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1. FIRST EVER PICTURE OF BLACK HOLE

Context:

- On April 10,2019 the first ever picture of black hole was captured by the **Event Horizon Telescope**. It is considered to be the historical moment for every single astronomer and stay as a breakthrough in the history of astronomy.

Background:

- The picture was captured by the **EVENT HORIZON TELESCOPE (EHT)** a network of eight radio telescopes spread across locations from Antarctica to Spain and Chile.
- It was found by the effort of more than 200 scientists along with the 29-year-old KATIE BOUMAN, PHD student in computer science and artificial intelligence at the Massachusetts Institute of Technology (MIT)
- Black hole was first though studied for so many years this is the first time it was captured into a picture format.
- The concept of Black Hole was first predicted by the Einstein's Relativity theory though he himself have many doubts about their existence.
- Since then Astronomers have tried to gather possible evidence regarding the Black Hole along with the Gravitational waves.
- The EHT has gathered enormous amount of data to give the first direct glimpse of a Black Hole's accretion disc.
- Though they gave the First Picture unable to reveal anything Interior of Black Hole.

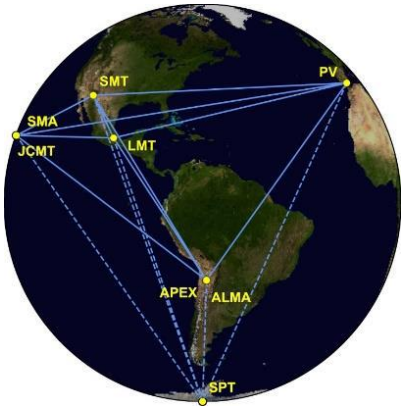
Black hole:

- A black hole is a region of space time exhibiting gravitational acceleration so strong that no particles or even electromagnetic radiation such as light can escape from it.
- The theory of general relativity predicts that a sufficiently compact mass can deform space time to form a black hole.
- In theory of relativity, Einstein predicted the concept of Black Hole.
- The Black Hole is 6500 million times the mass of the Sun.

Einstein's Relativity Theory:

- General relativity generalizes special relativity and supersedes Newton's law of universal gravitation, providing a unified description of gravity as a geometric property of space and time, or space time.

Event Horizon Telescope:



- The Event Horizon Telescope (EHT) is a large telescope array consisting of a global network of radio telescopes.
- The algorithm collated the masses of astronomical data collected by the telescope into single coherent image.
- MIT led the creation of an algorithm that made it possible to capture the image of a supermassive Black Hole at the heart of the Messier 87 galaxy, some 55 million light year from Earth.
- The Event Horizon Telescope project is an international collaboration launched in 2009 after a long period of theoretical and technical developments.
- The EHT projects combines the data from eight radio telescope station around the Earth that could enable to observe objects the size of a supermassive black hole's event horizon.
- The Black Hole is so small and distant the EHT combined all the data from the eight of the world's leading radio observation.
- The important station out of eight are Atacama large Millimetre array(ALMA) in Chile and the South Pole Telescope in Antarctica.
- The objective target of the project is the two Black Hole i.e. the black hole at the center of the supergiant elliptical galaxy Messier 87 (M87), and Sagittarius A* (Sgr A*) at the center of the Milky Way
- The image of the Black Hole is found from the center of the supergiant elliptical galaxy Messier 87 (M87).

MESSIER 87:

- The first direct image of a black hole, which showed the supermassive black hole is at the centre of Messier 87, designated M87*.
- The image tests the Einstein's relativity theory under extreme condition.
- Studies have previously tested general relativity by looking at the motions of stars and gas clouds near the edge of a black hole.
- Relativity predicts a dark shadow-like region, caused by gravitational bending and capture of light, which matches the observed image.
- The observed image is consistent with expectations for the shadow of a spinning KERR black hole as predicted by general relativity.

Challenges Faced by EHT:

- The Black Hole is so small and at a very long distant it possesses which leads to the enormous amount of challenges in observing them.
- The scientist while working to capture the image of Black Hole by combining data from the eight different station, they had to wait for six months for data from South Pole to arrive as it is in the Antarctica.

2. STUDY ON DARK MATTER

Context:

- The study disapproves the theoretical claim of Prof Stephen Hawking as the tiny Black holes may not account for Dark matter.

Background:

- Research team from Inter- University Centre for Astronomy and Astrophysics has ruled out the possibility of Primordial Black Holes that constitute the Dark matter.
- Cosmologist have postulate various hypothesis and theories to explain the Dark Matter.
- Stephen Hawking investigating Primordial Black Holes in 1971 by computing the ranges from as low as one hundredth of a milligram to as high as more than the mass of thousands of Sun.
- Similarly, the theory of Stephen Hawking postulates that Black Holes makeup all of Dark Matter is proved wrong according to the Research.

Dark Matter:

- According to law of gravity the stars rotating near and edge of the galaxy will always complete the revolution in same duration (in most galaxies).
- This is because of some external force acting upon it which give an extra push to complete it rotation quickly.
- The something which is invisible and enveloping the galaxies giving an extra push to the outer stars are known to be DARK MATTER.
- The material is considered to be 'MATTER' since it appears to have gravitational attraction and it is 'DARK' because it does not seem to interact with light.
- The survey of the cosmos indicates that about 85% of the total mass of the universe is composed of Dark matter.

Primordial Black Holes:

- Primordial Black Holes are a hypothetical type of black hole that formed soon after the Big Bang.
- At initial instant of the big bang, the densities would have been very high at many points, resulting in the formation of small Black Holes i.e. named as Primordial Black Holes.

Hypothesis Postulated:

- Some postulate it to be composed of Neutrinos (tiny particles that have no charge but have tiny mass and don't interact with electromagnetic spectrum but are gravitationally interacting).
- Some other postulate that new kind of elementary particles i.e. weakly interacting massive particles (WIMPs) Or gravitationally interacting massive particles (GIMPs).
- Big bang hypothesis talks about the Primordial Black Holes.

About the Research:

- The research team used the Hyper suprime-cam on Japanese Subaru telescope located in Hawaii to look for an evidence of primordial black holes. Research team looking upon the telescope for the Primordial black holes between Earth and Andromeda Galaxy using gravitational technique.

Andromeda Galaxy:

- The nearest major galaxy to the way. It consisting of lakhs of stars and a chance of some primordial black holes. 190 consecutives of Andromeda taken for this research purpose.

Gravitational Lensing:

- A tiny Primordial Black Holes eclipses a distant star, light rays of the star will bend around the black hole due to gravitational effect, resulting in the star appearing to be brighter than it originally is for short while is called as GRAVITATIONAL LENSING.

Result of the Research:

- The result of research disapproves Stephen hawking's theory which implies that black hole makes up all of dark matter. As there is no such evidence of primordial black hole in large numbers available in galaxy. Thus, the previous studies had already ruled out the existence of large numbers of primordial Black Holes that could range in size from the mass of the Moon to about 10 solar masses.

3. NEW HORIZON GOES BEYOND

Context:

- The new horizon reached a milestone by travelling and going beyond where humans have not explored before yet.

Background:

- New horizon, a NASA'S robotic probe reached Neptune, Pluto and its Moons which already put it in the elite position as it is the only organization to visit all the planets of solar system.
- New horizon already entered the Kuiper's belt, able to capture the pictures beyond Pluto and its moon.
- The New Horizon was a part of **New Frontiers program** in which it is engaged to explore the frigid edge of the solar system and engage with Pluto due to faster cooling Pluto.
- The never stopped probe was eager enough to explore further mysteries and visualize the fusion of Ultima and Thule.
- The journey of the probe continued and was able to hunt down space resident at 20 miles' distance from there.

New Horizon:

- New Horizons is an interplanetary space probe that was launched as a part of NASA's New Frontiers program.
- The spacecraft was launched in 2006 with the primary mission to perform a flyby study of the Pluto system in 2015.
- A secondary mission to fly by and study one or more other Kuiper belt objects (KBOs) in 2019 includes 2014 MU69.
- It is the fifth space probe to achieve the escape velocity needed to leave the Solar System.
- On January 15, 2015, the spacecraft began its approach phase to Pluto.
- The mission launched to understand the formation of plutonian system, the Kuiper belt and the transformation of the early solar system.
- The spacecraft collected data on the atmospheres, surfaces, interiors, and environments of Pluto and its moons. It will also study other objects in the Kuiper belt.

The Scientific Instruments of New Horizon:

- **THE NAVIGATOR:** Ensure the craft cruises in spin-stabilized mode during inter planetary travels and also make corrections during flybys.
- **THE COMMANDER:** It comprises of command and Data handling system which processes the signals, collects and sequences the beam.
- **THE PROTECTOR:** Designed to maintain the optimal temperatures.

- **THE FUEL ENGINEER:** Carrying 77 kilos of hydrazine propellant, 16 thrusters spread around 8 locations on the craft with 8 backup thrusters.
- **THE GUIDE:** every sec ten times it takes pictures which analyses with the data to provide guidance from the guidance and controller processer.
- **THE COMMUNICATION EXPERT:** Scientific data and information of its status is exchanged with the NASA's deep space tracking antennae positioned at various location around the globe and communications unit operates accordingly.
- **THE POWER ENGINEER:** System regulate power consumption to maintain a steady output at Radio Isotopic Thermoelectric Generator.

The Kuiper Belt:

- It is the Frigid Zone of Solar System, a Billion Kilometres away from Neptune.
- In 1951, Gerard Kuiper theorized that beyond the chilly Neptune lies a doughnut-shaped region filled with trillions of tiny, icy volatiles such as methane, ammonia and water.
- This region is known as Kuiper's belt and the objects as Kuiper's objects.
- 4-7 billion kilometres spread belt have small space objects traverse in eccentric, ever-changing and unpredictable orbits.
- Pluto which is considered as dwarf planet located in this region
- Beyond Kuiper belt lies Oort cloud, a spherical plane of objects.

New Frontiers Program:

- The New Frontiers program is a series of space exploration missions being conducted by NASA with the purpose of researching several of the Solar System bodies, including the dwarf planet Pluto.
- As part of this program, NEW HORIZON explores the planet Pluto and Charon by reaching it 3 months' prior as planned.
- After reaching Pluto, it started explore the surface of it and found that it has 1/3 of water ice and remaining 2/3 of rocky surface.
- **PLUTO:** it is not considered as the planet because it doesn't fall under definition of planets like Pluto does not revolve around the orbit completely.

ULTIMA and THULE:

- The probe captures visual of two fused, frozen, rocky spheres Ultima and Thule which is 12 and 9 miles away respectively.
- This fusion gives a glimpse of how the solar system have been built four and a half millions of years ago. The ultima Thule is an object from initial stages of the formation of solar system. This could give the real picture of what happened during the birth of the solar system.
- The image as been taken from 27000km by the New Horizon.

4. THE RACE FOR NEW CHEMICAL ELEMENTS

Context:

- In Modernized World Scientist are in a race to synthesis new chemical elements. The efforts are made to synthesis the 8th period and elements from 119 to 124.

Background:

- Modern periodic table is formulated by leaving space for the elements which are not found yet or not been synthesized.

- The scientists are in the process of synthesizing elements with atomic numbers from 119 to 122.
- This process enables to begin the addition of a new period, the 8th in the periodic table and opened the challenge to find the next 14 elements to complete it.
- The elements with atomic number 119 and 120 named as Ununennium (Uue119) and from 121 to 122 named as Unbiunium (Ubu121).

Modern Periodic Table:

- In 1913 Henry Mosely classified the elements replacing the atomic weights by atomic numbers.
- It retained many characteristics of earlier one but there is some changes like giving vacant position which could be gradually filled once it is discovered or synthesized.
- The modern periodic table has 18 groups and can accommodates 118 elements of which from hydrogen to uranium(U92) is formed naturally.
- From Neptunium(N93) till Oganesson (O118) it is being man-made elements which led to the 7th period of the periodic table.

Future Thirst:

- The process for acquiring new chemical elements are still continuing and scientist are in the thirst of finding many new man-made elements
- The findings could lead to the addition of new period to the modern periodic table i.e. 8th period with 14 more new elements to complete the period.
- As of now elements from 119 to 122 have been drafting and possibly in future the 8th period could be completed.

Synthesizing Process:

- The super heavy elements are synthesized by Nuclear fusion- hot and cold
- **HOT Fusion:** very light, high energy projectiles are accelerated towards very heavy targets (like the actinides) giving rise to compound nuclei at higher excitation energy (40 to 50 Me V) that may undergo fission and evaporate (3 to 5) neurons.

- **COLD Fusion:** 4th period elements fuse with the lighter like Leads or Bismuth. It gives low excitation energy (10 to 20 MeV).

Elements to be Synthesised:

- The elements with atomic number 119 and 120 named as Ununennium (Uue119).
- **ELEMENT 119:** Researchers at joint institute for nuclear research in Dubna, Russia is planning to begin to experiment targeting of Berkelium-249(BK249).
- **ELEMENT 120:** Researchers at GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, Germany planned to begin new experiments with a mixture of Isotopes Californium-249(CF249) and Californium-251(CF251) targeting those with titanium-50(Ti50) by 2050.
- The elements with atomic number from 121 to 122 named as Unbiunium (Ubu121).
- **ELEMENT 121:** The research team at RIKEN, Japan has already planned to attempt its synthesis by 2020 or 2021.
- **ELEMENT 122:** There is no plan yet to synthesis the element 122, which has been provisionally named as Unbibium (UBB122).

5. ANDROGENESIS: POSSIBLE WAY IN PHARMACEUTICAL INDUSTRIES

Context:

- Androgenesis technique will enhance the growth of Pharmaceutical industries.

Background:

- The researchers are planning to enhance the **plant tissue culture** for agronomic performance.
- As there is a great demand for disease free plants for various need such as ornamental, horticulture, floricultural and agroforestry sector.
- **Androgenesis technique** has been taken in hands for the improvement of the growth of plants.

Challenges Faced by Shortage of Plants:

- Pharmaceutical companies are facing tough time in procuring medical plant materials as several medicinal plants are in short supply.
- Most of the Asian and African countries are still depending on the primary health care necessities.
- International tariff in medicinal plants and herbal product may also increase tremendously if the **shortage continues.**

Plant Tissue Culture:

- Plant tissue culture is a collection of techniques used to maintain or grow plant cells, tissues or organs under sterile conditions on a nutrient culture medium of known composition.
- Plant tissue culture is widely used to produce clones of a plant in a method known as micro propagation.
- Preparation of plant tissue for tissue culture is performed under aseptic conditions under HEPA filtered air provided by a laminar flow cabinet.

Androgenesis Technique:

- This is a technique by which immature pollen is made to divide and grow into tissue (either callus or embryonic tissue), primarily to produce haploids (plants with an N chromosome number) known to be Anther culture.
- Haploid production through anther culture has been referred to as **Androgenesis**.
- **Haploid production** through anther/microspore culture scores higher over other methods due to the fact that anthers harbour large numbers of haploid microspores per anther and is a potentially efficient means to generate.

Conclusion:

- The Androgenesis technique is the wise way to tackle the demand and supply of pharmaceutical products based on plants. If the supply and demand are met the economical and health sector of the country could be able to survive out of danger.

6. PERIODIC TABLE AND HENRY MOSELEY

Context:

- The united nation proclaimed 2019 as the International year of the periodic table. So the relationship of periodic table and Henry Moseley who provided a scientifically rigorous classification scheme.

Background:

- Earlier times chemist is confusion in aligning the elements in Mendeleev's table.
- Chemists discovered that the existence of chemical isotopes with respect to atomic weight is not the Optimal criterion for ordering the periodic table.
- Henry Moseley provided a scientifically rigorous classification scheme.

About Henry Moseley:

- Henry Moseley was an English physicist, whose contribution to the science of physics was the justification from physical laws of the previous empirical and chemical concept of the atomic number.

Scientific work in Formulating Periodic Table:

- Laue observed X-rays spectrum which is invisible to the human eye.
- In 1913, Moseley observed and measured the X-ray spectra of various chemical elements (mostly metals) that were found by the method of diffraction through crystals.
- Rutherford had profounded a major theory of the nucleus of an atom. And Moseley experiments helped in proving it.
- The force of repulsion between its positively charges proton and surface tension could separate it. Both the forces of repulsion increase more rapidly over surface tension when numbers of protons reach about 100. Thus, the periodic table does not go beyond 100.
- Moseley had examined the X-ray spectra of thirty-eight different elements from Aluminum to gold. This experiment resulted in finding that X-ray spectra with heavier element is shorter and more penetrating.
- Moseley discovered a systematic mathematical relationship between the wavelengths of the X-rays produced and the atomic numbers of the metals that were used as the targets in X-ray tubes. This has become known as Moseley's law.
- Also found more fundamental property than atomic weight i.e. is termed as Atomic number or Moseley number.

Conclusion:

- Moseley's work was on comparable level and the experiments are certainly in support of Rutherfors model of atom.
- Earlier the atomic number is not accepted by the scientific community but Moseley paved way for the great change in the world of elements.