ENZYMES AND THE NERVOUS SYSTEM

DESCRIPTION:
In the first part of the activity, students use iodine and Benedict's solution as color indicators to detect enzyme activity, specifically, the ability of the enzyme amylase, found in human saliva, to break down starch into sugar. Students will then develop their own diagnostic protocols to test for enzyme activity in starch samples. In the second part, they study the nervous system to see how enzymes are key to nerve cell transmission.

RATIONALE:
During the Hydroville Mysterious Illness Outbreak, students will confirm pesticide exposure in animals and humans by studying the effects of the pesticide chlorpyrifos on acetylcholinesterase, an enzyme found in nerve cells. Students will know if the enzyme is active by detecting it using a color indicator.

PURPOSE/GOALS:
Students will be able to:

- Describe the function of an enzyme.
- Describe the function of a color indicator in detecting an enzyme reaction.
- Design a method to test for the amylase activity in a series of unknown samples.
- Describe by words or drawings how messages are transmitted by nerve cells.

PREREQUISITES:
Students should be familiar with chemical reactions and how enzymes work.

TIME ESTIMATE:
Part I-III: Enzymes
Prep: 40 minutes
Activity Time: two 50-minute class periods
Part IV: How enzymes help nerves to work- to be written (suggestions?)

SAFETY HAZARDS:
Iodine is toxic and an irritant and will stain clothing. Handle chemicals with care, wear proper safety equipment (gloves, glasses), and avoid contact with skin or eyes.

MATERIALS:

- Hydroville Learning Log
- Hot plate or microwave

MATERIALS (PER GROUP OF 2 STUDENTS):
Part I: Getting Started

- Plastic Petri Dish
- 2 kernels of dry corn
- 2 kernels of wet corn (soak overnight to allow kernels to soften)
- a pinch of corn starch
- a drop of corn starch solution (cornstarch mixed with a small amount of water to create a paste)

- a drop of soluble potato starch solution (potato starch mixed with a small amount of water to create a paste)
-
- Iodine solution
- Eye dropper or plastic pipette
- Dixie cup
- Safety glasses
- Latex or plastic gloves

Part II: Testing for Amylase activity

- Soluble starch solution (0.5%), 12 mL
- Iodine solution
- Amylase solution (0.5%), 7 mL
- Dry sucrose or glucose
- Benedict's solution, 3 mL
- Distilled water, 15 mL
- Test tubes (13 X 100 mm) or spot plates (with 10 wells)
- Test tube racks
- 250 mL beaker (can substitute Solo party cups)
- Foil-covered dropper bottles (for Iodine solution)
- 10 mL graduated cylinders or pipettes
- Stopwatch or timer
- Safety glasses
- Latex or plastic gloves
- Masking or other labeling tape and permanent marking pen
- Wax marking pens
- Plastic waste container for solutions

Part III. Testing for the presence of amylase: a case study

- Use same materials from Part II

MATERIALS TO PHOTOCOPY:

(1 copy/student)

- Student Worksheet 1: Part I: Making Observations of the Digestion of Starch
- Student Worksheet 2: Part II: Establishing a Systematic Test for the Presence of Starch or Sugar
- Student Worksheet 3: Part III: Testing for the Presence of Amylase - A Case Study at the International House of Potatoes

TEAMWORK SKILL:

Basic Team Skills	*Problem Solving Skills*
• Everyone contributes and helps. • Encourage all in the group to participate.	• Criticize ideas without criticizing people. • Integrate a number of different ideas into a single position.

BACKGROUND INFORMATION:

Enzymes are the largest and most highly specialized class of proteins. They function as biological catalysts. A catalyst is a chemical that speeds up the rate of a reaction without being used up in the

reaction. It can be used over and over again. Chemical catalysts, therefore, need to be present in only very small amounts. Catalysts work by forming a complex with the reactive molecule(s) and increasing the probability that a reaction will occur.

Everything that goes on within a cell is either catalyzed by or directed by enzymes. The chemical reactions in your body would ordinarily occur at extremely slow rates at normal body temperature and pH. Without enzymes in our digestive tract, it would take us about 50 years to digest a single meal. Digestion of a meal begins in your mouth. Saliva contains an enzyme, amylase, which helps break large starch molecules into small sugar molecules that can be absorbed by the intestines. This reaction, which involves the reaction of the starch with water molecules, is called hydrolysis. Starch reacts with iodine, as I^-_3, to produce a blue starch-iodine complex.

$$I^-_3 \quad + \quad \text{starch} \quad \rightarrow \underset{\text{Blue}}{\text{starch} - I^-_3}$$

Small sugar molecules do not react with iodine to from this blue complex. We will use this colorimetric indicator to follow the rate of the reaction of the hydrolysis of starch.

How does amylase starch digestion work?
(Excerpted from www.sciencenet.org.uk/database/Biology/9701/b00705d.html)
Amylase, like other enzymes, works as a catalyst and makes the reaction easier by reducing the energy required for it to happen. Catalysts speed up the reaction. The theory behind the working is called the "lock and key" theory: the enzyme is shaped so that the products fit into them, react and are released. Amylase digests starch by catalyzing hydrolysis, which is splitting by the addition of a water molecule. Therefore starch plus water becomes maltose (which is equivalent to two joined glucose molecules).

There are two kinds of amylase enzymes. Alpha-amylase is found in saliva and is called ptyalin. The other kind is called pancreatic amylase and is secreted in pancreatic juice, into the small intestine or ileum. Other enzymes then further digest the maltose to glucose and this is then absorbed through the wall of the small intestine by the body to be used as energy after being taken to the liver.

Body temperature is optimal for the best reaction of amylase (as with other enzymes) - if the temperature is too high, it comes apart, and if too low, the reaction slows to a stop.

Students should know that an enzyme is a protein that has the ability to break down other compounds into smaller molecules. In the human body, there is a particular enzyme, amylase, which is present in the mouth and small intestine. Amylase breaks down starch into sugars (starch → maltose and glucose). In this lab we can detect enzyme activity by using indicators that change colors as the amylase breaks down starch (the color indicator detects starch or sugar).

TERMINOLOGY:

Protein	glucose	catalyst
Enzyme	Starch	digestive enzyme
Hydrolysis reaction	amylase	
Carbohydrate		

SUGGESTED LESSON PLAN:

Getting Started

1. Mix up the amylase and starch solutions fresh the day of the laboratory.
    A. 0.5% Soluble Starch Solution
        1. In a Pyrex beaker ~~or Er~~lenmeyer flask, add 0.5 g of soluble starch solution to 100 ml of cold distilled water. Stir or swirl to evenly distribute the starch in the water.
        2. Slowly heat the solution until it is no longer cloudy. This can be done in one of two ways:
            a. Microwave Method: (note: the microwave should have a rotating carousel) Put the starch solution in the microwave and heat for 30 seconds. Remove the container and swirl or stir to make sure the starch is evenly suspended. REPEAT this step until the solution turns from cloudy to clear (about 5-7 minutes).
            b. Hot Plate Method: Add a stir bar to the solution and heat over medium heat with the stir bar spinning to keep the starch suspended evenly in solution. Heat until the solution turns from cloudy to clear.
    B. B. 0.5% Amylase solution
        1. Dissolve 0.5g amylase in 100 mL of distilled water. The solution will appear cloudy. (Note: If amylase activity is low, then check pH; the solution should be about pH 6.5.)
    C. Iodine solution (if necessary)
        1. Dissolve 2.5 g of potassium iodide (KI) in 500 mL of distilled water. Add 1.0 g of iodine (I_2) and stir until all particles are dissolved. Place in amber glass or foil covered dropper bottles.
2. Prepare samples for Part III "Henri the Angry Waiter": The easiest way to prep for this part of the lab is to store bought potato flakes. Make up a batch of potato solution by adding approx 1/3 cup of potato flakes 1 cup distilled water. Stir until the potato dissolves. To disguise the contaminated solution, use several drops of blue food coloring in the potato solution and the days amylase solution. You can measure out half the potato solution to be mixed up as "contaminated solution" Each students will need five 10 mL test tubes. Two or three of the test tubes will have just potato solution. It takes a small amount of the amylase solution to contaminate the potatoes and have a positive reading for the presence of amylase.

Doing the Activity

1. **Learning Log Prompt**: Describe an example of diagnostic test that a doctor might run using a color indicator. (Start with a discussion of diagnostic tests or chemical reactions that use color indicators. Have students brainstorm as many examples as they can think of. Examples might include: pH paper, glucose test kits used by diabetics, pregnancy tests, silica desiccant, etc.)
2. Review the digestion of starch into sugar in the presence of the enzyme, amylase and that starch and sugar can be detected using chemicals as color indicators. Briefly review vocabulary terms.
   Hydrolysis is the reactions in which large molecules are broken down into smaller molecules with the addition of water molecules. The reactions can be speeded up by an enzyme. In the human body the enzyme is amylase. Indicators can be used to measure the rate of the reaction.

   Starch + water -----amylase → maltose + glucose

   - Starch is blue in the iodine solution indicator and glucose is clear.
   - Starch does not react with benedicts solution, glucose produces a brick red precipitate.
3. Students should work in pairs on this activity.

4. Part I is an observational lab to get students to observe, detect and record the presence of starch or the digestion of starch by using iodine as a color indicator.
5. Part 2 of the activity uses Iodine to detect the presence of starch and Benedict's solution to detect sugar, the breakdown products of starch in the presence of amylase enzyme.
6. Part 3 serves as an assessment of students' understanding of the digestion of starch by amylase and the use of color indicators to detect amylase activity.

CLASSROOM HINTS:

- Starch Solution: **Moderately easy prep**. **15-20 minutes**
  *Note: Microwave method is the easiest way to do this IF you have a rotating carousel.
- Amylase solution: **Easy prep. 5-10 minutes**.
  *Note: The best source of amylase is from the chemicals and recipe provided. However, you can also have students "donate" their own amylase by having students chew on a clean rubber band and spit into a test tube or Dixie cup. It is nearly worth doing this lab just to watch students do this! The drooling technique will not yield enough saliva for the entire lab, but will produce enough for Part I. Students can also develop experiments to compare 0.5% amylase solution with their own bodies' amylase if they wish.
- Samples for Part III "Henri the Angry Waiter": The easiest way to prep for this part of the lab is to use a bag of frozen mashed potatoes from the freezer section of the grocery store. You can use pre-made amylase solution or have a student volunteer use the "rubber band" method to add saliva to the samples.

SAFETY NOTES

- Students should wear safety glasses and rubber gloves for all parts of the experiment
- Iodine solution stains clothes

Wrap-up

1. Learning Log Prompt: In two minutes, you will be given a cracker to eat. Based on your knowledge of what the enzyme amylase does, what do you expect to happen? (your answer should be more detailed than " it gets soggy and starts to be digested".

ASSESSMENT:

- Ask students to develop an experiment to confirm or refute the following statement:
  Hypothesis: Henri spit in the potatoes of customers at the International House of Pancakes and he should be fired from his job.

- Student work can be evaluated on
  (1) the repeatability of the protocol
  (2) understanding the function of iodine and Benedict's solution as color indicators,
  (3) the use of a control in their experiment,
  (4) the interpretation of results -- whether their experiment can conclusively link Henri to the crime.

EXTENSIONS:

Language Arts

- Using "Part III. Testing for the presence of Amylase: A case study" have students write a present arguments in a mock trial prosecuting or defending Henri.

Science/Mathematics

- Hydroville Times Crossword Puzzle
- The original enzyme activity written for this curriculum explores the effect of temperature, pH, and concentration on enzyme activity and incorporates science inquiry with data collection and graphing. See Appendix.

RESOURCES:

Other web-based labs and information about enzymes and amylase:

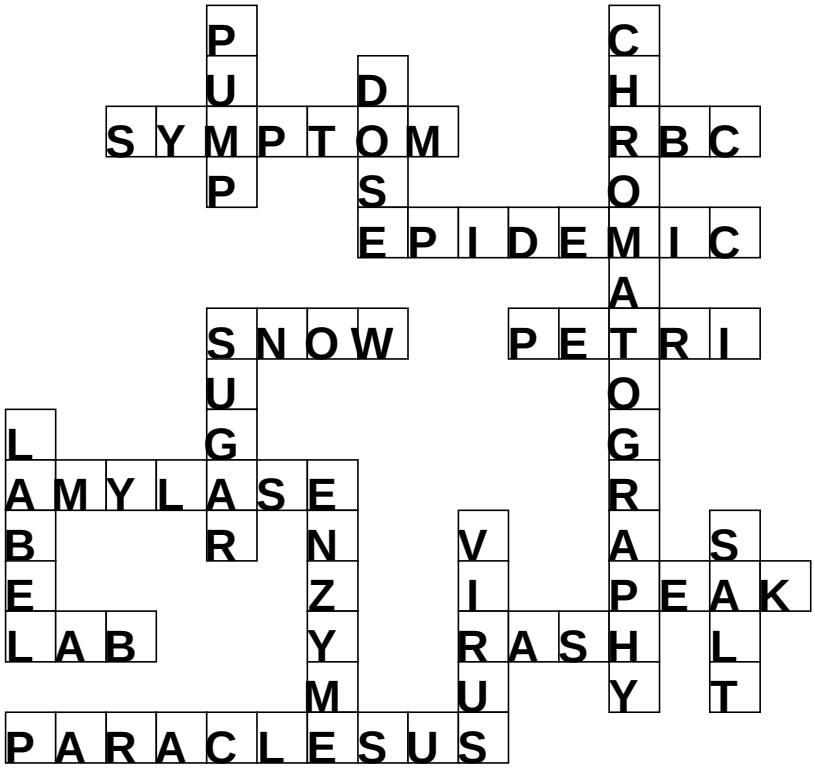
- Amy L. Caruano. Revision of Amylase and Starch Experiment-Presence of Contaminant Sugar in Amylase Control. Biology Department, Kean University of New Jersey. <www.kean.edu/~biology/amylase.html>.
- How does amylase starch digestion work? Science Net, Biology and Medicine. <www.sciencenet.org.uk/database/Biology/9701/b00705d.html>.
- Laboratory on Enzymes. Department of Biology. University of North Dakota. <www.und.nodak.edu/dept/jcarmich/101lab/lab6/lab6.html>.
- The Effect of pH on Enzyme Activity- Salivary Amylase and Starch Digestion. The Woodrow Wilson Leadership Program in Chemistry, Salivary Amylase and Starch Digestion <www.woodrow.org/teachers/ci/1988/starch.html>.
- Robert Goodman. Digestive Enzymes. The National Health Museum. Access Excellence. Activities Exchange.<www.accessexcellence.org/atg/data/released/0334-RobertGoodman/>.

CORRELATION WITH NATIONAL SCIENCE CONTENT STANDARDS:

- Unifying Concepts and Processes: Change, consistency and measurement: the students will be making measurements of color in response to a time change.
- Scientific Inquiry: Understandings about scientific inquiry: the students will be creating their own laboratory procedure for part of this activity.
- Physical Science: Chemical reactions: the students will be making observations of multiple chemical reactions.
- Life Science: The cell: all reactions within a cell are either catalyzed by or directed by enzymes.

STUDENT WORKSHEET 2:

Puzzle Solutions



Teacher Key

PART I: MAKING OBSERVATIONS OF THE DIGESTION OF STARCH

1. Fill a plastic pipette (or eye dropper) with iodine. Add 1 drop of Iodine to each of the items on the Petri dish. Record your observations, especially any color changes you see.
   The formation of the blue complex is a test for the presence of starch.

8. Add one drop of I_2 to the #1 starch solution. Record your observations. Is there evidence that the saliva digested the starch?
   Depending on how long the amylase reacts with the starch solution, students will notice that when they add iodine the color of the solution might be brown or even yellow and not blue, indicating that there is very little starch present.

9. Place one drop of potato starch solution onto area #2 on the Petri dish. Add one drop of I_2 to the starch solution first and then add one drop of saliva. Record your observations. Is there evidence for a different result between the procedures in part 8 and 9? *Yes.*
   Adding iodine first to the starch solution will produce a deep purple black color, indicating the presence of starch. The amylase will digest the starch in solution and the color of the mixture might change slightly from dark blue to a lighter color as the starch is digested, but this might be hard to detect.

PART II: ESTABLISHING A SYSTEMATIC TEST FOR THE PRESENCE OF STARCH OR SUGAR

Test Tube	#1 Water	#2 Starch Solution	#3 Sugar Solution	#4 Sugar + Enzyme	#5 Starch Solution	#6 Sugar Solution	#7 Starch + Enzyme
Distilled H2O	**3 mL**		**3 mL**			**4 mL**	**1 mL**
Glucose			**Add a pinch**			**Add a pinch**	
Starch Solution		**3 mL**		**1 mL**	**4 mL**		**1 mL**
Amylase				**2 mL**			**2 mL**
Read Steps 3 & 4 to add:	**Benedict's Solution**	**Benedict's Solution**	**Benedict's Solution**	**Benedict's Solution**	**Iodine Solution**	**Iodine Solution**	**Iodine Solution**
Initial Color	***Blue***	***Blue***	***Blue***	***Blue***	***Clear***	***Clear***	***Clear***
Color of solution after test	***Blue***	***Blue***	***Yellow Orange***	***Yellow Orange***	***Dark Blue Purple***	***Iodine Yellow***	***Iodine Yellow***

1. When Benedict's solution reacts with a sugar solution, describe the color change that takes place.
   After heating, the solution turns from blue to yellow-orange.
2. When Benedict's solution is added to a starch solution, describe the color change that takes place. *None*

3. When Iodine (I_2) is added to a starch solution, describe the color change that takes place.
   The solution changes from clear to a deep indigo-purple color.

4. When Iodine (I_2) is added to a sugar solution, describe the color change that takes place.
   None. The solution remains the color of the iodine, yellow-brown.

5. Which test tubes served as the controls in this experiment? Explain.
   Test tube #1 of distilled served as a control for the entire experiment to confirm that water does not react with Benedict's solution or iodine. Test tube #2 served as a control for the Benedict's solution experiment to confirm that Benedict's does not react with starch. Test tube #6 served as a control for the iodine solution experiment to confirm that iodine does not react with sugar.

PART III. TESTING FOR THE PRESENCE OF AMYLASE: A CASE STUDY AT THE INTERNATIONAL HOUSE OF POTATOES

2. On the back of this worksheet, write a clear and detailed protocol that other inspectors could use to test for spitters.
   Protocols will vary. Most students will test only for the presence of starch looking to see if there has been the hydrolysis of starch into sugar by the amylase. Other students will use Benedict's solution as confirmation of the presence of sugar, the breakdown product of the reaction. One suggestion to assess student work is to have students exchange protocols and have other groups repeat the experiment using their peers' protocols.

3. Record the results of your test. Did Henri spit in restaurant customers' potatoes? Explain.
   The results can indirectly confirm the presence of amylase in certain samples. The exact samples will vary from class to class at the discretion of the instructor.

4. Can you positively link Henri to the crime? Can you positively prove that Henri is innocent? Explain why or why not.
   No. Unless Henri is caught in the act of spitting, we cannot confirm that the amylase detected in the samples is Henri's unless we conducted other diagnostic tests, like DNA analysis. The evidence is circumstantial.

STUDENT PAGES
FOR

BACKGROUND ACTIVITY 9:
ENZYMES – THE CATALYSTS OF LIFE

FOLLOW THIS PAGE

STUDENT INSTRUCTIONS – PART I:

Part I: Making Observations of the Digestion of Starch

Everything that goes on within a cell is either catalyzed by or directed by enzymes. The chemical reactions in your body would ordinarily occur at extremely slow rates at normal body temperature and pH. Enzymes act as catalysts to speed up these reactions. Without enzymes in our digestive tract, it would take us about 50 years to digest a single meal. Digestion of a meal begins in your mouth. Saliva contains an enzyme, amylase, which helps break large starch molecules into small sugar molecules that can be absorbed by the intestines. This reaction, which involves the reaction of the starch with water molecules to form sugar, is called hydrolysis.

$$\text{Starch} + H_20 \text{ -----amylase-----> sugar } (C_6H_{12}O_6)$$

We can detect the presence of starch by adding a color indicator, iodine. Starch reacts with iodine, as I^-_3, to produce a blue starch-iodine complex.

$$I^-_3 + \text{starch} \rightarrow \text{starch} - I^-_3 \quad \text{(dark blue complex)}$$

When the starch (a very large molecule) has been broken down (digested) into glucose (a small molecule) by the enzyme, the blue Iodine-starch complex can no longer form. Small sugar molecules do not react with iodine and do not form this blue complex. You will see this when you do steps 1-10.

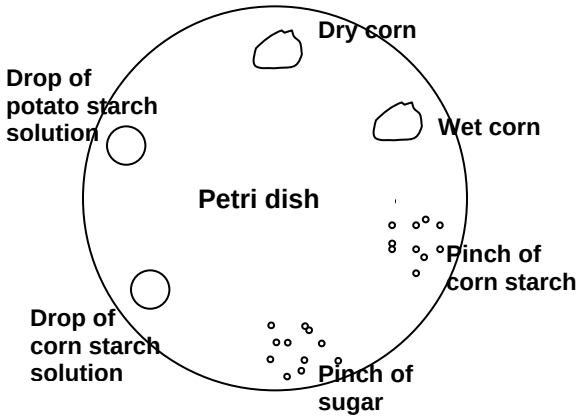
Materials per group of students:

Plastic Petri Dish (dish + lid)
2 kernels each of dry and wet corn (peas)
Pinch of corn starch
Drop of corn starch solution and drop of soluble potato starch solution
Iodine solution
Plastic pipette (2)
Dixie cup
Safety glasses
Latex or plastic gloves

Procedure:

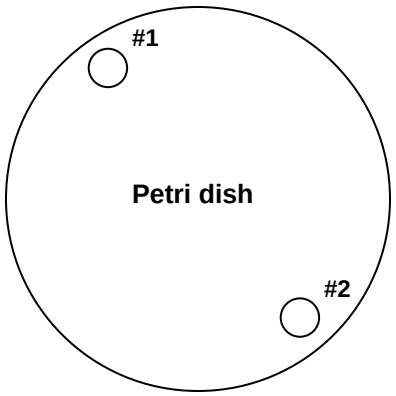
1. Safety Information: Wear safety glasses and rubber gloves to perform this lab.
   Iodine solution stains clothes. Use with care.

2. Set up the bottom of a Petri dish like this: Write the items used in the data table on the student worksheet.



3. Based on the knowledge you have gained, predict what will occur if you add iodine solution to each item on the plate. Write you prediction in the Table on the worksheet.
4. Fill a plastic pipette (or eye dropper) with iodine indicator solution. Add 1 drop of iodine indicator to each of the items on the Petri dish. Record your observations in on the worksheet, especially any color changes you see. The formation of the blue complex is a test for the presence of starch.

5. Mark the other half of the Petri dish like this:



6. Obtain a new rubber band, and wash it carefully with drinking water.
7. One member of each pair chews the rubber band vigorously to activate the flow of saliva in your mouth. Collect the saliva in a Dixie cup. You need about 5-6 drops of saliva.

Safety Note: ***Since this saliva contains your very own personal germs, you should be careful not to allow anyone to come in contact with your saliva. You should also be careful to avoid coming in contact with anyone else's saliva during this part of the experiment.***

8. Carefully transfer the saliva to a clean plastic pipette.
9. Place one drop of potato starch solution onto area #1 on the Petri dish. Add one drop of iodine solution to the starch solution first and then add one drop of saliva. Wait 5 minutes to observe the results, but proceed with Step 9 while waiting.
10. Add one drop of starch solution to the #2 circle in the Petri dish. Add one drop of saliva to the starch solution in #2. Add one drop of iodine solution to the #2 drop starch solution.

    #1 Starch + Saliva ------wait 5 minutes ----+ Iodine solution
    #2 Starch + Saliva ------ no wait ----------+ Iodine solution

10. Record your predictions and observations in on the student worksheet. Is there evidence that saliva digested the starch? Is there evidence for a different result between the procedures use in part 8 and 9?
11. Wash the rubber band and the cup you used to collected your saliva and throw both away in the trash container.

STUDENT WORKSHEET: PART I **NAME**_____

Starch Digestion Table

Item on Dish	Predictions (hypothesis)	Actual Test Results	Starch present	Enzyme activity?
#1				
#2				

Student Instructions – Part II:

Part II: Establishing a Systematic Test for the Presence of Starch or Sugar

Materials (per 2 students):
Foil-covered dropper bottles of iodine (I_2)
7 mL - 0.5% Amylase solution
3 mL Benedict's solution
15 mL Distilled Water
12 mL - 0.5% Starch solution
Glucose or sucrose (dry)
7 Test tubes (13x100 mm) or spot plates with 10 wells
Test tube rack
Wax pencil for marking test tubes
Graduated cylinders or graduated pipettes (10 mL)
Central water bath
Safety glasses
Gloves
Masking or other labeling tape, permanent marking pen
Stopwatch or timer
Plastic container for waste solutions

Procedure:
1. Label seven test tubes #1-7.
2. Use the following data table in your Learning Log or on the worksheet to record your observations.

Test Tube	#1	#2	#3	#4	#5	#6	#7
Contents of test tube							
Initial Color							
Color of solution after test							
Color Changes?							

3. Use a graduated cylinder to measure out distilled water, glucose, starch solution, and amylase in each tube following the amounts listed under the test tube number in Table 1.

Table 1

Test Tube	#1 Water	#2 Starch Solution	#3 Sugar Solution	#4 Sugar + Enzyme	#5 Starch Solution	#6 Sugar Solution	#7 Starch + Enzyme
Distilled H2O	3 mL		3 mL			4 mL	1 mL
Glucose			Add a pinch			Add a pinch	
Starch Solution		3 mL		1 mL	4 mL		1 mL
Amylase				2 mL			2 mL
Read Steps 6 and 7 to add:	Benedict's Solution	Benedict's Solution	Benedict's Solution	Benedict's Solution	Iodine Solution	Iodine Solution	Iodine Solution

4. Let all test tubes sit for 2-3 minutes.
5. **Test tube 1 - 4:** Add 1 mL of Benedict's solution to test tubes 1-4. Record the initial color of the solution in your data table. Place the test tubes in a boiling water bath for 2-3 minutes. Record the color in each tube in your data table, noting any changes in color.

6. **Test tubes 5 - 7**: Record the color of the solution before adding Iodine for samples 5-7. Add one drop of iodine to test tubes 5, 6, and 7. Record the color after adding the Iodine. Note any color change in your data table.

Conclusion Questions *(Answer in your Learning Logs or on a worksheet)***:**

1. When Benedict's solution reacts with a sugar solution, describe the color change that takes place.

2. When Benedict's solution is added to a starch solution, describe the color change that takes place.

3. When iodine solution is added to a starch solution, describe the color change that takes place.

4. When Iodine solution is added to a sugar solution, describe the color change that takes place.

5. Which test tubes served as the controls in this experiment? Explain.

6. Summarize what you observed in this experiment in 3 to 4 sentences.

STUDENT WORKSHEET: PART II **NAME**_____

1. In your own words, what is an enzyme?

2. What is amylase and what does it do?

DATA TABLE

Test Tube	#1	#2	#3	#4	#5	#6	#7
Contents of test tube							
Initial Color							
Color of solution after test							
Color Changes?							

Conclusion Questions:

7. When Benedict's solution reacts with a sugar solution, describe the color change that takes place.

8. When Benedict's solution is added to a starch solution, describe the color change that takes place.

9. When iodine solution is added to a starch solution, describe the color change that takes place.

10. When Iodine solution is added to a sugar solution, describe the color change that takes place.

11. Which test tubes served as the controls in this experiment? Explain.

12. Summarize what you observed in this experiment in 3 to 4 sentences.

Part III. Testing for the Presence of Amylase – A Case Study at the International House of Potatoes

Overview:
You are the maitre'd of the famous International House of Potatoes, a restaurant known for its hash browns, French fries, and mashed potatoes. Your co-worker Henri has a bad attitude: he is a disgruntled waiter who rarely gets good tips. Several customers have complained recently of a funny taste to their mashed potatoes and coincidentally (or not!) you walk into the restaurant kitchen and find Henri chewing on a rubber band and bending over a plate of steaming mashed potatoes. Is Henri spitting in people's food?! Henri assures you that nothing is going on, but how can you be sure?! Should Henri be fired?

Materials per 2 students:
- Samples of potato starch solutions (5 unknown samples)
- Dropper bottles of iodine (I_2)
- Benedict's solution, 3 mL
- Distilled Water, 15 mL
- Plastic pipettes
- Graduated cylinders or syringes
- 1 - 250 mL beaker (can substitute Solo party cups, these will be filled with hot water)
- Safety glasses
- Latex or plastic gloves

Procedure:
1. Work in pairs and write the answers to all of the following questions on the worksheet.

2. Using the materials and chemical reagents available to you and your partner, develop a test to determine if Henri spit in any of the samples of potatoes taken from the restaurant. Describe the test that you developed.

3. Write a clear and detailed protocol that other inspectors could use to test for spitters.

4. Carry out your test and record the results. Did Henri spit in restaurant customers' potatoes? Explain.

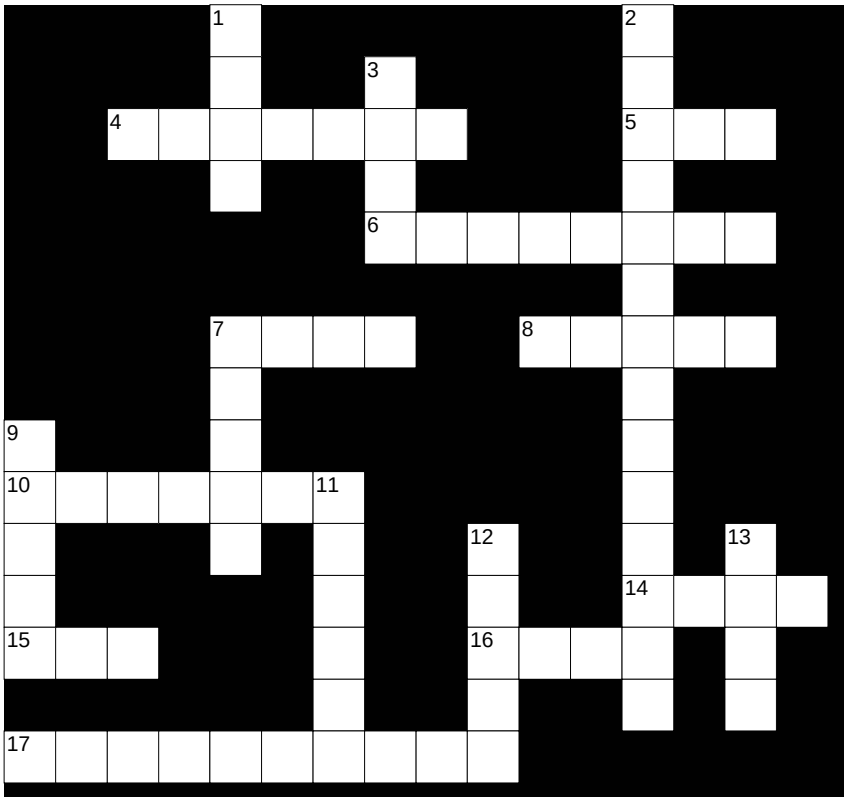
5. Can you positively link Henri to the crime? Can you positively prove that Henri is innocent? Explain why or why not.

PART IV: HOW ENZYMES HELP NERVES TO WORK (TO BE WRITTEN)

OTHER POSSIBLE WORKSHEETS

Student Worksheet: **Name** _____

Hydroville Times Crossword Puzzle



Across

4 evidence of a health problem
5 carries oxygen in the blood
6 widespread illness
7 19th century physician John _____
8 used to grow bacteria
10 mouth enzyme
14 data on chromatogram
15 where environmental samples are sent
16 itchy red skin
17 the father of toxicology

Down

1 water source
2 method used to separate and identify chemicals
3 the ____ makes the poison
7 Benedict's solution tests for this
9 where "signal words" are found
11 biological catalyst
12 causes some diseases
13 NaCl