**Origin of Life Review Sheet**

**SC.912.L.15.8 Describe the scientific explanations of the origin of life on Earth**

Scientists who study the origins of life think that the path to the development of living things began when molecules of nonliving matter reacted chemically during the first billion years of Earth’s history. These chemical reactions, energized by the Sun and volcanic heat, produced simple, organic molecules that later formed more complex molecules that eventually became the building blocks of the first cells.

Spontaneous Generation was thought to be the Origin of Life until the late 1850's. It wasn't until Frenchman Louis Pasteur that this fallacy was finally disproved. In 1859, the French Academy of Science sponsored a Science Fair, the goal being to prove or disprove Spontaneous Generation. Young Pasteur's award winning experiment was a clever variation of earlier experiments performed by John Needham (1713-1781) and Lazzaro Spallanzani (1729-1799). Pasteur filled a long necked flask with meat broth. He then heated the glass neck and bent it into an "S" shape. Air could reach the broth, but gravity acted to trap airborne microorganisms in the curve of the neck. He then boiled the broth. After a time, no microorganisms had formed in the broth. When the flask was tipped so that the broth reached the microorganisms trapped in the neck, the broth quickly became cloudy with microscopic life. Thus, Pasteur disproved Spontaneous Generation. Furthermore, Pasteur proved that some microorganisms are airborne.

In the 1920s, the Russian scientist A. I. Oparin and the British scientist J.B.S. Haldane both suggested that Earth’s early oceans contained large amounts of organic molecules. This hypothesis became known as the primordial soup model. Oparin and Haldane hypothesized that the organic molecules in Earth’s vast oceans formed spontaneously through chemical reactions in the early atmosphere activated by energy from solar radiation, volcanic eruptions, and lightning.

In 1953, the primordial soup model was tested by Stanley Miller and Harold Urey. Miller placed the gases thought to have existed on early Earth into a device made up of glass tubes and vessels. To simulate lightning, he provided electrical sparks. After a few days, Miller found a complex collection of organic molecules, including some of life’s basic building blocks: amino acids, fatty acids, and other hydrocarbons. These results support the hypothesis that some basic chemicals of life could have formed spontaneously under conditions similar to those in the experiment.

S.W. Fox of the University of Miami has demonstrated that if a nearly dry mixture of amino acids is heated, polypeptide molecules are synthesized. Similarly simple sugars could form polysaccharides and fatty acids could combine to produce fats. Amino acids could form proteins, when other factors were involved.

Thus the small simple organic molecules combined to form large complex organic molecules, e.g., amino acid units joined to form polypeptides and proteins, simple sugar units combined to form polysaccharides, fatty acids and glycerol united to form fats, sugars, nitrogenous bases, and phosphates combined into nucleotides which polymer­ized into nucleic acids in the ancient oceans.

Single celled organisms existed 3.8 billion years ago. The first organisms on Earth were most likely anaerobic prokaryotes. One theory of eukaryotic evolution, endosymbiosis, was proposed by Biologist Lynn Margulis. The theory of endosymbiosis proposes that early mitochondria and chloroplasts were once simple prokaryotic cells that were taken up by larger prokaryotes about 1.5 billion years ago. This relationship would have had its advantages. If it took in a prokaryote that acts as a mitochondria, the larger cell got energy in the form or ATP. If it took in a prokaryote that acted as a chloroplasts, the larger cell could use photosynthesis to make sugars. In exchange, the mitochondria and the chloroplasts found a stable environment and nutrients. Margulis based here theory on several factors:

* Mitochondria and chloroplasts have their own DNA and ribosomes
* They are able to copy themselves within the cells they are found
* They are the same size as prokaryotes
* Their DNA forms a circle, and their gene structures are similar to that of prokaryotes.

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| **Scientist Name** | ***Summarize how their contribution aided in the explanation of the origin of life.*** |
| Pasteur |  |
| Oparin |  |
| Miller and Urey |  |
| Margulis |  |
| Fox |  |

1. The Miller-Urey experiment showed that, under certain conditions, organic compounds could form from inorganic molecules. What is one consequence of this experiment?
2. Scientists think that life could not have developed through natural chemical and physical processes.
3. The experiment proved that methane and ammonia will always give rise to organic molecules in any circumstance.
4. Scientists think it is possible that organic compounds formed from the inorganic compounds present on Earth billions of years ago.
5. The experiment used the exact inorganic compounds present on Earth billions of years ago and left little doubt about the mechanism of early life.
6. One of the accepted scientific theories describing the origin of life on Earth is known as chemical evolution. According to this theory, which of the following events would need to occur first for life to evolve?
7. **onset of photosynthesis**
8. **origin of genetic material**
9. **Synthesis of organic molecules**
10. **formation of the plasma membrane**
11. Which types of organisms developed first due to the early environmental conditions on Earth?
12. **prokaryotic and aerobic**
13. **prokaryotic and anaerobic**
14. **eukaryotic and aerobic**
15. **eukaryotic and anaerobic**
16. The Miller-Urey experiment of 1953 was designed to test the hypothesis that lightning supplied the energy needed to turn atmospheric gases into organic molecules such as amino acids. Which of the following describes why the Miller-Urey theory is widely accepted today?
17. **Amino acids spontaneously form from molecules in the atmosphere today.**
18. **Organic molecules are present today in extremely high concentrations.**
19. **The process of synthesizing organic molecules from a mixture of gases has been successfully modeled in the laboratory.**
20. **No other alternative hypotheses have been introduced.**
21. The diagram below shows a proposed theory of the origin of eukaryotic cells, called endosymbiosis.



Which of the following explains why cells that contained mitochondria-like organelles had an evolutionary advantage?

1. **They were able to photosynthesize**
2. **They had more DNA**
3. **They were able to make more use of available energy**
4. **They were immune to bacterial invasion.**
5. **Scientists hypothesize that complex organic molecules could have assembled in the environment of early Earth because**
6. **these molecules are found assembling under the conditions present today.**
7. **there are no other alternative hypotheses.**
8. **this process has been successfully modeled in the laboratory**
9. **these molecules were present at extremely high concentrations**
10. **In the evolution of eukaryotes, cells that contained mitochondria-like organelles had an advantage because they**
11. **could make use of photosynthesis**
12. **could make use of more available energy**
13. **had more DNA**
14. **were protected from bacterial invasion.**