Lesson - 2

Earth as a Planet

Earth is the third planet from the sun in our solar system, geographically and geologically it is the only planet where the melody of life could be heard than other planets. In such a vast universe its not possible that the life do not exist other than earth. But the present day facts and evidence indicates life to be present only on earth. Life is present on the earth because of its definite distance from the sun and ideal solar radiation received. This type of stage is called Goldilocks zone. In which with an appropriate distance from the sun, water is available in liquid form as that on earth. Scientist are constantly working to discover more planets similar to earth and some planets have already been discovered where earth like environment may be possible and human species may become- "**multi-planet**" species. That day will serve as revolutionary era for earth and humanity.

Origin of the Earth

Many philosophers and scientists have propounded many hypothesis regarding the origin of the earth. One of the most early and most famous hypothesis is of Immanuel Kant. In 1769 Laplace a mathematician, modified this hypothesis as "Nebular Hypothesis". According to this hypothesis the origin of the solar system is from the cloud of primordial matter which was revolving slowly around the sun, Later in 19th century Chamberlain and Moulton postulated that another star passed near to the sun. This resulted in detaching of some matter from the sun due to gravitational force applied by the other star. As the star moved farther, the detached matter starting revolving round the sun and this material with the passage of time formed of planets. Firstly, Sir James Jeans and Sir Harold Jeffrey supported this hypothesis. Although some arguments were in favour of companion star of sun. These arguments are called 'Binary Theories'. In Russia, in 1950 Otto Schmidt and Carl Weizsacker of Germany presented a modified version of Nebular Hypothesis. According to them, the sun was surrounded by a nebula which was primarily made up of hydrogen helium and dust particles. These dust particles in the Nebula were undergoing friction and collision which resulted into formation of flat disc of cloud which started revolving a round the sun and accretion process formed planets. After this the scientist around world not only tried to solve the mysteries of earth and other planets, thus made an attempt to solve the problems regarding the origin of the universe.

Origin of Universe :

In reference to the origin of universe 'Big Bang Theory' is most widely accepted. Its also called 'Expanding Universe Hypothesis'. In 1929 Edwin Hubble proved that our universe is expanding.

Galaxies are moving apart from one another. You can experiment, to understand this concept of expansion. Take a balloon and mark some points on it as galaxies. When you will blow up the balloon, you will observe the points marked on the balloon are also moving apart. Similarly galaxies are moving further away from one another, resulting in expansion of universe. You will also observe that not only the distances between the points are

increasing but points are also growing in size but this is not a factual reality.

Scientists believe that galaxies are constantly moving apart from one another but observations do not prove this. Therefore the example of a blowing balloon is correct only to some extent. According to Big Bang theory the expansion of universe is in following stages -

(i) In the beginning, all the substances and the material which formed the universe, were present in form of singular atmosphere its volume was extremely subtle and the temperature and density was infinite.

(ii) Due to Big Bang, there was a massive explosion. This caused extensive expansion. Scientists believed that origin of universe occured about 14 billion years ago. Universe is still expanding. Some energy is transformed into matter because of expansion. The universe expanded extensively in micro second after the bang. Later the speed of expansion reduced. Atom was formed in the first three minutes of Big Bang.

(iii) After the Big Bang during the 3,00,000 years temperatures drastically decreased and atomic formation occured. Universe then became transparent.

The expansion of Universe means constantly increasing distances between galaxies. Hoyle has named it as 'Steady State Concept'.

According to this hypothesis Universe never remained in a static position. Although with numerous theories about expansion of universe, many scientists support the expansion theory.

Formation of Star

Initially the distribution of energy and matter was not equal in universe. As there was differences in density, the gravitational forces also acted differently which resulted in accumulation of matter. This formed the basis of formation of galaxies. There are millions of stars is a single galaxy. The extension of galaxies are so vast that it's measured in thousands of light years. The diameter of a single galaxy is thousand to one lakh 50 thousand light years. The formation of a galaxy is thought to be from accumulation of huge cloud which is called Nebula, growing Nebula developed clusters of gases respectively. These clusters kept on getting bigger and formed dense gaseous bodies which led to the formation of stars. It is believed that stars were formed about 5 to 6 billion years ago.

Light year is not a unit of time but of distance. The speed of light is 3,00,000 kms per second. In one year, light will travel 9.5 million kms. This is called light year. The average distance between earth and sun is 14 crore 98 thousand kms. In reference to light-year, this distance is covered in 8 minutes.

Formation of Planets

The planets were formed in the following stages :

(i) Stars are clouds of intertwined clusters of gases in a Nebula. The gravitational force of these intertwined clusters of gases formed the core. The clouds of gases and dust particles started revolving a round core and a rotating disc was formed.

(ii) Condensation of gaseous clouds began in the next stage and congruence of accumulated material which was in the form of balls developed 'Planetesimals'. Process of Collision resulted in formation of huge bodies and they combined together under the impact of gravitational force. Smaller bodies in larger number is Planetesimal.

(iii) In the last stage as these smaller planetesimal augmented some huge bodies were formed as planets.

Solar System

There are 8 planets in our solar system. Nebulas are considered as a source of origin of entire universe, its collapse and formation of core began 5 to 5.6 million years ago and the planets were formed about 4.6 to 4.56 million years ago.

In 8 planets, Mercury, Venus, Earth and Mars are called Inner Planets as they are situated between sun and asteroid belt. Other four planets are called Outer planets . The first four planets are also called Terrestrial planets. It means that alike earth these planets are formed of rocks and minerals are

Table 2.1 - Solar System								
Planet	**Mercury**	**Venus**	**Earth**	**Mars**	**Jupiter**	**Saturn**	**Uranus**	**Neptune**
Distance*	0.387	0.723	1.000	1.524	5.203	9.539	19.182	30.058
Density@	5.44	5.245	5.517	3.945	1.33	0.70	1.17	1.66
Diameter#	0.383	0.949	1.000	0.533	11.19	9.460	4.11	3.88
Satellite	0	0	1	2	67	62	27	14

* The distance from the sun is in the form of celestial unit. Therefore if the mean distance of earth is 14 crore, 95 lakh. 98 thousand kms it is one celestial unit.
@ density gram per cubic centimeter (gm/cm)
# diameter = If equatorial diameter is 6378.137km = 1

(i) Terrestrial planets were formed very close to parent star as the gases were not able to get condensed. The formation of Jovian planets took place at much greater distance.
(ii) Solar waves were stronger near sun. Therefore extracted more gases and dust particles from terrestrial planets. Solar waves were not stronger near Jovian planets and could not extract much gases from them.
(iii) As the terrestrial planets were smaller. They had weaker gravitational force too and as result the extracted gases couldn't remain on the planet.

denser comparatively. Other four planets are made up of gases and are also called Jovian Planets. Jovian means similar to Jupiter. Most of these planets are larger than terrestrial planets and have a dense atmosphere made up of hydrogen and helium. All planets were formed together about 4.6 to 4.56 ago million years ago.

Our solar system consists of 8 planets, 183 satellites, lakhs of asteroids, comets and large number of dust particles and gases.

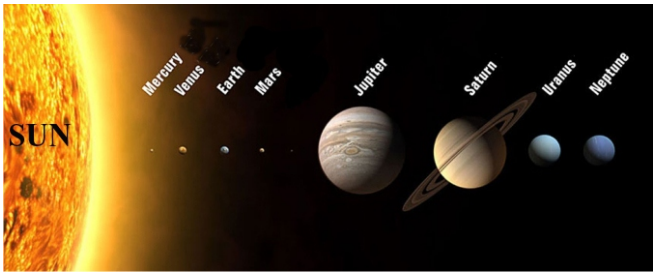

Fig. 2.1 : Solar System and Planets

Till now Pluto was also considered to be a planet. But International Astronomical Organization in its meeting (August, 2006) declared pluto to be a 'dwarf planet'. There are five satellites of the planet Pluto. Some factual details about the planet are given in table 2.1.

Moon

Moon is the only natural satellite of our earth. Many theories about the origin of the moon were presented like that of earth. In 1838, Sir George Darwin postulated that the earth and the moon were a single revolving celestial body. This entire celestial body changed in form of double (Thinner at the center and thicker at the edges) shake

Fig. 2.2 : Moon

and then got disintegrated. According to them the moon is formed of same material where Oceanic Trench of Pacific is situated presently.

However scientists do not accept any of these theories. It is believed that earth's satellite, our moon, is formed as a result of giant impact which is called Big Bang. It is believed that just after the formation of earth, a celestial part which was about 3 times bigger than Mars, disintegrated into universe.

This material which was separated because of the collision, started revolving round the earth and the present day Moon was formed. This incident of origin of the moon occurred about 4.44 million years ago.

Origin of Earth :

Earth was rocky, hot and deserted and the atmosphere was composed of Hydrogen and Helium. This was very different from the present day atmosphere. There were some incidents and activities that caused the transformation of rocky,

Table 2.2 : Geological Time Scale

Eons	*Era*	*Period*	*Epoch*	*Age/ Years Before Present*	*Life / Major Events*
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene	0 - 10,000	Modern Man
			Pleistocene	10,000 - 2 million	Homo Sapiens
		Tertiary	Pliocene	2 - 5 million	Early Human Ancestor
			Miocene	5 - 24 million	Ape: Flowering Plants and Trees
			Oligocene	24 - 37 million	Anthropoid Ape
			Eocene	37 - 58 Million	Rabbits and Hare
			Palaeocene	57 - 65 Million	Small Mammals : Rats – Mice
	Mesozoic 65 - 245 Million Mammals	Cretaceous		65 - 144 Million	Extinction of Dinosaurs
		Jurassic		144 - 208 Million	Age of Dinosaurs
		Triassic		208 - 245 Million	Frogs and turtles
	Palaeozoic 245 - 570 Million	Permian		245 - 286 Million	Reptile dominate-replace amphibians
		Carboniferous		286 - 360 Million	First Reptiles: Vertebrates: Coal beds
		Devonian		360 - 408 Million	Amphibians
		Silurian		408 - 438 Million	First trace of life on land: Plants
		Ordovician		438 - 505 Million	First Fish
		Cambrian		505 - 570 Million	No terrestrial Life : Marine Invertebrate
Proterozoic	Pre-Cambrian 570 Million - 4,800 Million			570 - 2,500 Million	Soft-bodied arthropods
Archean				2,500 - 3,800 Million	Blue green Algae: Unicellular bacteria
Hadean				3,800 - 4,800 Million	Oceans and Continents form – Ocean and Atmosphere are rich in Carbon dioxide
Origin of Stars	5,000 - 13,700 Million			5,000 Million	Origin of the sun
Supernova				12,000 Million	Origin of the universe
Big Bang				13,700 Million	

hot and deserted place, into a place where there is availability of water and favourable environment.

In the next few of segments you will come to know that how did life begins on earth about 460 crores years ago. (Table 2.2)

The structure of earth is in form of layers. The material from the outer layers of atmosphere till the core of the earth are not similar. Atmospheric matter is of least density.

There are many zones from earth's surface to the core of the earth and the matter of every zone has its own characteristics.

Development of Lithosphere :

The planetesimal and other celestial bodies are mostly formed of mixture of dense and lighter substances. This is known to us through the study of meteors. The collection of many planetesimals formed planets. Similar process resulted in the formation of the earth. When the matter was being accumulated under the impact of gravitational force, the collective celestial bodies affected the matter. This generated lot of heat. This process continued and the matter started to melt. This happened during and just after the origin of the earth. Due to excess heat, earth partially remained in a semi-molten state, high temperature caused separation of light and heavy metals. This segregation resulted in moving of heavier material (like iron) to centre of the earth and lighter materials moved towards the surface of the earth or upper regions of the earth. Gradually, over the time it became solid and turned into smaller size. Later it formed the crust of the earth. The process of segregation of lighter and heavier material is called differentiation. During the formation of moon, due to giant impact the temperature of earth increased again and generated heat, this was the second stage of differentiation. The earth was divided into different layers because of this differentiation. Many layers are found from crust to its core like Crust, Mantle, Outer Core. Inner core. The density of the earth's matter increases from the upper to inner region.

Comets

Comets are the most attractive celestial bodies of our solar system. They revolve a round the sun in their fixed elliptical orbit. The nucleus part of of the comet is made of solid rocks in which minerals, glacial crystals, dust particles are covered with gases like carbon-di-oxide, carbon-monoxide and methane. Some of the comets have lakhs of kilometers long orbits whereas taking hundreds of years to come near to the sun.

When comets come near to the sun the matter and gases found in them, expand in opposite direction to the sun due to extensive heat and forms the 'tail of the comets. It can be lakhs of kilometers long. Some scientists believe that comets are the source of water and life on earth.

Meteor :

Smaller and larger particles of rocks found between two planets Mars and Jupiter are called Asteroids. As these asteroids enter the gravity zone of earth they pass through earth's atmosphere. Due to friction it catches fire. Meteors move towards the earth's surface, from the atmosphere and are called 'Shooting Stars'. Only the ashes reaches the earth surface. When these meteroids are not burnt in the atmospheric layers due to friction, it collides with the earth surface like a bomb and causes heavy loss of life and property. Huge crators are developed in Arizona Province of America and Siberia (Russia) due to the collision of meteroids and several kilometres of area was under the impact.

Development of Atmosphere and Hydrosphere :

The present composition of Atmosphere is contributed by Nitrogen and Oxygen. The present day atmosphere is formed in three stages. Its first stage of formation include decline of primordial atmospheric gases. In the second stage the steam and water vapour released from the earth's interior. In the last stage, the composition of atmosphere was affected by the photosynthesis process of biosphere.

Hydrogen and Helium which were the part of initial atmosphere depleted due to waves near the earth. This caused the origin of present day atmosphere. In the beginning in atmosphere there was excess of water vapour, nitrogen carbon-di-oxide, methane and amonia, free oxygen was very less. The process through which the gases of interior of the earth reached to its surface is called Degassing. Constant volcanic eruptions caused increase in water vapours and gases. Along with the cooling of the earth, condensation of water vapours

started. As the carbon-di-oxide present in the atmosphere dissolved, the temperature started to decrease.

Thus resulting in more condensation and more rainfall. The rainwater started accumulating in trenches on earth's surface, which formed the oceans. The oceans present on the earth were formed almost 50 crore years after the origin of the earth. By this we know that oceans are 400 crore years old. The life emerged after 380 crore years. Although the process of photo-symthesis started about 250 to 300 crore years ago. Increase in oxygen due to photo-synthesis is the gift of the oceans. Gradually, the oceans got saturated with oxygen and the atmosphere was filled completely with oxygen about 200 crore years ago.

Origin of Life :

The last stage of origin of the earth is related to origin of life and its development. It is undoubtful that the initial atmosphere was not suitable for any development of life. Modern scientist, describe the origin of earth as a chemical process, firstly, in which complex organic molecules were formed and then their aggregation occurred. This aggregation repeated itself (capable of recreating itself) and was able to transform non-living matter into living matter. The inprints of our life on our earth are found as fossils on rocks of different times. The Blue green algae of present day is similar to that of 300 million years old microscopic structure. It is imaginable that in earlier time simple structure algae would be in existence. It is believed that the development of life began about 380 crore years ago. From the unicellular organism to the present day human. The essence of development of life can be derived from geological period scale which is depicted in the form of Geological time scale. (Table 2.2)

Important Points

1. There are two categories of planets in solar system:
   (A) Inner Planets (Mercury, Venus, Earth & Mars)
   (B) Outer Planets (Jupiter, Saturn, Uranus, Neptune)
2. With suitable distance from the star and favourable solar radiation, water can be available in liquid form, which increases the possibility of life. This is also called Goldilocks zone. The life on earth is possible as it comes under this zone.
3. Many other planets with an environment similar to that of earth, have been discovered where humans, plants, organisms can thrive and a new earth can be formed. This work will be considered as revolutionary period for humanity.
4. As per Modern view, the origin of universe is considered to be from Big Bang Theory. From its beginning, every energy and all the powers were centered at one place. In which there was giant explosion and the energy was spread all around. After this, due to impact of gravitational forces and agglomeration of outer materials, stars, planets and nebulas, galaxies were formed. Our solar system was also formed in the last stages of this process.
5. The entire history of the earth is divided into four big eras. The last of the eras, Cenozoicera witnessed emergence of humans or animals like humans.

Exercise
Multiple Questions

1. Earth's position from the sun is :
   (A) On Fourth place (B) On Second place
   (C) On Third place (D) On First place

2. The correct position of the inner planets is :
   (A) After Jupiter
   (B) From Jupiter to Uranus
   (C) Saturn to Neptune
   (D) From Mercury to Mars

3. The natural satellite of the earth is :
   (A) Moon (B) Titan
   (C) Aryabhatta (D) Chanakya

4. The speed of light per second is :
   (A) 4 lakh km (B) 3 lakh km
   (C) 3.6 lakh km (D) 4.3 lakh km

5. The highest temperature, density and pressure is found on earth :
   (A) Near the earth's surface

(B) Middle of the earth
(C) Upper part of the atmosphere
(D) Centre of the earth

Very Short Questions :

6. What is the other name of rocky sphere?
7. Which astrologist discovered 'Expanding Universe'?
8. What is Nebula?
9. What are asteroids?
10. What is Dwarf Planet?

Short Type Questions :

11. What is Expanding Universe Hypothesis?
12. What is the contribution of Fred Hoyel astrologist?
13. Explain the difference between Terrestrial and Jovian planets.
14. What is Goldilocks Zone?

Essay Type Questions :

15. Critically analyze Big Bang Theory.
16. Explain solar system.
17. Describe Geological line scale.

Answer Key

1. C 2. D 3. A 4. B 5. D