

TEACHER GUIDE

Lesson 2: Nutrient Detective Lab



Time Estimate: Two 45-minute class periods

Items needed:

- Nutrient Detective Student Guide
- Nutrient Detective Fueling for Performance Reading
- Nutrient Detective Student Guide - KEY

NGSS:

DCI Connections

LS1.C: Organization for Matter and Energy Flow in Organisms

LS1.C-H2: The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used, for example, to form new cells.

LS1.C-H3: As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

SEP Connections

CEDS-H2: Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

CCC Connections

CE-H2: Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller-scale mechanisms within the system.

PAT-H1: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Driving Question: Why might someone who exercises consume whey protein?

Goals

- Students will conduct experiments to test various “health foods” for the presence of macromolecules (carbohydrates, lipids, and proteins).
- Students will generate an explanation that incorporates their experimental data to support their claims related to the unit driving question and the phenomenon of why an athlete might consume whey protein.

Instructional Approach

1. Reintroduce students to the Driving Question for the unit - Why might someone who exercises consume whey protein?
2. Ask them to revisit the Driving Question Board they created in the Anchor Phenomenon and look through questions and/or categories that drive curiosity about what whey protein is, other types of protein or macromolecules that exist, and how the components of milk can impact exercise.
3. Let students know that they will be exploring various health food products for the presence and quantity of macromolecules. You can decide how many food items to provide. If you want everyone testing the same things, only provide 4. If you want a variety, provide more than 4. Some possible foods to choose from are yogurt, protein powder, protein shake/drink, granola bar, energy bar, protein bar, fruit, beef jerky, etc.
4. To begin, distribute the Nutrient Detective: Fueling for Performance Reading to students. Begin by reading the Introduction and Macronutrients paragraphs together as a class.
5. To complete the reading, break students into small groups to complete a Jigsaw Activity.
 - a. Divide students into 6 small Jigsaw groups (2 groups each for protein, 2 groups for carbohydrates, and 2 groups for fat).
 - b. Assign each person in the Jigsaw group to a different content area (protein, carbohydrates, and fat). Give them time to read their section.
 - c. Ask students to meet in Expert groups, so that students with the same content are now in the same group. Give them time to discuss the content and agree upon their understanding.
 - d. Have students return to the Jigsaw group and provide time for them to discuss each area of content to share their understanding with one another.
6. Facilitate whole-class discussion to norm on the content and come to agreement on the types of macromolecules, their importance, and the ways in which they might impact an athlete. Write these understandings in Part 1: Reading About Macromolecules on their Student Guide.
7. Prior to students starting the experiments, students will need to complete a general internet search to research the types of tests for the various macromolecules. They should write their protocol in Part 2: Protocols for Testing Macromolecules on their Student Guide. If students are working in groups, there could be one “expert” for that particular test who is

responsible for communicating their understanding to the group. One person would take on the responsibility of identifying a testing protocol for one macromolecule. If using this strategy, consider spending a moment before you begin to allow the group to share the protocol, get feedback from their peers, and adjust the test protocol if necessary.

8. Provide time for students to complete Table 1: Positive & Negative Results when Testing for the Presence of Macromolecules.
9. Facilitate whole-class discussion to make sure that students agree on the expected positive and negative results for each macromolecule chemical test. This is important to ensure that students are looking for the correct positive and negative colors in their samples. If needed, give students time to edit their previous responses in Table 1: Positive & Negative Results when Testing for the Presence of Macromolecules before moving on.
10. Direct students to Part 3: Preparing Samples for Testing on their Student Guide. Have student lab groups choose four food items to complete the macromolecule tests for. Review the directions for prepping samples with students by facilitating a whole-class discussion before having students prepare their test samples.
11. Give students time to make the test sample and verify its pH. This information should be written in Part 3: Preparing Samples for Testing on their Student Guide. Facilitate whole-class discussion regarding the pH of the various foods to come to an agreement on the values obtained. Discuss any outliers. Also, ask students to think about the importance of establishing the pH prior to testing for macromolecules present in the sample.
12. As students conduct their macromolecule testing, they should keep track of their results in the tables in Part 4: Data Analysis on their Student Guide. Under each table is a space for keeping notes to capture any additional observations or important understandings from the results.
13. Direct students to Part 5: Summary of Results on their Student Guide. Give them time to answer the questions and make sense of the data obtained. This section will be non-assessed. Before moving on to Part 6, consider holding a whole-class discussion to address each of the questions in this section. Give students an opportunity to share their thoughts and understanding with one another to help them make sense of the phenomenon and Driving Question. Sharing with an elbow partner can help students:
 - a. clarify their understanding by exchanging ideas
 - b. connect their learning to what they currently know
 - c. reflect on new perspectives based on the topic
 - d. more fully engage in the learning experience
 - e. share their ideas in casual conversation with peers and the teacher
14. Ask students to use their findings and evidence from the investigation to begin constructing their final explanation related to the Driving Question. Direct them to Part 6: Constructing an Explanation About Whey Protein Consumption. Give them time to generate their explanations. Consider providing an opportunity for students to share upon completion (in small groups or with the class) as a final reflection on this learning experience.

Scientific Background

Macromolecules are the essential building blocks of life, playing vital roles in the structure and function of all living organisms. The three primary types of macromolecules found in food are carbohydrates, lipids, and proteins. Carbohydrates provide a primary energy source; lipids serve as energy storage and are crucial for cell membranes; proteins are fundamental for growth, repair, and enzymatic activities.

In this lab, we will explore the nutritional content of various health foods by testing for the presence of these key macromolecules. We can identify and quantify the carbohydrates, lipids, and proteins in our food samples by utilizing specific chemical tests. This analysis will help us understand the composition and potential health benefits of the foods we consume.

Understanding the macromolecular content of foods is not only important for nutrition science but also offers practical insights into maintaining a balanced diet. Through this experiment, you will gain hands-on experience with biochemical testing techniques and develop a deeper appreciation for the complexity of food chemistry.

General Setup

The start of experimentation requires students to prepare four test samples using four “health foods”. After each sample is prepared, students will conduct a series of investigations (labs) to identify the macromolecule composition of each. At each lab grouping (table or grouping of desks), students will have the materials needed to complete the lab. Prior to starting this lesson, prepare stations with materials. Below is an outline of the sample preparation and each of the tests to be performed, including a list of materials, set-up suggestions, and expected outcomes.

TEACHER SUPPORT

Have access to a water bath at 37 degrees C for every lab station. A water bath can be made by placing a glass beaker of water on a hot plate. Use a thermometer to control its temperature over time. Having a water bath already at room temperature for each station is ideal to eliminate time spent waiting for “materials” to heat up.

Test Sample Preparation

Materials

Healthy food samples (e.g., nuts, yogurt, granola bars, fruit)
Test tubes (16, at least 4)
Test tube rack
Test tube clamp

Distilled water
pH paper
Weigh boats
Mortar & Pestle
Gloves & Safety Glasses

TEACHER SUPPORT

Be sure to keep the labels for all of the food items used in the activity so that students can refer to them when they are answering the questions in Part 5: Summary of Results in their Student Guide.

Set-Up

Ask students to use the following directions depending on the state of matter of the healthy food options to prepare their samples for testing for each of the macromolecules.

- Liquid- pour it into a test tube until it is $\frac{1}{4}$ of the way full (less than half). Add 20mL of water to the test tube. Seal the test tube with your gloved thumb and vigorously shake to mix. After 30 seconds of shaking, allow the contents to settle for 1 minute.
- Solid- use a mortar and pestle to grind the food into a fine powder if it is not already a powder. Add your sample to a test tube and add 20mL of water to the test tube. Seal the test tube with a clean gloved finger (not one used already) and vigorously shake to mix. After 30 seconds of shaking, allow the contents to settle for 1 minute.

A brief note about lab materials:

For each of the healthy food options available, students will need to make four test samples of each. This means that each student group will either need 16 test tubes or need time to wash and re-use the ones at their station before making the test samples for the next healthy food. If you are using the latter method, students will need reminders to prepare the other samples for testing.

Once students have prepared their samples, they should use the pH paper to test the pH of each one. Remind them to use a new piece of pH paper for each sample. They should discard the pH paper after it has been used and write the pH number on the lines next to each sample name. They will circle if it is an acid, base, or neutral before moving on to the next part of the lab.

If students need to make the test samples for the next healthy food option, remind them that they will also need to get the pH of that sample prior to completing the macromolecules testing on it.

Expected Outcomes

Shown below are just examples of possible lab outcomes when provided the following healthy food options to test. It should be noted that students were provided with almonds, plain yogurt, a crunchy granola bar containing oats and honey, and a medium-sized red apple to obtain the sample student responses shown below.

Sample 1: Nuts	pH 6-7	Acid, Base or Neutral (circle one)
Sample 2: Yogurt	pH 4-5	Acid, Base or Neutral (circle one)
Sample 3: Granola Bar	pH 6-7	Acid, Base or Neutral (circle one)
Sample 4: Fruit	pH 3-5	Acid, Base or Neutral (circle one)

Benedict's Test for Simple Sugars (Carbohydrates)

Materials

4 prepared food samples
4 Test tubes (1 for each
food sample, if needed)

Gloves and safety glasses
Benedict's solution (simple
sugars)

Pipettes or droppers
Water bath
Stirring rod

Set-Up

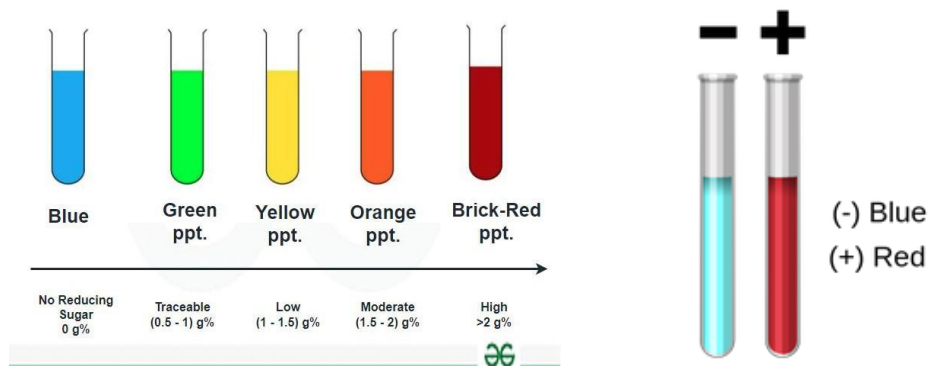
Students use one of the prepared samples of healthy food options, ensuring there are approximately 40 drops of it in the test tube. To that test tube, they will add 15 drops of Benedict's solution. The test tube should be heated in a water bath for 10 minutes. At that time, they should use the test tube clamps to remove the test tube from the water bath to observe any color change that may have taken place during that time, indicating the presence of reducing sugars in the solution.

Expected Outcomes

Depending on the types of healthy food options available for testing, students may find positive or negative results for the Benedict's testing. A negative result will mean that no color change has taken place and the solution remains blue. A blue solution means that there are no reducing sugars present in the sample. A positive result can have a variety of different possibilities for color depending on the amount of reducing sugars that are present in the test sample. Additionally, within those colors, there may be varying degrees of faintness or strength of color.

Positive results are:

- Green - traceable amount of reducing sugars
- Yellow - low amount of reducing sugars
- Orange - moderate amount of reducing sugars
- Red - high amount of reducing sugars



From:

<https://www.geeksforgeeks.org/benedicts-test/>

<https://microbiologyinfo.com/wp-content/uploads/2016/01/Result-Interpretation-of-Benedicts-Test.jpg.webp>

Foods like yogurt, granola bars, and fruit will likely have a positive result when tested.
Foods like nuts will likely have a negative result when tested.

Lugol's Iodine Test for Complex Carbohydrates (Starch)

Materials

4 prepared food samples
4 Test tubes (1 for each
food sample, if needed)

Gloves and safety glasses
Lugol's Iodine solution
Pipettes or droppers

Stirring rod
Well plate or paint tray

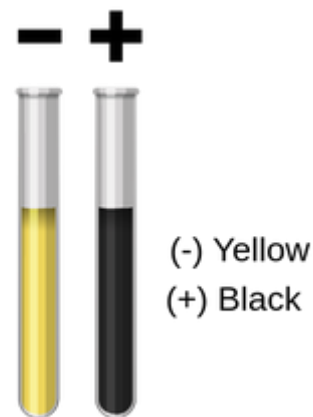
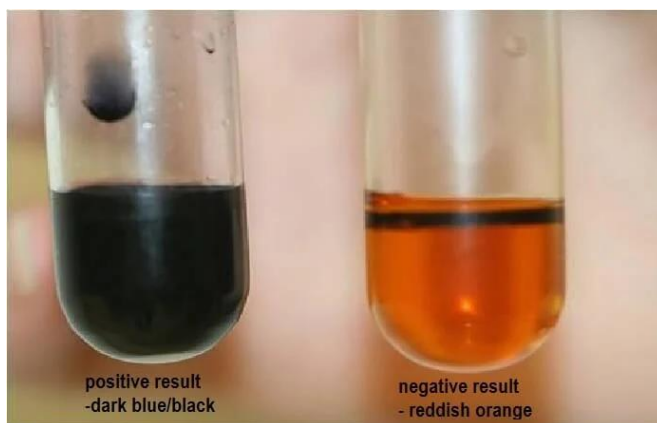
Set-Up

Students use one of the prepared samples of healthy food options, ensuring there are approximately 30 drops of the sample in a well in the well plate or paint tray. To that well, they will add 5 drops of Lugol's Iodine solution. Use the stirring rod to stir the solution (if needed) to observe any color change that may have taken place, indicating the presence of complex sugars, particularly starch - a long chain of glucose molecules, in the solution.

Expected Outcomes

Depending on the types of healthy food options available for testing, students may find positive or negative results for Lugol's Iodine testing. A negative result will mean that no color change has taken place, and the solution will look reddish-orange or yellow (depending on the amount of iodine added). No color change means that there are no complex sugars present in the sample.

A positive result will change color to a dark blue or black color. Depending on the amount of complex sugars present in the test sample, there may be varying degrees of faintness or strength of color.



From:

<https://theory.labster.com/food-biochem-assay/>

<https://microbenotes.com/testing-for-biological-molecules/>

Foods like granola bars will likely have a positive result when tested.

Foods like nuts, yogurt, and fruit will likely have a negative result when tested.

Biuret's Testing for Proteins

Materials

4 prepared food samples
4 Test tubes (1 for each
food sample, if needed)

Gloves and safety glasses
Biuret reagent
Pipettes or droppers

Stirring rod
Well plate or paint tray

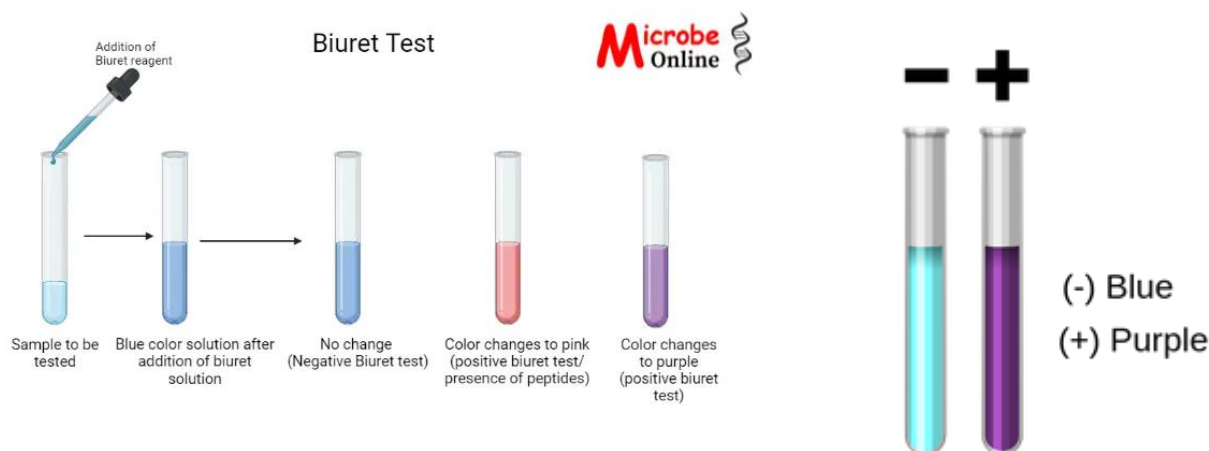
Set-Up

Students use one of the prepared samples of healthy food options, ensuring there are approximately 30 drops of the sample in a well in the well plate or paint tray. To that well, they will add 5 drops of Biuret solution. Use the stirring rod to stir the solution (if needed) to observe any color change that may have taken place, indicating the presence of proteins in the solution.

Expected Outcomes

Depending on the types of healthy food options available for testing, students may find positive or negative results for Biuret's testing. A negative result will mean that no color change has taken place and the solution will look Blue (depending on the amount of Biuret's reagent added). No color change means that there are no proteins present in the sample.

A positive result will change color to a pink or purple color. There may be varying degrees of faintness or strength of color depending on the amount of and types of proteins that are present in the test sample.



From:

<https://iO.wp.com/microbeonline.com/wp-content/uploads/2023/05/Biuret-Test.png?ssl=1>

<https://theory.labster.com/food-biochem-assay/>

Foods like nuts, yogurt, and granola bars will likely have a positive result when tested. Foods like fruit will likely have a negative result when tested.

Sudan III Testing for Fats

Materials

4 prepared food samples
4 Test tubes (1 for each
food sample, if needed)

Gloves and safety glasses
Sudan III Stain
Pipettes or droppers

Distilled water
(50 mL per lab station)

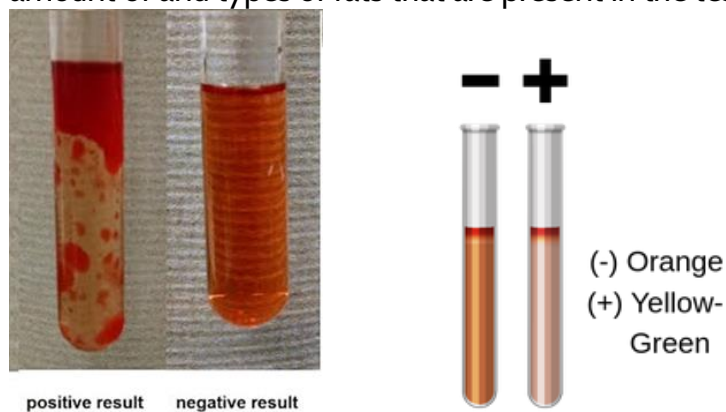
Set-Up

Students use one of the prepared samples of healthy food options, ensuring it is filled one-quarter of the way to the top of the test tube. They will add distilled water to that test tube, filling it to just about half full. The next step will be to add drops of Sudan III Stain. Using a gloved hand, students should cover the top of the test tube and gently shake it to distribute the stain. Let the test tube sit for a minute or two. After that time, students can observe any changes in appearance and color that may have taken place, indicating the presence of fats (lipids) in the solution.

Expected Outcomes

Depending on the types of healthy food options available for testing, students may find positive or negative results for the Sudan III Stain testing. A negative result will mean that no color change has taken place, and the entire solution will be orange in color (depending on the amount of Biuret's reagent added). This even distribution of the orange color in the test tube means that there are no proteins present in the sample.

A positive result will appear as either large reddish-orange colored clumps formed throughout the solution or a heavily colored, reddish-orange layer of fats at the top of the liquid's surface in the test tube. There may be varying degrees of faintness or strength of color depending on the amount of and types of fats that are present in the test sample.



From:

<https://www.coursehero.com/qa/attachment/35390126/>

<https://theory.labster.com/food-biochem-assay/>

Foods like nuts, yogurt, and granola bars will likely have a positive result when tested.
Foods like fruits will likely have a negative result when tested.