public Distribution, the shape and size of the fortified rice kernel should "resemble the normal milled rice as closely as possible".
- The length and breadth of the grain should be 5 mm and 2.2 mm respectively.





What are the standards for fortification?

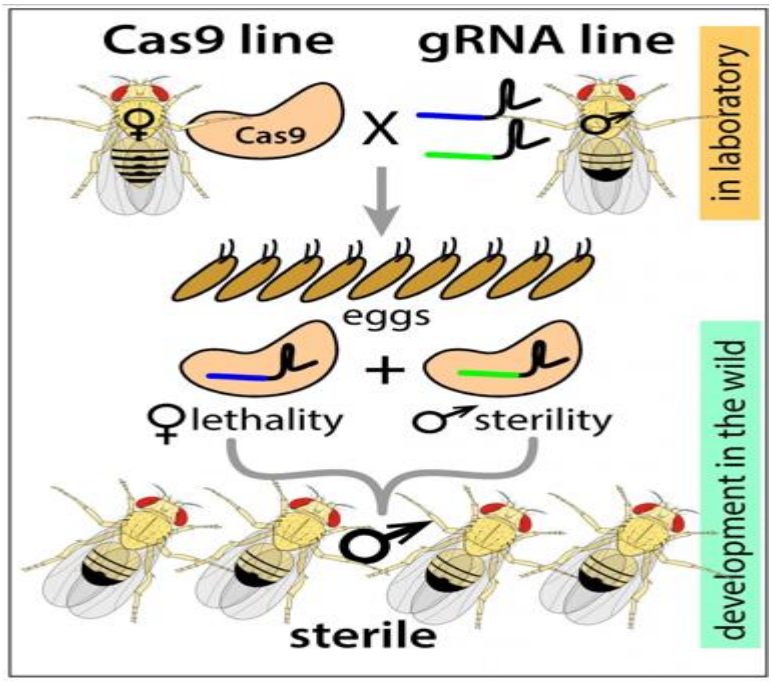
- Under the Ministry's guidelines, 10 g of FRK must be blended with 1 kg of regular rice.
- According to FSSAI norms, 1 kg of fortified rice will contain the following: iron (28 mg-42.5 mg), folic acid (75-125 microgram), and vitamin B-12 (0.75-1.25 microgram). Rice may also be fortified with zinc (10 mg-15 mg), vitamin A (500-750 microgram RE), vitamin B-1 (1 mg-1.5 mg), vitamin B-2 (1.25 mg-1.75 mg), vitamin B-3 (12.5 mg-20 mg) and vitamin B-6 (1.5 mg-2.5 mg) per kg.

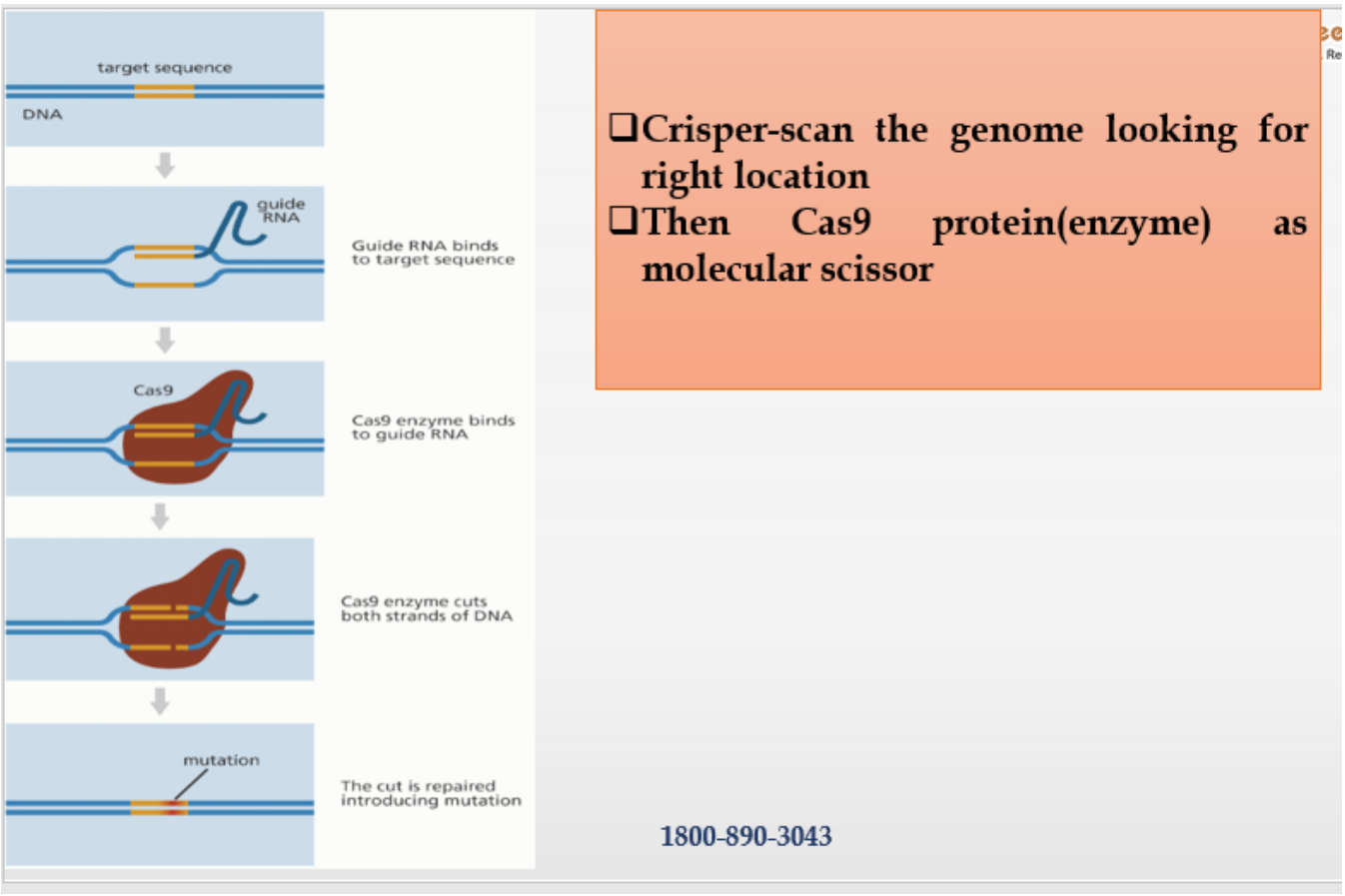
Precision-guided sterile insect technique (IE)

- Scientist created new tech based on CRISPR to control growth of mosquitoes.

About pgSIT

- It 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 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.





Zolgensma Gene Therapy

- The Government of India has decided to waive off some GST amount against the import of gene therapy – Zolgensma. This therapy is required to treat a child who is suffering from Spinal Muscular Atrophy.

Spinal Muscular Atrophy

- Spinal muscular atrophy is a rare genetic disease. The person suffering from this disease cannot control the movement of their muscles.
- It is caused by the loss of nerve cells that carry electrical signals from the brain to the muscles.
- The protein needed for this signaling is coded by a gene. Everyone has two copies of this gene- one from the mother and the other from the father.
- A child develops this disorder only if both the copies are faulty.

Zolgensma Gene therapy

- It replaces the faulty gene. US regulators approved this therapy in May 2019.

- Zolgensma works by supplying a healthy copy of the faulty gene.
- It allows nerve cells to then start producing the needed protein.
- This halts the deterioration of the nerve cells and allows the baby to grow more normally.

GalSafe Pigs

- Recently, the US Food and Drug Administration (FDA) approved a first-of-its-kind Intentional Genomic Alteration (IGA) in a line of domestic pigs referred to as GalSafe pigs.
- This will be the first time that the regulator has approved an animal biotechnology product for both food and biomedical purposes.

Intentional Genomic Alteration (IGA)

- IGA in animals means making specific changes to the genome of the organism using modern molecular technologies that are popularly referred to as genome editing or genetic engineering.

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