Who took Jerell's iPod? -- An organic compound mystery

Dr. Jennifer Doherty, Dr. Ingrid Waldron and Dr. Lori Spindler, Department of Biology, University of Pennsylvania, copyright 2009[1]
Adapted from "Identity of Organic Compounds" from Biology Laboratory Manual A from Prentice-Hall;
Also inspired by "Crime Scene Activity" by Kathy Paris, Bethel High School http://www.accessexcellence.org/AE/ATG/data/released/0535-KathyParis/index.php

Jerell is a 10th grade student at City High School who works at McDonald's on the weekends. While on break, Jerell was studying for his biology test and listening to his new iPod. There were four other workers taking a break at the same time, each having something different for lunch.

Jerell's girlfriend stopped by near the end of his break, and he rushed out to see her and forgot his iPod and biology book in the break room. When he realized, he hurried back and found only his biology book and some food crumbs. His iPod was gone!

First Jerell freaked out, but he calmed down when he realized he could use his knowledge of organic compounds to figure out which of his coworkers left the crumbs on his textbook and who took his iPod.

What are organic compounds?
Almost all of the food we eat comes from plants and animals. Plants and animals contain mainly water and organic compounds, which are molecules made by living organisms such as plants or animals. The table below lists the most common types of organic compounds found in living organisms. For each type of organic compound, give one or two examples and describe one characteristic, e.g. whether it is greasy, whether it contains genetic material, whether there is lots of this type of organic compound in meat or lots in pretzels and potatoes.

Type of Organic Compound	Examples	Characteristic or Type of Food That Has Lots of This Type of Organic Compound
Carbohydrates		
Lipids		
Nucleic acids		
Proteins		

Today you will be testing the substances listed in the following table. Predict whether each substance is an organic compound and if so, what type.

Substance	Do you think this substance is a carbohydrate, lipid, protein, or none of these?
Vegetable oil	
Glucose	
Starch from corn or potatoes	
Powdered egg whites	
Water	

[1] Teachers are encouraged to copy this student handout for classroom use. A Word file, which can be used to prepare a modified version if desired, and Teacher Preparation Notes are available at http://serendip.brynmawr.edu/sci_edu/waldron/.

What are indicators?
An indicator is a substance that changes color in the presence of a particular type of molecule. Today you will learn how to use several indicators to test for the presence of carbohydrates and proteins. You will also use a different type of test for lipids. In your next class, you will use these tests to analyze several types of food and the evidence left at the scene of the crime to find out who left the crumbs on Jerell's textbook.

Testing for lipids

1. If a food that contains lipids is put on brown paper, it will leave a spot that lets light through. To test for lipids, divide a piece of a brown paper bag into 5 sections. Label the sections "vegetable oil", "glucose", "starch", "egg whites", and "water".

2. In each section, rub a small amount of the substance onto the brown paper.

3. With a paper towel, rub off any excess that may stick to the paper. Set the paper aside until the spots appear dry—about 10 to 15 minutes.

4. Which section do you expect to test positive for lipids?

5. Which sections do you expect to test negative for lipids?
   What is the purpose of doing these tests?

6. Continue on with the rest of the tests. After all the sections of the brown paper are dry, hold it up to a bright light or window. You will notice that at least one sample has left a spot that lets light through on the brown paper. The spot indicates the presence of lipids.

7. Complete the last column of the data table below. Put a plus for any samples which tested positive for lipids and a minus for the samples which tested negative.

Sample	**Carbohydrate Tests**				**Protein Test**		**Lipid Test**
	Test strip color	Glucose present	Iodine test color	Starch present	Biuret test color	Protein present	Lipid present
Vegetable oil							
Glucose							
Starch from corn or potatoes							
Powdered egg whites							
Water							

Testing for Carbohydrates

1. Today you will be using chemicals as indicators. You must **wear gloves to protect yourself**.

2. You will use indicators to test for two common types of carbohydrates: glucose (a specific type of sugar) and starch. Obtain 5 containers and use masking tape to make labels for each container. Label the containers "vegetable oil", "glucose", "starch", "egg whites", and “water”.

3. For each container, add a small amount of the substance indicated on the masking-tape label. Now add about 2 ml of water to each container. Stir the contents of each container to mix the sample and water.

4. To test for glucose you will use a test strip with an indicator pad that changes color in the presence of glucose. Prepare a piece of paper with the name of each substance and a place to put the glucose test strip used to test that substance. Dip one test strip into each sample for 1-2 seconds. Remove the strip, put it in the appropriate spot on your labeled paper, and wait 3 minutes.

5. Which substance do you expect to test positive for glucose?

6. Which substances do you expect to test negative for glucose?
   What is the purpose of doing these tests?

7. After 3 minutes, record the color for each glucose test strip in the data table on page 2. Put a plus next to those samples testing positive for glucose and a minus for those testing negative.

8. To test for starch you will use iodine as an indicator. In the presence of starch, iodine will change color from yellow-brown to blue-black. Add 5 drops of iodine solution to each container. Stir the contents of each container.
   CAUTION: ***Be careful when handling iodine; it can stain hands and clothing***.

9. In the data table on page 2, record the color of the iodine solutions. Put a plus next to those samples testing positive for starch and a minus for those testing negative.

Testing for Proteins

1. Label five clean containers "vegetable oil", "glucose", "starch", "egg whites", and “water”. Add a small amount of the substance indicated on the label to each container. Add about 2 ml of water to each container. Stir the contents of each container to mix the food and water.

2. To test for protein you will use Biuret reagent as an indicator. Biuret reagent turns from blue to purple in the presence of protein. Add 20 drops of biuret reagent to each container. Stir the contents of each container.
   CAUTION: ***Biuret reagent contains sodium hydroxide, a strong base. Be very careful not to splash or spill any. If you splash any reagent on yourself, wash it off immediately with water. Call your teacher for assistance***.

3. Record the color of each Biuret solution in the data table on page 2. Put a plus next to those samples testing positive for protein and a minus for those testing negative.

4. Rinse all ten containers thoroughly.

Questions

1. Compare your predictions in the table on page 1 with your test results in the table on page 2. Were there any differences between your test results and your predictions for what type of organic compound each test substance is?

   If you found any differences between your predictions and your results, what do you think is the reason for these differences? You may want to check with your teacher, your textbook, or the nutrition information in the label on each food package to help you interpret your results.

2. Did your test for glucose indicate there was glucose in the starch sample?

   Does that mean that there is no glucose in starch? (Hint: Check your textbook or other reliable source if you do not already know the chemical structure of starch.)

   This result shows that the glucose indicator is quite specific. It reacts with glucose dissolved in water, but it does not react with glucose molecules that are combined into a large organic compound like starch.

3. Suppose that for the container containing water you found a positive test for one of the organic compounds. How would you interpret this result?

Testing Different Types of Food and Testing the Evidence

Today you will perform all four organic compound tests on one or two of the types of food listed below or the evidence Jerell found at the crime scene (your teacher will assign you a sample or samples to test). Begin by predicting which types of compounds you expect to find in each type of food you will be testing.

Food	**Do you expect this food to contain**			
	Glucose?	**Starch?**	**Protein?**	**Lipid?**
Pretzel				
Butter				
Jelly				
Fat-free yogurt				
Beans				

Record your positive and negative test results using plus and minus signs in the data table below. For each glucose test strip, record the specific matching color from the glucose test strip bottle or packet (needed for question 1 on page 7). The evidence that Jerell found has been separated into a liquid and a solid in two separate bottles. After you perform the tests, your teacher will collect your data to share with the rest of the class. Complete the table below using data from your classmates.

Food	**Carbohydrate Tests**				**Protein Test**		**Lipid Test**
	Test strip color	Glucose present	Iodine test color	Starch present	Biuret test color	Protein present	Lipid present
Pretzel (crumble into the container)							
Butter							
Jelly							
Fat-free yogurt							
Beans (mash into a paste)							
Dry part of Jerell's evidence							
Liquid part of Jerell's evidence							

Questions

1. Compare your predictions in the top table with the results in the bottom table. Were there any differences?

If you found any differences between your predictions and your results, what do you think is the reason for these differences? You may want to check with your textbook, your teacher, or the nutrition information in the label on each food package to help you interpret your results.

Who took Jerell's iPod?

The workers in the break room are listed below with the type of lunch they were eating while Jerell was studying. As preparation for interpreting the evidence, complete the chart below to indicate what kinds of organic compounds are found in each type of food and what kinds of organic compounds were found in the combined liquid + dry evidence.

Worker in break room	Lunch/Snack	Glucose	Starch	Protein	Lipid
Jose	Bean burrito with cheese				
Ashley	Fat-Free Yogurt				
Bruce	Toast with butter and jelly				
Kiara	Pretzel				
Thief	Combined liquid + dry evidence				

Complete the following table to summarize the evidence and your interpretation of the evidence.

Worker in break room	Did he/she take Jerell's ipod?	How do you know? Describe the evidence that supports your conclusion.
Jose		
Ashley		
Bruce		
Kiara		

Who took Jerell's iPod? Do you have any doubts about your conclusion? Explain.

Questions

1. In this activity you have recorded whether an indicator tested positive or negative for each type of organic compound. We have ignored the fact that different foods contain different amounts of the various types of organic compounds. For example, cream cheese and cottage cheese both have fat and protein, but cream cheese has much more fat than protein, whereas cottage cheese has much more protein than fat.

Most foods contain at least a tiny amount of proteins and lipids since all cells in a plant or animal need to have at least some lipids and proteins. Did you get a positive test for proteins and lipids in all the foods you tested?

How can you explain any cases where you did not get a positive test for proteins and lipids?

Use the different colors that were recorded for the glucose test strips and the information on the glucose test strip packet to identify foods that have smaller amounts of glucose vs. larger amounts of glucose.

Some foods test positive for glucose, but do not taste sweet. What is one possible explanation?

Some foods taste sweet, but have very little glucose. What is one possible explanation?

2. Our bodies are made up of the same types of organic compounds as all other living organisms. Complete the following sentences by filling in each blank to indicate the function of each type of molecule in different parts of our body.

Our muscles contain lots of protein. This protein enables the muscles to _____.

Glucose is carried by our blood to all the cells in our body. Our cells use the glucose for _____.

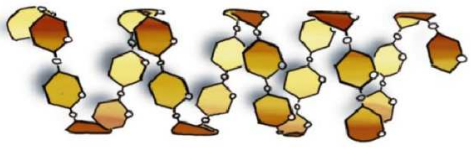
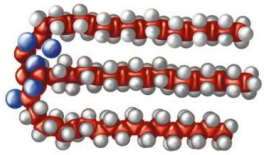
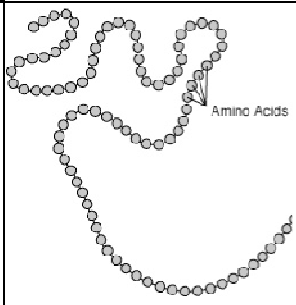
Lipids are found in fat cells in our bodies. The fat cells store fat molecules to be used for _____ if a person can not get enough food.

Our bodies do not make starch, but we often eat plant foods which contain starch which we digest to _____, the building block that is used to make starch.

DNA is a nucleic acid that is found in every cell. DNA carries the _____ information.

3. To show your understanding of organic compounds, identify the type of organic compound shown in each diagram and complete the first three columns of the table.

Many large organic compounds are made of multiple repeats of smaller building block compounds. Starch, proteins, and nucleic acids are examples of this type of organic compound. Circle a building block in the starch, protein, and nucleic acid figures, and write the name of the building block in the fourth column.

Type of Organic Compound	Functions	Which test is used to detect this compound or type of compound?	Name of building block	Diagram of Structure of Organic Compound
				
				
				
				
		Not tested for