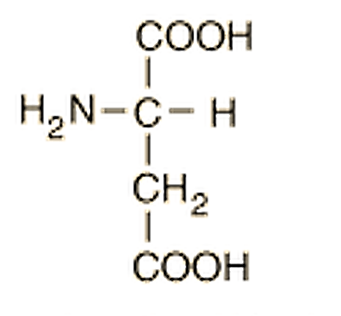
**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period\_\_\_\_\_\_\_\_**

**Understanding Abiogenesis**

In 1920 Oparin and Haldane proposed a reducing atmosphere hypothesis for early earth. In 1953 Miller and Urey devise a way to test this hypothesis by recreating the proposed reducing atmosphere as well as replicating the proposed lightning energy source. The products of this experiment were biomolecules essential to life or important precursors to those molecules. This experiment provided support for Abiogenesis or life arising from nonlife.

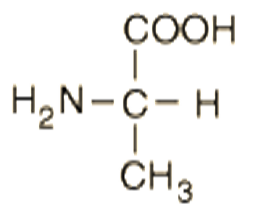
**Biomolecules (or Precursors) Produced by Abiogenesis Experiments**



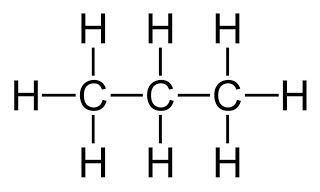
C4H7NO4

Aspartic acid

C3H7NO2

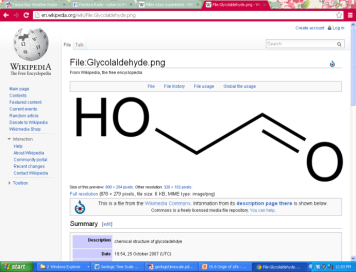


Alanine



Propane

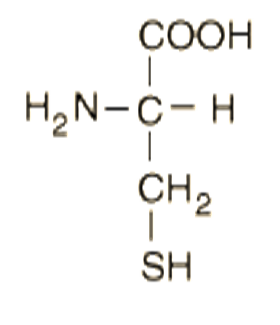
C3H8



Glycolaldehyde

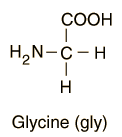
C2H6O2

C3H7NO2S

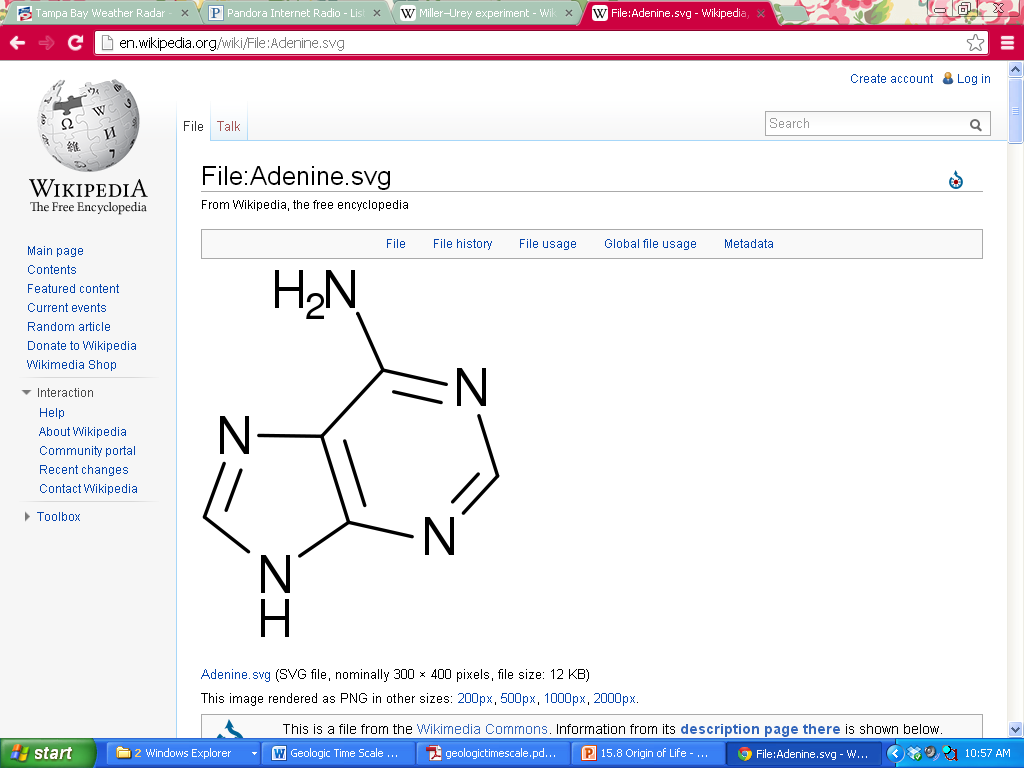


Cysteine

C2H5NO2

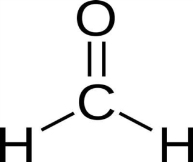


Glycine



Adenine

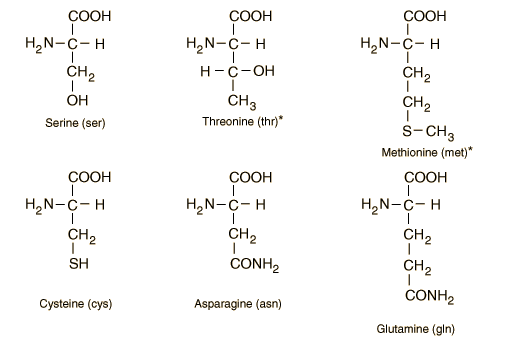
C5H5N5



Formaldehyde

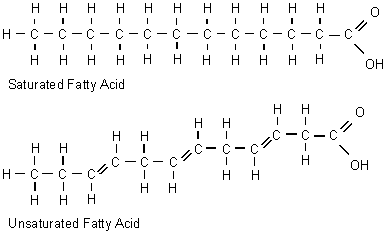
CH2O

C5H11NO2S



Methionine

Fatty Acid



CH3(CH2)10COOH

1) Examine the molecules produced in the Abiogenesis experiments. Categorize their importance to life into the chart below based on the structure of each. Be sure to draw and label the molecule in each appropriate column.

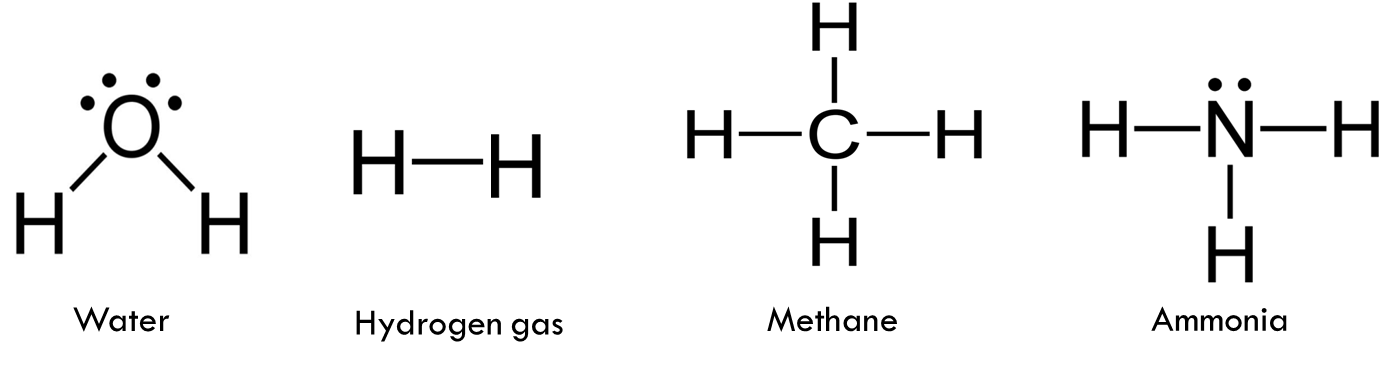
\*Hints have been inserted into each column to help you.

|  |  |  |  |
| --- | --- | --- | --- |
| **Carbohydrates**  **(CxH2Ox)** | **Lipids**  **(Hydrocarbons: C backbone bonded to many H’s)** | **Proteins**  **(Amino Acids: Central Carbon bonded to H, NH2, COOH and variable group)** | **Nucleic Acids**  **(Nitrogenous bases: purines- double C & N ring, Pyrimidines- single C & N ring)** |
| Glycolaldehyde  C2H6O2  Formaldehyde  CH2O | Fatty Acid  CH3(CH2)10COOH  Propane  C3H8 | C5H11NO2S  Methionine  C3H7NO2S  Cysteine  C2H5NO2  Glycine  C4H7NO4  Aspartic acid  C3H7NO2  Alanine | Adenine  C5H5N5 |

2) Why were these molecules so important to the formation of life?

|  |
| --- |
| These molecules form the building blocks of life- they make up the four categories of biomolecules (or percursors to those) necessary to building cells.  Carbohydrates- energy and structure (formaldehyde and glycolaldehyde are precursors to sugars)  Lipids- cell membranes, energy (propane is a basic hydrocarbon which is a precursor to lipids, fatty acids are necessary components of phospholipids which make up cell membranes and triglycerides which are important lipids involved in energy storage)  Proteins- structure, catalysis, transport, etc (Methionine is an especially important amino acid as it is the initiation amino acid during protein synthesis for eukaryotes as well as archeans- the extremophiles that were among the first living organisms.  Nucleic Acids (DNA/RNA)- cell reproduction, protein synthesis/ genetic expression (adenine is a nitrogenous base involved in the structure and genetic coding of DNA; it is also a vital component of the energy molecule ATP) |

The inorganic molecules present in the Miller-Urey laboratory atmosphere (H2O, H2, CH4, NH3), are shown below.

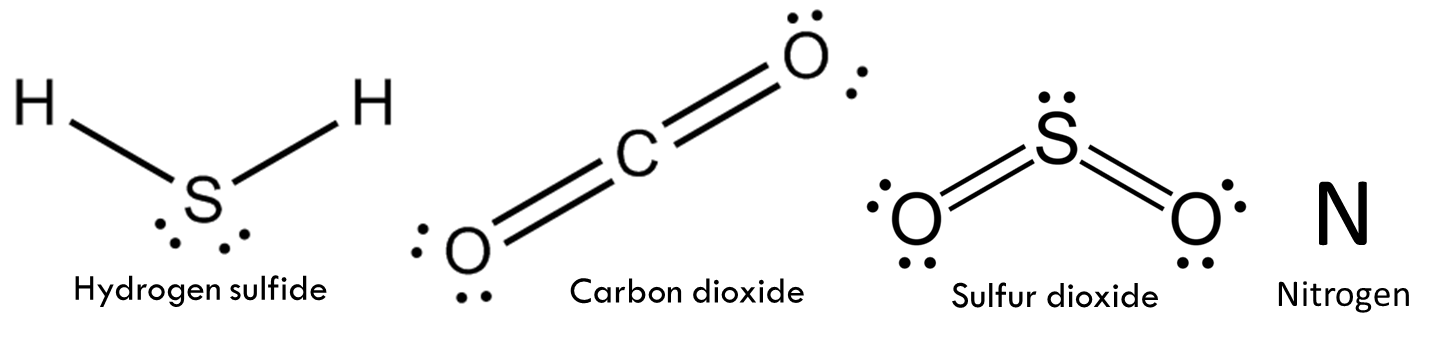


3) Examine the chart “Biomolecules Produced by Abiogenesis Experiments” and determine for each molecule listed which molecules in Miller’s laboratory atmosphere would have come together to create these biomolecules.

*\*\*\*Shown below are some possible student answers.\*\*\**

|  |  |
| --- | --- |
| Biomolecule Produced | Possible Inorganic Molecules Needed to Build Biomolecule |
| Propane  C3H8 | Methane  **H-H** Hydrogen gas |
| Glycolaldehyde  C2H6O2 | Methane  Water |
| C3H7NO2  Alanine | Methane  Water  Ammonia |
| C4H7NO4  Aspartic acid | Methane  Water |
| Formaldehyde  CH2O | Methane  Water |
| Adenine  C5H5N5  C2H5NO2  Glycine | Ammonia  Methane  Water |
|  | Ammonia  Methane  Water |
| Fatty Acid  CH3(CH2)10COOH | Methane  Water |

Some evidence suggests that Earth's original atmosphere may have differed from the one proposed by the Urey Miller Experiment. There is abundant evidence of major volcanic eruptions 4 billion years ago, which would have released carbon dioxide(CO2), nitrogen(N), hydrogen sulfide (H2S), and sulfur dioxide (SO2) into the atmosphere.  Experiments using these gases in addition to the ones in the original Miller–Urey experiment have produced more diverse molecules.



4) Examine the molecules remaining on the “Biomolecules Produced by Abiogenesis Experiments” chart and determine if the molecules available in this revised atmosphere could have played a part in their formation.

Complete the chart for these molecules as before.

*\*\*\*Shown below are some possible student answers.\*\*\**

|  |  |
| --- | --- |
| Biomolecule Produced | Possible Inorganic Molecules Needed to Build Biomolecule |
| Sulfur dioxide  C3H7NO2S  Cysteine | Ammonia  Methane |
| C5H11NO2S  Methionine | Methane  Ammonia  Sulfur dioxide |

5) The following are statements about the nature of science. For each evaluate how the Miller-Urey Experiment as well as later experiments discussed supports these statements.

A) Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

|  |
| --- |
| Science is limited to investigating the natural world and therefore unable to investigate supernatural phenomena or religious dogma which are neither tangible nor repeatable in nature. The products of science (probable explanations for natural phenomena) are always based on observations carefully analyzed and tested. The  Abiogenesis experiments investigate the natural phenomena of life through observations and repeatable experimentation. Oparin and Haldane began with observation of the nature of chemistry and life and hypothesis, Miller and Urey were able to test that hypothesis in a lab many times, and later scientists were able to further these experiments as new data/observations became available. |

B) Scientific knowledge is durable and robust, but open to change.

|  |
| --- |
| The initial data favored water, hydrogen gas, methane and ammonia being present in an early reducing atmosphere and this is the scenario that Miller and Urey tested. More recent data suggests volcanic activity played a major role in contributing sulfurous molecules into the atmosphere. Scientists have adapted this information into more recent tests and experiments using these gases in addition to the ones in the original Miller–Urey experiment have produced more diverse molecules. |