Teacher Preparation Notes for 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 2010[1]

This activity reinforces student understanding of different types of organic compounds and several aspects of scientific method. Before you begin this activity, your students should be familiar with the basic chemical structures and general properties of carbohydrates, proteins and lipids.

In the first class period, students learn how to use chemical indicators to test for different types of organic compounds (pages 1-4), and in the second class period each student group will test one or two types of food or a sample of evidence to figure out who took Jerell's iPod (pages 5-8). You may want to assign each type of food or evidence to two student groups in order to assess reliability of results. If the student handout provided seems too long and complex for your students, you may prefer shorter, reorganized handouts, available at http://serendip.brynmawr.edu/exchange/waldron/organic (click on the attachments).

A different approach eliminates the mystery and culminates with having the students identify an unknown organic compound. Introduce the students to the indicator tests on Day 1, use the questions from the student handout to review the biological concepts on Day 2, and give each group of students an unknown to identify on Day 3. The instructions for Day 3 are that students should design an experiment to identify whether their sample is sugar, starch, protein or none of these, using the techniques learned on Day 1.

Equipment and Supplies

Containers for testing food such as test tubes, specimen jars, etc. (10 per student lab group or half this amount if you want the students to wash the containers between the carbohydrate and protein tests) (If you are using test tubes that are too tall to easily dip glucose test strips, you will also need one forceps per group.)
Stirrers, such as plastic spoons (10 per student lab group; an alternative is to have the students shake the containers)
Masking tape for labeling testing containers
Biuret reagent for protein testing (approximately 4 ml per student lab group)
Iodine-Potassium Iodide Solution for starch testing (approximately 1 ml per student lab group)
Glucose test strips (5 per student lab group for the first day and 1 per student lab group for the second day)
(You may need to modify steps 3-4 on page 3, depending on the specific type of glucose test strip. For one type of test strip we have found it necessary to rinse the strip before reading the color.)
Brown paper bag for lipid testing (1 per student lab group; half for each day)
Gloves (1 or 2 per student for each day)
Samples for testing
Day 1: (approximately 1.5 ml of each per student lab group)
Vegetable oil
Corn starch or potato starch (both can be found in the baking needs aisle in a grocery store)
Powdered egg whites (can be found in the baking needs aisle) or unsweetened gelatin (you will need to change the student handout tables on pages 1 and 2 and caution the students to use only one quarter milliliter of gelatin to avoid having it gel, and they may need to use more Biuret reagent in testing for protein)
Glucose (may also be sold as Dextrose, can be found online, in the pharmacy often times in tablet form, or sometimes, in a cake decorating supply store (e.g. Joann's))
Day 2: (approximately 3 ml of each per class)
Pretzels
Butter
Jelly (You may want to make sure this tests positive for glucose; we have had success with strawberry jelly and we believe that any jelly sweetened with high fructose corn syrup will test positive for glucose.)
Fat-Free or low-fat vanilla or plain yogurt
Beans (canned beans that have been mashed into a paste; e.g. canned white beans)
(Save the labels with nutrition information from all the food packages. These will be useful for discussing any discrepancies between predictions and observed results.)

[1] These teacher preparation notes and the related student handout are available at http://serendip.brynmawr.edu/sci_edu/waldron

You will need to make evidence samples for Day 2. For example, to make the evidence samples for Jose, mix starch and protein in one small sample jar labeled A and put oil in another small sample jar labeled A. (Unfortunately, we have only had success in carrying out the tests when the solid and liquid evidence are tested separately.) We suggest that you make four different pairs of dry and liquid evidence samples so different student groups will get different results.

Worker in break room	Lunch/Snack	Solid Evidence	Glucose	Starch	Protein	Liquid Evidence	Lipid
Jose	Bean burrito with cheese	A	-	+	+	A	+ (oil)
Ashley	Fat-free yogurt	B	+	-	+	B	- (water)
Bruce	Toast with butter and jelly	C	+	+	-	A	+ (oil)
Kiara	Pretzels	D	-	+	-	B	- (water)

Safety precautions
Students should at least wear gloves while performing tests for carbohydrate and proteins; goggles are also recommended. You may also want to keep the Biuret reagent and iodine solution at your desk and have students come to pick it up when they need it.

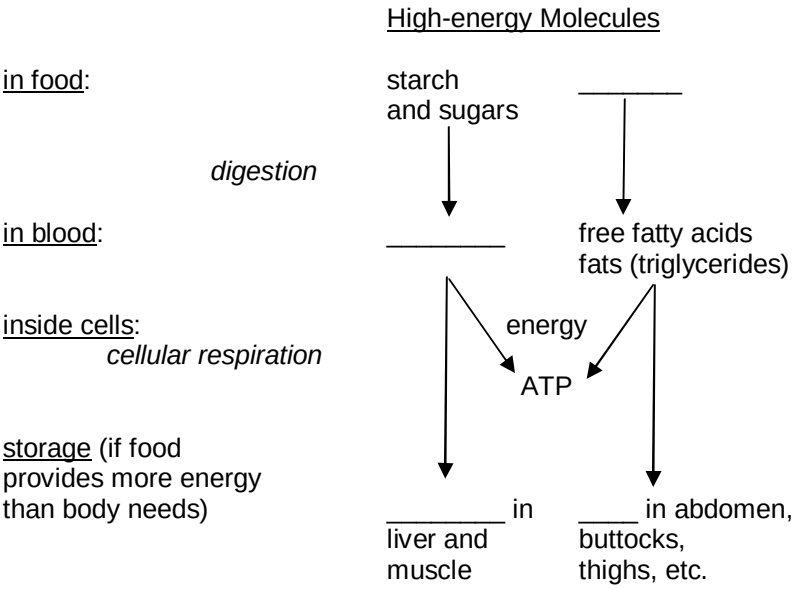
Teaching points
- Plants and animals contain mainly water and organic compounds, which are molecules made by living organisms such as plants or animals.
- The most common organic compounds found in living organisms are lipids, carbohydrates, proteins, and nucleic acids.
- Most of the food we eat comes from plants and animals. Different types of food have large amounts of different types of organic compounds.
- An indicator is a substance that changes color in the presence of a particular type of compound.
  - Indicators can be used to determine what types of organic compounds are in a sample.
- Points of review
  - Examples and functions of each type of organic compound.
  - Many large organic compounds are made of multiple repeats of smaller building block compounds.
- Aspects of scientific method, including:
  - Significance of negative controls
  - Comparing results with predictions
  - Using evidence to draw conclusions

Suggestions for Discussion
Page 1 -- First Table
- Include distinctions between different types of carbohydrates-- monosaccharides (e.g. glucose), disaccharides (e.g. sucrose), polysaccharides (e.g. starch, glycogen, cellulose).
- Protein functions include:
  - enzymes (e.g. digestive enzymes such as lactase; but some enzymes are RNA, e.g. in ribosomes)
  - structural (e.g. collagen)
  - transport proteins (e.g. across cell membranes or hemoglobin in blood)
  - some hormones (e.g. insulin)
  - receptor molecules for hormones, neurotransmitters, etc.,
  - antibodies
  - muscle contraction
- Encourage students to give multiple characteristics, e.g. sugars are sweet; starch comes from plants, mainly from grains and potatoes; protein abundant in muscle which is what most meat and fish foods are.
- Lipids feel greasy because nonpolar molecules slip past each other (and your fingers) more easily than polar groups.

Page 1 -- Second Table
- concentrated sources of specific types of organic compounds are storage parts of plant or animal (often to provide nutrients for growing embryo); vegetable oil from seeds, protein from egg whites, glucose from starch (e.g. from potatoes or grains)

Page 3 – Instruction 4. Why do drugstores sell glucose test strips? What are they used for? Brief discussion of diabetes

Page 4 -- Possible Additional Question
Complete the following diagram, using the following terms: fat glucose glycogen.



- The advantage of fat as primary energy storage in animals and seeds = more energy per weight than carbohydrates or proteins (intrinsic, 9 kcal per gram vs. 4, and less water) -- the facilitates movement
- In addition to energy, what else do we need to get from food? This question can be used to lead into discussion of our own bodies are made up of organic compounds.

Pages 5-6
Background for discussion of findings -- grams per serving (data from www.nutritiondata.com)

Food	Sugars	Glucose (most data missing)	Starch (some data missing)	Total carbohydrates	Protein	Fat
Vegetable oil (corn oil)	0	0	0	0	0	218
Dried egg whites	1.5			2	23	0
Gelatin, unsweetened	0	0	0	0	6	0
Pretzels	1		42	47.5	5.5	2
Butter	0	0	0	0	2	184
Jellies	11			15	0	0
Low-fat vanilla yogurt	34		0	34	12	3
White beans (canned)	1			55.5	19	1
Kidney beans (canned)	5	0	23	41	13	1.5
Burritos with beans and cheese	2	0	7	48	10	8.5
Toasted white bread	2			24.5	4	2

Results may vary, and we strongly encourage you to test your particular food samples with your indicators before presenting this lab to your students. There is sometimes an ambiguity in test results (see page 7 of Student Handout).

Page 7
- When there is a small amount of a type of molecule (e.g. fat in beans) the test may not read positive.
- Sweet foods may have little glucose, but significant amounts of other sugars (or artificial sweeteners that bind to taste receptors for sugars).
- A food may test positive for glucose but not have enough glucose to taste sweet, or the sweet flavor may be masked, e.g. by a sour flavor.

Page 8 – Possible Additional Question

For each of the following, indicate whether it is a polymer (P) or not a polymer (N).

___ DNA
___ fat
___ glucose
___ glycogen
___ protein
___ starch
___ steroid hormone (if you have discussed this type of molecule)
___ sucrose

(Hint: Only four of the above are polymers.)