

Cell Structure and Function Question Set #1

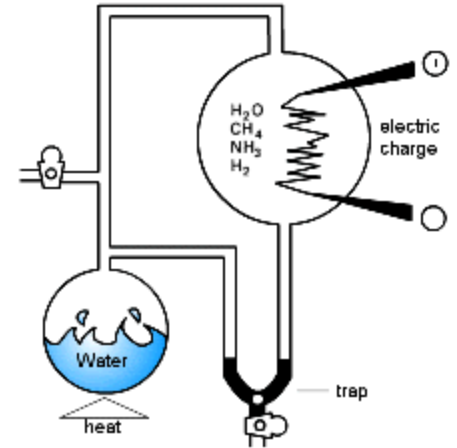
1. Read the attached article "On the Origin of Cells: From Molecules to the First Cell Simple Biological Molecules Were Formed Under Prebiotic Conditions"
2. Discuss the significance (or give your interpretation) of this paragraph.
3. Give the job for the following organelles:
 - a. Nucleus
 - b. Ribosomes
 - c. Endoplasmic reticulum
 - d. Golgi Apparatus
 - e. Lysosome
 - f. Cell Membrane
 - g. Mitochondria
 - h. Vacuoles
 - i. Cytoplasm
 - j. Centrioles
 - k. Nucleolus
 - l. Chloroplast
4. Define:
 - a. Prokaryote
 - b. Eukaryote
5. Construct a two sided chart that compares prokaryotes with eukaryotes. Consider:
 - a. cell size
 - b. reproduction
 - c. DNA structure
 - d. Nucleolus
 - e. Ribosomes
 - f. Mitochondria
 - g. golgi apparatus
 - h. vacuoles
 - i. endoplasmic reticulum
 - j. cell wall
 - k. and any 2 other characteristics of your own choice
6. Make a list of different types of *cells* (not parts of cells!) - and briefly describe each cell.
7. Illustrate any one type of cell on unlined paper and in pencil.
8. Have the parts of the cell neatly lined up and labelled.
9. Write a short paragraph, on the sheet, about what is unique to your cell, or possibly what its job is.
10. Consider whether or not cells might change in the future. If so, what are the possibilities?

On the Origin of Cells: From Molecules to the First Cell

Simple Biological Molecules Were Formed Under Prebiotic Conditions

During the first billion years on earth, there was little free oxygen and no ozone to absorb UV radiation from the sun. Yet, simple organic molecules were formed under such harsh conditions. Laboratory experiments simulating the primitive earth have confirmed that organic molecules could have been formed. When gases such as CO_2 , CH_4 , NH_3 , and H_2 were heated with water and energized by electrical discharge or by UV radiation, they reacted and formed small organic molecules. More importantly, the organic molecules that were crucial to life (amino acids, nucleotides, sugars, and fatty acids) were also generated.

The picture on the right shows the experimental simulation of prebiotic conditions. Water is heated in a closed apparatus containing CH_4 , NH_3 , and H_2 , and an electric discharge is passed through the vaporized mixture. Organic compounds accumulated in the U-tube trap.

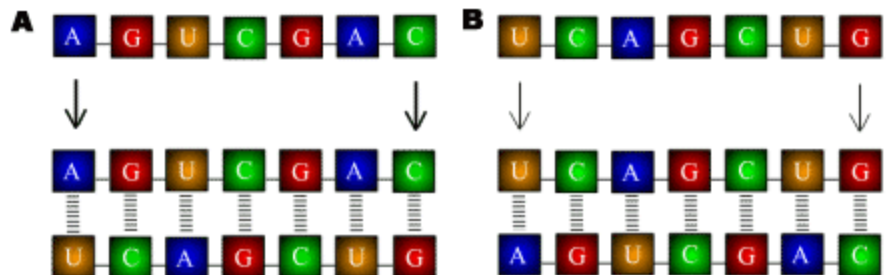


Polymers Containing Nucleotides Are Capable of Self-replication

Organic molecules such as amino acids and nucleotides can interact to form polymers. The polymer of amino acids and nucleotides are called polypeptides and polynucleotides respectively. These polymers are capable of directing their own synthesis. For example, a polynucleotide is able to influence the replication of other polynucleotides by acting as a template.

The complementary nature of nucleotides is crucial in the origin of life. Because A preferentially binds to U and G preferentially binds to C, a polynucleotide is thus able to serve as a template for synthesizing the complementary strand. However, this complementary templating mechanism only occurs slowly without the assistance of certain protein catalysts, or enzymes. Although no such enzyme existed in the "prebiotic soup," certain minerals and metal ions filled in the role of enzymes. After a period of time, slow replicating systems of polynucleotides were established.

Replication of polynucleotide sequence. In step A, the original RNA acts as a template for making the complementary sequence. In step B, the complementary strand of RNA acts as a template for reproducing the original RNA sequence. This process is repeated to generate many copies of the original RNA.



Natural Selection Helps to Shape the Self-Replication Systems

Just as a polynucleotide can serve as the template for synthesis of the complementary strand, specific portions of a polynucleotide can also pair with free complementary nucleotides within itself. This self-complementary binding allows the polynucleotide to form specific structures. Much like proteins, this structure determines a polynucleotide's stability and ability to replicate.

While polynucleotides can self-replicate, their replication is not always error free. Errors during replication could influence the polynucleotide sequence and subsequently result in a different structure. Therefore, as polynucleotides undergo numerous cycles of replication, the ones that have received more beneficial mutations will survive over the ones that received non-favorable mutations.

Polynucleotides Became The Blueprint for Polypeptides

It has been hypothesized that between 3.5 and 4 billion years ago, self-replicating systems of polynucleotides began the process of evolution. Different strands of polynucleotides competed for resources to ensure their own reproduction. Since then, polynucleotides can no longer depend on slow replication aided by primitive catalysts. To ensure the accuracy and efficiency of their own replication, polynucleotides have adapted polypeptides as catalysts to aid their reproduction. Therefore polynucleotides and polypeptides became intertwined in their evolutionary struggle for survival. The details regarding how polynucleotides became capable of directing synthesis of specific polypeptides (protein synthesis) is still unknown. However, many research efforts are directed toward understanding that mysterious leap in the origin of life.

The First Cell

In order to ensure the survival of a species of polynucleotide, newly synthesized polynucleotides must be retained in the same area. Also, the polypeptide that was used to facilitate the synthesis of polynucleotide must also be kept in the same vicinity. To achieve this purpose, present-day cells are surrounded by a plasma membrane that envelops the internal organelles of the cell. Current research has suggested that the first cell was formed when phospholipid molecules spontaneously assembled into a membrane structure under the primitive conditions. The oligonucleotides were then able to evolve and natural selection was able to select the cells with the most efficient system of replication machineries.