McMush Lab
Testing for the Presence of Macromolecules

Carbohydrates, lipids, proteins, and nucleic acids are organic molecules found in every living organism. These macromolecules are large carbon based structures. The macromolecules are assembled by joining several smaller units, called monomers, together through a chemical reaction called dehydration synthesis. The resulting polymer can be disassembled through the complimentary process called hydrolysis.

Carbohydrates are made of carbon, hydrogen and oxygen atoms in a 1:2:1 ratio. This means that for every carbon atom present in the carbohydrate there are two hydrogen atoms and one oxygen atom present. The monomers for carbohydrates are referred to as monosaccharides. When many monosaccharides are chained together the resulting molecule is called a polysaccharide. Carbohydrates are used by living organisms as an important source of energy. Examples of carbohydrates include glucose, fructose, sucrose, galactose, ribose, deoxyribose, cellulose and chitin.

Lipids are also made of carbon, hydrogen and oxygen but the ratio of carbon, hydrogen, and oxygen is not 1:2:1. Instead, lipids have a much higher number of carbons and hydrogens with few oxygen atoms present. The nonpolar bonds that form between the carbon and hydrogen atoms of a lipid cause them to be hydrophobic, or water-repellent, molecules. This explains why water and oil do not mix. The large number of carbon to hydrogen bonds also serves to make lipids energy rich storage molecules. One gram of lipid stores twice as much energy as one gram of a carbohydrate. Lipids from animals are referred to as fats and are solids at room temperature, while those found in plants are referred to as oils which are liquids at room temperature. Fats and oils are made of smaller units called triglycerides which are composed of a glycerol and three fatty acid molecules. One important relative of true lipids are the phospholipids. Phospholipids differ in structure from regular lipids in that phospholipids are made of a glycerol and two fatty acids joined by a phosphate group. This arrangement makes phospholipid molecules have both hydrophilic and hydrophobic regions. This feature makes phospholipids an ideal structural component of the plasma membrane of cells. Steroids are another significant group of lipids. They differ slightly in structure because the carbon atoms are arranged in four rings. Examples of steroids include cholesterol, estrogen, testosterone and morphine.

Proteins are composed of amino acids which are composed of atoms of carbon, hydrogen, oxygen and nitrogen. Proteins serve as the major building blocks of organisms. Proteins are large complex molecules that combine to form various components of living organisms such as muscle fibers, enzymes, and hemoglobin. Proteins are made of unique combinations of the twenty amino acid monomers. A string of amino acid monomers joined together by peptide bonds is called a polypeptide.

PURPOSE

This lab activity provides an opportunity for the development of skills involved in chemically testing for the presence of the carbohydrates, lipids and proteins found in food samples. You will learn how to test for the presence of proteins using the Biuret test. to test for the presence of monosaccharides using the Benedicts test, to test for the presence of starches using Lugol's solution and to detect the presence of lipids using Sudan III. Once familiar with the detection techniques, you will apply those techniques to a

slurry that has been made by blending a complete Happy Meal. Using the skills that you have developed you should be able to determine which organic compounds are present in the slurry.

MATERIALS

McDonald's Happy Meal™ McMush slurry
~~gelatin solution~~
~~glucose solution~~
~~starch solution~~
2 beakers or plastic cups
Benedict's solution in dropper bottle
Lugol's iodine in dropper bottle
6-8 test tubes
graduated cylinder
2 test tube holders
hot water bath
Biuret Reagent in dropper bottle
Sudan III in dropper bottle

Safety Alert

1. Goggles and aprons should be worn at all times during this lab investigation.
2. Point test tubes away from all people when heating samples.
3. Handle hot test tubes with test tube clamps.

PROCEDURE

PART I: TESTING FOR MONOSACCHARIDES

1. Benedict's solution can be used to detect the presence of monosaccharides. In the presence of a monosaccharide like glucose, Benedict's solution will change color from blue to orange when heated. Place 5 mL of the glucose solution into your test tube. Add 3 mL of Benedict's solution. Place the tube in a beaker of boiling water and boil for five minutes. Use test tube clamps to hold hot test tubes. Note any change in color.

2. Rinse out your test tube and record your results for the glucose test in Data Table 1.

3. Using the Benedict's solution test, determine whether or not the McMush slurry contains any monosaccharides and record you findings in Data Table 2.

PART II: TESTING FOR STARCHES

1. Lugol's solution can be used to test for the presence of the polysaccharide or starch. In the presence of starch, the Lugol's solution will change color from amber to a dark blue. Place 5 mL of the starch solution into your test tube. Add 5 drops of Lugol's iodine solution. Observe the change in color.

2. Rinse out your test tube and record your results for the starch test in Data Table 1.

3. Using the Lugol's solution, determine whether or not the McMush slurry contains starch. Record your findings in Data Table 2.

PART III: TESTING FOR PROTEINS

1. Biuret's reagent can be used to test for the presence of protein. Place 5 mL of the gelatin solution into your test tube. Add 10 drops of Biuret's reagent. The gelatin is a protein-rich solution and will test positive for the presence of protein. Biuret's reagent will change color from yellow to blue-violet in the presence of protein.

2. Rinse out your test tube and record your results for the protein test in Data Table 1.

3. Using the Biuret's test for protein, test the McMush slurry to determine whether or not protein is present. Record your findings in Data Table 2.

PART IV: TESTING FOR LIPIDS

1. Sudan III can be used to detect the presence of lipids. In the presence of a lipid rich solution and water, Sudan III will diffuse through the solution producing an orange-pink color. Add 5 mL of water and 5 mL of oil to a clean test tube. Add 5 drops of Sudan III to the test tube. Record your observations in Table 1.

2. Rinse out your test tube and record your results for the lipid test in Data Table 1.

3. Using the Sudan III test, determine whether or not the McMush slurry contains lipids. Record your findings in Data Table 2.

Name _____

Period _____

McMush Lab
Testing for the Presence of Macromolecules

DATA AND OBSERVATIONS

Data Table 1: Positive Tests Performed on Knowns		
Test Performed	**Substance Tested**	**Results**
Benedict's Test		
Lugol's Test		
Biuret Test		
Sudan III		

Data Table 2: McMush Tests	
Test Performed	**Results**
Benedict's Test	
Lugol's Test	
Biuret Test	
Sudan III	

CONCLUSION QUESTIONS

1. How are monomers and polymers different?

2. What are the monomers for each of these macromolecules?
   a. Carbohydrates-_____
   b. Lipids-_____
   c. Proteins-_____

3. Circle any of the following compounds that would be classified as carbohydrates.
   a. amino acids
   b. triglycerides
   c. glucose
   d. hemoglobin
   e. fructose
   f. hemoglobin
   g. chitin
   h. starch

4. If you were given an unknown food sample and asked to identify its contents, which test would you use to determine the presence of
   a. Lipids-_____
   b. Proteins-_____
   c. Glucose-_____
   d. Starch-_____

5. Which macromolecule groups were found in the McMush slurry?

6. What portion of the Happy Meal may have provided each of these macromolecules?
   a. Lipids-_____
   b. Proteins-_____
   c. Glucose-_____
   d. Starch-_____

7. Jonathan and Molly performed a similar lab except that in their lab they tested a slurry made from crackers. Their results show that crackers contain both protein and fat. After checking the cracker package, the students were surprised to find that protein and fat are not listed on the nutritional label. No other groups in their class have results that show protein and fat present in the sample. Describe three factors that could contribute to their erroneous results:

8. Predict which macromolecules should be present in the following food substances and indicate which test you would apply in order to detect the presence of that macromolecule. You may need to consult additional resources.

Food Substance	Predicted Macromolecule	Test to be used
a. Potato juice		
b. Cracker		
c. Egg white		
d. Honey		

9. Design and describe an experiment to test for the presence of carbohydrates, lipids, and proteins in a taco.