

Our Earth is the home of man. All activities of human life are carried out on the Earth's surface. After death the human body also becomes one with the Earth's soil. That is the reason why man is called the Earth's child. The entire history of human civilization is related to mother Earth. Man has been continuously thinking about the Earth's origin and its various spheres right since his existence on the Earth. Although science has progressed in various fields, a question still remains controversial- how did the Earth originate ? Mysteries of the Universe have remained unsolved even today.

Right from our childhood we were curious to know why stars twinkle in the sky ? How many stars are there ? Why did God create stars ? When a person dies does he get a place among the stars ? On what does the Earth rest in space ? What is hidden in its interior ? Can we go to the far side of space ? Is there life anywhere else in the world ? To have answers to these questions let us make a purposeful study of this chapter.

Ancient Views about the Earth's Origin

Beliefs and assumptions regarding the Earth's origin can be seen in various religious scriptures. In ancient times people of many countries imagined Earth to be elliptical in shape. According to ancient views, Hindus maintained that Lord Brahma remained in penance for several ages and created a gold egg. In Croatia, the Earth is believed to be an egg created by the Sun God. In Scandinavian countries (Sweden, Finland and Norway) the Earth is imagined having a shield shape. This shield like Earth rests on a tree. Root of the tree is patal and the upper crown is paradise. According to Hindu mythology, there is a great tortoise. There are four big elephants on the back of tortoise and the Earth rests on their back. There is abode of Sun (suryalok) high above the Earth.

Some people believed that the Earth rests on a huge, strong back of a demon. Till the demon is asleep, everything is normal, but when he wakes up and moves, there will be earthquakes. Some people believed that the Earth is balanced on three big Whales. Also, people of ancient times believed that there is some complex and intellectual machine hidden beyond the skies. Perhaps it resembles a clock. In it wheels with giant teeth of the size of mountains go around slowly and hence the sky along with stars move around the Earth.

Our ancestors believed that the Earth rests on the head of Sheshnag, and when it shakes its head the Earth shakes. Also, some people believed that the Sun goes around the Earth, resulting in day and night. Such were our ancient beliefs.

It is believed that when the Earth originated some 4.5 billion years ago it was in the form of intensely hot ball of gases. As time passed, its outer surface cooled and solidified to form an outer solid crust. Our Earth is the only member of the solar system on which life exists. The Earth's origin is related to the origin of the solar system. Several hypothesis, beliefs and theories have been presented regarding birth of the Earth. There are various theories about the Earth's origin : nebular, planetesimal, tidal, unitary star, binary star theory, nebular cloud theory, super nova burst, etc. Every theory has remained controversial in absence of necessary support or evidence.

Theories about the Earth's Origin

Scientists and philosophers have presented several hypothesis about the Earth's origin. They can be placed into three categories :

(1) Monistic Hypothesis : According to this hypothesis, the Earth is believed to have originated from a single star. It is also known as one parent hypothesis.

(2) Binary Star or Dualistic hypothesis : According to this hypothesis, the Earth is believed to have originated from a collision between two stars.

(3) Theory based on gaseous and dust clouds : According to this theory, the solar system originated from ancient matter like gas and dust.

(1) Monistic Hypothesis :

(1) Gaseous hypothesis : The German philosopher **Immanuel Kant** presented this hypothesis in 1755. In his opinion there was a cold and motionless gaseous cloud in space. The particles of this gaseous cloud began to collide against each other under their mutual gravitational attractions. In due course it started spinning around its axis and became a vast hot nebula.

(2) Nebular Hypothesis : In 1796, French astronomer and mathematician **Laplace** presented a modified version to the gaseous hypothesis of Kant. According to him, Sun and planets were formed from primordial gaseous matter.

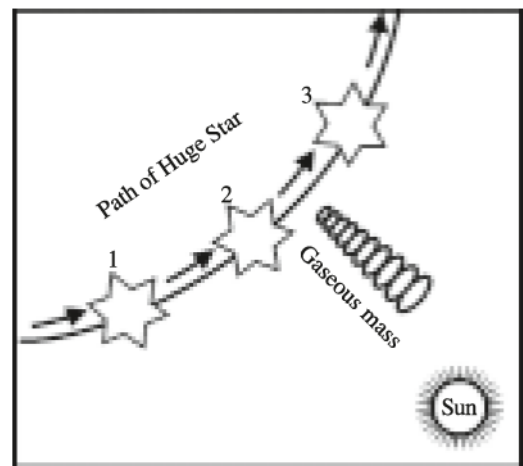
(2) Binary Star or Dualistic hypothesis :

Planetsimal Hypothesis : Two American scientists **T. C. Chamberlain** and **Forest Ray Moulton** presented the planetsimal hypothesis in 1900. In their opinion, a randomly moving star passed nearby the Sun. Under the gravitational force of this star some matter got separated from the Sun's surface and got dispersed in the universe. These separated parts formed into planets and started revolving round the Sun. The hypothesis was later on supported by Sir James Jeans and Sir Harold Jeffery.

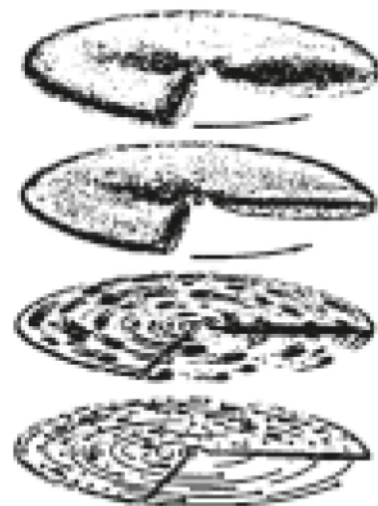
Planetsimal hypothesis is presented in Fig 2.1

(3) Hypothesis based on Gaseous and Dust Clouds :

(1) Inter stellar Dust Hypothesis : Russian thinker **Otto Schmidt** in 1943 presented his Inter Steller Dust Hypothesis regarding origin of the solar system. In his opinion, the primitive Sun already existed in the universe. About 600 crore years before present, the planet forming matter existed in atomic form. As time passed, hydrogen and helium gases and dust clouds were formed from these atoms. The dust particles and gaseous clouds were attracted towards each other due to the Sun's attraction. The dust and gaseous clouds started revolving around the Sun in the form of a flat disc. Later on planets were formed from dust and gaseous clouds. As indicated in fig. 2.2, dust particles combined to form planets and satellites respectively.



2.1 Hypothesis of Chamberlain and Moulton



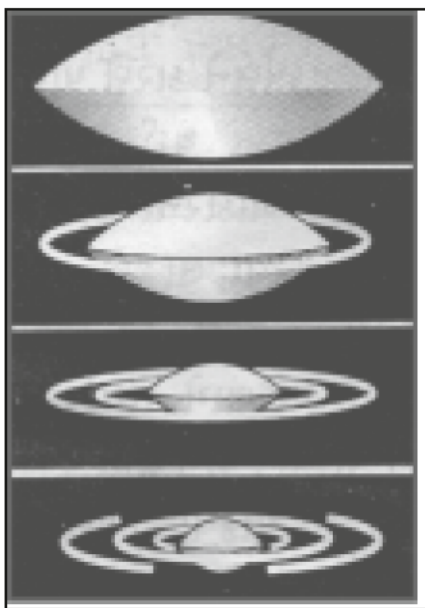
2.2 Formation of planetsimals, planets, satellites from consolidation of particles

(2) Nebular Hypothesis : In the opinion of **Carl Von Weizsacker**, the Sun entered in a gaseous and dust cloud. Because of the Sun's attraction, some part of the gaseous and dust clouds began to revolve round the Sun, and the remaining part escaped into space. Dust particles condensed into each other like a necklace of pearls. With the passage of time, big pearls became planets while smaller ones formed satellites. It took almost 10 crore years in the formation of such planets and satellites.

Recent Theories about the Earth's Origin

Among the several hypothesis about the Earth's origin, two have been widely recognized (1) Nebular Hypothesis and (2) Tidal Hypothesis. Let us have an idea about them in detail.

(1) Nebular Hypothesis : The German Philosopher, Immanuel Kant presented this hypothesis in 1755. In his opinion, billions of years before there existed a cool and motionless gaseous cloud in space. Because of gravitational force the gas particles in the gaseous cloud were mutually attracted this produced



2.3 Nebular Hypothesis

great friction and this gaseous cloud got heated and got converted into a nebula revolving around its imaginary axis. The gaseous clouds seen between the group of stars in space is known as nebula. In 1796, French mathematician Laplace suggested some modifications. He assumed that there was a hot and huge nebula rotating on its axis. From the outer surface of the nebula, heat was continuously lost. This resulted in a continuous decrease in its heat. It cooled gradually and so parts of its surface contracted and became dense. As the size of the nebula gradually decreased, it increased the rotatory motion of the nebula. So its centrifugal force increased compared to the centripetal force. Because of this centrifugal force, one by one gaseous masses got released from the nebula's surface in the form of rings. This mass of gaseous material began to revolve round the nebula under its own gravitation. As this gaseous material got coalesced and collected, the ring-shaped gaseous material took

the shape of a sphere, which we know as planets. Before the solidification of planets, the entire process was repeated to form satellites from some planets. The remaining part of the nebula became known as the Sun. In this way the solar system originated crores of years before.

(2) Tidal Hypothesis : Tides are formed in sea water because of the gravitational force of the moon and the sun. Keeping in view these tides, British geographers, Sir James Jeans and Jeffreys presented the Tidal Hypothesis about the origin of the solar system in 1919.

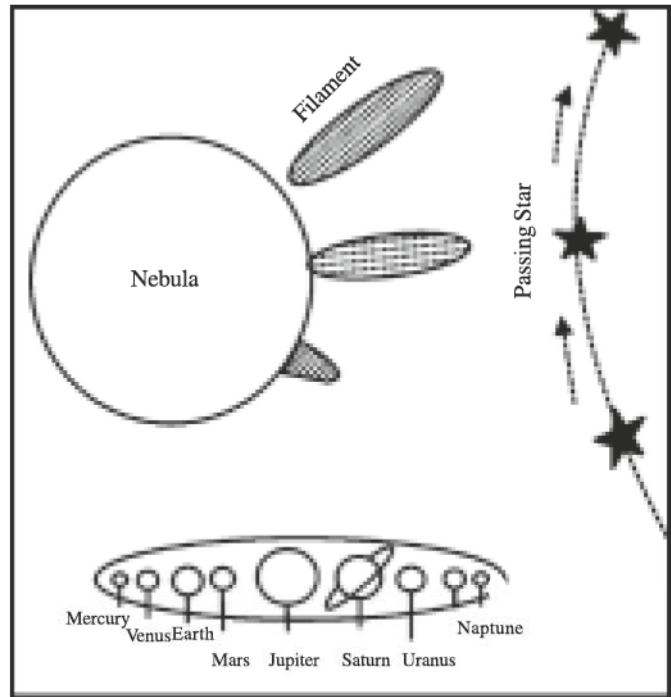
According to this Hypothesis, a moving star happened to pass nearby the primitive Sun with huge gaseous mass.

This moving star was several times bigger than our Sun. Hence its gravitational force was also much higher. Under the gravitational force of this roaming star, a gaseous tide was formed on the Sun's

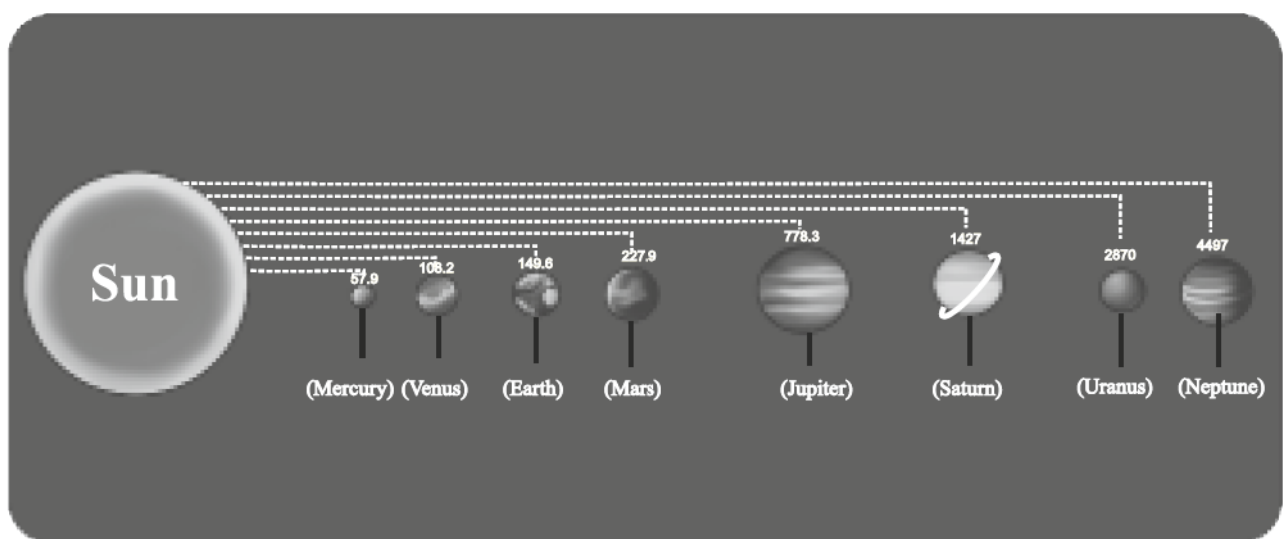
surface. As the roaming star approached closer and closer to the Sun, the tide also rose higher and higher. The cigar or cheroot shaped gaseous mass was attracted towards the roaming star and eventually got separated from the Sun. As the roaming star went farther away from the Sun, its gravitational force declined. The fragment or filament that separated from the Sun, attained axial rotation and revolution-motion because of the Sun's gravitation. The cigar shaped mass condensed with time. It fragmented because of contraction. Planets were formed from it. The same process was repeated between the Sun and planets to form satellites. Our solar system originated according to this hypothesis. This tidal hypothesis gave solution to many questions such

as origin of planets including the Earth, satellites, their sequence and size from the Sun, inclination of axis, number of satellites, etc. This concept became popular and widely accepted. Our solar system is formed from the same tidal process of gaseous materials.

The Solar System : It is a system of planets, satellites, planetoids, meteors, comets, etc., at the centre of which is the Sun. In the solar family, there are eight planets, more than 173 satellites, about more than 45,000 planetoids, comets, meteors, etc., collectively known as the solar family or the solar system.



2.4 Tidal Hypothesis



2.5 Our Solar System

Our Sun is an average sized star, which shines on its own and also provides light to all its members. The Sun's diameter is 13,92,000 km, which is about 109 times the Earth's diameter. Its gravitation force is 28 times that of the Earth. It is a very hot gaseous mass. Its surface temperature is about 6000⁰ C. and the temperature of its centre is about 1.5 crore degrees Celsius. The pressure and temperature at the Sun's centre is many times higher than that at the Earth's centre. Hence in the nuclear process occurring here, the hydrogen nuclei are fused into helium. Tremendous light and heat energy are released during the process. The energy released from the Sun per second is equivalent to the energy produced by burning of about 12,000 billion tons of coal. This energy is emitted into space in the form of radiation.

The black spots seen on the Sun's surface (Photosphere) are known as Sun spots. They are rift valleys on the Sun's surface, through which the Sun's inner heat comes out. When Sun spots increase in number, we experience more heat. The bright layer surrounding the Sun upto 400 km is known as the **Photosphere**. Presently the Sun is in a stage of full development. It is estimated that the Sun will cease to exist after some five billion years.

Sun is our main source of energy. Sun gives essential energy to the Earth. This is highly essential for the origin and evolution of life.

The heavenly bodies with a characteristic shape and appearance and that go round the Sun in an elliptical orbit are known as comets. When seen from the Earth the comets appear to have a bright tail, hence are known as tailed stars. Halley's comet is the most well known. It was last seen in 1986 and would be seen again in 2062. In ancient times, it was believed that appearance of comets will cause war, epidemic, disastrous events like flood, but its appearance is just a normal astronomical event. Shooting stars or meteors seen at night are also members of the solar system. When we observe the clear but dark sky, a long belt of milky colour can be seen stretching from north to south, which is known as the Milky-Way. There is a huge number of star clusters in the **Milky Way**.

Planets :

Our solar system has a total of 8 planets. Mercury, Venus, Earth and Mars are known as **Terrestrial planets**. Jupiter, Saturn, Uranus and Neptune are known as **Jovian planets**. We have obtained information about these planets in earlier standards.

Planets of the Solar Family

Planet	Mean distance from Sun (lac km)	Revolution Time	Rotation Time	Diameter (in km)	Number of satellites	Characteristics	Other
1. Mercury	579	88 days	59 days	4878	0	Mt., valleys, volcanoes on planets surface	Smallest in size but nearest to Sun
2. Venus	1082	225 days	243 days	12,100	0	Venus means Goddess of love and beauty	Brightest, revolves west to east
3. Earth	1496	365.25 days	24 hours	12,756	01	Located between venus and mars	Life Orange coloured, small, cold, dry planet
4. Mars	2280	687 days	24.6 hours	6787	02	Terraforming by NASA	Biggest in size, fastest to rotate
5. Jupiter	7783	11.86 years	9.9 hours	1,42,800	67	Planets composition resembles Sun	3 rings, Titan and Thimal are satellites
6. Saturn	14,270	29.46 years	10.7 hours	1,20,600	62	Size 700 times that of Earth	Discovered by William Harshall in 1781
7. Uranus	28,700	84.9 years	17 hours	51,118	27	Indian Scientist Dr. J C Bhattacharya discovered its 6 th satellite.	Green coloured, Titon, Nerid imp. satellites
8. Neptune	44970	165.9 years	18 hours	49,500	14	Discovered in 1846	

(**Note** : Before 2006, Pluto was considered a planet. As per decision in International Astronomical Union,

Pluto is not included among planets.)

Earth

Earth, the mans habitat is also a planet. The thickness of atmospheric layer around it is about 800 to 1000 km. It is at a distance of about 15 crore km from the Sun, located between the planets Venus and Mars and dependent on Sun for its light. It is an orange like sphere. Its polar diameter is 12,714 km and equatorial diameter is 12, 756 km. It takes 365.25 days to revolve round the Sun. The Earth rotates round

its axis once in 24 hours, from west to east. Its axis is inclined at an angle of 66.5 degrees with respect to its plane of revolution. The Earth's atmosphere is mainly composed of nitrogen and oxygen with carbon dioxide, hydrogen, ozone in trace amounts. The Earth's atmosphere protects us from meteors. The layer of ozone gas protects life by absorbing ultra violet radiation coming from the Sun. Moon is the Earth's only natural satellite where there is no life. The Moon's diameter is 3475 km and it is at a distance of about 3,85,000 km from the Earth. The moon rotates round its axis and also revolves round the Earth. Its rotation and revolution time is 29.5 days. Neil Armstrong became the first astronaut to land on the moon on 20th July, 1969. Its rocks are mainly igneous. Moon's gravity is almost 1/6th of the Earth. So everything weighs lighter on the moon. There are extinct volcanoes on it.

Big Bang and its various stages

In the 20th century, scientists have tried to solve the mystery related to the Universe, over and above that of the Earth and other planets. Presently, the Big Bang theory about origin of the Universe is considered more modern. It is a theory known as the theory of expanding Universe. It is an expansionism theory. The Belgian scientist **George Lemaître** gave the Big Bang theory. In 1920, an astronomer named **Edwin Hubble** declared that the Universe is expanding. The galaxies are continuously receding away from each other with time. According to Big Bang theory, various stages related to expansion of the Universe are as follows :

- The matter from which the Earth originated was initially in the form of a small sphere. They were also stationary at a place. This primordial matter was extremely minute and its temperature and density extremely high.
- With a bang in this small sphere, particles of primordial matter contained in it got dispersed into space.
- Big Bang took place some 13.7 billion years back. After the Bang, particles of the primordial matter dispersed into space in time little more than a second. Expansion of Universe is still continuing but its speed has decreased.
- The first atom was formed just after about three minutes.
- After the Big Bang, temperature fell to about 4500 degree Kelvin in about three lakh years and molecules of matter may have formed.

Evolution of Earth

In the past, the Earth was not in the same form as it is today. The Earth's present form has been attained through several ages of gradual evolution. The Earth was in the form of an extremely heated gaseous sphere at the time of its origin. The Earth's atmosphere was composed of hydrogen and helium. But today it is a lively planet with water and beautiful forms of life. Several phenomena and processes were responsible for such a change in the Earth's form. Water is distributed on about 71% of the Earth's surface. So it is called a **watery planet**. The layer of air surrounding the Earth is called the **atmosphere**, and the huge watertmass is known as the **hydrosphere**. Oxygen and nitrogen in the atmosphere give life to all living world. The solid layer of the Earth's surface made of soil or rock layers is known as **lithosphere**. Lithosphere forms the crust. Various forms of life exist in the atmosphere, hydrosphere and lithosphere. The layer comprising of all living forms is known as the **biosphere**.

Lithosphere

The average thickness of the lithosphere is about 33 km. As we go from the solid surface towards the Earth's centre temperature rises by 1°C for every increase in depth of 32 m. Near the Earth's surface there is a thin layer of sedimentary rocks. It has two sub layers : (1) Crust (Sial) and (2) Magma (Sima) - Sial is made of granite while sima is made of basalt rocks. Below the lithosphere and upto a depth of 2880 km there is mantle layer. It is also known as magma. Below the mantle upto the Earth's centre is the core. It is also known as the central metallic core. Its diameter is 6020 km. In this layer the mineral matter is mainly of Nickel and ferrous, it is known as Nife. The Earth's gravity or magnetic force is due to this metallic core. Because of the Earth movements and interactions taking place in the interior, various landforms are formed, such as continents, oceans, mountains, plateaus, rift valleys, coastal plains, etc.

Origin and evolution of Atmosphere and Hydrosphere :

First Stage : In the Earth's primitive atmosphere, there was an abundance of hydrogen and helium gases. Solar winds removed the primitive gases from the Earth. This was the first stage in the evolution of the atmosphere.

Second Stage : The Earth cooled gradually. As a result, gases and water vapour began to escape from its interior. In this stage, there was more of water vapour, nitrogen, carbon dioxide, methane and ammonia gases in the atmosphere. Amount of water vapour and gases in the atmosphere continued to increase due to volcanic eruptions.

Third Stage : In this stage, condensation of water vapour became possible as the Earth cooled. Precipitation occurred. The atmospheric carbon dioxide mixed with precipitation and this decreased the Earth's temperature, and resulted in heavy rainfall. This rain water collected in deep and wide depressions of the Earth's surface and formed seas and oceans. Oceans were formed about 50 crore years after the Earth's origin. Evolution of life began crores of years afterwards. Process of photosynthesis developed 250 to 500 crore years before present. For a long time life remained confined only to oceans. Oxygen increased in the atmosphere due to photosynthesis. Oceans gradually became saturated with oxygen. Amount of oxygen in the atmosphere became sufficient about 200 crore years back.

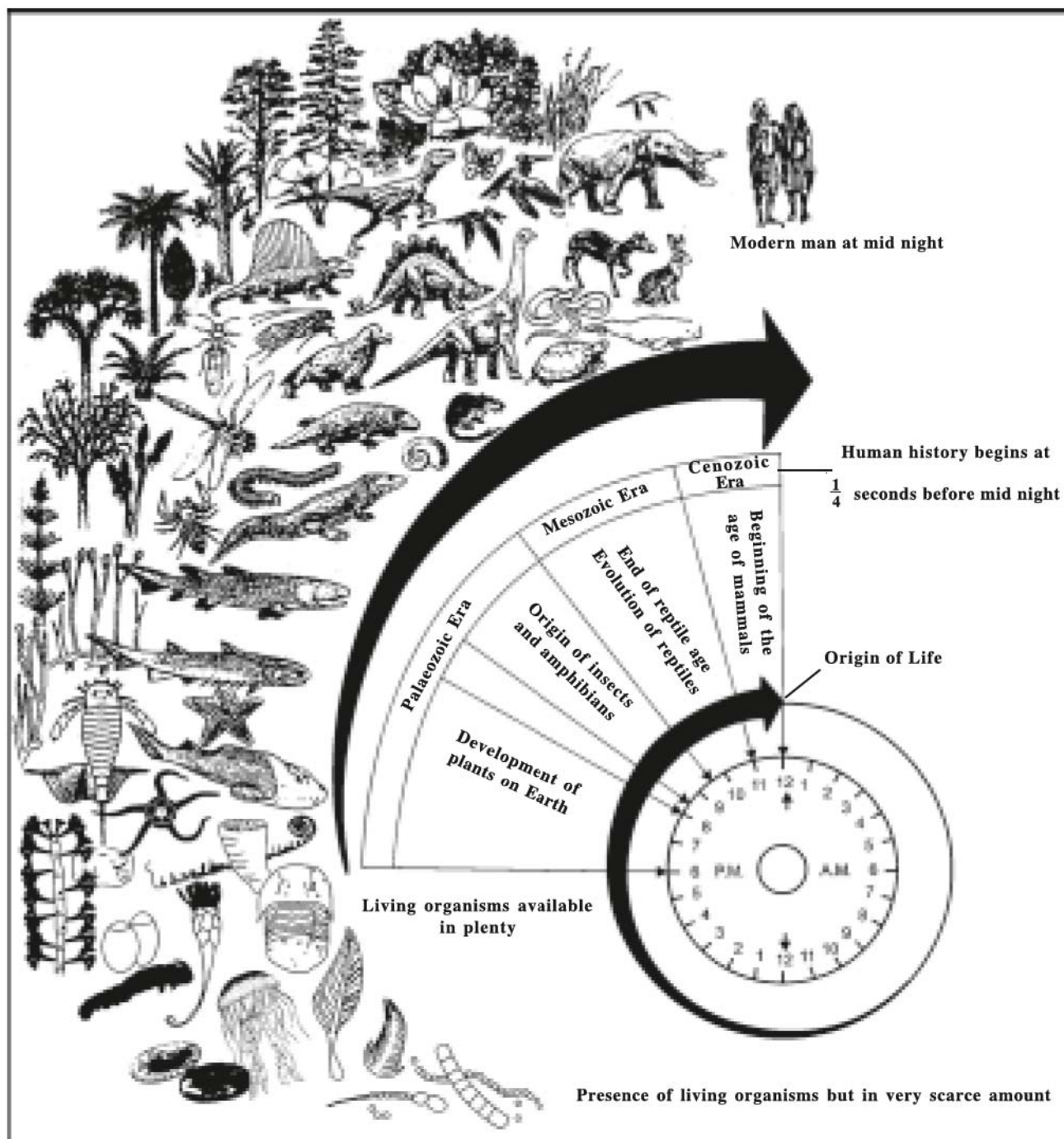
Origination of Life

Initially the Earth's atmosphere was not suitable for origin and evolution of life. Hence life originated in the last stage of Earth's evolution. Modern scientists believe origin of life to be a chemical phenomenon. It all began with origin of a complex bio molecule. Life originated from such group of molecules.

Life began some 3.8 billion years back, in the form of microscopic organisms in oceanic waters. Life in the beginning was unicellular and was known as amoeba. These microorganisms were like boneless soft mass. With the passage of time, organisms with soft bodies without vertebral column and jaws such as crabs evolved.

Evolution of the plant life also took crores of years. In the beginning, algae developed in oceans, later on followed by terrestrial plants like grass, small plants, flowering plants, climbers and trees.

Later on vertebrates evolved. With time physical changes in the body led to evolution of huge birds and giant sized dinosaurs. As conditions on land became favourable, mammals came into existence. Such animals directly gave birth to their young ones instead of laying eggs. They also took care of their young ones. Apes evolved some four crore years back. With time, animals with developed brain such as chimpanzee, gorilla and baboons developed. Developed apes show some characters resembling humans, hence scholars also call them ape-man.



2.6 Evolution of Life on a 24 Hour Scale

EXERCISE

1. Answer the following questions in detail :

- (1) Discuss the Tidal Hypothesis explaining the Earth's origin.
- (2) Explain Nebular Theory
- (3) Describe the Earth's interior.
- (4) What is the Solar System ? Discuss Earth as a member of the Solar System.
- (5) Describe the Big Bang Theory.
- (6) How did the atmosphere and hydrosphere develop ? Write in detail.

2. Write to-the-point answer of the following questions :

- (1) Write short note on Monistic Hypothesis.
- (2) Write about the solar system.
- (3) Write about the Binary Star Hypothesis.
- (4) Write about the Sun

3. Answer the following questions in brief :

- (1) What is a comet ?
- (2) What is the Milky Way ?
- (3) Which are terrestrial planets ?
- (4) Which are the Jovian planets ?
- (5) What is Terrafarming ?
- (6) Which theories explain the Earth's origin ?

4. Answer the following questions in one-two sentences :

- (1) Which is the brightest and beautiful planet ?
- (2) Triton is a satellite of which planet ?
- (3) Who presented the Nebular hypothesis ?
- (4) What are sun spots ?
- (5) What is a nebula ?
- (6) Who gave the Nebular hypothesis ?
- (7) Who gave the Inter Stellar Dust Cloud hypothesis ?

5. Select the correct option from the options given and write the answer :

- (1) Which is the brightest planet ?
(a) Mercury (b) Venus (c) Saturn (d) Mars
- (2) What is the total number of satellites of solar system ?
(a) 173 (b) 141 (c) 09 (d) 136
- (3) Which of the following is a name of Saturn's satellite ?
(a) Titan (b) Moon (c) Aron (d) Triton
- (4) Who gave the theory of Big Bang ?
(a) Lemaître (b) Hubble (c) Otto Schmidt (d) Laplace
- (5) Who presented the theory of Nebular Cloud ?
(a) Kant (b) Weizsacker (c) Moulton (d) Chamberlain

