Contributors

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Claxton, GA

Intended Audience

<table>
<thead>
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Activity Characteristics

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<td>Classroom Setting</td>
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<tr>
<td>Requires special equipment</td>
<td>X</td>
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<tr>
<td>Uses hands-on manipulatives</td>
<td>X</td>
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<tr>
<td>Requires mathematical skills</td>
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<tr>
<td>Can be performed individually</td>
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</tr>
<tr>
<td>Requires group work</td>
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<tr>
<td>Requires more than one (45 min class) period</td>
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<tr>
<td>Appropriate for special needs student</td>
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Introduction

Description

The presence of different macromolecules is detected in various liquids using chemical indicators.

Abstract

Students use chemical indicators to detect for the presence of different macromolecules in various liquids. Each group of students will place a small volume of each solution in different test tubes to detect for the presence of simple carbohydrates, complex carbohydrates, proteins, and lipids. After observing the color change in the presence of each different macromolecule, students make predictions on the presence of each of these macromolecules in a solution then test for their presence.

Core Themes Addressed

<table>
<thead>
<tr>
<th>Microbial Cell Biology</th>
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<tbody>
<tr>
<td>Microbial Genetics</td>
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<td>Microorganisms and Humans</td>
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<td>Microorganisms and the Environment</td>
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<tr>
<td>Microbial Evolution and Diversity</td>
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<td>Other -Macromolecules X</td>
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</tbody>
</table>

Keywords

Macromolecules, carbohydrates, proteins, lipids, chemical indicators

Learning Objectives

At completion of this activity, learner will

1. Describe the function of carbohydrates, proteins, and lipids
2. Explain the differences between simple and complex carbohydrates
3. Explain how chemical indicators work

National Science Education Standards Addressed

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

Standard B: Physical Science

- Chemical reactions
Teacher Handout

Macromolecules in Food

Teacher Background Information

Macromolecules are very large molecules that are assembled from nearly identical subunits called monomers. These molecules make up the majority of the structural components within every living cell and some also have catalytic functions. While each type of macromolecule has a different function within a cell, they are all essential for cell survival. Chemical indicators can be used to detect for the presence of macromolecules in the cells or aqueous solutions.

Class Time

This activity will require a minimum of one 90 minute class period.

1. Introductory PowerPoint (15 minutes)
2. The testing for each macromolecule will take 10 – 15 minute. There are four macromolecules to be tested.
3. Testing of the unknown substance will take an additional 10-15 minutes.
4. It will take another 10-15 minutes for students to answer the concluding questions.
5. Clean-up (10 minutes)

Teacher Preparation Time

This lesson will require approximately 20 minutes of preparation time.

1. Prepare the gelatin solution just before the class to ensure that it will not solidify during the activity.
2. Start hot water bath so it will be ready for the students to use.
3. Divide supplies so that each group will have each necessary component.
Materials and Equipment (Per group)

1. Warm water bath with test tube holders to remove tubes from the water (per class)
2. 24 test tubes
3. 20 ml of distilled water
4. 20 ml of cooking oil
5. 20 ml of gelatin solution
6. 20 ml of apple juice
7. 20 ml of potato solution
8. 20 ml of unknown solution (Groups should have different unknown solutions)
9. Benedict’s solution
10. Iodine solution
11. Biuret Reagent
12. Sudan IV stain

Methods

Part 1

1. Simple Carbohydrate Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 10 drops of Benedict’s solution to each test tube
   d. Gently shake the contents of each test tube and place them in the hot water bath for 3-5 minutes.
   e. Remove the test tubes using test tube holders
   f. The final color of the solution depends on how much simple carbohydrate was present. Write a “-” if simple carbohydrates are not present or a “+” if simple carbohydrates are present (see Rating scale below) in Table 1.

   Rating scale: Increasing amounts of simple carbohydrate.

<table>
<thead>
<tr>
<th>blue</th>
<th>green</th>
<th>orange</th>
<th>red</th>
<th>reddish brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-)</td>
<td>(+)</td>
<td>(++)</td>
<td>(++++)</td>
<td>(+++++)</td>
</tr>
</tbody>
</table>

2. Complex Carbohydrate Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Iodine to each test tube
   d. Gently shake the contents of each test tube
   e. Iodine causes complex carbohydrates to turn dark blue or black. Write a “+” if complex carbohydrates are present or a “-“ if complex carbohydrates are not present in Table 1.
3. **Protein Test**
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Biuret Reagent to each test tube
   d. Gently shake the contents of each test tube
   e. Biuret Reagent changes color from blue to pink or violet in the presence of protein. Write a “+” if protein is present or a “-” if protein is not present in Table 1.

4. **Lipid Test**
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Sudan IV stain to each test tube
   d. Gently shake the contents of each test tube
   e. Sudan IV will dissolve in lipids and stain them red. Write a “+” if lipids are present or a “-” if lipids are not present in Table 1.

**Part 2**

1. Share your results with other teams
2. Obtain unknown substance from your teacher. Your teacher will tell you what the substance is. Using background knowledge, form a hypothesis that will state what macromolecules will be present in your unknown substance in Table 1
3. Perform the tests you completed in part one with your unknown substance and record in Table 1
4. Once all groups have completed the tests with the unknown substance, share your data.

**Tips/Suggestions**

1. Meat tenderizer can be added to the gelatin solution to prevent it from solidifying.
2. The potato solution can be prepared by adding potato flakes to water and dissolve it. The flakes are not very soluble in water so have the students mixed the potato solution prior to testing it.

**Safety Precautions**

Some of the testing solutions can be dangerous to students or their clothing. If students get solutions on them they need to wash with soap and water. They may also want to wear lab coats.
### Answers to Student Handouts

<table>
<thead>
<tr>
<th>Tube</th>
<th>Solution</th>
<th>Simple Carbohydrates</th>
<th>Complex Carbohydrates</th>
<th>Proteins</th>
<th>Lipids</th>
</tr>
</thead>
<tbody>
<tr>
<td>dH₂O</td>
<td>Distilled Water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO</td>
<td>Cooking Oil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>GS</td>
<td>Gelatin Solution</td>
<td>+++</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>AJ</td>
<td>Apple Juice</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PS</td>
<td>Potato Solution</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>UK</td>
<td>Unknown</td>
<td>Hyp: *Answers will vary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Which macromolecules were present in your unknown? Does this agree or disagree with your hypothesis? Be specific. *Answers will vary depending on unknown solutions*

2. You are getting prepared to take a “Man vs. Wild” hike. Using your data and your understanding of nutrition, which of the unknown substances would provide the best fuel for your body to endure this long adventure? Explain. *Answers will vary depending on unknown solutions; however substances high in all three macromolecules will be the best ones. Lipids are the most energy dense, followed by proteins, and carbohydrates.*

3. What conclusion could you make if a positive test for any of the macromolecules occurred in the test tube containing only distilled water? *Possible Contamination can occur*

4. You must save the world! Using your data and the information provided by the scientists (in the introduction), which of the unknown substances is the best defense against the undead? Why? *Answers may vary but the unknown substances must test positive for complex carbohydrates and proteins.*
Introduction

You are a scientist at the FDA’s Center for Nutrient Analysis. You analyze food based on the label declaration. Tests are performed for proteins, lipids and carbohydrates. Recently, there has been fear of an attack by a new species of undead (similar to a zombie) chickens. Scientists believe that the only way to combat this attack is by feeding them a substance with high levels of complex carbohydrates and protein. Your team is taking a break from the regular task of food label analysis in order to determine which types of food will be best to stop the undead chicken invasion, based on the tests you will be performing today.

Vocabulary

Macromolecules: large molecules that are assembled from monomers

Carbohydrates: organic polymers made out of monosaccharides that are often used by many organisms for energy

Proteins: polymers consisting of amino acids that make up the structural components of living cells; many proteins can also serve as enzymes

Lipids: hydrophobic macromolecules that function primarily as energy storage within cells or components of the cell membrane

Materials Checklist

<table>
<thead>
<tr>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td>24 Test tubes</td>
</tr>
<tr>
<td>Benedict’s Solution</td>
</tr>
<tr>
<td>Iodine Solution</td>
</tr>
<tr>
<td>Biuret Reagent</td>
</tr>
<tr>
<td>Sudan IV stain</td>
</tr>
<tr>
<td>Distilled Water</td>
</tr>
<tr>
<td>Cooking oil</td>
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<td>Gelatin Solution</td>
</tr>
<tr>
<td>Apple Juice</td>
</tr>
<tr>
<td>Potato Solution</td>
</tr>
<tr>
<td>Unknown Solution</td>
</tr>
</tbody>
</table>

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Procedure

Part 1

5. Simple Carbohydrate Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 10 drops of Benedict’s solution to each test tube
   d. Gently shake the contents of each test tube and place them in the hot water bath for 3-5 minutes.
   e. Remove the test tubes using test tube holders
   f. The final color of the solution depends on how much simple carbohydrate was present. Write a “-” if simple carbohydrates are not present or a “+” if simple carbohydrates are present (see Rating scale below) in Table 1.

   Rating scale: Increasing amounts of simple carbohydrate.

   blue green orange red reddish brown
   (-) (+) (++) (+++) (++++)

6. Complex Carbohydrate Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Iodine to each test tube
   d. Gently shake the contents of each test tube
   e. Iodine causes complex carbohydrates to turn dark blue or black. Write a “+” if complex carbohydrates are present or a “-” if complex carbohydrates are not present in Table 1.

7. Protein Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Biuret Reagent to each test tube
   d. Gently shake the contents of each test tube
   e. Biuret Reagent changes color from blue to pink or violet in the presence of protein. Write a “+” if protein is present or a “-” if protein is not present in Table 1.

8. Lipid Test
   a. Obtain 5 test tubes and label each
   b. Measure 5 ml of each substance to be tested and place into the labeled test tubes
   c. Add 5 drops of Sudan IV stain to each test tube
   d. Gently shake the contents of each test tube
   e. Sudan IV will dissolve in lipids and stain them red. Write a “+” if lipids are present or a “-” if lipids are not present in Table 1.
Part 2

5. Share your results with other teams

6. Obtain unknown substance from your teacher. Your teacher will tell you what the substance is. Using background knowledge, form a hypothesis that will state what macromolecules will be present in your unknown substance in Table 1

7. Perform the tests you completed in part one with your unknown substance and record in Table 1

8. Once all groups have completed the tests with the unknown substance, share your data.

Results

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3. What conclusion could you make if a positive test for any of the macromolecules occurred in the test tube containing only distilled water?

4. You must save the world! Using your data and the information provided by the scientists (in the introduction), which of the unknown substances is the best defense against the undead? Why?