INTRODUCTION

Did you know that protein does more than build tissue? It is necessary for the digestion of food. Proteins provide the amino acids that are required for building enzymes – the special proteins that start chemical reactions. These are the same enzymes that break food down so the body can use it. Enzyme reactions break food into compounds that are used by the body. Enzymes are also what causes fruit to turn brown when it is exposed to air. Enzymes are critical to everyday life.

FOCUS ASSIGNMENTS

• Go to http://www.enzymetechnicalassoc.org/benefits_paper.pdf which is a PDF document. Go to page 9 of the PDF document. It should have the heading “Food/Food Ingredient—Applications.” Read the information presented on pages 9-14.

Continued on next page
UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Lab Activities and Assignments and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Explain the function of enzymes as catalysts in chemical reactions.
2. Describe the relationship between an enzyme and a substance.
3. Discuss denaturation of enzymes.
4. Observe catalase denaturation. (Lab Activity 1)
5. Compare the functions and activities of enzymes and coenzymes.
6. Examine enzyme action on protein. (Lab Activity 2)
7. Explain how enzyme reactions are involved in food preparation.
8. Relate enzyme reactions to food.
9. Demonstrate the role of enzymes in food preparation. (Lab Assignment 1)
10. Observe the role of enzymes in food preparation. (Lab Activity 3)
11. Observe enzyme reactions by making cheese. (Lab Activity 4)
OBJECTIVE 1

Explain the function of enzymes as catalysts in chemical reactions.

WORDS YOU SHOULD KNOW

**catalyst**
substance that speeds up a chemical process; the catalyst remains unchanged; can build up or break down various compounds

**enzyme**
protein that can produce chemical changes or control chemical activity; often named for the compound they change

EXAMPLES: lipase which works on fats (lipids) and lactase which acts on milk sugar (lactose)

************
**Enzymes** are special proteins that cause chemical reactions, like the browning of cut apples. There are thousands of enzymes and each has a specific job to perform. Just as certain enzymes are used to digest food, others affect food preparation like ones that react with oxygen and cause the apples to turn brown and those that are used to make cheese.

Enzymes serve as **catalysts**. As catalysts, they can speed up a chemical process without changing or being destroyed by the process. They increase the rate of a chemical reaction. They also can slow down a reaction. Without enzymes, most biological reactions would be so slow that they could not sustain life.

**OBJECTIVE 2**

Describe the relationship between an enzyme and a substance.

**WORDS YOU SHOULD KNOW**

- **active site**: the part of an enzyme where the substrate bonds and the catalysis occurs
- **allosteric**: of or involving a change in the shape and activity of an enzyme that results from molecular binding with a regulatory substance at a site other than the enzymatically active one
- **catalysis**: the action of a catalyst; the process where a chemical reaction is increased
- **product**: a substance that forms as a result of a reaction
- **substrate**: a substance on which an enzyme acts

**********
Web Activity

Go to http://bio.winona.edu/berg/ANIMTNS/alostan.htm to see an animation of allosteric activators.

Enzymes have very specific tasks. Each enzyme will only affect a particular kind of substance, called a substrate. This is known as a “lock and key” model since it is very similar to the way a key opens a lock. Each type of enzyme has a very specific shape that fits exactly with the shape of the substrate. The part of the enzyme that binds with the substrate is called the active site. Sometimes the enzyme and the substrate need to modify to make the best fit; this process is called induced fit. Once the enzyme and the substrate bond, a reaction occurs. This reaction is called catalysis, and it is when the substrate is changed into something different and the substrate is then called the product. Once the conversion of the substrate into the product is finished, the enzyme splits off. Since the enzyme is unchanged, it can react with more substrate if it is present.

Some factors that affect the enzyme reactions are:

- inhibitors — Inhibitors keep the enzyme from bonding with the substrate. There are two types: competitive inhibitors which bond with the enzyme’s active site, keeping the substrate from bonding, and noncompetitive inhibitors that bind on other parts of the enzyme and decrease the rate of the reaction.
EXAMPLES: Grains like wheat and corn contain enzyme inhibitors; other foods containing inhibitors include olives, tomatoes, onions, and garlic; egg whites contain two different inhibitors, one binds with the vitamin biotin to inhibit the growth of specific bacteria.

- **activators** — Activators change the activity of an enzyme by bonding another substance to a site other than the active site on the enzyme. This can enhance the reaction by helping the substrate bond to the enzyme.

EXAMPLE: Yeast contains maltase which breaks maltose into simple sugars; when the sugars break down, they create carbon dioxide which makes dough rise. Heat then serves to stop the process when the temperature gets high enough to destroy the yeast cells.

- **pH levels** — Changes in pH affect the attraction of the enzyme to the substrate and make the reaction process less efficient. Many times there is a specific pH that an enzyme needs to work.

EXAMPLE: In cheese making, rennin needs a pH level of 5.8 or lower. Since milk has a pH of about 6, an acid must be added to the milk to lower the pH and allow the rennin to curdle to make cheese.

- **temperature** — High heat can change the shape of the enzyme, damaging and changing it to where it cannot bind with the substrate. Very low temperatures can make the enzymes less active, slowing or stopping the conversion process.

EXAMPLE: The action of enzymes in meat tenderizers is stopped when the meat is cooked.

### OBJECTIVE 3

**Discuss denaturation of enzymes.**

### WORDS YOU SHOULD KNOW

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>denaturation</td>
<td>using physical or chemical means to change the shape of a protein molecule while leaving the peptide bond intact</td>
</tr>
<tr>
<td>electrolyte</td>
<td>substance or compound that breaks into ions when dissolved; may be positively or negatively charged</td>
</tr>
</tbody>
</table>

Denaturation is a process that uses physical or chemical means to change the shape of a protein molecule while leaving the peptide bond intact. This process can slow or stop the action of the enzymes.
Factors that denature enzymes include:

- Heat

- Changing the pH level – enzymes react best at certain pH levels; raising or lowering pH can speed, slow, stop enzymatic reactions

- Electrolytes

**OBJECTIVE 4**

Complete Lab Activity 1.

**OBJECTIVE 5**

Compare the functions and activities of enzymes and coenzymes.

**WORDS YOU SHOULD KNOW**

- **coenzyme** small molecules that are required for the function of certain enzymes
- **vitamins** an organic compound required by an organism as a nutrient

Sometimes enzymes need helpers to function properly. A coenzyme participates in the chemical reaction by binding the enzyme with other chemicals to enhance the reaction rate. Coenzymes carry many different chemical groups and chemical energy between enzymes. These are chemicals which the enzymes need to carry out the conversion of the substrate so the coenzyme is very important to the reaction. Sometimes the coenzyme is changed during the reaction, but it is not changed permanently. Like enzymes, they can be used repeatedly in reactions. Many coenzymes are found in vitamins and are an essential part of the diet of all living things. For example, B vitamins act as coenzymes to help the body use fat, carbohydrates, and protein to produce energy for cells.

**OBJECTIVE 6**

Complete Lab Activity 2.
OBJECTIVE 7

Explain how enzyme reactions are involved in food preparation.

WORDS YOU SHOULD KNOW

- coagulate: the process in which a liquid turns into a semi-solid
- collagen: an insoluble protein
- denature: a change in a protein brought about by temperature changes, pH changes, or irradiation
- enzymes: proteins that accelerate the rate of chemical reactions; present in plant and animal tissue. Enzymes continue to act until deactivated. Temperature and pH affect enzyme activity.
- fermentation: the conversion of sugar to carbon dioxide and alcohol by yeast
- leavening: a substance used in dough and batter that causes the finished product to be lighter and softer
- pasteurization: a process that uses heat to destroy bacteria in milk

Even before people knew what enzymes were, they were being used in food preparation. Bread, cheese, and wine, which have been made for thousands of years, all require some sort of enzyme in their preparation process. Today, enzymes are used to improve foods in such ways as flavor, texture, appearance, and nutritional value. Using enzymes can also reduce the need for synthetic chemicals in foods, improve the efficiency of food manufacturing, and help provide a wider variety of products to consumers. New food products and ingredients can be created through the use of enzymes.

EXAMPLE: Enzymes are used to create oleic acid from beef fat which in turn is used to make margarine.

A common example of how enzymes work in food preparation is yeast. Yeast is used both in the baking of bread and the brewing of wine and beer. Baker’s yeast is added to dough to give bread a light texture. The enzymes in the yeast break down starch and sugar in the dough and produce carbon dioxide, which makes bubbles in the dough and cause it to rise. The air holes from the bubbles give the bread its texture. Brewer’s yeast used in making wine and beer works in much the same way, but since oxygen is not present in the fermentation process, the enzymes in the yeast produce alcohol as a product.
There are many other examples of enzymes used in food preparation, such as rennet, used in cheese-making; papain, used in tenderizing meat; and pectinase, used to make fruit juices clear instead of cloudy.

- **Meats**
  - Enzymes attack and degrade the proteins in meat and act on the connective tissue.
  - Commercial tenderizers contain enzymes used to break down the protein collagen, which tenderizes the meat.
  - Enzymes used as a tenderizer are most effective on thin cuts of meat, since penetration is not deep into the surface.
  - Certain enzymes are activated at the death of the animal and will tenderize and add flavor to the meat. This process is called aging.

- **Dairy products**
  - During pasteurization, heat denatures the enzymes and destroys harmful microorganisms. The adequacy of milk pasteurization can be measured by enzyme activity.
  - Enzyme coagulation is used in the production of cheese, ice cream, and puddings.

- **Fruits and vegetables**
  - Enzymes found in plant tissues cause ripening, which softens and tenderizes fruit. Enzyme reactions during ripening help in the formation of pectin needed to make jellied products.
Certain enzymes in pineapple, figs, kiwi fruit, and papaya prevent gelation in gelatin mixtures. These enzymes can be **denatured** by heat or pH level.

**EXAMPLE:** Cooked or canned pineapple can be used in flavored gelatin products because the enzymes have been denatured.

Enzyme action helps starch change to sugar, which brings out flavor.

- **Bakery products**
  - During fermentation, starch-degrading enzymes help break down starch to provide food for yeast.
  - Yeast is a leavening agent in many breads.

- **Food preservation**
  - Preservation methods such as blanching, freezing, canning, and drying slow or stop enzyme activity when food is at its peak quality.

**OBJECTIVE 8**

Relate enzyme reactions to food.

Enzyme reactions have both beneficial and harmful reactions in foods. Some enzymes that provide beneficial reactions include:

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Reaction in food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rennin</td>
<td>Forms cheese curds through coagulation of casein</td>
</tr>
<tr>
<td>Lactase</td>
<td>Prevents lactose from forming crystals and stabilizes milk protein in ice cream; can be used to remove or reduce lactose in milk for those with lactose intolerance</td>
</tr>
<tr>
<td>Papain and bromelin</td>
<td>Used to tenderize meats; combined with salt to create meat tenderizers</td>
</tr>
<tr>
<td>Amylase</td>
<td>Releases sugar which feeds yeast; increases loaf volume of bread; clarifies fruit juice</td>
</tr>
<tr>
<td>Naringinase</td>
<td>Breaks down bitter compounds in fruits</td>
</tr>
</tbody>
</table>

[10 — INFORMATION SHEET]
Some of the enzymes that cause harmful reactions include:

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Reaction in food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protease</td>
<td>Causes rotting of food</td>
</tr>
<tr>
<td>Polygalacturonase</td>
<td>Causes over-ripening of fruits</td>
</tr>
<tr>
<td>Peroxidase</td>
<td>Causes vegetables to soften</td>
</tr>
<tr>
<td>Polyphenolase</td>
<td>Causes certain vegetables and fruits to brown when cut</td>
</tr>
</tbody>
</table>

**OBJECTIVE 9**
Complete Lab Assignment 1.

**OBJECTIVE 10**
Complete Lab Activity 3.

**OBJECTIVE 11**
Complete Lab Activity 4.
Lab Activity 1

Name _________________________________________
Date _________________ Score ________________

OBJECTIVE 4
Observe catalase denaturation.

BASIC SKILLS

INTRODUCTION

This activity is designed to study the effects of heat on enzymes. The enzyme catalase is found in not only your blood and cells but also in potatoes. Potatoes will be heated to determine the effect of heat on catalase.

Pre Lab Activity

Read about catalase at http://nicholasacademy.com/scienceexperiment213peroxidebubbles.html
EQUIPMENT AND SUPPLIES

- 1-76 mm (3 inch) diameter red-skinned potato
- Knife
- 4-25 mm (1 inch) test tubes
- Test tube rack
- Distilled water
- Hot plate
- Thermometer
- Small beaker or measuring tool in milliliters
- 250 mL beaker
- 3% hydrogen peroxide
- Strainer
- Ruler
- Marker
- Stop watch or clock with second hand
- Lab Report form

INSTRUCTIONS

Yes  No

1. Fill out the first section of your Lab Report form.

2. Cut the potato into quarters.

3. Finely dice one quarter and put it in the first test tube.

4. Mark the level of the potatoes on the tube, label it #1, and place it in the rack. Repeat with the remaining potato quarters, labeling them 2 - 4.

5. Add 5 mL (1 tsp) hydrogen peroxide to tube #1. Observe for 15 seconds.

6. Measure the level of froth in the tube and record.

7. Add the potatoes from tube 2 to the 250 mL beaker and add distilled water to just cover. Rinse the tube.

8. Place the beaker on the hot plate and heat the potatoes and water to 30°C.

9. Remove from the beaker and drain the potatoes. Return the potatoes to tube 2.

10. Add 5 mL (1 tsp) hydrogen peroxide to tube 2. Observe for 15 seconds.

11. Measure the level of froth in the tube and record results.

12. Add the potatoes from tube 3 to the 250 mL beaker and add distilled water to just cover. Rinse the tube.

13. Place the beaker on the hot plate and heat the potatoes and water to 45°C.
14. Remove from the beaker and drain the potatoes. Return the potatoes to tube 3.

15. Add 5 mL (1 tsp) hydrogen peroxide to tube 3. Observe for 15 seconds.

16. Measure the level of froth in the tube and record results.

17. Add the potatoes from tube 4 to the 250 mL beaker and add distilled water to just cover. Rinse the tube.

18. Place the beaker on the hot plate and heat the potatoes and water to 60°C.

19. Remove from the beaker and drain the potatoes. Return the potatoes to tube 4.

20. Add 5 mL (1 tsp) hydrogen peroxide to tube 4. Observe for 15 seconds.

21. Measure the level of froth in the tube and record results on the data chart provided.

22. Clean equipment and area.

23. Draw conclusions on the effect of heat on the enzyme catalase.

_______________________________________________________________________
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_______________________________________________________________________

<table>
<thead>
<tr>
<th>Data Chart</th>
<th>Level of Potatoes</th>
<th>Level of Froth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube 1 control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube 2 30°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube 45°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube 60°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment — The Student:**

**Yes**  **No**

- ☐ ☐ 1. Read and prepared for the lab in advance.
- ☐ ☐ 2. Gathered all necessary equipment and supplies.
- ☐ ☐ 3. Complied with lab safety guidelines.
- ☐ ☐ 4. Followed the specific directions.
- ☐ ☐ 5. Measured accurately.
- ☐ ☐ 6. Completed lab fully and properly.
- ☐ ☐ 7. Included specific data and information.
- ☐ ☐ 8. Drew appropriate conclusions.
ENZYMES AND FOOD PREPARATION

Lab Report

Name ___________________________________________     Date _______________

Title of Lab Activity: ___________________________________________________________

Preparation (Complete this information prior to your lab activity.)

1. The purpose of this lab activity is:
   
   __________________________________________________________
   
   __________________________________________________________

2. The process or procedure for this activity is:
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________

Results (Complete this information during and after your lab activity.)

3. I observed:
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________

4. Data I collected:
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
5. Calculations:

_________________________________________________________________________________
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6. Questions:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

7. Conclusion:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
OBJECTIVE 6
Examine enzyme action on protein.

BASIC SKILLS

INTRODUCTION
There are several types of fruits that have naturally-occurring enzymes that can break down proteins. They include pineapple, papaya, kiwi, and figs. This activity will demonstrate the effect of the enzymes on protein. You will be using gelatin as the substrate for this activity.

EQUIPMENT AND SUPPLIES

- Lemon-flavored gelatin mix
- Water
- Fresh pineapple juice

NOTE: You must use fresh juice as canned has been heated during processing.

- Vinegar
- Saucepan
- Measuring cups
- 100 mL graduated cylinders
- Marbles
- Lab Report form

INSTRUCTIONS
Write a hypothesis about the effects of enzymes on protein.
1. Fill out the first section of your Lab Report form.
2. Mix the gelatin according to the directions on the package.
3. Pour 80 mL (1/3 cup) into three graduated cylinders and label them 1, 2, and 3.
4. Clean the area and equipment.
5. Refrigerate overnight.
6. Remove the cylinders from the refrigerator.
7. Add 10 mL (2 tsp) of fresh pineapple juice to cylinder 1.
8. Place a marble on the top of the gelatin and observe the results after 15 minutes, 30 minutes, and 45 minutes. Record your observations on the data chart provided.
9. Heat 10 mL (2 tsp) of fresh pineapple juice in a saucepan to 100°C and simmer for 2 minutes.
10. Add the heated juice to cylinder 2. This cylinder’s contents will demonstrate the effect of heat on enzyme action.
11. Place a marble on the top of the gelatin and observe the results after 15 minutes, 30 minutes, and 45 minutes. Record your observations on the data chart provided.
12. Combine 5 mL (1 tsp) of fresh pineapple juice with 5 mL (1 tsp) of vinegar. Add to cylinder 3. This cylinder’s contents will demonstrate the effect of pH on enzyme action.
13. Place a marble on the top of the gelatin and observe the results after 15 minutes, 30 minutes, and 45 minutes. Record your observations on the data chart provided.
14. After 45 minutes, refrigerate the cylinders.
15. The following day, observe the position of the marbles in the cylinders. Record your observations on the data chart provided.
16. Clean the area and equipment.
17. Draw conclusions about the effects of enzymes, heat, and pH added to the three cylinders.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

18. Did your conclusions match your hypothesis? Why or why not?

_______________________________________________________________________
_______________________________________________________________________


<table>
<thead>
<tr>
<th>Cylinder Number</th>
<th>Observations at 15 minutes</th>
<th>Observations at 30 minutes</th>
<th>Observations at 45 minutes</th>
<th>Observations at 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Assessment** — The Student:

Yes  No

- 1. Read and prepared for the lab in advance.
- 2. Gathered all necessary equipment and supplies.
- 3. Complied with lab safety guidelines.
- 4. Followed the specific directions.
- 5. Measured accurately.
- 6. Completed lab fully and properly.
- 7. Included specific data and information.
- 8. Drew appropriate conclusions.
ENZYMES AND FOOD PREPARATION

Lab Report

Name ___________________________________________     Date _______________

Title of Lab Activity: _______________________________________________________

Preparation (Complete this information prior to your lab activity.)

1. The purpose of this lab activity is:
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2. The process or procedure for this activity is:
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Results (Complete this information during and after your lab activity.)

3. I observed:
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

4. Data I collected:
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
5. Calculations:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

6. Questions:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

7. Conclusion:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
OBJECTIVE 9
Demonstrate the role of enzymes in food preparation.

EQUIPMENT AND SUPPLIES
- Pen or Pencil
- Posterboard and markers (optional)
- Computer with internet access
- Samples of food product you are researching (optional)

INSTRUCTIONS
Using the Internet, printed resources, interviews with experts, and/or other resources, choose one food production process that involves enzymes as a part of that process. Examples might be bread making, fruit juice production, or cheese making. At minimum, you should write a
detailed report about the process and include the questions listed below. Include visual aids such as a poster or PowerPoint® demonstrating the process or showing the chemical reactions, or have samples of the food you researched.

Questions to consider:

1. What is the process being researched?
2. What enzymes are involved in this process? (list all if there are more than one)
3. How do these enzymes aid in the food process?
4. What are the chemical reactions involved in the process?
5. What are the products of these reactions?
6. How has this particular food production process changed over the years, if any?
7. Who is more likely to use this process, a manufacturer or a small-scale or home producer?
8. Did you know anything about this process before you started researching it? If so, what did you learn about this process that you did not know before you started the research? If not, why did you choose this process to research?
ENZYMES AND FOOD PREPARATION

Lab Activity 3

Name ____________________________________________

Date _________________ Score ________________

OBJECTIVE 10
Observe the role of enzymes in food preparation.

BASIC SKILLS

INTRODUCTION

Meat consists of muscle tissue, connective tissue, fat and bone. Muscle tissue is composed of fibers held together by connective tissue. Connective tissue contains protein called collagen which is tough and elastic. Collagen can be broken down by commercial meat tenderizers which contain plant enzymes (from green papayas, figs, or pineapples). These enzymes break down the tissue. Meat can also be tenderized mechanically by pounding it with a special mallet. In the following experiment, you will tenderize meat using a commercial tenderizing agent, pineapple juice, and a marinade, then compare it to meat that is mechanically tenderized and meat that is not treated at all.
EQUIPMENT AND SUPPLIES

<table>
<thead>
<tr>
<th>Ingredients:</th>
<th>Tools:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• round steak (lean, 8 oz., cut into 5 pieces)</td>
<td>• Forks (plastic)</td>
</tr>
<tr>
<td>• Tenderizing agent (dry, 1 package)</td>
<td>• Knife (sharp for cutting raw meat)</td>
</tr>
<tr>
<td>• Commercial, all-natural marinade (bottled)</td>
<td>• Knife (for cutting cooked meat)</td>
</tr>
<tr>
<td>✔ NOTE: You can make a simple marinade, if desired.</td>
<td>• Labels (8, self-sticking)</td>
</tr>
<tr>
<td>• Pineapple juice</td>
<td>• Mallet</td>
</tr>
<tr>
<td>• Broiler</td>
<td>• Marking pen (non-toxic)</td>
</tr>
<tr>
<td>• Broiling rack and pan</td>
<td>• Oven mitt</td>
</tr>
<tr>
<td>• Cutting board</td>
<td>• Paper plates (6)</td>
</tr>
<tr>
<td>• Fork (1, metal)</td>
<td>• Paper towels</td>
</tr>
<tr>
<td>• Forks (plastic)</td>
<td>• Pen or pencil</td>
</tr>
<tr>
<td>• Knife (for cutting cooked meat)</td>
<td>• Tongs</td>
</tr>
<tr>
<td>• Knife (for cutting raw meat)</td>
<td>• Toothpicks: green, red, blue, yellow, and plain</td>
</tr>
<tr>
<td>• Labels (8, self-sticking)</td>
<td>• Lab Report form</td>
</tr>
<tr>
<td>• Mallet</td>
<td></td>
</tr>
<tr>
<td>• Marking pen (non-toxic)</td>
<td></td>
</tr>
<tr>
<td>• Oven mitt</td>
<td></td>
</tr>
<tr>
<td>• Paper plates (6)</td>
<td></td>
</tr>
<tr>
<td>• Paper towels</td>
<td></td>
</tr>
<tr>
<td>• Pen or pencil</td>
<td></td>
</tr>
<tr>
<td>• Tongs</td>
<td></td>
</tr>
<tr>
<td>• Toothpicks: green, red, blue, yellow, and plain</td>
<td></td>
</tr>
</tbody>
</table>

INSTRUCTIONS

Yes   No

1. Complete the first part of your Lab Report form.
2. Mark two labels with “control,” two with “chemical,” two with “natural” and two with “mallet.”
3. Attach one label at the edge of each paper plate.
4. Wash the surface of the meat and pat dry with paper towel. Discard towel.
5. Place the meat on a cutting board and slice it into fourths. Place one piece of the meat on a paper plate, one piece on a cutting board, two pieces in two different resealable plastic bags, and one piece on a broiler rack.
6. Pour marinade over the meat in one of the plastic bags and marinate according to manufacturer’s directions.
7. Pour pineapple juice over the meat in the other plastic bag.
8. Sprinkle packaged tenderizer according to package directions on the piece of meat on the plate labeled “chemical.”
9. With a fork, poke several dozen evenly distributed holes in the meat so that the tenderizer can soak in.
10. Place the tenderized meat next to the control meat on the broiler rack. Put a green toothpick in the side of the tenderized meat. Place a plain toothpick in the side of the control meat.

11. Pound the meat on the cutting board with the mallet until it is about $\frac{3}{8}$ inch thick. Place a red toothpick in the side of the pounded meat.

12. Place the pounded meat on the broiler rack next to the other pieces.

13. Remove the marinated meat from the bag after recommended time. Place a blue toothpick in the side of the marinated meat.

14. Place the marinated meat on the broiler pan next to the others.

15. Remove the meat from the bag with pineapple juice. Place a yellow toothpick in the side of the meat and place on the broiler pan.

16. Discard used plates.

17. Cook the meat until done (about 3 minutes each side).

**NOTE:** Cooking times will vary. Ask your instructor and adjust accordingly. Remove the pan from the oven with an oven mitt.

**NOTICE:** The broiler pan will be extremely hot. Take care not to burn yourself or others!

18. Transfer the meat to clean, labeled plates. Match the toothpick color with the appropriate plate.

19. Cut samples from each piece of meat with a fork. Record your observations on the Tenderization Observation Chart at the end of this activity.

20. Cut samples from each piece with a knife. Record your observations on the chart.

21. Cut equal size pieces from each type of meat. Count the number of times you have to chew each piece until it dissolves. Record the number on the chart.

22. Cut one more sample from each type of meat. Taste each piece, paying attention to the flavor and texture. Record your observations on the chart.

23. Describe the appearance of each meat sample. Record your observations on the chart.

24. Clean your work area and clean and put away your equipment.
Answer the following questions:

a. Did you notice any difference in appearance?

________________________________________________________________________
________________________________________________________________________

b. Which meat was more tender?

________________________________________________________________________
________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

c. Which meat had the best flavor and texture?

________________________________________________________________________
________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

d. Which piece took the longest to chew? Why?

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________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

e. What conclusions can you draw from this experiment?

________________________________________________________________________
________________________________________________________________________

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________________________________________________________________________

Complete your Lab Report form.
### Tenderization Observation Chart

<table>
<thead>
<tr>
<th>Observations</th>
<th>Control</th>
<th>Chemical</th>
<th>Mallet</th>
<th>Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothpick Color</td>
<td>Plain</td>
<td>Green</td>
<td>Red</td>
<td>Blue</td>
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<tr>
<td>Fork Test</td>
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<tr>
<td>Knife Test</td>
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<tr>
<td>Chew Test</td>
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<tr>
<td>Texture</td>
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<tr>
<td>Flavor</td>
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<td></td>
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<td></td>
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<tr>
<td>Appearance</td>
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<td></td>
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</tbody>
</table>

**Assessment — The Student:**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
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<tbody>
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</tbody>
</table>
ENZYMES AND FOOD PREPARATION

Lab Report

Name ___________________________________________     Date _______________

Title of Lab Activity: _______________________________________________________

Preparation (Complete this information prior to your lab activity.)

1. The purpose of this lab activity is:

__________________________________________________________________________
__________________________________________________________________________

2. The process or procedure for this activity is:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Results (Complete this information during and after your lab activity.)

3. I observed:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

4. Data I collected:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
5. Calculations:

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6. Questions:

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7. Conclusion:

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________
ENZYMES AND FOOD PREPARATION

Lab Activity 4

Name ________________________________

Date _______________ Score ____________

OBJECTIVE 11
Observe enzyme reactions by making cheese.

BASIC SKILLS

INTRODUCTION

Have you ever wondered how cottage cheese is made? It is made using enzymes to coagulate the milk. This activity will show you, first hand, how the process works.

EQUIPMENT AND SUPPLIES

- 3.8 liters (1 gallon) skim milk
- 118 mL (1/2 cup) fresh cultured buttermilk
- 1.25 mL (1/4 tsp) liquid rennet
- Salt, optional
- 59 mL (1/4 cup) cool water
- Heavy cream, optional
- Stainless steel double boiler (top must be large enough to hold the milks and rennet solution); if not available, use double boiler method of heating using large pots or pots/bowl
- Stainless steel spoon
- Thermometer
- Stainless steel knife
- Heavy cheesecloth
- String
- Colander, stainless steel or plastic
- Lab Report form

NOTE: Do not use aluminum pans or utensils when making cheese.
1. Fill out the first part of your Lab Report form.

2. Mix liquid rennet into the cool water.

3. Slowly heat the skim milk to 86°F (30°C).

4. Stir buttermilk into warm milk.

5. Add rennet/water solution.

6. Let milk stand at room temperature until it coagulates. This will take about an hour, depending on temperature.

7. Cut the curds into cubes about 1/2” across.

8. Slowly heat the curd mixture to 110°F (43.3°C) and hold at this temperature for 30 minutes until curds are firm.

9. Stir mixture often.

10. Line colander with cheesecloth.

11. Pour curds into colander and drain for about 20 minutes.

12. Rinse curds with cold water and drain well.

13. Put curds in a bowl and season with salt if desired.

14. Add 60 mL (1/4 cup) heavy cream to make creamed cottage cheese if desired.

**NOTE:** You can add more or less cream according to taste and consistency desired.

15. Clean equipment and area.

ASSessment — The Student:

Yes  No

1. Read and prepared for the lab in advance.
2. Gathered all necessary equipment and supplies.
3. Complied with lab safety guidelines.
4. Followed the specific directions.
5. Measured accurately.
6. Completed lab fully and properly.
7. Included specific data and information.
8. Drew appropriate conclusions.
ENZYMES AND FOOD PREPARATION

Lab Report

Name ___________________________________________     Date _______________

Title of Lab Activity: _______________________________________________________

Preparation (Complete this information prior to your lab activity.)

1. The purpose of this lab activity is:

   ________________________________________________________________
   ________________________________________________________________

2. The process or procedure for this activity is:

   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

Results (Complete this information during and after your lab activity.)

3. I observed:

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   ________________________________________________________________
   ________________________________________________________________
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4. Data I collected:

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   ________________________________________________________________
5. Calculations:

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6. Questions:

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7. Conclusion:

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