

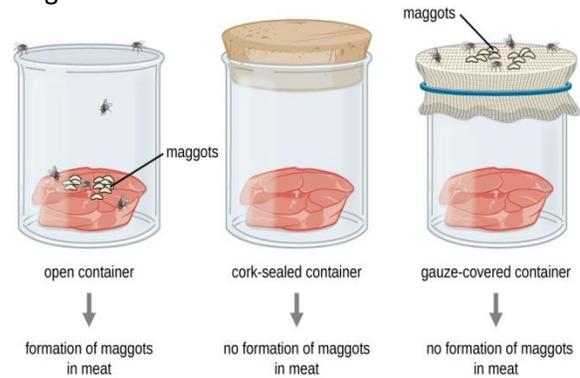
Core Course II: Biomolecules and Cell Biology
Course Code: BOTACOR02T

Unit: 4 The Cell (Part 2)

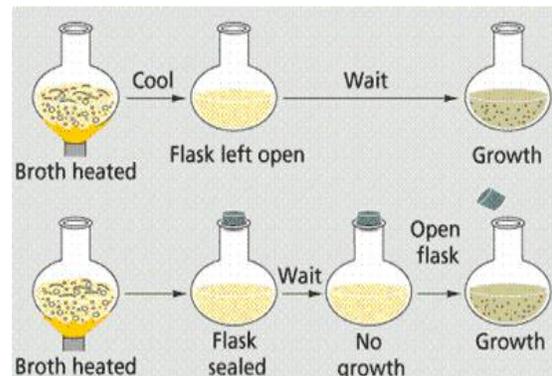
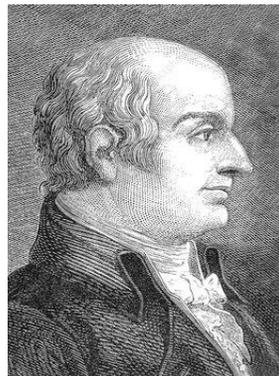
❖ **Formation of Eukaryotic Cells:**

• **Concept about Biogenesis:**

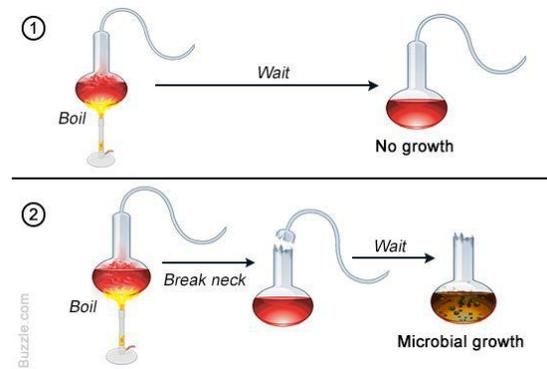
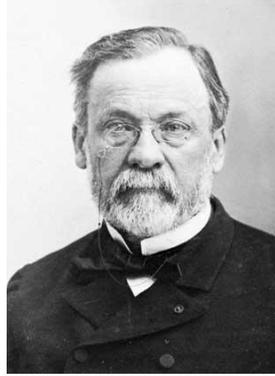
- **Biogenesis** is the formation / **development of new organisms from preexisting / old organism**. It was supported by maximum pioneer scientists by their experimental proofs.
- **Experiment by Francisco Redi (1668):** On exposed surface of meat piece, small flies are seen to fly known as maggots. But he proved that, if the meat piece remains inside of a covered container maggots unable to develop above meat surface. Hence, life is not formed abiotically, obviously they developed from their parents present at surrounding environment.



- **Experiment by Lazzaro Spallanzani (1769):** In laboratory microbes are allowed to grow within the nutrient rich liquid medium known as nutrient broth. Spallanzani in his experiment took two containers with nutrient broth and boiled the broth to kill preexisting microbes within the broth. Then kept the one container in open condition another in leaded condition. Observed microbes are developed inside of broth of open container. Hence, he reestablished the theory of Redi.



- **Experiment by Louis Pasteur (1859):** He also reestablished the theory of Redi. His experiment was modification of Spallanzani's experiment. He used the round bottom flasks with S shaped neck. Through this type of neck only air can pass (help in respiration of microbes) but microbes cannot pass inside of the vial. He proved within the broth only microbes able to grow if the neck breaks.

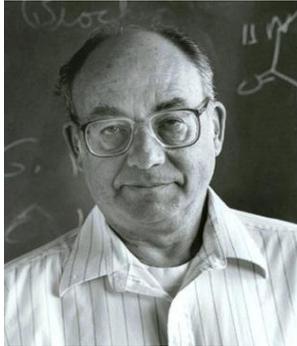


- **Concept about Abiogenesis:**

- Abiogenesis is the formation of **life forms from non living matters**, more specifically from the organic substances. Also it is known as **Spontaneous Generation of Life**.

Concept of abiogenesis comes when scientists started to search the background of formation of life.

- According to this theory life was formed due to conversion of organic substances over prolonged period. It is known as Chemical Evolution. Hence, **the reason of Spontaneous Generation of Life in the earth is Chemical Evolution**. It was supported by many new age scientists, like **Miller & Urey, Sidney Fox and James Watson etc.**



Abiogenesis concept as well as formation of life, the prolonged process can be explained in two different phases according to their chronological order – formation of RNA world and Endosymbiotic hypothesis.

❖ **Formation of RNA world:**

- Cells are composed of four types of macromolecules – **carbohydrates, proteins, lipids and nucleic acids** (DNA+RNA). Chemically all macromolecules are composed of four types of atoms – **C,H,O and N**. Actually all of these compounds are polymeric in nature, their unit forms are –

Name of the Macromolecules of the cell	Name of unit of Macromolecules
Carbohydrates / Polysaccharides	Simple sugar / Monosaccharide
Proteins	Amino Acids
Lipids	Fatty Acids + Glycerol
Nucleic Acids	Nucleotides (Pentose sugar + Nitrogen base+ Phosphoric acid)

- Macromolecules form the different part of the cell structure and having different functions –

Name of the Macromolecules of the cell	Functions (major)
Carbohydrates / Polysaccharides	Matrix of cell (Cytoplasm), nucleus (Nucleoplasm), mitochondria, plastid.
Proteins	Matrix of cell (Cytoplasm), nucleus (Nucleoplasm), mitochondria, plastid.
Lipids	Formation of all types of membranes.
Nucleic Acids	Genetic material, responsible for inheritance.

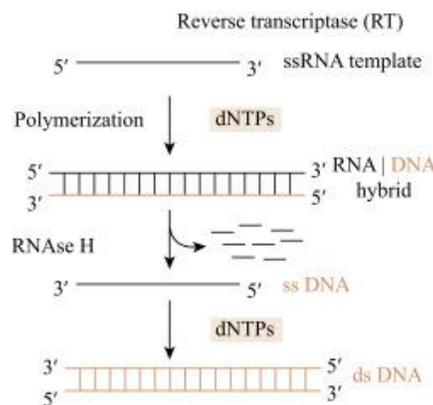
- **Oparin (1924)** proposed that the cells are developed due to reaction of **water vapor, ammonia (g) and methane (g)**. As a result of the reaction a **colloidal substance** was developed known as **Coacervate** (contains C,H,O and N). Coacervate particles were self replicable. Finally because of natural selection of Coacervate particles (which one will survive and which not) modern cells are derived. It was the explanation of Chemical Evolution according to him.
- Oparin's hypothesis was correct, first time proved by **Miller and Urey (1953)**. They performed their experiment by three gases - **water vapor, methane and ammonia**. When these gases react with each other in **presence of electrical energy** (similar as sunlight energy; sunlight = electromagnetic ray) results the formation of **Amino acids**. So, from this discovery they assumed the chemical nature of Coacervate was protein in nature.
 Apart from that, in absence of water vapor **ammonia and methane** react to form the **HCN and Cyanoacetelene**. In next step, HCN+Cyanoacetelene react among themselves to form the **nitrogen bases**. Hence, it indicated the tendency of formation of nucleic acids within the Coacevate particles.
- **Sidney Fox (1964)** by their experiment confirmed that **amino acids join with each other to form the protein in presence of heat energy**. His experiment was also accepted because during formation of earth sun was preexisting structure and was the principal source of energy.
 Actually Fox proved that **colloidal diameter (10^{-4} - 10^{-7} micron) is satisfied by the protein structure**. Single amino acid having much lesser diameter respect to it. Hence, chemically Coacervate was composed of protein.
- **Watson et al. (1986)** explained how other atoms enter inside of the cell (Coacervate). According to them, **formation of Coacervate was inside of aqueous medium**, more

specifically in ocean. Because cellular atoms apart from C, H, O and N all remain in earth crust. So entry of those atoms only possible if the **colloidal structure remain in submerged condition inside of water due to the mechanism of imbibitions by colloidal particles.**

- Hence, in ocean all atoms enter within the Coacervate and started to react with each other to form the simple sugars, fatty acids, glycerol, nucleotides etc. So, unit structures are also joined to each other to make macromolecular forms, which are known as **Probiotic Synthesis** (formation of polymeric structures).
- After probiotic synthesis the colloidal structure is called **ProtoCell / Progenote**.
- Hence, formation of protoCell took place inside of sea water as a result of numerous chemical reactions over prolonged period. On that time sea water environment explained by scientists as **Hot Dilute Soup**.
- In pioneer stage, during formation of nucleic acid, it is expected that single stranded RNA was prepared prior to the double stranded DNA. So, all ProtoCell was with RNA as their genetic material. Because of why first phase of cell appearance on the earth is known as **RNA world**.

❖ **Endosymbiotic Hypothesis:**

- It was proposed by **Lynn Margulis (1970)**. According to him, **recent day cells are developed from ProtoCells by the endocytosis mechanism**. His hypothesis also explains the development of nuclear membrane outside of nucleic acid.
- At first step, **RNA** of the protoCells is **converted into DNA** by a **special type of protein** (enzyme), which is recently known as **reverse transcriptase**. Enzyme is a type of protein which does not form the cellular structure (like matrix) but acts like biocatalyst of the cell. There are different types of enzymes having independent function; reverse transcriptase is the category of enzyme having the capacity to formation RNA to DNA. It is also known as **RNA dependent DNA polymerase**.



- After formation of DNA, ProtoCells are then termed as **Prokaryotic cells**. So, all prokaryotic cells have DNA as their genetic element.
- **Prokaryotic cells were of two types**, one type was capable of formation of simple sugars and oxygen using the CO₂, H₂O and sunlight energy because of presence of one special type of pigment inside of their cells known as chlorophyll. So, the chlorophyll containing cells were **photosynthetic i.e. autotrophic**. On other hand **non chlorophyllous cells were heterotrophic** as they had no capacity to make simple sugars (as food material).

- **Non chlorophyllous** cells again were of two types on the basis of their **oxygen intake capacity**. One group of them were capable of intake oxygen known as **aerobic cells / aerobes** and another group were opposite to it known as **anaerobic cells / anaerobes**.
- At second step, in case of **anaerobic heterotrophic ones**, external membrane (**cell membrane**) **started to fold inside and surrounds the centrally placed genetic material of the cell to form the nucleus**. Its authenticity is proved by the presence of double membranous **nuclear membrane**.
- At third step, **nucleus containing anaerobic cells start to engulf (endocytosis mechanism) the other two types** (i.e. autotrophic prokaryotes and aerobic heterotrophic cells) in selective manner to form the recent eukaryotic cells.
- Actually **autotrophic prokaryotes inside of the cell form the plastid** and **aerobic heterotrophic ones mitochondria**. It is also proved as true due to presence of DNA inside of plastid and mitochondria (as organelle DNA).
- Selective endocytosis indicates, the anaerobic ones **which engulfed both types, plant cells were developed** from that cell and those anaerobic ones **which engulfed only aerobic heterotrophic cells, animal cells are developed** from that cell.
- But in case of all prokaryotic ones above mentioned evolution does not took place till now. So, they remain in **free condition in the nature as anaerobic bacteria, aerobic bacteria and photosynthetic bacteria**.

Prokaryotic Cell types		Inside of the cell	In nature (free condition)
Autotrophic / Photosynthetic		Plastid	Photosynthetic Bacteria or, Blue Green Algae.
Heterotrophic / Non Photosynthetic	Aerobic	Mitochondria	Aerobic Bacteria.
	Anaerobic	Cytoplasm & Nucleus.	Anaerobic Bacteria.

