

# 1. ORIGIN OF LIFE

## Big-Bang Theory :

This theory was proposed by **Abbe Lemaitre**. According to it, the universe originated about 20 billion years ago due to a thermonuclear explosion of a dense entity. This thermonuclear explosion is called **Big-bang**. About **4.6** billion years ago, the origin of our solar system took place by the gaseous clouds formed due to this explosion. These gaseous clouds collapsed and converted into flat disc-like structure made up of atoms and small particles due to their own gravitational pull. These flat-disc like structure is called **SOLAR-NEBULA**. The very hot central part of this solar Nebula became still hotter & converted into the **sun**. Now, due to condensation of atoms and dust particles moving around the sun formation of the other planets took place [**Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune**]. The solid part of our planet earth was called Lithosphere and the gaseous part was known as atmosphere. When the earth's surface cooled down and its temperature decreased to  $100^{\circ}\text{C}$ , water formed on it.

## Ancient Theories for origin of life :

### 1. Theory of special creation –

#### Mythology based theory

The greatest supporter of this theory was **father Suarez**. According to Bible life and everything was created by god in 6 days.

According to **hindu mythology** the world was created by **God Brahma**. (The first man was **Manu** and the first woman was **Shraddha**).

According to it life has not changed ever since its origin.

Special creation theory lacks scientific evidences so it is not accepted.

- Theory of special creation has three connotations–

- All living organisms that we see today were created as such.
- The diversity was always the same since creation and will be the same in future.
- The earth is about 4000 years old.

### 2. Theory of Spontaneous Generation (Abiogenesis or Auto genesis) –

This hypothesis was supported by ancient Greek philosophers like Thales, Anaximander, Xenophanes, Plato, Empedocles, Aristotle.

According to this theory life was originated from nonliving things or decaying and rotting matter like straw, mud etc. spontaneously.

They believed that the mud of the **Nile** river could give rise to frogs, snakes, crocodiles. Abiogenesis was strongly supported by **Von Helmont**. He claimed that formation of mice occurs in 21 days, if a sweat soaked dirty shirt is kept in wheat barn.

### 3. Cosmozoic Theory –

Proposed by **Richter**.

Protoplasm reached on earth in the form of **spores** or other simple particles from some unknown part of the universe with cosmic dust and they gave rise to various forms of life.

### 4. Cosmic panspermia theory –

Proposed by **Arrhenius**.

According to this theory organisms existed throughout the universe and their spores could freely travel through space from one star to the other.



## 5. Theory of Eternity of Life –

Helmhotz believed that life is **immortal**.

## 6. Theory of Biogenesis –

**Harvey (1651) and Huxley (1870)**

**Omnis vivum ex ovo or vivo.**

New organisms can be originated on earth only by pre-existing life.

This theory reject the theory of Spontaneous generation but cannot explain origin of life.

To prove Biogenesis and to disprove abiogenesis experiments were performed by –

### Francesco Redi's Experiment (Italian 1668) –

He took cooked meat in three jars one was uncovered, the second was covered with parchment and the third was air tight.

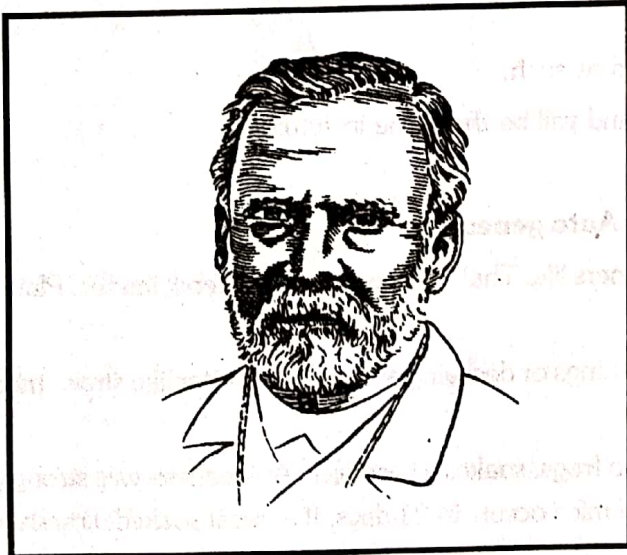
He observed that maggots developed only in the uncovered jar while maggots could not developed in the meat in closed jars.

This proved that larvae were formed from eggs laid by the flies in open jars. Since the meat in closed jars could not be visited by flies so no larvae could develop. Therefore life originated from preexisting life.

### Lazzaro Spallanzani (Italian 1767) –

He boiled vegetables and meat to prepare a sterilized nutritive soup and he kept some of it in air sealed flasks and some in loosely corked flasks. He observed that the soup in sealed flask remained sterile while microorganisms appeared in the soup in loosely corked flasks.

Thus even microorganisms were formed from pre-existing ones in the air rather than spontaneously.

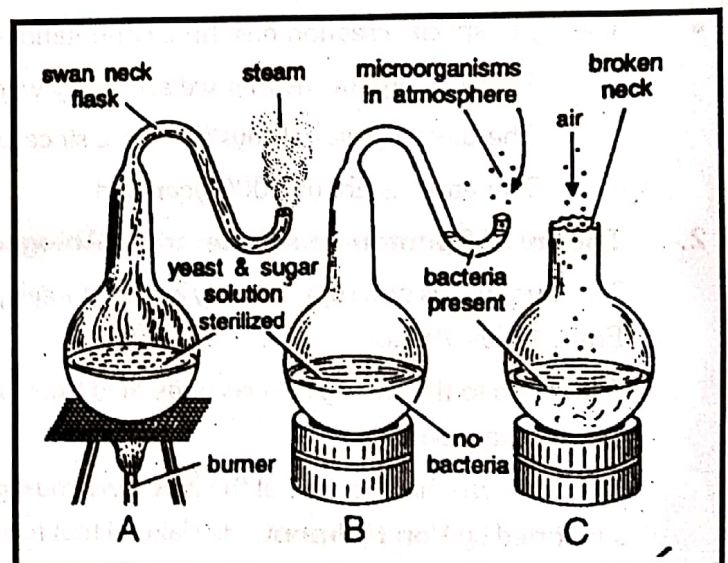


### Louis Pasteur (French 1862) –

Pasteur is popular for **Germ Theory of Diseases or Germ theory** and he disproved abiogenesis.

He prepared sterilized **syrup** of sugar and killed yeast by boiling them in flasks.

He took two flasks one of broken neck and another of curved neck (swan neck flask). No life appeared in swan neck flask because germ laden dust particles in the air were trapped by the curved neck which serves as filter while in broken neck flask colonies of microorganism were developed. By the experiment he proved that life comes only from pre-existing life.





# Modern theory of origin of life

(Oparin-Haldane theory of origin of life)

## Naturalistic theory OR Theory of Chemical Evolution-

This theory was proposed by Russian Scientist **A.I. Oparin** and **J.B.S. Haldane** (England born Indian scientist). Oparin's theory was published in his book 'ORIGIN OF LIFE'.

## Important Points

- ☞ According to this theory life originated by the **composition of chemicals**.
- ☞ Oparin and Haldane proposed that the first form of life could have come from pre-existing non living organic molecules and that formation of life was preceded by chemical evolution.
- ☞ Oparin's theory is based on Artificial Synthesis. So also called as **artificial synthetic theory**.
- ☞ 1st life originated in the water of oceans. So water is essential for origin of life.
- ☞ At the time of origin of life free  $O_2$  was absent, so first life was **anaerobic**.
- ☞ In the primitive atmosphere free oxygen was present but complete oxygen consumed in composition so primitive atmosphere of earth was **reducing**.
- ☞ Oxygen was reproduced by photosynthesis and atmosphere converted in **oxydising**.

## Chemical Evolution

### 1. The atomic stage -

The earth was originated about 4.6 billion years ago. Early earth had free atoms of all those elements which are essential for the formation of protoplasm.

The lightest atoms like **carbon, hydrogen, nitrogen and oxygen** formed the primitive atmosphere.

**Most abundant of all of them was hydrogen.**

### 2. Molecular stage (Origin of molecules and simple Inorganic compounds) -

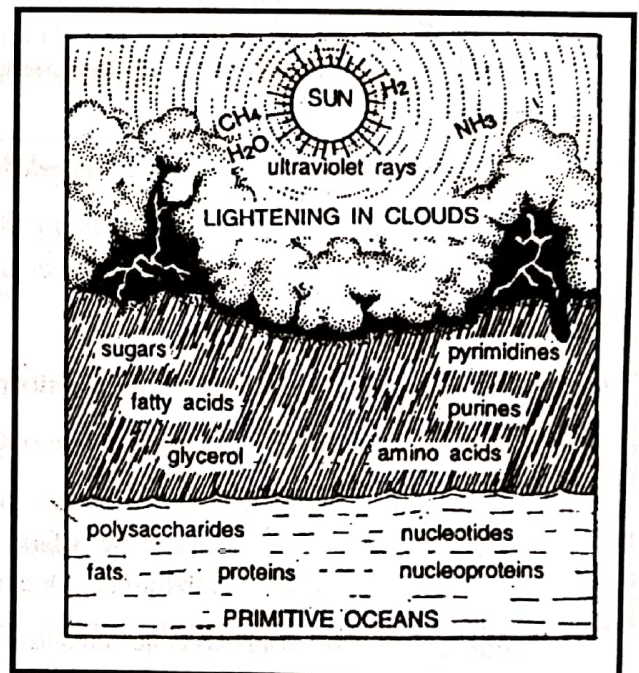
Free atoms combined to form molecules and simple inorganic compounds.

Due to presence of high temperature, active hydrogen atoms combined with all oxygen atoms to form water and leaving no free oxygen.

Thus the primitive atmosphere was **reducing** (without free oxygen) unlike present **oxidising** atmosphere (with free oxygen). Hydrogen atoms also combined with nitrogen to form  $NH_3$ .

**(The first molecular compounds formed were probably water and Ammonia).**

These lighter elements also formed  $CO_2$ ,  $CO$ ,  $N_2$ ,  $H_2$  etc.





### 3. **Origin of early organic compounds –**

The nitrogen and carbon of the atmosphere combined with metallic atoms forming nitrides and carbides.

Water vapour and metallic carbides reacted to form the **first organic compound Methane(CH<sub>4</sub>)**. Later on **hydrogen cyanide(HCN)** was formed.

Water which formed on earth due to high temperature evaporated so **clouds** were formed.

Water vapour changed into rain drops and by the collection of water on earth primitive oceans were formed.

### 4. **Origin of simple organic compounds –**

Water of primitive oceans contained large amount of methane, ammonia, hydrogen, cyanides, carbides, nitrides.

These early compounds interacted and formed simple organic compounds like, aldehyde, Ketones, Alcohols, Pentose and hexose sugar, Amino Acids, Glycerol, Fatty Acids, Purines, Pyrimidines etc.

**Energy was obtained from U.V. Rays of sunlight, cosmic rays and heat of volcanic eruptions.**

### 5. **Origin of complex organic compounds –**

The small simple organic molecules combined to form large complex organic molecules.

– Amino acids Joined to form polypeptides and proteins, which were non-enzymatic.

– Simple sugar units combined to form polysaccharides.

– Fatty acids and glycerols united to form fats and lipids.

– Sugar, nitrogenous bases, phosphates combined into nucleotides which polymerized into nucleic acid, which unable to replicate.

These macromolecules forms main component of protoplasm hence the possibility of origin of life in primitive oceans could be established.

After long time the water of primitive oceans became rich mixture of organic compounds as a result of chemical evolution.

**Haldane called this saturated water of oceans as prebiotic soup or hot dilute soup.**

The major requirement for promoting polymerisation is the availability of continuous source of energy and removal of water from the surface of reactants so that they can concentrate and prevent depolymerisation.

### **Experimental evidence for formation of simple organic compounds –**

**By Stanley Miller.** Who was a student of **Harold Urey**.

In this experiment Miller took the mixture of **methane, ammonia and hydrogen (ratio 2 : 1 : 2)** in a large flask and passed steam over it by boiling water and connecting it with a glass tube. Electric spark was discharged at 800 °C in the mixture by using two tungsten electrodes as **source of energy**.

After 18 days this fluid was collected and analysed. This dark red fluid was found to contain.

– Simple amino acids – glycine, alanine, aspartic acid.

– Simple organic acids – formic, acetic, oxalic, lactic, succinic acids. etc.

– Pentose, hexose, aldehyde, ketone etc.

From these compounds how various forms of life was originated we will studied it in **Biological evolution**.



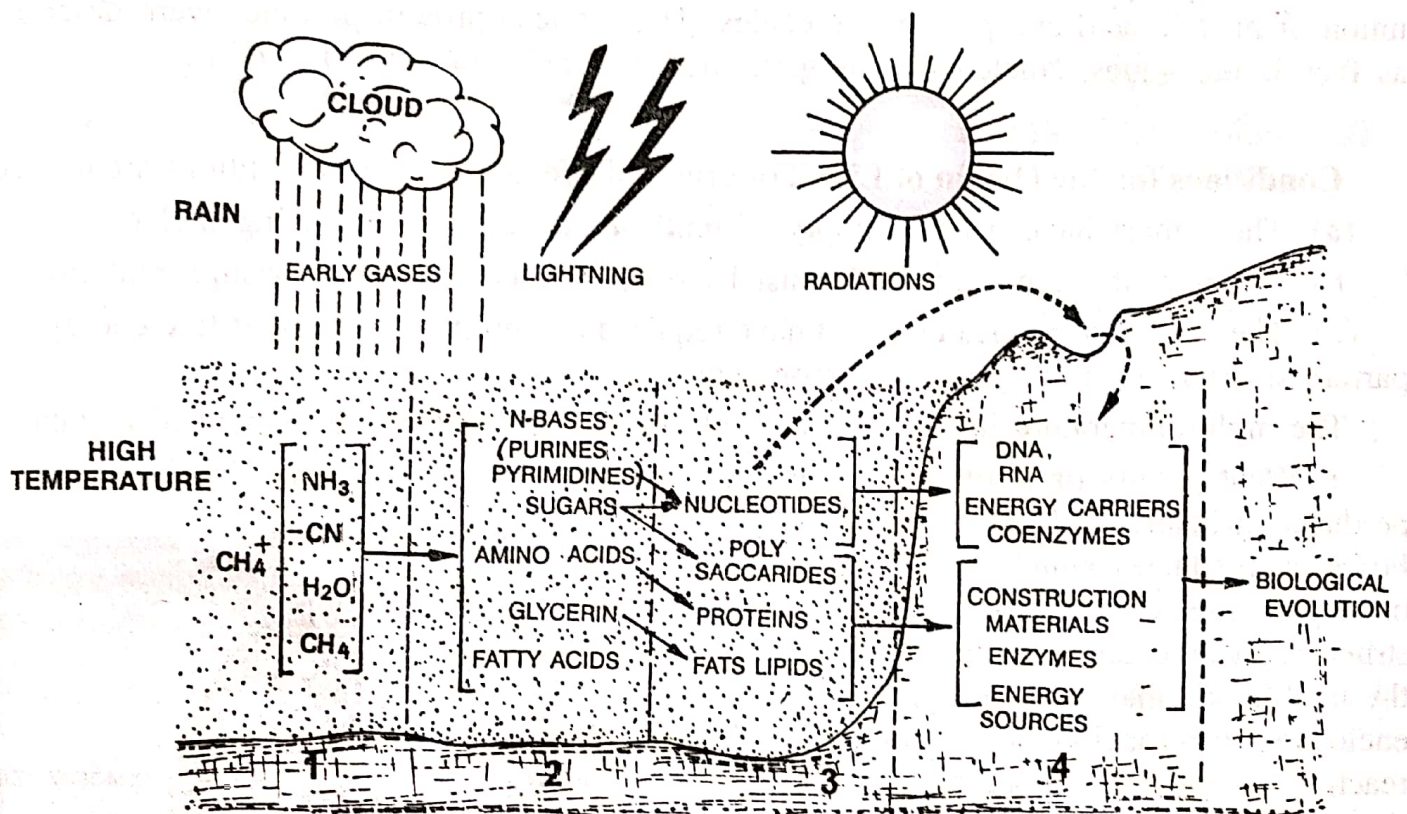
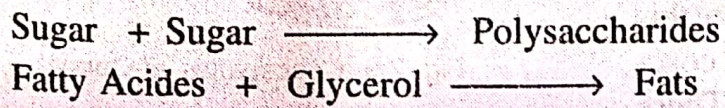
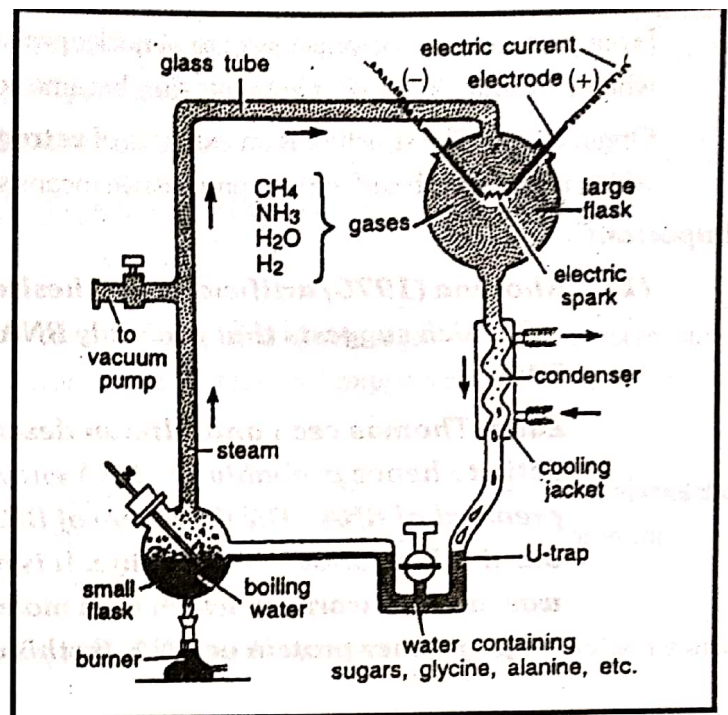


Fig. 7.8. Chemical evolution on early earth.



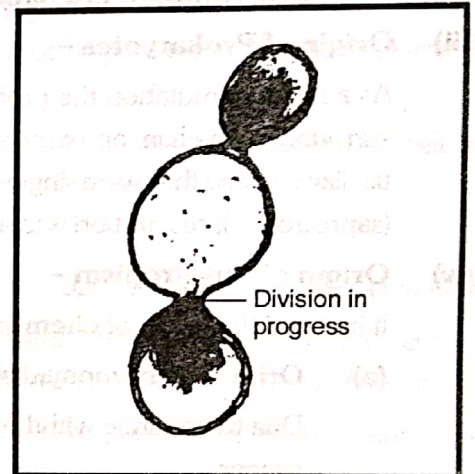




## BIOLOGICAL EVOLUTION

### (i) Origin of Protobionts and Nucleoprotein (Coacervates)

Macromolecules which were synthesized abiotically in primitive ocean later came together and formed large colloidal drop like structures named as Protobionts (**Later called coacervates by Oparin, Fox called them Microsphere and Deamer called them vesicles**). Each protobiont was a **cluster** of macromolecules. They contain proteins, nucleic acids, lipids, polysaccharides etc. They grew by absorbing molecules from their environment. They could divide by budding like bacteria, many chemical reactions including the decomposition of glucose took place inside the protobionts. The sun provide energy for chemical reaction. According to oparin **coacervates were the first sole living molecules** which gave rise to cell .



### Different type of Protobionts obtained by scientists

**Oparin (1924)** took a solution of carbohydrate and large protein. The solution was shaken. It caused separation of coacervates. In coacervates higher concentration of protein, carbohydrate were present with small amount of water. Oparin's coacervates could grow and exhibit simple form of metabolism. However a lipid membrane and reproduction was Absent.

**Fox (1957)** obtain microspheres with a primitive membrane. He heated a dry mixture of Amino acids at  $130^{\circ} - 180^{\circ} \text{C}$ . It formed **PROTEIDS** (Polymer of amino Acid). When these proteids poured in Cold water along with lipids, microsphere get seperated. (size  $1-2 \mu\text{m}$ )

**Deamer (1993)** Microsphere and coacervates could fused to form protobionts having various type of chemicals like Proteins, Nucleic acids, Carbohydrates etc. enclosed inside a lipid membrane. Deamer called them **vesicles**.

### (ii) Origin of protocells [Eobiont] :

The **first living form named protocell** originated in the primitive oceans.

The protocell were clusters of nucleo proteins which formed by composition of nucleic acids and enzymetic proteins. Nucleoproteins had the property of self duplication. **Nucleo proteins were first sign of life. The protocell represented the beginning of life.**



From protocells or eobionts few core of nucleoproteins gets separated free in oceans and became inactive but when they enter in another eobionts they became active so virus like structures were formed.

Origin of virus like structure is an example of **retrogressive evolution** (complex to simple). While evolution which inhibits earth surface was progressive means simple to complex.

### Important

- (1) **Khorana (1970) artificially synthesized 77 nucleotide RNA molecule out side a living cell which suggests that probably RNA was the premordial genetic material rather than DNA.**

**Zaug, Thomas cech and Altman described that some RNA molecules have enzymatic activity hence probably the RNA enzymes called ribozymes were able to replicate the premordial RNA. The discovery of RNA molecule working as enzyme has also changed our thinking about origin of life. It is now believed that about 4 billion years ago earth was an 'RNA world' in which RNA molecule carried out all the process of life without the help of either protein or DNA. By this discovery evolution is named as RNA world.**

**[CBSE 2002]**

- (2) **It is estimated that life originated about 3.9 billion years ago as protocell (eobionts) in precambrian era which was anaerobic heterotrophic.**

### (iii) Origin of Prokaryotes –

As a result of mutation the protocells became more complex and efficient to use the materials available in the surrounding medium and condensed themselves into prokaryotic cells. Thus the first living being were prokaryotic, like bacteria they were single celled and consisted of naked DNA. Nutritionally they were **chemoheterotrophs** (saprotrophs), respiration was **anaerobic**.

### (iv) Origin of Autotropism –

It includes the origin of **chemosynthesis** and **photosynthesis**.

#### (a) Origin of chemosynthesis :

Due to continue withdrawal of organic molecules by chemoheterotrophs organic material decreased in oceans.

Before the organic material disappeared in sea, new modes of nutrition developed, one of them was **chemosynthesis**.

The organism which perform chemosynthesis are called as **chemoautotrophs**. They were anaerobic and synthesise organic molecules from inorganic material. The energy was obtained by oxidising inorganic materials present in the sea.

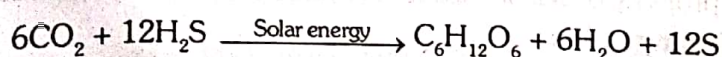
**Such mode of nutrition is found in Bacteria e.g. sulphur bacteria, iron bacteria, nitrifying bacteria.**

#### (b) Origin of Photosynthesis :

After some time bacteriochlorophyll developed in some autotrophic bacteria like organism. They could absorb solar energy and convert it into chemical form. These organism called **photoautotrophs**.

They utilise solar energy for synthesizing organic compounds. This process is called **photosynthesis**. They were anaerobic and utilised hydrogen from sources other than water like  $H_2S$ . Therefore, no oxygen was evolved and atmosphere remained reducing.

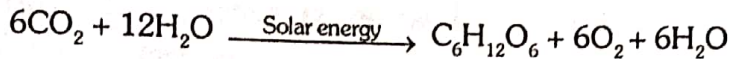
**This stage of photosynthetic autotrophism is represented by planktonic sulphur bacteria of today.**





The Bacterio chlorophyll formed true chlorophyll by molecular changes. Such organism which were bearing true chlorophyll are similar to today's **Cyanobacteria (B.G.Algae)**.

They utilized water as hydrogen donor and evolved oxygen.



### Oxygen revolution -

During the origin and evolution of life liberation of free  $\text{O}_2$  by blue green algae like prokaryotes due to photosynthesis was a revolutionary change in the history of earth. It is called **oxygen revolution**.

It includes important changes like -

- (1) Atmosphere of earth changed from reducing to oxidising, hence possibilities of further chemical evolution and abiogenesis finished, because chemical evolution always take place in reducing environment.
- (2) Free  $\text{O}_2$  oxidized  $\text{CH}_4$  and  $\text{NH}_3$  to form gases like  $\text{CO}_2$ ,  $\text{N}_2$  and  $\text{H}_2\text{O}$ .
- (3) Accumulation of free  $\text{O}_2$  formed a layer of  $\text{O}_3$  (ozone) above the atmosphere of earth. Which started absorbing most of the U.V. rays of sunlight.

### Origin of Eukaryotic cell -

**About billion years ago** conditions became suitable for aerobic respiration with the release of free  $\text{O}_2$ . Aerobic respiration yields about **20 times more energy** than anaerobic respiration hence the prokaryotes adapted themselves for aerobic mode of respiration.

Nucleus, mitochondria and other cell organelles developed in the cell and thus free living eukaryotic cell like organism originated about **1.5 billion years ago** in the primitive ocean.

### Organic Evolution -

1. Though life originated by chemical evolution on primitive earth, was later replaced by organic evolution.
2. Organic evolution states "**Descent with modification**". i.e. the present day complex organism have evolved from earlier simpler organism by small but gradual changes which have occurred over millions of years.
3. Though living organisms show great diversity in size, structure, function, behaviour etc. they also show basically similar metabolic processes indicating **common ancestry**.

### Special Points :

1. Evolution up to formation of coacervates termed as **chemical evolution**, in which complex organic compound were formed which were essential for formation of cellular structure.
2. Evolution from coacervates to simple cell structure known as **biological evolution**.
3. From simple cell to recent..... evolution is called **organic evolution**, in which organism developed structures and modified them by which they became more adaptive in their changing environment.
4. First protein which is formed during evolution in primitive oceans were not structural.
5. First nucleic acid which was formed in primitive oceans from combination of nucleotides, did not have power of replication. They obtained power of replication later by mutation.
6. Evolution term introduced by - **Herbert Spencer**.
7. # **What is evolution ?**  
The word evolution means to unfold or unroll or to reveal hidden potentialities. Evolution simply means an orderly change from one condition to another.
8. # **Stellar Evolution -**  
Changes in planets and stars from their origin to death.
9. # **Inorganic evolution -** The matter, elements change in time called Inorganic evolution.