

## Theories of origin of life on earth

Different scientists and philosophers have put forwards different explanation of origin of life on earth from time to time. Among them some of popular theories of origin of life are following;

1. **Theory of Special Creation**
  2. **Theory of Spontaneous generation or Abiogenesis theory**
  3. **Biogenesis theory**
  4. **Panspermia Theory or Cosmozoic theory**
  5. **Modern theory of origin of life or Oparin-Haldane theory of origin of life**
1. **Special creation theory**

This theory is stated that "**God created the whole universe, sun, moon, stars atmosphere, earth and all different living creatures that present on earth as the form that they are existed today**". This theory was strongly supported by father Suarez (1548-1671 AD) and major religions and civilization of world. Popularity of this theory was decreased with increased of scientific thinking in people.

### 2. **Theory of Spontaneous generation or Abiogenesis theory**

This is the oldest theory of origin of life. It is stated that **living things were originated from the non-living substances or inanimate matters spontaneously or automatically and they remain unchanged**. Like; in ancient time, Chinese people believed that aphids and other insects were arose under the influence of heat and moisture and Aristotle (384-322 BC) proposed that worms, insects and fish were developed from excreta etc. This theory was widely appreciated and accepted till mid17<sup>th</sup> century. But belief on this theory was decreased with establishment of experimental biology and this theory was experimentally rejected by scientists like Francisco Redi, Lazzaro Spallanzani and Louis Pasteur.

### 3. **Biogenesis theory**

This theory was proposed by French microbiologist Louis Pasteur (1822-1895 AD). It is stated that **life originated from pre-existing life only, not from inanimate substances**. This theory is rejected because it unable to explain the process of origin of life.

#### a. **Pasteur's experiment**

**To support the biogenesis theory**, Pasteur conducted an experiment. In his experiment, he prepared the hay infusion in swan neck flask. To kill the microbes and sterilize both infusion and flask, the infusion was boiled. The opening of flask was unsealed and left the apparatus undisturbed for several days. No life or microbes were appeared in flask because the design of flask was such that its neck trapped all viable microbial particles

and only allowed the pure air into the infusion. But, when he broke the neck of flask, microbes were appeared in infusion. Thus, he proved that life can arise from pre-existing life only.

#### **4. Cosmozoic theory or Panspermia theory**

This theory was proposed by Richter (1865 AD). According to this, **Life came on earth from other planet in the form of seeds or spores, called panspermia, along with dust particles and they subsequently found suitable environment to grow into life.** It was rejected because it could not able to explain the mechanism by which panspermia survived at adverse condition of temperature and lethal radiation of inter-planetary space during migration.

#### **5. Modern theory of origin of life or Chemosynthesis theory of life or Oparin-Haldane theory of origin of life**

This theory was proposed by Russian biochemist Alexander Ivanovich Oparin in 1923AD in his book of title “The origin of life on the earth”. This was supported by English biochemist JBS Haldane in 1928 AD. Thus, this theory is also known as Oparin-Haldane theory. This theory can be explained in following headings;

##### **A. Origin of earth**

##### **B. Origin of life on earth**

##### **A. Origin of earth**

The earth was supposed to be originated about 4.6 to 5 billion years ago and it is believed to be formed by the condensation of clouds of cosmic dust particles and gases called ylem.

##### **B. Origin of life on earth**

It was expected that life was originated on earth about 3.7 billion years ago and involved following changes

##### **1. Chemogeny**

##### **2. Biogeny**

##### **3. Cognogeny**

##### **1. Chemogeny**

It is a stage of formation of chemical constituents required for formation of living organisms by the evolution in chemicals especially lighter gases (like hydrogen, carbon, nitrogen and oxygen etc.). It occurred in following ways-

##### **i. Formation of Inorganic compounds**

##### **ii. Formation of simple Organic compounds**

### iii. Formation of Complex Organic compounds

#### i. Formation of Inorganic compounds

At the time of earth's origin, it was red hot rapidly rotating gaseous cloud of free atoms of different elements. Later, the gaseous cloud was gradually cooled down and slowed its whirling power in few millions of years. As a result of this, condensation and stratification were occurred in the gaseous cloud. Atoms of high atomic weight moved to center to form core of earth, atoms of intermediate atomic weight were get arranged just outside the core in a shell to form crust and mantle of future earth. The light atoms moved outside the shell. As the temperature of earth was gradually cooled down, the atoms were moved, collided and combined continuously to form elements and compounds like hydrogen gas, water, methane, ammonia, hydrogen cyanide, metal carbides, metal carbides and metal nitrides etc. Water was existed as super-heated steam condition. All these compound and elements formed the primitive atmosphere of the earth. Oxygen was not existed in free form because the reduced substances immediately combined with it to form oxides. Thus, the primitive atmosphere became reducing type.

#### ii. Formation of Simple organic compounds

When temperature of earth was cool down further 1000 °C or below, the solid crust of earth was formed and depressions of earth surface able to hold the water forming large sized water bodies like primitive oceans or seas. The oceanic water contained large amount of dissolved ammonia, methane, metal carbides, metal nitrides, gases and elements etc. When these compounds reacted with each other in presence of water, formed variety of saturated and unsaturated hydrocarbons. The saturated and unsaturated hydrocarbons were reacted with water and formed oxy and hydroxy derivatives likes aldehydes, ketones, alcohols, organic acids (amino acids, fatty acids), glycerol, glucose, nitrogen bases (purines and pyrimidines) etc. Energy required for all these reactions were supplied by ultra-violet rays of sun, electrical discharges from thunder, heat from volcanic eruption and radio-active elements etc.

#### iii. Formation of complex organic compounds

Simple organic compounds like glucose and amino acids etc. were polymerized by losing water molecules and formed complex organic compounds like polysaccharides, proteins and lipids etc. in primitive oceanic water. The oceanic water mixed with these (carbohydrates, proteins and lipids) complex organic compounds are called **hot dilute soup** or **prebiotic soup** or **primordial soup** by Haldane. These complex molecules are constituents of protoplasm. Therefore, formation of these compounds especially protein is crucial start of transformation of non-living to living form.



Amino acid + amino acids + amino acid + .....  $\xrightarrow{\text{polymerization}}$  Protein

#### 4. Biogeny

Process of formation of self-multiplying biological units or primordial life from chemical constituents like carbohydrates, proteins and lipids etc. called biogeny. It occurs by following steps:

##### i. Formation of nucleotides and nucleic acid

When Nitrogen bases like purines and pyrimidines combined with simple sugars and phosphate group present in primitive sea water, formed the nucleotides. Later on, the nucleotides were polymerized and formed nucleic acids like DNA and RNA.

Nitrogen base + sugar + phosphate  $\rightarrow$  Nucleotides

Nucleotide + Nucleotide + Nucleotide + Nucleotide + .....  $\xrightarrow{\text{Polymerization}}$  Nucleic Acid (DNA)

##### ii. Formation of coacervates or aggregates

The complex organic compounds were collided, reacted and aggregated in various combination to form a new type of large, complex and insoluble colloidal organic particles in primitive sea water called coacervates. The coacervates absorbed organic substances from the sea water and acquired variable chemical composition. They increased their size up to the optimum limit and then, they broke down into small droplets to increase their numbers. Thus, coacervates had some properties of living beings i.e., absorbed substances, grown in size and replicated themselves. So, they are considered to be the foundation of life. Some of protein droplets of coacervates along with metal ions and water, acted as catalytic agent in breaking down and synthesis reaction.

##### iii. Formation of primitive life or primordial life

It is believed that coacervates would have been undergone further series of chemical changes due to formation of enzymes. Thus, the enzymes induced the breaking down and synthesis reactions. The coacervates like nucleoprotein; that formed by union of nucleic acids and proteins, had power of self-replication i.e., manufacture other molecules like themselves by gathering necessary substances present in primitive sea water. When nucleoproteins were surrounded by the thin fold of phospholipids molecules as limiting membrane or primitive cell membrane. They developed pre-cell like structure called as **eobiont** or **proto-biont** or **pre-biotic** structure. Later, they modified their parts due to chemical changes in their nucleic acids and internal re-arrangement of phospholipid coat that may have produced primitive cell. The primitive cell lacked a definite nucleus and feed on the organic matters present in primordial soup. Thus, the first formed cell was

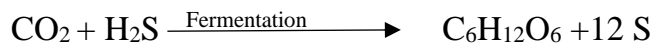
prokaryotic, chemo-heterotrophic and anaerobic type and believed to be originated approximately 3.7 billion years ago.

## 5. Cognogeny

Cognogeny is evolution in living organisms from simple first formed living cell. It takes place in following ways;

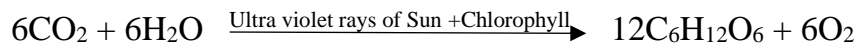
### i. Origin of chemo-autotrophs

With gradual increased in number of prokaryotic, anerobic and chemo-heterotrophs, most of organic matters present in primitive sea water gradually decreased, that lead the scarcity of foods and they struggled for existence. However, in due course of time, some of them developed certain enzymes or mechanism that helped them to synthesize organic molecules from the inorganic molecules that were abundantly present in primitive sea. This was the beginning of the auto-trophism and energy required for this process was supplied by the anaerobic break down reactions. That types of organic molecules or food production process is called chemosynthesis or chemo-auto-trophism. In this way, prokaryotic, anaerobic and chemo-autotrophs were developed.



### ii. Origin of photo-autotrophs

Later on, certain chemo-autotrophs developed chlorophyll molecules which acts as catalyst that enabled them to use water and carbon-dioxide for the synthesis of organic molecules or food in presence of solar energy. With increased of photosynthetic prokaryotes, oxygen was released in the sea and then in atmosphere which turned the reducing environment into oxidizing type.



(Oxygen revolution- With increased of photosynthetic organisms, free oxygen molecules were available in atmosphere which converted reducing atmosphere to oxidizing type)

### iii. Origin of Eukaryotes

With the released of free oxygen in the environment, the condition was suitable for aerobic respiration upon the earth which was probably about 2.7 billion years ago. The anaerobic prokaryotes gradually modified to adopt for aerobic mode of respiration and they, later developed a true nucleus, mitochondria and other cells organelles. Thus, free living eukaryotes were formed from some prokaryotes in the ocean of about 1.5 billion years ago and from them developed different types of higher organisms.

## Miller and Urey's Experiment

Stanley Miller performed a simulation experiment under guidance of his Professor Harold C. Urey to test the hypothesis of biochemical origin of life given by Oparin and Haldane in 1953 AD.

## Experiment

Miller tried to create the primitive atmospheric condition that might be existed in primitive earth by using apparatus like glass tubes and flasks. The apparatus contained two flasks; larger one was called Gaseous chamber and smaller one was called liquid chamber. Gaseous chamber contained the mixture of gases like methane ( $\text{CH}_4$ ), Ammonia ( $\text{NH}_3$ ) and hydrogen ( $\text{H}_2$ ) in ratio of 2:2:1 and two electrodes that connected with electric source to provide energy of electrical sparks for simulating effect of lightening of the primitive atmosphere. For this reason, this apparatus is called **Spark discharge apparatus**. Liquid chamber contained water for production of water vapor. The experiment was start with switching on the electric source and boiling the water and it was continued for a week.

## Observation

Miller found a dark colored condensed liquid. He collected it and analyzed chromatographically and found the liquid was mixture of sugar, amino acids and aldehyde etc.

## Conclusion

The result of this experiment supports the Oparin and Haldane theory of origin of life that during the course of origin of life, simple molecules evolved into complex organic molecules.

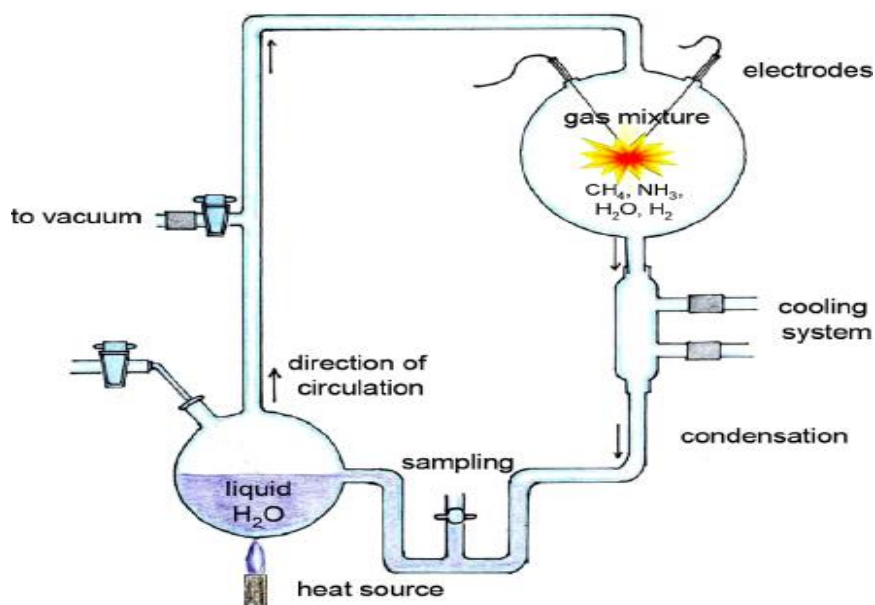


Figure of Miller and Urey experiment