Name	Period	Date

Food Chemistry: The Identification of Macromolecules

Unknown Sample #_____

Introduction:

All living things are made up of macromolecules. These macromolecules include **carbohydrates, lipids, proteins, and nucleic acids. Monosaccharides** are the simplest form of **carbohydrates**. Glucose is a **monosaccharide** that circulates in your blood and provides energy to your body. Starch and cellulose are **polysaccharides** that are produced by plants. When you digest starches from the food that you eat, they are broken down into **monosaccharides,** making energy available to your body.

About 15% of your body is made up of **lipids** which are fats that are insoluble in water. Fats commonly found in humans are triglycerides, phospholipids, and steroids. These **lipids** have different functions within your body such as long-term energy storage, formation of cell membranes, and regulation of hormonal changes. Another 17% of your body is made up of **proteins** which perform a variety of functions throughout your body. They can be structural proteins, **enzymes** (which catalyze reactions), or signaling proteins.

Many of these **macromolecules** are obtained through the food that we eat. Usually, most of the nutrients that are eaten are absorbed in the body. But, sometimes, when people are sick, these **macromolecules** might pass through the body without being absorbed and end up being eliminated in our urine. Sometimes, when you are sick, the doctor might order a urinalysis, a test that looks at the presence of different **macromolecules** in your urine. Urinalysis can often reveal diseases that often go unnoticed such as diabetes.

You are going to be given a "urine" sample from a patient. You will use 4 different tests to determine whether the sample contains sugar, starch, lipids, or protein. Once you have analyzed the sample, you will then determine whether the patient should undergo further tests or whether they are perfectly healthy.

Materials:

1 unknown patient "urine" sample
Iodine solution (starch indicator)
Biuret reagent (protein indicator)
Benedict's solution (glucose indicator)
Brown paper towel (lipid indicator)
Pipettes
12 Test tubes
Test tube rack
Test tube holders
Warm water bath
Marker
Distilled water
1% glucose solution
1% starch solution
Egg white
Lipid (oil)
Waste Beaker
Goggles

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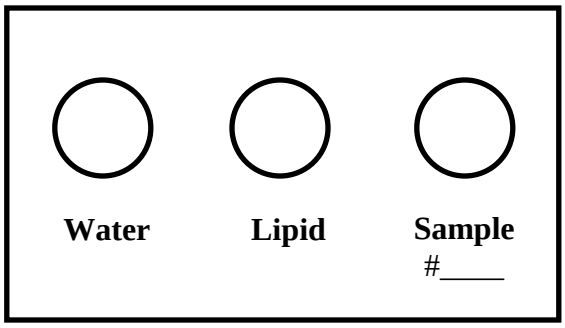
Procedure:

Working in the urinalysis laboratory, you are responsible for determining the results of your patient's urine test by testing for the presence of **macromolecules.**

(1)Lipid test

a. Obtain a brown paper towel and label it with water, lipid and your sample number.
b. Place two drops of water on the paper towel next to the word *water*, place 2 drops of the lipid next to the word *lipid* and place two drops of your sample next to the *sample* name.
c. Set this aside and wait for it to dry.
d. After *several* minutes, if you can detect a grease spot on the paper, then the sample contains lipids.
e. Record the results in your data table.
f. What is the water in this experiment? _____



(2)Simple sugar test (Monosaccharide)

a. Label test tube #1 water. Add 2 mL of water to that test tube. This is your *negative* control.
b. Label test tube #2 1% glucose. Add 2 mL glucose to your test tube. This is your *positive* control.
c. Label a test tube #3 with your sample number. Add 2mL of the urine sample to the test tube.
d. Add 5 drops of **Benedict's solution** to each tube and mix well.
e. Place test tubes in warm water bath for 3 minutes.
f. Record any color change in your data table.

(3)Starch test

a. Label test tube #1 water. Add 2 mL of water. This is your *negative* control.
b. Label test tube #2 starch solution. Add 2 mL of starch solution. This is your *positive* control.
c. Label a test tube #3 with your sample number. Add 2 mL of the urine sample to the test tube.
d. Add 4 drops of **iodine** to each tube and mix.
e. Record any color change in your data table.

(4)Protein test

a. Label test tube #1 water. Add 2 mL of water. This is your *negative* control.
b. Label test tube #2 egg. Add 2 mL of egg. This is your *positive* control.
c. Label test tube #3 with your sample number. Add 2 mL of the urine sample to the test tube.
d. Add 4 drops of Biuret's reagent to each tube. Mix.
e. Record any color change in your data table.

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What macromolecules tell you about health:

To be able to absorb nutrients from food you eat, your digestive system must break down the polymers into their constituent monomers by using enzymes (type of proteins which *catalyze* or speed up chemical reactions). This process of breaking chemical bonds in the macromolecules by adding a water molecule is called *hydrolysis.* When monomers form a chain of polymers by removing a water molecule, the process is called *dehydration synthesis.* These two chemical processes are essential for the human body to maintain health and homeostasis.

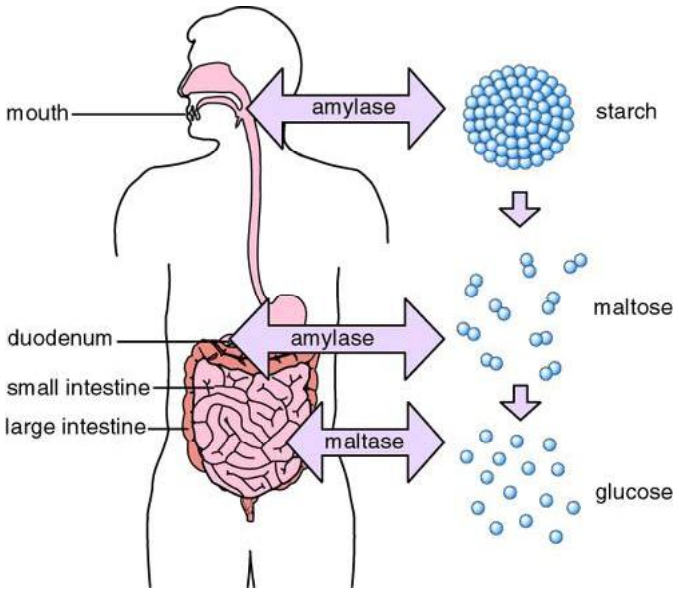
Urine, which is produced by the kidneys, is an indicator of health. If substances found in urine are too high, then the results could suggest that the body is not functioning as it should. The kidneys help to filter out all of the nutrients (protein, sugars, and lipids) from your blood and unneeded water is eliminated as a part of urine. Therefore, in a "normal" urine sample, there should be very little protein, sugar, or lipid.

If there are high levels of **protein** found in the urine, this could be caused by *nephrotic syndrome*. This occurs when the kidneys are damaged, causing them to leak protein into the urine. There are a number of underlying causes for nephrotic syndrome, so additional tests should be done if protein is found in the urine. The type of protein that is detected can also provide some clue as to what is going on in the patient.

Less than 0.1% of glucose (a simple sugar) normally appears in the urine. If excess sugar (glucose) is found in the urine, this is likely caused by diabetes, a disease in which a person no longer produces insulin or is insensitive to it. Insulin is a hormone that tells cells in the body to make glucose into glycogen which is stored in the liver until it is needed. In diabetic patients, because insulin signaling is defective, the levels of sugar in their blood may get extremely high (hyperglycemia) or low (hypoglycemia), and this can cause some of the excess sugar to be leak into the urine.

Although lipids are not normally found in the urine, certain medical conditions can cause the excretion of cholesterol, triglycerides, and phospholipids. In addition to diseases that affect kidney functions, taking certain medications can injure the kidneys and lead to the presence of lipid in the urine. For example, antibiotics like gentamicin can injure the tubes of the kidney, causing the body to eliminate phospholipids in the urine.

Starches are not normally found in the urine, even in patients with kidney disease. That is because starches are broken down into glucose during digestion. The digestion of starch begins in the mouth by the enzyme *amylase* and is completely hydrolyzed by the enzyme *maltase* in the intestine.



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Directions: **Complete the answers on the right based on the questions on the left.**

Question	*Answer*
(1) What macromolecules were present in your unknown urine sample?	
(2) What was the purpose of having a positive and negative control for each test?	
(3) How do the controls help you to determine the presence of macromolecules even if you did not know exactly how the test works?	
(4) Is your patient healthy or should they undergo further tests? (see article on the next page)	
(5) If they should undergo further tests, then explain your initial diagnosis? In other words, what could be wrong?	
(6) Carbohydrates contain elements carbon, hydrogen, and oxygen. Proteins are made up of carbon, hydrogen, oxygen, and nitrogen while lipids are mostly comprised of carbon and hydrogen. What type of chemical bond forms between the atoms of these macromolecules? Explain.	
(7) Explain the role of enzymes in chemical reactions.	

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Data Table:

Sample # _____

Lipid			
	Can you see through paper?		Is lipid present?
Water			
Sample _____			
Sugar (Glucose)			
(Light blue to orange)	Describe color change		Is sugar present?
	Initial Color	**Final Color**	
Water			
1% glucose			
Sample _____			
Starch			
(rust to blue-black)	Describe color change		Is starch present?
	Initial Color	**Final Color**	
Water			
1% starch			
Sample _____			
Protein			
(periwinkle to lavender)	Describe color change		Is protein present?
	Initial Color	**Final Color**	
Water			
Egg white (Albumin)			
Sample _____			

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Macromolecules Graphic Organizer

Directions: There are 4 classes of macromolecules: carbohydrates, proteins, lipids and nucleic acids. Each macromolecule has its own unique characteristics and each is also necessary for the survival of living things. Fill in the missing information below to highlight some of these characteristics.

Macromolecule	Function	Structure	Monomer (Building Block) 	Polymer (Chain) 
Carbohydrate  			 (2-sugar)	
Protein 				

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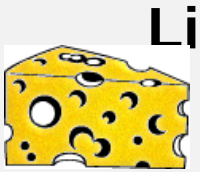
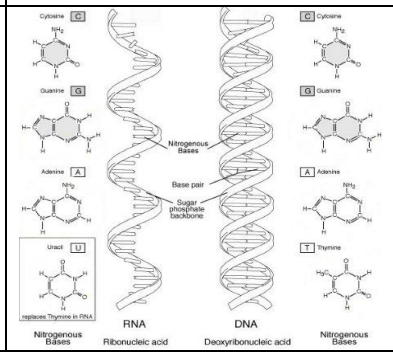
Macromolecule	Function	Structure	Monomer (Building Block) 	Polymer (Chain of monomers) 
Lipid   				
Nucleic Acid				

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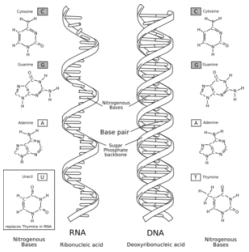
Macromolecule Notes: Fill in the missing information below

<table>
<tr><td rowspan="2">Macromolecules are made up of 4 classes:</td><td>1)
  </td><td>2)
  </td></tr>
<tr><td>3)
  </td><td>4)
  </td></tr>
<tr><td>Monomers Make Polymers during

_____</td><td colspan="2">Draw and Describe <u>Dehydration Synthesis</u></td></tr>
<tr><td>Polymers Break to Make Monomers during

_____</td><td colspan="2">Draw and Describe <u>Hydrolysis</u></td></tr>
</table>

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