Chapter-5

Concept of Life

5.1 Major Differences between Living and Non-Living :

We come across both living and nonliving things in our day-to-day life. At times it is easy to differentiate between the two but sometimes it is difficult. We can classify things present at our home and in our surrounding environment into living and nonliving. For example furniture, radio, television and buildings belong to the non-living category and plants and animals belong to the living category. We can establish differences between the two categories on the basis of some features (Table 5.1).

5.2 Various Hypothesis Related to Origin of Life :

According to the theory of biological evolution, various types of unicellular and multicellular organisms have developed from some unicellular organism similar to a simple Amoeba. This evolution took place over millions of years.

Various scientists gave their views and hypothesis regarding the origin of life. They are as follows :

(1) Spontaneous Generation (Abiogenesis)

During ancient times it was believed that frogs, snakes, mice, alligators etc originate spontaneously when the sun rays heat the mud on river banks. Von Helmont was of the opinion that a shirt soaked in sweat when placed with wheat straw, spontaneously generates mice in 21 days.

(2) Cosmozoic Theory (Theory of Panspermia)

This theory was put forward by Liebig, Calvin and Arrhenius and Crick, a French and Leslie Orgel supported it. According to this theory the first organism reached earth from some unknown planet of the universe, in the form of showers of minute spores and evolved in the favourable environment of the earth. This led to the origin of life. This theory, however, was not accepted by many scientists because no organism could reach earth from the universe in living condition.

(3) Theory of Biogenesis

In 1668 Francesco Redi proposed biogenesis and rejected spontaneous generation or

Fig. 5.1 : Difference between living and non living

Table 5.1
Differences between Living and Non-Living

Character	Living	Non-Living
(1) Reproduction	Reproduction is prevalent, in them. This is a very specific character of living beings. They are capable of producing organisms similar to themselves. It is because of this that survival of organisms is maintained.	Non-living are not capable of reproducing.
(2) Growth and Development	Living being, exhibit development. Growth also is a specific character. Animals grow upto a particular age but in plants growth is a life long process.	There is no development. Non-living does not exhibit growth.
(3) Cellular organisation	Cells are present in it. A definite organisation of tissues and organs is present.	There is no cellular organisation.
(4) Respiration	Respiration occurs. In living beings energy is obtained by oxidation of organic substances. This process is known as Respiration.	Respiration does not take place. It is not required.
(5) Nourishment	Needs Nourishment because in living beings food is required for obtaining energy. Plants synthesize food on their own by photo-synthesis and animals depend on plants and other organisms for their food.	Nourishment is not needed by non-living because they do not require energy.
(6) Metabolism	Metabolism takes place. Both catabolism and anabolism occurs.	Metabolism does not occur.
(7) Excretion	Exhibits excretion. Passing out unwanted substances from the body is a characteristic feature of living beings.	Excretion does not take place.
(8) Reaction or Response	Reaction occurs, living beings exhibit response for various stimuli; for example we remove hand in response to contact with hot object.	In non-living no response occurs against any stimuli.
(9) Movement or Locomotion	Locomotion or movement is the act of moving body or a part there of, change of place or posture etc. Living beings have organs for locomotion.	They do not have any inherent or intrinsic movement.

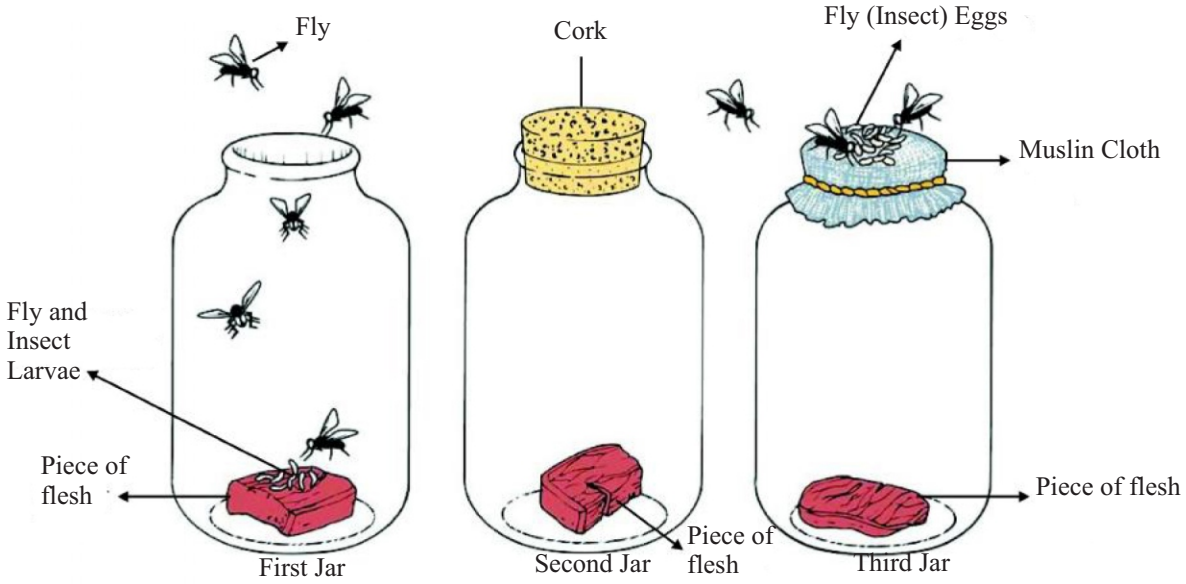

Fig. 5.2 : Experiment of Francesco redi

Abiogenesis. According to him the origin of life is only possible from the organisms. He boiled the flesh of fish, snake etc to kill all the organisms present on it. Then he placed these flesh pieces in different jars. The first jar was left open, the second was covered with a cork and the third was covered with a fine muslin gauze. After a few days Redi observed that in the first jar flies and maggots appeared. In the second jar there were no flies or maggots and in the third jar flies laid eggs on the gauze. The larvae developed in the third jar only if any egg could pass through the gauze. He inferred that organisms could originate from other organisms only.

Louis Pasteur also refuted the theory of spontaneous generation by his experiments. (Fig 5.3) For his experiment he used flasks with S-shaped tubular neck. He boiled yeast powder along with sugar syrup in these jars and left them to cool. Even after some days neither any micro-organisms developed in it nor was the broth spoiled. However, when left open by removing the S-shaped tube from the neck, micro-organisms developed and the broth was contaminated.

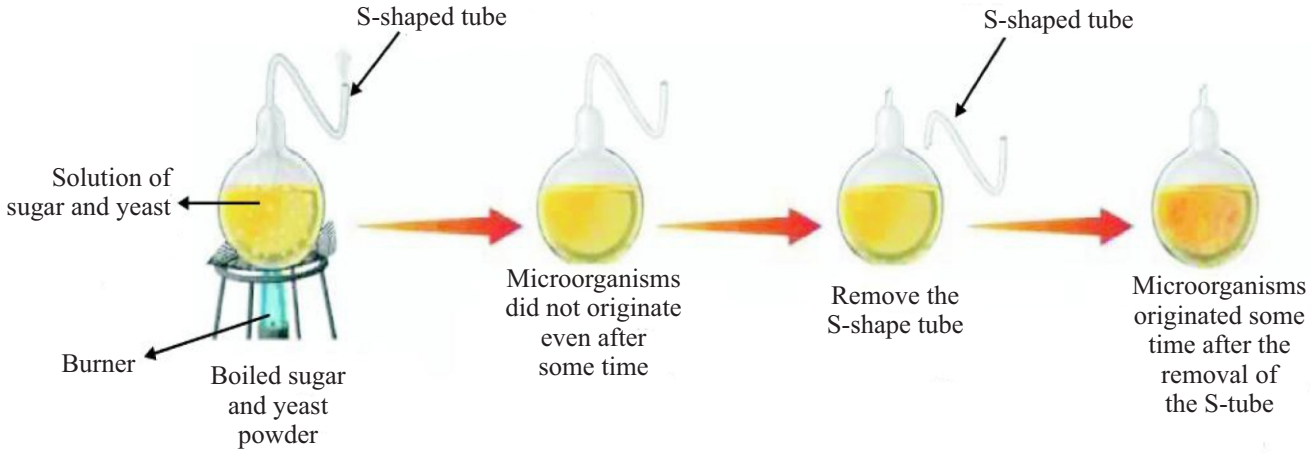

Fig. 5.3 : Experimental conducted by Louis Pasteur which refuted Spontaneous Generation

(4) Oparin Thoery

The famous Russian bio-chemist, A.I. Oparin proposed a hypothesis regarding origin of life, in 1924, on the basis of his studies. According to this hypothesis only carbonic compounds were present on primordial earth which were present in dissolved condition in the oceanic waters. Gradually specific or complex organic (carbonic) compounds were formed from these simple organic substances. Ultimately it was from the aggregates of these complex organic substances that there was development of such a creation which had characteristics of life. The entire process of the origin of life was divided by Oparin in seven stages :

(i) **First stage :** According to scientists the age of earth is 5-6 billion years. It originated from a mass of hot cosmic dust and gases that was moving rapidly in the universe. Various planets were formed by the division of this massive block. Earth was one of them. The temperature of the primitive earth was 5000-6000ºC. The hydrogen, carbon and oxygen molecules were present in it in abundance. Their mutual reactions resulted in the formation of compounds like water, ammonia and methane. Over a period of time the temperature of the earth reduced, as a result these compounds started solidifying and liquefying and clouds were formed. Gaseous ammonia and methane started accumulating in sea-water through the rain waters. Some minerals also reached the oceans along with river waters. Finally, the first organism originated by the chemical synthesis of these compounds.

(ii) **Second stage :** The initial environment of earth was of reducing nature because of excess of hydrogen. After billions of years, when the earth temperature reduced, simple hydrocarbons started forming by the condensation of methane. These simple organic molecules formed complex organic molecules like sugars, glycerine, fatty acids amino acids, pyrimidines, purines etc. The earth crust was hardened because of solidification of many compounds. Thus Lithosphere was formed.

(iii) **Third stage :** Various organic compounds like sugars, glycerine, amino acids, fatty acids, purines and pyrimidines formed by chemical synthesis, started boiling in the water bodies, just like soup. This resulted in their mutual combination forming complex organic molecules like carbohydrates, fats, proteins and nucleic acids, which laid the basis of origin of life.

(iv) **Fourth stage :** Nucleoproteins and other macro molecules were formed by the mutual reactions of carbohydrates, fats, proteins and nucleic acids. Certain specific nucleoproteins had the capability of replication because of which, replication was made possible. Replication resulted in increase in the amount of nucleoproteins and this lead to competition. New nucleoproteins were formed by mutation of some existing nucleoproteins. In this way, the process of evolution of nucleoproteins was established.

(v) **Fifth stage :** During this stage the first cell evolved. With the reduction of nutrients available in the sea water, competition between nucleoproteins started. The sticky nature of the newly formed mutated nucleoproteins resulted in formation of their aggregates. They remained in such groups and got a regular supply of nutrients.

(vi) **Sixth stage :** During this stage evolution started on the basis of nourishment methods in the primitive organisms. Parasitic, saprophytic, chemo-tropic and phototropic organisms evolved.

(vii) Seventh stage : The amount of usable oxygen in the environment started increasing with the gradual increase in number of photosynthetic organisms. Gases like CO_2 and N_2 were formed by reaction of free oxygen with methane and ammonia. It was because of these processes that the primitive atmosphere converted into the present day atmosphere. Oparin's hypothesis was practically demonstrated by Miller's experiments.

Miller's Experiments :

In 1954, scientist from Chicago, Stanley Miller, reproduced the conditions prevalent on primitive earth, i.e. 3 to 4 trillion years ago, to explain the origin of life. Miller boiled a mixture of methane, ammonia and hydrogen along with water in his apparatus for days together. The vapours formed were condensed. Thus mixtures of various gases were formed by their mutual reaction. After one week he observed a red coloured substance in the flask. Chemical analysis revealed the presence of various organic substances like alanine, glycine, glycerine etc. It was inferred from this experiment that life originated on earth in a similar manner. (Fig. 5.4)

5.3 Search of life in Extra-terrestrial Environment :

During the initial phase entire universe was in the form of a dot. Edwin Hubble postulated that when we look at the space, we observe that the galaxies and planets are moving away from each other. In our solar system there is possibility of existence of life on the planets where the conditions are similar to those on the primitive earth. However, on most of the planets the temperature is either too high or too low, which is not considered favourable for life. Moreover on some planets there is no environment because of which the life could never originate on them.

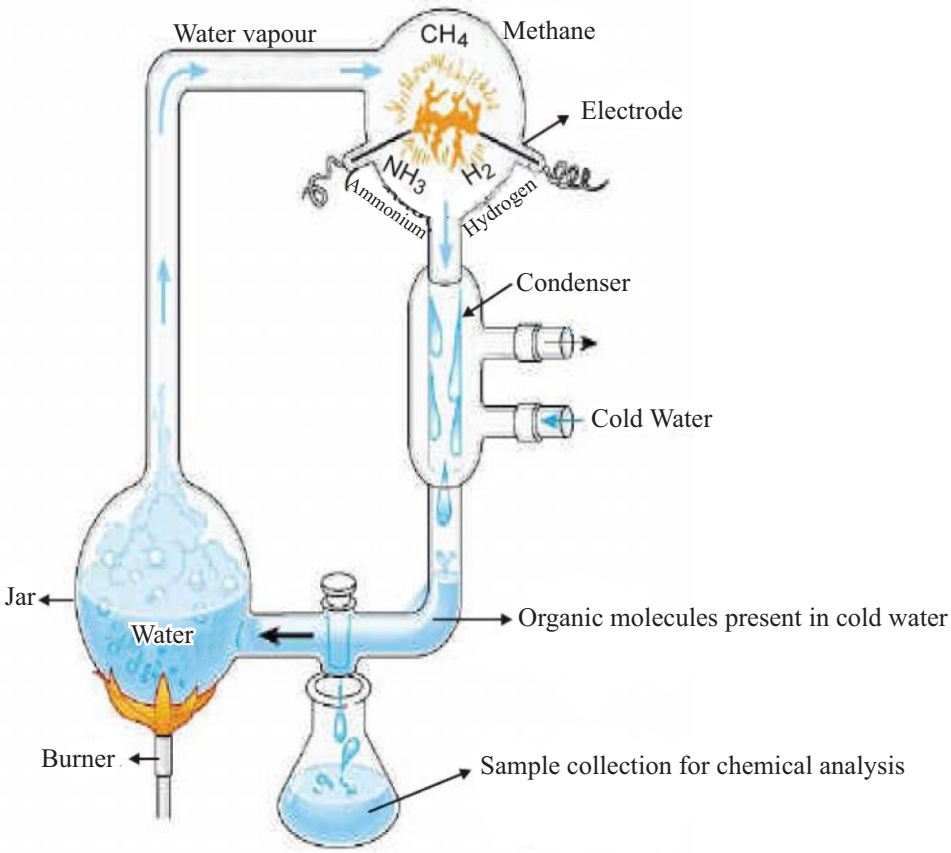

Fig. 5.4 : Miller explained the environment of primitive earth by means of an experiment

Mercury is too hot because of its nearness to the Sun, hence life is not possible on it. On Venus, the atmosphere is made up of thick clouds of carbon-di-oxide; as a result the temperature there is 200-300ºC and life is not possible there too. In the atmosphere of Jupiter, Saturn and other planets, there exists dense clouds of hydrogen, helium, methane, ammonia etc., quite similar to the primitive earth. But because of very low

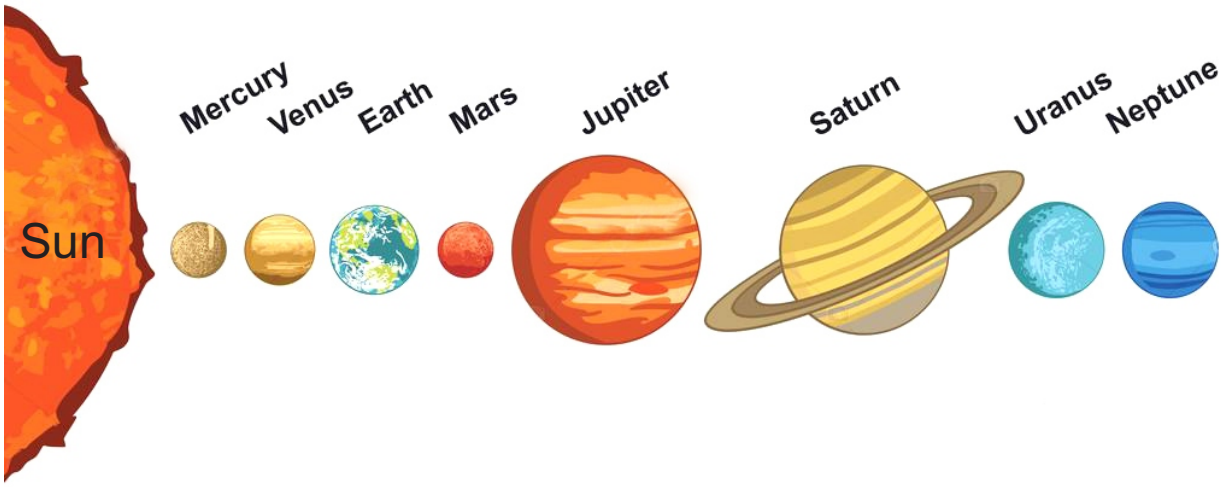

Fig. 5.5 : Solar System

temperature (–200 to –400ºF) life is not possible here. Mars is the only planet of our solar system where life may exist. It is, said that there is bitting cold on this planet and there are tornadoes of dust storms. On it, there is no life as on earth, but its geographical position is fairly good. Here the temperature during summers is 30–50ºC while during winters it may reach a low of –133ºC. The biggest mountain of the solar family is on Mars, along with huge valleys. One year on Mars is equal to 687 earth days. The first space craft was sent to this planet in the 1960 decade. CO_2 is the major component of this planet while the amount of oxygen present

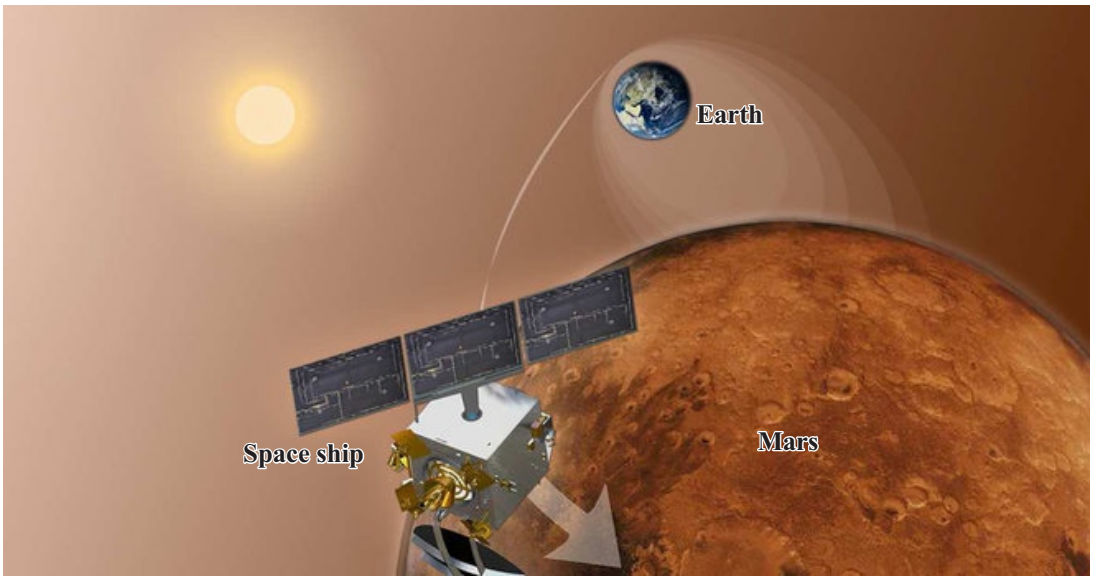

Fig. 5.6 : India's satellite launched in Mars Orbiter Mission rotating around Mars Planet

is only 0.13%. The gravitational force of Mars is very less as compared to that on earth. Yet as compared to other planets, Mars seems quite similar to the Earth. (Fig. 5.5)

Even the Mars Orbiter Mission (MOM), of Bharat, recorded success in 2014. We became the first nation in the world to register success in the first effort and that too at a considerably low cost. This Mars Orbiter will estimate the amount of methane gas in atmosphere and will also find its source. The temperature and minerals available will also be recorded. It will also note the amount of hydrogen and deutirium and will test the various particles it will come across on its outer surface. (Fig. 5.6)

In the solar system moon is closet to earth. Life is not possible on it because of lack of both, water and atmosphere.

5.4 Search of a New Planet like Earth :

By saying planet similar to earth, it refers that during summers it should be able to keep water in liquid form and the temperature and atmosphere should be like that of earth. Ultimately, after considerable efforts, a planet similar to earth was found and was referred to as the earth's "Bigger Older Cousin" or the "Big Brother". It was named as Kepler 452 b. It is 1400 light years away from earth. It is 60% bigger than earth. Kepler 452 is a star, like our Sun. It is 1.5 billion years older than Sun, nearly 20% more bright and is very hot. Kepler 452 b has orbit similar to our earth and its sun-light is received throughout the year in equivalent quantity and stretch. Scientists believe that on it there are rocks, sea and atmosphere like that on earth. Even the surface of this planet seems to be rocky and like that of the earth.

Fig. 5.7 : Earth and earth like planets Kepler 452b and Kepler 186f

Similarly another planet 186f (Kepler-186f) is also considered similar to the earth. It was discovered on 17 April 2014. Scientists are searching for planets similar to earth so that in future when earth will be uninhabitable, we may conserve life by transferring it there and ensure the survival of our race.

Important Points

1. According to the theory of biological evolution various unicelluler and multicellular organisms have evolved from some simplest unicellular organism like Amoeba.
2. Biogenesis was proposed by Francisco Redi of Italy and it refuted abiogenesis or the theory of Spontaneous Generation.
3. Even Louis Pasteur negated spontaneous generation of the basis of his experiments.
4. Oparin divided the entire process of origin of life in seven stages.
5. Stanley Miller, a scientist from Chicago, generated conditions prevalent on earth to explain the origin of life.
6. Miller filled the apparatus of his experiment with a mixture of methane, ammonia and hydrogen and boiled water in the flask continuously.
7. During the initial phase, the entire universe was in the form of a dot.
8. Mercury is very hot because of its nearness to the Sun, hence life is not possible on it.

9. On Venus the atmosphere is made up of dense carbon-di-oxide clouds which raises its temperature to 200-300ºC. Hence life is not possible .
10. Jupiter, Saturn and other planets have dense clouds of hydrogen, helium, methane and ammonia in its atmosphere, which is very much similar to that of the primitive earth. But life is not possible on these planets because of extremely low temperature. (–200 to –400ºF).
11. Mars is the only planet of our solar system on which life may exist.
12. The gravitational force on Mars is very less as compared to that on Earth but otherwise, Mars is very much similar to Earth as compared to other planets.
13. The Mars Orbiter Mission (MOM) of Bharat registered success in September 2014. We have come up as the first nation on this Earth to have achieved it in the first attempt and at a very low cost.
14. In the solar system Moon is the nearest celestial body to the earth. Life is not possible on it because of the lack of water and atmosphere.
15. After several efforts a planet quite similar to Earth has been found which is considered to be the "Big Brother" or "Bigger Older Cousin" and is named as **Kepler 452b**.
16. After **Kepler-452b** another planet resembling Earth, **Kepler-186f** has been discovered.

Questions

Objective type (Multiple Choice) Questions :

1. Besides Earth, on which planet of our Solar System is life possible ?
   (a) Mercury (b) Jupiter
   (c) Venus (d) Mars
2. Which is not a characteristic feature of living beings ?
   (a) Reproduction (b) Evolution
   (c) Growth (d) All options are wrong
3. According to Oparin's theory, Origin of life have been divided into how many stages ?
   (a) 5 (b) 6
   (c) 7 (d) 8
4. Who propounded the theory of biogenesis ?
   (a) Oparin (b) Francisco Redi
   (c) Von Helmont (d) Liebig
5. Name of the earth-like planet discovered on 17 April 2014 is :
   (a) Kepler 186 f (b) Kepler 452 a
   (c) Kepler 186 g (d) Kepler 452 b

Very short answer type questions :

6. Name the scientist who negated the theory of spontaneous generation.
7. Which are the two planets similar to earth?
8. Which scientist propounded the Cosmozoic theory?

Short Answer type Questions :

9. Explain the differences between living and non-living with the help of an examples.
10. Give on illustrated a account of the Miller's experiment.
11. Describe biogenesis.

Essay type questions :

12. Name the various hypothesis regarding the origin of life. Explain any one of them.
13. Explain the Oparin theory of origin of life.

Answer Key

Question	1	2	3	4	5
Answer	d	d	c	b	a