Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe the uses of salt as a food preservative and explain why salt is an effective food preservative.

2. Discuss the relationship between moisture content in meat products and microbial activity.
List of Resources. The following resources may be useful in teaching this lesson:


http://www.saltinstitute.org/
http://www.cargillsalt.com/cargillsalt/default.asp
http://www.micron.com/k12/lessonplans/salt/uses.html
http://www.howstuffworks.com/food-preservation.htm

List of Equipment, Tools, Supplies, and Facilities

✓ Writing surface
✓ Overhead projector
✓ Transparencies from attached masters
✓ Copies of student lab sheet
✓ Copies of technical supplement

Terms. The following terms are presented in this lesson (shown in bold italics):

► Aerobic
► Bacteria
► Condensation
► Dehydration
► Food spoilage
► Mold
► Plasmolysis
► Proteolytic enzyme
► Spores
Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Present to your students two small samples of a fresh meat product, one sealed in a zip lock bag and one loosely covered with clear plastic wrap. Which sample will have the longest “shelf life”?

How long will the samples remain of satisfactory quality? Challenge students to identify causes of food deterioration and the effects of certain conditions (e.g., oxygen, moisture, light) on product shelf life.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Describe the uses of salt as a food preservative and explain why salt is an effective food preservative.

Anticipated Problem: What are the uses of salt as a food preservative and why is salt an effective food preservative?

I. Salt is commonly used as an effective food preservative.

A. Chemical preservatives, such as salt, are used when terminal treatment (thermal processing, freezing, drying, fermentation, or refrigeration) is not a suitable preservation method. Chemical preservatives are also used to reduce the intensity (amount needed) of a terminal treatment.

B. Salt enhances flavor and improves keeping quality. Salt inhibits microbial growth by causing dehydration, removal of water from a molecule by the action of heat or a dehydrating agent. Most microbes and bacteria require moisture to survive. Salt also preserves food by:

1. Reducing water available to microorganisms.
2. Increasing osmotic pressure created in the aqueous environment surrounding the microbial cell. The increase in osmotic pressure causes plasmolysis, a partial dehydration where the protoplast of a cell shrinks away from the wall following water loss due to exposure of a solution of higher osmotic pressure.
3. Reducing the solubility of oxygen in water.
4. Sensitizing cells to carbon dioxide.
5. Interfering with the action of proteolytic enzymes, enzymes that catalyze the breakdown of proteins into simpler substances.

Use a variety of methods to master this objective. Use a lecture/discussion approach to introduce students to the information. Have students record vocabulary terms and definitions in their notebooks. Use TM–A as a visual aid in the discussion of salt as a food preservative.

Objective 2: Discuss the relationship between moisture content in meat products and microbial activity.

Anticipated Problem: What is the relationship between moisture content in meat products and microbial activity?

II. Moisture content in meat products has a direct relationship to microbial activity.

A. Food deterioration is a broad term that includes reduction in nutritional safety or aesthetic appeal. Food spoilage is the deterioration of a food product due to microorganisms, enzymes, environment (heat and cold), light and other radiation, oxygen, moisture (or lack of it), industrial contaminants, macroorganisms, and time.

B. Microorganisms such as bacteria, yeast, and molds, that are on or in food products are frequently a major cause of food spoilage. Bacteria are microscopic, relatively simple microorganisms that have a primitive nucleus. Yeast is a collective name for those fungi which possess a vegetative body (thallus) consisting of simple individual cells. Mold is any type of various wooly fungus growths. Microorganisms are found in the soil, water, air, and on the exterior of nearly everything that is not sterilized. Microorganisms are usually not found within living tissue.

C. Bacterial spores, an asexual, reproductive body that is resistant to unfavorable environmental conditions and produces a new vegetative individual when the environment is favorable, are far more resistant to adverse conditions and most processing methods than mold or yeast spores. Sterilization methods are aimed at these highly resistant bacterial spores.

D. When food is contaminated, several types of microorganisms are present together to produce acid, gas, putrification, or discoloration. Putrid odors are produced when microorganisms digest proteins.

E. Bacteria, yeasts, and molds prefer warm, moist conditions. Some bacteria and all molds require oxygen for growth and survival, a condition known as aerobic. Most food-associated bacteria multiply best at temperatures between 16 and 38 degrees C. The slightest amount of condensation, liquid forming from a vapor, on the surface of food can become a hot spot for the rapid multiplication of bacteria or growth of mold. Moisture trapped in packaging containers supports the growth of microorganisms.
Use a variety of methods to master this objective. Use TM–B as a visual aid for the discussion of this objective. Have students conduct laboratory exercise LS–A to experiment with the effect of salt on moisture retention and food spoilage odors.

**Review/Summary.** Review and summary of this lesson should be based on the two student objectives listed earlier in this lesson. Begin with a review of the uses of salt as a food preservative and the preservation effects salt has on food products. Have students describe the characteristics of bacteria, molds, yeasts, and spores and explain how these microorganisms spoil food products. Finally discuss the conditions that are favorable for microorganism growth and what food processors, packagers, and consumers can do to prevent food spoilage.

**Application.** Application can occur as students consider food science, specifically the activity of salt as a preservative in meat products, and how these processes must be understood to effectively produce, process, and handle a quality food product. Some students may be able to use their supervised agricultural experiences to expand their knowledge of food science outside of the classroom. Use the following transparency masters, lab sheet, and technical supplement to apply the information.

- TM–A: Uses of Salt
- TM–B: Food Spoilage
- LS–A: Salt as a Food Preservative
- TS–A: Salt as a Food Preservative

**Evaluation.** Evaluation should be based on mastery of the objectives by the students. This can occur during instruction, review, or later as students apply the information. A sample written test is attached.

**Answers to Sample Test:**

**Part One: Matching**

1. g
2. c
3. e
4. h
5. a
6. f
7. b
8. d

**Part Two: Completion**

1. Molds
2. Water (moisture)

**Part Three: Multiple Choice**

1. a proteolytic enzyme
2. all of the above
3. a and b
4. plasmolysis
5. proteins
6. salt, reduced
7. bacterial

**Part Four: Short Answer**

Food spoilage is the deterioration of a food product due to microorganisms, enzymes, environment (heat and cold), light and other radiation, oxygen, moisture (or lack of it), industrial contaminants, macroorganisms, and time.
PART ONE: MATCHING

Instructions: Match the term with the correct response.

a. Aerobic  
b. Bacteria  
c. Dehydration  
d. Mold  
e. Plasmolysis  
f. Spore  
g. Terminal treatment  
h. Yeast

_______ 1. Thermal processing, freezing, drying, fermentation, or refrigeration.
_______ 2. Removal of water by the action of heat or an agent.
_______ 3. Partial dehydration due to exposure to a solution of higher osmotic pressure.
_______ 4. Fungi which possess a vegetative body.
_______ 5. Requiring air or oxygen to survive and grow.
_______ 6. Asexual, reproductive body resistant to unfavorable environmental conditions.
_______ 7. Microscopic, simple microorganism with a primitive nucleus.
_______ 8. Any wooly fungus growth.

PART TWO: COMPLETION

Instructions: Provide the word or words to complete the following statements.

1. Some bacteria and all ________ are aerobic.
2. Salt preserves food by reducing the amount of ________ available to microorganisms.

PART THREE: MULTIPLE CHOICE

Instructions: Circle the letter of the correct answer.

_____ 1. An enzyme that catalyzes the breakdown of proteins into simpler substances is known as:
   a. a proteolytic enzyme  
   b. condensation  
   c. dehydration  
   d. plasmolysis
2. Salt enhances flavor and preserves food by:
   a. reducing water available to microorganisms
   b. increasing osmotic pressure
   c. reducing solubility of oxygen in water
   d. all of the above

3. Food deterioration can be caused by:
   a. oxygen
   b. moisture
   c. salt
   d. a and b

4. The process at which the protoplast of a cell shrinks away from the wall following water loss due to exposure of a solution of higher osmotic pressure is known as:
   a. a proteolytic enzyme
   b. condensation
   c. dehydration
   d. plasmolysis

5. Putrid odors are produced when microorganisms digest
   a. carbohydrates
   b. proteins
   c. fats
   d. all of the above

6. Without the use of ______________, the variety of cured meat products available nationwide to consumers today would be greatly______________.
   a. enzymes, reduced
   b. enzymes, increased
   c. salt, increased
   d. salt, reduced

7. Which type of spores are the most difficult to control or eliminate?
   a. bacterial
   b. yeast
   c. mold
   d. none of the above

Part Four: Short Answer

Instructions: Provide information to answer the following question.

What are five general conditions that can lead to food spoilage?
USES OF SALT

♦ Salt enhances flavor and improves keeping quality.

♦ Salt also preserves food by:
  - Reducing water available to microorganisms.
  - Increasing osmotic pressure created in the aqueous environment surrounding the microbial cell.
  - Reducing the solubility of oxygen in water.
  - Sensitizing cells to carbon dioxide.
  - Interfering with the action of proteolytic enzymes, enzymes that catalyze the breakdown of proteins into simpler substances.
FOOD SPOILAGE

♦ Food spoilage—the deterioration of a food product due to microorganisms, enzymes, environment (heat and cold), light and other radiation, oxygen, moisture (or lack of it), industrial contaminants, macroorganisms, and time.

♦ Microorganisms such as bacteria, yeast, and molds, that are on or in food products are frequently a major cause of food spoilage.
  
  ▪ Bacteria—microscopic, relatively simple microorganisms that have a primitive nucleus.
  ▪ Yeast—a collective name for those fungi which possess a vegetative body (thallus) consisting of simple individual cells.
  ▪ Mold—any type of various wooly fungus growths.

♦ Bacteria, yeasts, and molds prefer warm, moist conditions.
SALT AS A FOOD PRESERVATIVE

Agricultural Applications and Practices

Salt is probably the first substance intentionally added as a food preservative (as early as 3,000 B.C.). Today, salt is commonly used in combination with other substances to preserve fresh, cooked, and cured meat products. Processes such as sun drying, salting, smoking, or fermentations are considered to be the early forms of food preservation.

A variety of preservation techniques are needed to match the supply of food produced in agriculture with the time and geographical demand for food by consumers. Food is produced in rural areas many miles away from the urban consumer. While food production is cyclical and seasonal, demand for food by consumers generally is continuous.

Meat processing plants are primarily located in urban areas, yet the demand for meat products reaches every corner of the United States. Without the use of salts and other preservatives and curing agents, the variety of cured meat products available nationwide to consumers today would be greatly reduced.

Science Connections—Questions to Answer

1. How does salt act as a preservative in meats?
2. Why does moisture content affect the shelf life of meat products?
3. What causes meat products to spoil?

Purpose of Lab and Student Performance Objectives

The purpose of this experiment is to examine the preservative effects of salt on meat products (fish). Upon completing the experiment students should be able to:
1. Describe the uses of salt as a food preservative and explain why salt is an effective food preservative.

2. Discuss the relationship between moisture content in meat products and microbial activity.

**Materials and Equipment**

- 5 clean and dry zip lock plastic bags of equal size
- 2 beakers (100 ml)
- 10 beakers (50 ml)
- 3 pieces of fish 2 cm in length cut from the same fish
- 100 ml each of table salt and builder’s sand
- 1 burette or pipette graduated in ml
- distilled water

**Procedure**

Give each student or group of students a copy of the worksheet to perform the activity.

**Anticipated Findings**

- The bags containing beakers of sand or salt will show faster water disappearance than the bag with the beaker of only water and fish. Odors will also be less in these bags.
- The bag with only fish and water will have the strongest odor and the slowest water disappearance. The bag with salt and fish will exhibit the weakest odor.
SALT AS A FOOD PRESERVATIVE

Procedure

1. Place the salt and sand in separate 100 ml beakers. Cover the beakers and heat them in an oven at 110°C (230°F) for an hour. Allow beakers to cool with covers in place.

2. In a similar fashion, cover each of the empty 50 ml beakers, heat them at 110°C, and allow them to cool.

3. Place a cube of fish in each of three 50 ml beakers. Add “baked” salt to one of these beakers to fill it. Label that beaker “fish + salt.”

4. Add enough “baked” sand to a second beaker to fill it. Label that beaker “fish + sand.”

5. Make no addition to the third beaker. Label it “fish.”

6. Fill the fourth beaker with salt and label it accordingly. Fill the fifth beaker with sand and label it accordingly.

7. Place each of the five beakers in a separate plastic bag.

8. Using a burette or pipette, add 1 ml of distilled water to each of the five remaining 50 ml beakers. Place one of these beakers alongside each of the 50 ml beakers in the plastic bags and seal.

9. Place the five closed bags side by side at a constant temperature of approximately 25°C (room temperature).

Data Summary and Analysis

Briefly open the bags on a daily basis for five days to check for spoilage odors. Observe the time of disappearance of the water in the five beakers.

Ideas for Additional Experiments

1. Design an experiment to prove that the salt or sand did not simply absorb the odor from the fish.

2. Perform this experiment without baking the salt or sand first and compare the results.
1. **How does salt act as a preservative in meats?**

Salt, or NaCl, is made up of the two ions: Na+/sodium and Cl–/chloride. The chloride anions cause a net increase in negative charges in meat. This net increase results in repulsion of the protein groups and an enlargement of the space available for water absorption within the muscle. This repulsion could be compared to the repulsion of the like-charges of two magnets. The sodium/Na+ cation is responsible for the characteristically salty flavor of foods.

Salt acts as a preservative by:

a) reducing water availability to microorganisms thus minimizing or stopping microbial activity

b) increasing osmotic pressure created in the aqueous environment surrounding the microbial cell causing plasmolysis, or dehydration of cells—the water within the microbial cells leaves trying to dilute the salty solution outside of the cell

c) reducing solubility of oxygen in water thus decreasing the amount of available oxygen needed by microbes. Anaerobic bacteria would be better able to survive than aerobic

d) sensitizing cells to carbon dioxide

e) interfering with the action of proteolytic enzymes

Salt also provides flavor and tenderizes the meat by extracting myofibrillar protein.

2. **Why does moisture content affect the shelf life of meat?**

Water makes up about 65% of fresh meat's weight. Retaining this moisture is an important factor in meat processing. Water performs various function such as affecting its ‘eatability’ by providing the initial taste impression of meat and functions to dissolve and distribute additives during the processing of meat products such as ham and sausage. Water in the form of ice increases protein solubility, controls temperature during processing, and provides better microbial control. Micro-
organisms need water to live and reproduce. Because salt decreases the amount of available water, the chances of spoilage or deterioration are decreased.

3. **What causes meat products to spoil?**

Microorganisms such as bacteria, yeast, and molds are usually the cause of food deterioration. Food deterioration is a broad term that includes a reduction in nutrition, safety, or aesthetic appeal of food. Microorganisms are found in the soil, water, air, and on the surface of almost anything.

Heat, cold, light, oxygen, moisture, dryness, natural food enzymes, microorganisms, industrial contaminants, and time can also lead to food deterioration. Various types of meat curing and processing techniques are being used to prevent or at least slow down the deterioration of food.