

CHAPTER 2: MCMUSH LAB – TESTING FOR THE PRESENCE OF BIOMOLECULES

Objectives: Analyze the results of indicator solutions to test for the presence of biomolecules that could be found in a McDonald's Happy Meal

Background / Pre-Lab Reading:

Cells are made up of small molecules like water, ions such as sodium and magnesium, and large carbon-based molecules. There are four important types of large carbon-based molecules in living organisms – **proteins, carbohydrates (sugars and starches), lipids (fats), and nucleic acids**. Proteins, carbohydrates, and fats serve as nutrients in the food that we eat.

Nucleic acids are made of monomers called **nucleotides** that make up the information storing molecules in our cells, DNA. While we consume DNA when we eat other plants and animals, the DNA from our cells is copied each time our cells divide, it is not something that we must consume in our diets, though the building blocks to make new DNA are synthesized from materials we do consume. In this activity, we will not be testing for the presence of nucleic acids.

Carbohydrates are used by living organisms as an important source of energy. **Simple carbohydrates** are made of carbon, hydrogen, and oxygen atoms in a 1:2:1 ratio. This ratio means that for every one carbon atom present in the carbohydrate, there are two hydrogen atoms and one oxygen atom present. The **monomers** of carbohydrates are referred to as **monosaccharides**. Common examples of monosaccharides include glucose, fructose, galactose, ribose, and deoxyribose. Sucrose, or table sugar, and lactose, the sugar found in milk, are double sugars made from two monosaccharides. **Benedict's Solution** can be used to test for the presence of a monosaccharide, like glucose. In the presence of glucose, Benedict's Solution turns from blue to orange when heated (orange is positive, blue is negative).

When many monosaccharides join together, the resulting molecule is called a **polysaccharide**. Important polysaccharides include cellulose, starch, and chitin (also known as starches). **Lugol's Solution (Iodine)** can be used to test for the presence of a polysaccharide, like starch. In the presence of starch, Lugol's Solution turns from amber to dark blue (dark blue is positive, amber is negative).

Lipids are also made of carbon, hydrogen, and oxygen but the ratio of carbon, hydrogen, and oxygen atoms is not 1:2:1. Instead, lipids have a much greater number of carbon and hydrogen atoms with few oxygen atoms present. their individual subunits (monomers) are fatty acids and glycerol. **Lipids** are organic compounds that do not dissolve in water, examples include fats, oils, and the wax covering leaves.

The **nonpolar** bonds that form between the carbon and hydrogen atoms of a lipid cause them to be **hydrophobic** or "water repellent" molecules, as opposed to **hydrophilic** or "water loving" molecules. This attribute explains why water and oil do not mix. **Sudan III Solution** can be used to test for the presence of a lipid. In the presence of a lipid-rich solution and water, Sudan III Solution forms a distinct layer or clump in the well or test tube (layers or clumps is positive, no layers or clumps is negative).

The large number of carbon to hydrogen bonds also serves to make **lipids** energy-rich storage molecules. One gram of a lipid stores twice as much energy as one gram of carbohydrate or protein. Lipids from animals are referred to as **fats** and are solid at room temperature, whereas those found in plants are referred to as **oils**

and are liquid at room temperature. Fats and oils are **triglycerides**, which are biomolecules that are composed of a **glycerol** and three **fatty acids**. One important relative of triglycerides are **phospholipids**. Phospholipids differ in structure from regular triglycerides in that phospholipids are made of a glycerol and two fatty acids. A charged phosphate group replaces the third fatty acid. The arrangement causes phospholipid molecules to have both **hydrophilic** and **hydrophobic** regions. This feature also makes phospholipids an ideal structural component of cell membranes.

Proteins are made of monomers called **amino acids**, which are composed of atoms of carbon, hydrogen, oxygen, and nitrogen. Proteins are large and complex molecules that combine to form various components of living organisms such as muscle fibers, enzymes, and hemoglobin. Proteins are made from specific sequences of amino acids. A string of amino acid monomers joined together by peptide bonds is called a **polypeptide**.

Biuret's Solution can be used to test for the presence of protein. In the presence of protein, Biuret's Solution turns from blue to violet (violet is positive, blue is negative).

Pre-Lab Questions:

1. How are **monomers** and **polymers** different?

After reading the background information above, complete the following table to summarize the major organic molecules, their functions, and examples that might be found in the Happy Meal

Biomolecule	Monomer	Function	Examples
Carbohydrates			
Lipids			
Proteins			
Nucleic Acids			

Biomolecule	Test Reagent	Positive Test Color	Negative Test Color
Monosaccharides			
Polysaccharides			
Proteins			
Lipids			

Procedure:

- Gather 8 test tubes in a test tube rack and follow the procedures below for each biomolecule test.

SAFETY ALERTS

- Goggles and aprons must be worn at ALL times in the lab and long hair must be pulled back!
- Always handle test tubes with a test tube holder when transferring to and from the hot water bath
- Wash hands thoroughly following the lab and report any broken glass to your teacher immediately

PART I: TESTING FOR MONOSACCHARIDES

1. Place 5 mL of the glucose solution into a clean test tube.
2. Add 3 mL of Benedict's solution.
3. Using a test tube holder, place the tube in a beaker of boiling water and boil for 5 minutes or until a color change to orange occurs.
4. Record the color of the solution and your results for the glucose test in Table 1. Save your test tube for comparison – this is your control.
5. Place 5 mL of the hamburger meal slurry into another, **different** clean test tube. Repeat Step 2 and Step 3, and record your results in Table 1.

PART II: TESTING FOR STARCHES / POLYSACCHARIDES

1. Place 5 mL of the starch solution into a clean test tube.
2. Add 5 drops of Lugol's solution. Observe the change in color.
3. Record the color of the solution and your results for the starch test in Table 1. Save your test tube for comparison – this is your control.
4. Place 5 mL of the hamburger meal slurry in another clean test tube. Repeat Step 2 and Step 3, and record your results in Table 1.

PART III: TESTING FOR PROTEINS

1. Place 5 mL of the gelatin solution into a clean test tube.
2. Add 10 drops of Biuret's reagent. The gelatin is a protein-rich solution and should change color in the presence of protein.
3. Record the color of the solution and your results for the protein test in Table 1. Save your test tube for comparison – this is your control.
4. Place 5 mL of the hamburger meal slurry in another clean test tube. Repeat Step 2 and Step 3, and record your results in Table 1.

PART IV: TESTING FOR LIPIDS

1. Place 5 mL of water and 5 mL of oil into a clean test tube.
2. Add 5 drops of Sudan III to the test tube. Observe the results.
3. Record the color of the solution and your results for the lipid test in Table 1. Save your test tube for comparison – this is your control.
4. Place 5 mL of the hamburger meal slurry in another clean test tube. Repeat Step 2 and Step 3, and record your results in Table 1.

Record your test results in the data table on the following page. You must have your teacher CHECK YOUR RESULTS before you clean out your test tubes or you will have to repeat your experiment!

Data and Results:

Biomolecule	Control Substance Tested	Control Test Result	McMush Slurry Test Result
Monosaccharides			
Polysaccharides			
Proteins			
Lipids			

Conclusion Questions:

2. If you were given an unknown food sample and asked to identify its contents, which test reagent would you use to determine the presence of each of these biomolecules?
 - a. Lipids
 - b. Proteins
 - c. Glucose sugar
 - d. Starch
3. Which biomolecule groups were found in the Happy Meal? Explain using your data.
4. What portion of the children's hamburger meal may have included each of these biomolecules?
 - a. Lipids
 - b. Proteins
 - c. Glucose sugar
 - d. Starch
5. Jonathan and Molly performed a similar experiment 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 possible factors that could have contributed to their erroneous results.