Vista Murrieta High School
AP Biology
G. Nicholas

Molecules of Life Lab

Molecules of life refer to the four macro-molecules that all life depends on. They include carbohydrates, lipids, proteins, and nucleic acids.

Carbohydrates
Carbohydrates make up a large percentage of molecules that we find in cells; they are typically used for energy. Carbohydrates generally take on the empirical formula of CH_2O, which, upon closer examination, is why they are called carbohydrates....C (carbo) H_20 (hydrate or water) ☞ C + H_2O. To examine the macromolecules, we first must examine a water molecule, then we will examine three classes of carbohydrates: monosaccharides, disaccharides, and polysaccharides. By examining these molecules you will also be able to understand the differences between molecular and structural formulas as well as the terms synthesis, dehydration, and isomerism.

Students should work at desk groups to complete this lab.

Water
1) What elements make up water?
2) Build a structural model of water.
3) Draw the structural formula of a water molecule here

4) Write the chemical formula for water.

5) Draw the structural formula of water showing all bonds, lone pairs of electrons and explain why it is a polar molecule.

Carbohydrates
- Single sugars or monosaccharides

1) What elements make up a carbohydrate?

2) What is the ratio of these elements?

3) Using your smart device or a book, draw the structural formula of glucose and fructose in a ring structure below.

4) Build a structural model of glucose and fructose in a ring structure.

5) Write the molecular formula of glucose.

6) Write the molecular formula for fructose.

7) What do you notice about the two formulas?

8) What do we call the above molecules with respect to their chemical and structural formulas?

- Disaccharides and Polysaccharides

9) Using your smart device or the book, draw a the structural formula for sucrose.

10) What two molecules are joined to form sucrose?

11) Based on your drawing, what molecule must leave in order for the disaccharide to form?

12) What do we call this kind of chemical reaction?

Now separate the two molecules:

13) What molecule must be brought back in for the reaction to occur?

14) What do we call this type of reaction?

15) What do we call a molecule made of three or more monosaccharides?

16) Using your smart device or the book, name two specific types of these molecules.

17) What is the common name for these types of molecules?

18) Say we had 125 monosaccharides joined together. How many waters of hydration would be released in making this molecule?

19) Explain specifically why this is called a dehydration synthesis.

20) What do we call the bond between two monosaccharides?

Lipids

Fats, oils, and waxes are also known as lipids. Just like carbohydrates, lipids only have carbon, hydrogen and oxygen in there chemical structure, however, at very different ratios. Remember, carbohydrates have a carbon, hydrogen, oxygen ratio of 1:2:1, respectively. As you will see, lipids contain very little oxygen, but can generate a lot of energy when combined with oxygen. For this reason, they are a very good source of stored energy for organisms. Fat molecules have two distinct parts. They are usually a combination of an alcohol (remember what an alcohol is) usually glycerol, and a class of long chain molecules known as fatty acids.

1) What is an alcohol?

2) What is the chemical equation for:
    a) methanol

    b) ethanol

    c) glycerol

3) Build a chemical model for glycerol
    a) How many carbons are there in glycerol?

    b) How many -OH groups are in glycerol?

    c) How many hydrogens are in glycerol?

4) Using your smart device or your book, draw Butyric Acid.

5) What substitution group is in butyric acid?

6) Build three butyric acid molecules

7) Make a fatty acid by connecting the three butyric acid molecules to glycerol

8) What is the name of this molecule?

9) What molecule has to come off each time a fatty acid is joined to the glycerol molecule?

10) What is the name of this reaction?

11) Write a chemical formula that shows this reaction.

12) What molecule(s) are formed if a triglyceride is catabolized (broken apart)?

13) What is the name of this reaction?

Proteins

Proteins occur in two basic types: structural proteins are, well, structures, like hair, skin, muscle, blood, organs, etc. Regulatory proteins are enzymes and hormones that help to control chemical reactions needed to maintain homeostasis. Proteins are polymers of amino acids and are comprised of an amino group (NH_2) and a carboxylic acid (COOH). There are about 20 different amino acids that make up proteins; all amino acids have the same basic structure, but differ at their respective radical (**R**) sites.

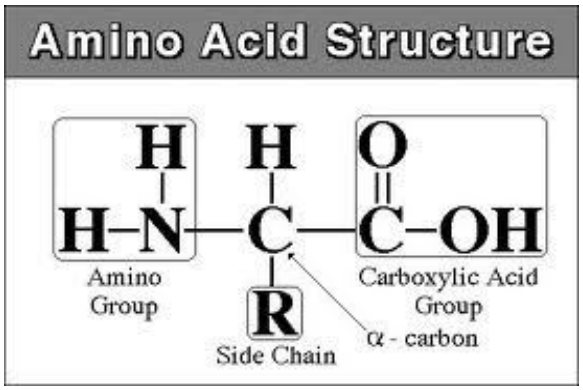

Figure 1: general structure of an amino acid

1) Using the above diagram as a guide, build the general structure of an amino acid and leave the radical open.

2) What is the molecular formula for the amino group?

3) What is the molecular formula for the carboxylic acid?

4) Now add a hydrogen to the R position, what is the name of this amino acid?

5) Build another amino acid and add a methyl group to the R position, what is the name of this amino acid?

6) What is similar about these amino acids?

7) What is different about these amino acids?

8) Using the above information, write a statement that describes the similarities and differences of all amino acids.

9) Connect the two amino acids by using the following diagram as a guide. What molecule is released as the two amino acids join?

10) What is the name of this reaction?

11) What molecule would need to come back into the reaction if you catabolized two joined amino acids?

12) What is the name of this reaction?

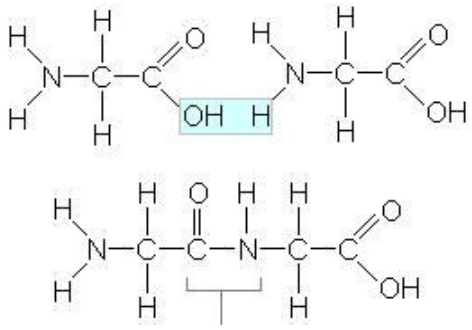

Figure2: connection of two amino acids

13) What is the name of the bond that is formed when two amino acids are joined?

14) Suppose 1326 amino acids joined to form the primary structure of a protein. How many of these bonds would form?

15) How many waters would be released in the above reaction?

16) What does that tell you about the relationship of the bond and waters leaving when forming the polymer?

17) What is another name for the primary structure of the polymer that is formed by joining several amino acids?

18) What are the forms of the secondary structures of proteins?

19) What element(s) are necessary for proteins to form the secondary structures of proteins?

20) What are the forms of the tertiary structures of proteins?

21) What element(s) are necessary for proteins to form the tertiary structures of proteins?

22) What are the forms of the quaternary structures of proteins?

23) What element(s) are necessary for proteins to form the quaternary structures of proteins?

24) Make a statement that describes the need for water with respect to the formation and catabolism of carbohydrates, lipids, and proteins.