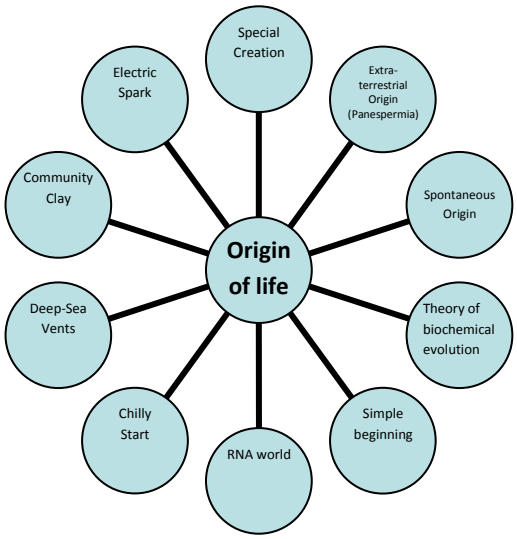
Theories of Origin of Life

The origin of life means the emergence of heritable and evolvable self-reproduction. “Origin of Life” is a very complex subject, and oftentimes controversial. Two opposing scientific theories that existed on this complex subject for a long time were the so-called *intelligent design* and *creationism*. The *big bang theory* of the origin of the Universe gave new ideas about the topic of biological evolution. It has been hypothesized that complex life-forms on Earth, including humans, arose over a period of time from simple bacteria-like tiny cells by a process of self-organization akin to the evolution of the Universe by self-organization of simple material structures (i.e,

fundamental particles produced by the big bang) toward more and more complex structures. There are several theories about the origin of life.



It is a very difficult task to find the theory involves behind the origin of life. Some important theories have been discussed here:

1. **Special creation:** Life formation on the earth may have been taken place due to supernatural or divine forces. There are different kinds of accreditations by different religions.

- ***HINDU CONCEPT:*** The whole world, plants, oceans, rivers, humans, animals are created by Lord Brahma.

- ***CHRISTIAN & ISLAM CONCEPT:*** God created the universe, human beings, plants, oceans and rivers in six days. All the plants and animals were created at once. All the living organisms were created in the same form as they exist today.

The theory of special creation also suggests that Diversity of life form will not change in future. This theory of origin of life has no scientific explanations.

2. **Extraterrestrial origin:** This theory is given by Richer in 1865 and also known as cosmozoic theory. Panspermia means "seeds everywhere". This hypothesis states that the "seeds" of life exist all over the Universe and can be propagated through space from one location to another. Some believe that life on Earth may have originated through these "seeds" i.e***. Life formation did not take place on earth. It took place somewhere else in the space or on any other planet and carried to the earth.*** Mechanisms for panspermia include the deflection of interstellar dust by solar radiation pressure and extremophile microorganisms traveling through space within an asteroid, meteorite or comet.

For example, rocks regularly get blasted off Mars by cosmic impacts, and a number of Martian meteorites have been found on earth that it is controversially stated that microbes brought over here, potentially making us all Martians originally. It is also suggested that life might have carried from comets.

Three popular variations of the panspermia hypothesis are:

Litho panspermia (interstellar panspermia) - impact-expelled rocks from a planet's surface serve as transfer vehicles for spreading biological material from one solar system to another.

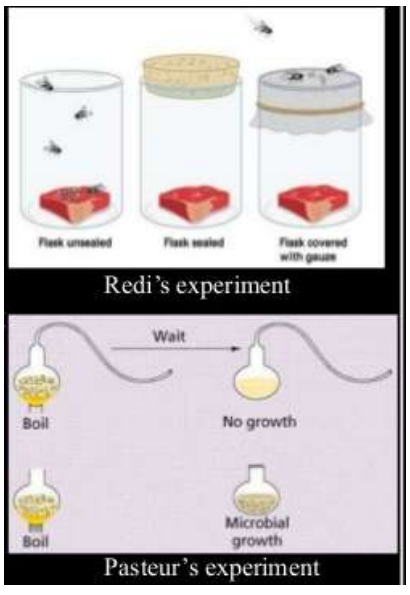
Ballistic panspermia (interplanetary panspermia) - impact-expelled rocks from a planet's surface serve as transfer vehicles for spreading biological material from one planet to another within the same solar system

Directed Panspermia - the intentional spreading of the seeds of life to other planets by an advanced extraterrestrial civilization, or the intentional spreading of the seeds of life from Earth to other planets by humans.

Panspermia does not provide an explanation for evolution or attempt pinpoint the origin of life in the Universe. The panspermia hypothesis gives no explanation for how life that arrived on Earth came to be. Even if we are able to show that life on Earth was a result of panspermia, the question of where and how life originated will be a lot harder to answer.

3. **Spontaneous origin:** Life may have evolved from non-living matter as association with prebiotic molecules under primitive earth conditions, became more and more complex. This theory suggests that life could come from nonliving things, decaying and rotting matter like straw, mud, etc. Several experiments have been conducted to disprove spontaneous generation.

In 1668, Francesco Redi a scientific experiment to test the spontaneous creation of maggots by placing fresh meat in three different jars. He found the maggots in open jar and on the exterior surface of the cloth that covered the jar. No maggots were found in the sealed jar. Redi successfully demonstrated that the maggots came from fly eggs and thereby helped to disprove spontaneous generation.



Louis Pasteur rejected the theory of spontaneous generation and demonstrated that life came from pre-existing life. In his experiment, he kept killed yeast cells in pre-sterilised flask and another flask open into air. The life did not evolved in the former but new living thing evolved in the later flask.

Several other experiments like Needham's experiment, Spallanzani's Experiment etc. have been performed which disprove the theory of spontaneous origin. Spontaneous generation is the incorrect hypothesis that nonliving things are capable of producing life.

4. Theory of Biochemical Evolution:

Several models for the origin of life have been suggested. The first 'modern' model for the origin of life was presented in the 1923 independently by the Russian biochemist A. I. Oparin and later supported by the British evolutionary biologist J. B. S. Haldane in 1928. The Oparin and Haldane theory is known as biochemical theory for the origin of life.

According to the Oparin-Haldane model, life could have arisen through a series of organic chemical reactions that produced ever more complex biochemical structures. They proposed that common gases in the early Earth atmosphere combined to form simple organic chemicals, and that these in turn combined to form more complex molecules. Then, the complex molecules became separated from the surrounding medium, and acquired some of the characters of living organisms. They became able to absorb nutrients, to grow, to divide (reproduce), and so on.

The biochemical origin of life can be studied in three catogeries:

A) Chemical Evolution of life:

1. Formation of Simple inorganic compounds

The atmosphere of primitive earth had various elements like hydrogen, oxygen, carbon, sulphur, phosphorous, nitrogen etc. These free atoms combine to form molecules and simple inorganic compounds like ammonia, water vapour, HCN etc.

2. Formation of simple organic molecules

The simple inorganic compounds formed in atmosphere interacted and combined to produce simple compounds such as simple sugars, purines, pyrimidines, amino acids, etc. The source of energy for chemical reaction might be solar radiations such as UV rays, lightening, radiations from radioactive rocks and heat of earth. The simple organic compounds forms reached the ocean with rainwater.

3. Formation of complex organic molecules

The simple organic molecules have undergone polymerization to form complex organic molecules like protiens, nucleic acids, amino acids etc in oceanic water. Formation of these molecules plays a key role in the chemical evolution of life. The oceanic water rich in mixture of organic compounds.

B) Biological evolution of life

Formation of life initiated from the ocean containing organic compounds.

1. Formation of Coacervate

The complex organic molecules of primordial soup in ocean aggregated together through the colloidal system and bounded by water layer were called coacervates. They can grow by absorbing nutrients. They have the power of self growing and dividing by budding like bacteria. They are intermediate between molecule and organism. Some of the proteins within coacervates acted as enzymes and began metabolic activities.

2. Formation of primary living organism

The coacervates presumably obtained energy by fermentation from the oceanic soup. They were anaerobes. They depended on the existing organic molecules for their nutrition.

3. Origin of Autotrophs

When supply of existing organic compounds was exhausted, some of the heterotrophs might have evolved into autotrophs. These organisms were capable of synthesizing their own organic compounds by chemosynthesis. They were therefore chemoautotrophs. They develop the chlorophyll through which the autotrophs can prepare the food. Oxygen evolved during the photosynthesis and started to accumulate in atmosphere.

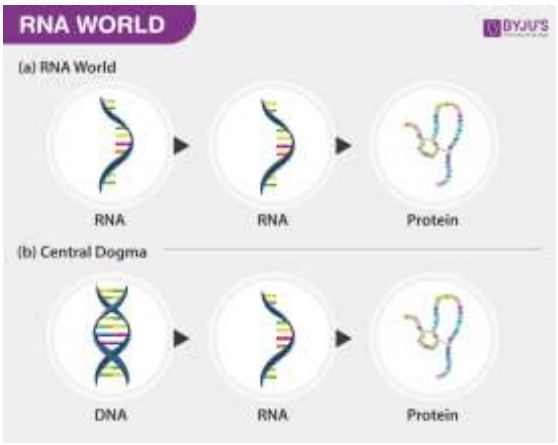
C) Cognogeny

With gradual increase in the number of heterotrophs as they consumed nutrients of the ocean, there became a declination in organic nutrients. So they began to search other alternatives for obtaining food. During photosynthesis, solar energy was trapped by light trapping pigment called chlorophyll. In this way several other organisms evolved (prokaryotic, anaerobic etc.). With the increase meant in number of photoautotrophs O_2 released in great extent in ocean and came into atmosphere. Now an oxidising type atmosphere has been formed. Then prokaryotes gradually modified to be adapted to the aerobic mode of respiration. Gradually many types of algae, fungi, protozoa and other organic living organisms developed.

5. Simple Beginnings: Instead of originating from complex molecules like RNA, DNA, life might have begun with small and simple molecules

interacting with each other in cycles of reactions. These reactions might have been change a simple capsule to cell membranes and over time more complex molecules or cells. This is the most simple of the standing theories, and is difficult to dismiss.

6. **RNA world:** In the formation of life DNA, RNA and proteins play important role. DNA can store genetic information and proteins can catalyze the reactions. But RNA can do both the jobs. RNA has the self-replicating properties. The RNA world theory suggests that life on Earth began with simple RNA molecule that could copy itself without help from any other molecule. The compelling feature of RNA World is that a primordial molecule provided both catalytic power and the ability to propagate its chemical identity over generations. Pieces of RNA have been made that can copy RNA strands longer than themselves, supporting the idea that the first life was based on self-replicating RNA, not DNA.



7. **Chilly start:** Ice might have covered the oceans 3 billion years ago, as the sun was three times less luminous than it now. This layer of ice, possibly hundreds of feet thick, might have protected fragile, organic compounds in the water below from ultraviolet light and destruction from cosmic impacts. The cold might have also helped these molecules to survive

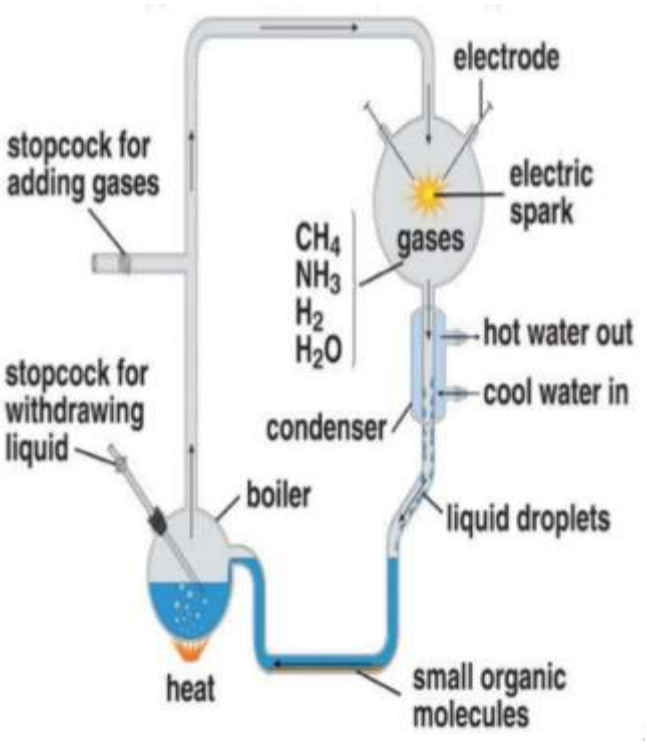
longer, allowing reactions to happen. The enzyme does not yet copy itself. The main barrier seems to be the folded structure that allows it to copy other RNA. The RNA enzyme's effectiveness at cold temperatures suggests ice was crucial to the first life. When a mix of RNA and metal ions freezes, growing ice crystals suck up the water, leaving tiny pockets of RNA. At cold temperatures, RNA strands often stick together, making it tricky to separate them after the RNA has been copied. Ice freezes and melts all the time, so you can easily see how an RNA replicator could be enclosed, released and allowed to spread.

8. Deep-Sea Vents: This theory suggests that life arose deep in the ocean within warm, rocky structures called hydrothermal vents. This theory suggests that life may have begun at submarine hydrothermal vents and ejecting hydrogen rich molecules. Their rocky nooks could then have concentrated these molecules together and provided mineral catalysts for critical reactions. These vents are rich in chemical and thermal energy. Deep-sea hydrothermal vents are porous geological structures produced by chemical reactions between solid rock and water. Alkaline fluids from the Earth's crust flow up the vent towards the more acidic ocean water, creating natural proton concentration differences remarkably similar to those powering all living cells.

9. Community Clay: The first molecule of life, hydrocarbon, might have met on the clay. These surfaces might not only have concentrated these organic compounds together but also helped organize them into patterns much like our genes. Mineral crystals in clay could have arranged organic molecules into organized patterns. Clay minerals played a key role in chemical evolution and the origins of life because of their ability to take up, protect (from UV radiations), concentrate, and catalyse the polymerization of organic molecules. Clay minerals can also store and replicate structural defects and ionic substitutions and act as 'genetic candidates'. So the minerals and organic molecules in the layers of clay would favour the formation and replication of biological molecules (e.g. enzymes, polynucleotides) and favour the possibility of origin of life through this theory.

10. Electric Spark: Lightning may have provided the spark needed for life to begin. There are two distinct versions of the spark of life theory. The first of these versions holds that the first form of life came into existence following "one spark" or on one particular "spark day." The other version argues that life came into existence, or rather emerged, following prolonged sparking rather one specific spark. Electric sparks can generate amino acids and sugars from an atmosphere loaded with water, methane, ammonia and hydrogen, as described in Miller Urey experiment. This suggests that

lightning might have helped create the key building blocks of life on Earth in its early days. Over time larger molecules could form as a result of this.



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