

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 1: Factors That Affect Food Safety and Quality

Objective

The student will be able to identify the factors that affect food safety and quality.

I. Study Questions

- A. What factors contribute to food spoilage?
- B. How do contaminants influence food safety?
- C. What production factors assure food safety and quality?
- D. How do food additives influence food safety and quality?
- E. How is food safety monitored?
- F. How do consumers assess the risk associated with food safety?

II. References

- A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
- B. Activity Sheets
 1. AS 1.1 Nitrates in Meat
 2. AS 1.2 Food Safety Issues
 3. AS 1.3 Food Safety Concerns Survey

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 1: Factors That Affect Food Safety and Quality

TEACHING PROCEDURES

A. Introduction

Define biochemistry in relation to food science. Biochemistry is the scientific study of the chemical properties of living matter, in this case food.

B. Motivation

1. Show the video, The Nature of Change, and discuss BST: The Facts, which are available from:

Monsanto Publication
800 N. Lindbergh Blvd
St. Louis, MO 63167
(314) 694 - 1000

2. Brainstorm with students to get their ideas on where biotechnology in food science might be going. One example is the fast-paced development of seedless watermelons.

Dennis J. Gray and Gary W. Elmstrom, of the University of Florida, have developed a tissue culture process that clones thousands of seedless watermelon plants in just months instead of years. Seedless watermelons could gain a large market share if their reproductive efficiency can be heightened.

Seedless watermelons do produce a small number of seeds, but only enough to postpone the complete development of a new cultivar for 10-15 years. A parent line with two copies of each chromosome in each cell is crossed with another parent line consisting of four copies of each chromosome/cell. The offspring is seedless because only three copies of each chromosome are present in each cell.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss with students the factors that contribute to food spoilage.

What factors contribute to food spoilage?

- a. Microorganisms
 - b. Natural enzymes
 - c. Insects, parasites, and rodents
 - d. Temperature
 - e. Moisture/dryness
 - f. Air - oxygen
 - g. Light
 - h. Time
2. Discuss how contaminants influence food safety.

How do contaminants influence food safety?

- a. Microorganisms ferment sugars; hydrolyze starches and fats; digest proteins; form acids, pigments and discolorations. These lead to rancid flavors, putrid odors, gas and foam production, and poisonous toxin production.
 - b. Enzymes catalyze reactions that lead to microbial invasion, rancid flavors, and browning.
 - c. Insect spoilage leads to microbial invasion; parasites inhabit the consumer; rodents spread diseases, and fecal material.
 - d. Natural dehydrating causes skin breakage which allows bacterial invasion. Freezing causes cell swelling, which causes the cell membrane to rupture.
 - e. Temperature, moisture, air, light, and time can lead to microbial invasion.
3. Discuss what production factors assure food safety.

What production factors assure food safety and quality?

- a. Quality Assurance Programs - document production and food processing practices
- b. Proper control of temperature and humidity
- c. Use of pesticides
- d. Use of animal drugs
 1. Follow withdrawal guidelines to avoid residues
 2. Proper injection procedures
 3. Proper handling of animals
- e. Grain producers - grade standards regulate grain quality

4. Discuss how food additives influence food safety. Food additives are to improve a food's appearance, flavor, texture, nutritional value or storage properties. The Food Additives Amendment of 1958 covers both intentional and incidental additives. See the student reference for definitions and examples of the food additives. Have students complete AS 1.1.

How do food additives influence food safety and quality?

- a. Preservatives
 - b. Antioxidants
 - c. Stabilizers/thickeners
 - d. Sequestrants
 - e. Nutrient supplements
 - f. Surface active ingredients
 - g. Bleaching and maturing agents
 - h. Buffers, acids, alkalies
 - i. Nitrates/nitrites
 - j. Food colors
 - k. Non-nutritive and special dietary sweeteners
 - l. Flavoring agents
 - m. Miscellaneous
5. Discuss how food safety is monitored.

How is food safety monitored?

- a. USDA's Food Safety and Inspection Service - inspectors
 - b. FDA inspects processing plants
 - c. Local, county, and state health departments
6. Discuss how consumers assess the risk associated with food safety. Have students complete AS 1.2 and AS 1.3. Discuss their answers to AS 1.3.

How do consumers assess the risk associated with food safety?

- a. Common sense/rational thinking
 - b. Irrational/fearful
- F. Other activities
1. Have students survey their parents' concern about food safety. Have them complete AS 1.3.
See how the parents' concerns compared to the class.

Food Science and Technology-Unit III

2. Have students prepare a paper from topics provided by the instructor. The paper should include: a summary of the facts; their personal views and the views of a classmate; and a journal article supporting their position.
3. Have students complete an activity from The Chemistry of Food Additives by Flinn Scientific, P.O. Box 29, Batavia, IL 60510, (708) 879-6900.

G. Conclusion

Various factors contribute to food spoilage. Microbes digest food and leave behind unpleasant reminders. Proper quality-assured handling can greatly promote food safety. Food quality is regulated by local, state, and federal authorities.

H. Competency

Identify the factors that affect food safety and quality.

Related Missouri Core Competencies and Key Skills:

- 9D-5: Describe the relationships between technologies which improve our lives and the environmental problems that can result from them.
- 10L-5: Identify the pros and cons of an environmental issue, take a position, and support.

I. Answers to Evaluation

1. Four of the following: microorganisms; natural enzymes; insects, parasites, rodents; temperature; moisture/dryness; air - oxygen; light; time
2. a
3. c
4. a, c
5. a
6. b
7. a
8. Two of the following:
 - a. Follow withdrawal guidelines - leave no residues
 - b. Proper injection procedures - do not damage tissue
 - c. Proper handling - avoid bruising
 - d. Honesty - consistent quality of entire truck with grain sample
9. d
10. c

11. f
12. a
13. l
14. h
15. c
16. d
17. e
18. k
19. g
20. j
21. b
22. i

J. Answers to Activity Sheets

AS 1.1

1. The sample with nitrite added is the one that looks more like ham since this is the treatment ham gets.
2. Students will choose the sample containing nitrate. The color alone does not justify the addition of nitrite since it also affects the taste (flavor). Without it, the ham would taste like a salty pork roast. Nitrites also act as powerful antioxidants. Nitrates also inhibit the growth of *clostridium botulinum* that causes botulism. This is an excellent opportunity to discuss the risk benefit of food additives.
3. Answer will vary.

The changes of color illustrate the reactions explained in the chart. Since the meat was not totally processed and the possible microorganisms are still present in the sample, meat should be disposed of and not consumed. One needs to know that nitrite in large concentrations is toxic, therefore, potentially dangerous.

The meat utilized in the experiment will be in the oxymyoglobin although the surface may be brown (metmyoglobin). The addition of nitrate to one portion will form the dark red nitrosomyoglobin after 24 hours in the refrigerator.

Heating the nitrosomyoglobin will form the more stable nitrosohemochrome (light pink). In the untreated sample, oxymyoglobin (bright red) will be in the interior, and on the surface. A gray brown denatured myoglobin (brown)

Food Science and Technology-Unit III

in the control sample will result after heating. This is the characteristic color of uncured, cooked meat.

AS 1.2 Instructor's discretion.

AS 1.3 Discuss student's responses. According to the United States Food and Drug Administration (FDA) the ranking for most important food safety considerations is as follows:

1 Disease--causing microorganisms

3 Environmental contaminants (lead poisoning for example)

6 Food additives

4 Naturally occurring toxins (poisonous plants for example)

5 Pesticide residue

2 Poor nutrition

Unit III-The Biochemistry of Foods: Lesson 1

UNIT III - THE BIOCHEMISTRY OF FOODS

Name _____

Lesson 1: Factors That Affect Food Safety and Quality

Date _____

EVALUATION

Match the spoilage with the agent that caused it.

- | | | | |
|-----------|---------------------------|----|-----------------------------|
| 1. ___ | Ferment sugars | a. | Microbes |
| 2. ___ | Enzymatic browning | b. | Insects, parasites, rodents |
| 3. ___ | Cause rancidity | c. | Enzymes |
| 4. ___ | Hydrolyze starch and fats | | |
| 5. ___ | Spread disease | | |
| 6. ___ | Cause microbial invasion | | |

Complete the following short answer questions.

7. Name four factors that contribute to food spoilage.

8. Name two production procedures and how they ensure food safety.

Circle the letter that corresponds to the best answer.

9. Who monitors food safety?
 - a. USDA only
 - b. FDA only
 - c. USDA and county and state inspectors
 - d. USDA, FDA, and local, county, and state inspectors

Food Science and Technology-Unit III

10. Risk assessment should be based on:
- Emotions
 - Only the media
 - Common sense
 - Traditions

Match the type of food additive on the right with the best description on the left.

- | | |
|-----------------------------------------------------------------------------|-------------------------------|
| 11. ___ Emulsify oil-in-water and water-in-oil mixtures, ex., lecithin | a. Preservatives |
| 12. ___ Extend shelf life and prevent deterioration, ex., sodium benzoate | b. Antioxidants |
| 13. ___ Low-calorie sweeteners, dietetic and diabetic foods | c. Sequestrants |
| 14. ___ Modify pH | d. Stabilizers |
| 15. ___ Chelate trace metals, prevent oxidation and off-coloring, ex., EDTA | e. Bleaching/maturing agents |
| 16. ___ Thickeners, ex., pectin | f. Surface active ingredients |
| 17. ___ Whiten flour and milk | g. Nutrient supplements |
| 18. ___ Contribute to pink color in meat | h. Buffers, acids, alkalies |
| 19. ___ Added to foods deficient in necessary nutrients | i. Food colors |
| 20. ___ Spices, herbs, extracts | j. Flavoring agents |
| 21. ___ Prevent breakdown of vitamins and lipids, ex., BHA | k. Nitrates/nitrites |
| 22. ___ Caramel, extract of annatto, natural grape red | l. Non-nutritive additives |

Nitrites in Meat

Objective: To observe the differences between fresh red meat with and without sodium nitrate added, and observe the changes after both samples are heated.

Activity Length: Two 50-minutes periods

Background Information: Cured meat is the result of a process whereby the addition of a nitrate salt causes flavor and color changes in fresh meat. The cure also acts as a preservative and inhibits the growth of pathogenic microorganisms. The nitrate salt in this process is always used in conjunction with a least some other additive such as salt, sugar, spices, and/or smoke.

Materials and Equipment:

200 g ground beef
Scale
0.016 g Sodium nitrate
2 Beakers
1 Plastic bag
Wax paper
Refrigerator
Stove or hot plate
Pan for steaming meat
Labels (masking tape will do)
Pen

Procedure:

1. Divide the freshly ground hamburger into two samples of 100 g each.
2. Put one of the samples of hamburger in a plastic bag and add 0.016 g of sodium nitrate. Mix thoroughly by kneading the bag for about 3 minutes. Label beakers A and B.

Food Science and Technology-Unit III

3. Empty the contents of each bag in a beaker. Pack meat down to get rid of as much air as possible. Cover the beakers with a piece of wax paper. Record which beaker contains nitrate. Also put your name on each beaker.
4. Examine and record both the surface color and the interior color of each sample. Do not taste either sample.
5. Place beakers in a refrigerator overnight.
6. After 24 hours, remove the beakers from the refrigerator and examine the surface and interior of the meat, compare colors.
7. Heat each beaker over a steam bath for 15-20 minutes.
8. Once again, examine the samples as before. Do not taste either sample.
9. Record your results on Table 1.1.

Table 1.1

| | Control (no nitrite) | | Experimental (with nitrite) | |
|----------------|----------------------|----------|-----------------------------|----------|
| | Surface | Interior | Surface | Interior |
| Before Storage | | | | |
| After Storage | | | | |
| After Cooking | | | | |

Key Questions:

1. Which of the samples, after cooking, most closely resembles sausage?
2. Which of the cooked samples looks the most appetizing?

Unit III-The Biochemistry of Foods: Lesson 1

3. Would you purchase meats processed with nitrates? Explain your answer.

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition*. The National Council for Agricultural Education, 1993.

Food Safety and Issues

Objective: Examine an issue regarding food safety.

Directions: Select a food safety issue. Research the topic and prepare a report to answer the following questions:

1. Why is this issue important?
2. What effect does this issue have on people?
3. What is the history behind the issue?
4. What are the risks caused by the issue?
5. Is there a definite right and wrong side to the issue?
6. What are possible solutions?
7. What is my opinion of the issue?

Topic Ideas:

- Are hormones given to beef cattle present in the meat eaten by humans?
- Do pesticides affect the quality of food in the U.S.?
- Is organically grown food more nutritious than foods grown with pesticides and fertilizers?
- Does food coloring affect food quality?

Lesson 1: Factors That Affect Food Safety and Quality

Food Safety Concerns Survey

Please rank your greatest food safety concern #1 and your least concern #6, and rank all of the numbers in between in a similar manner. Do not put your name on this paper. The purpose of this exercise is to see how your answers compare with others.

The following food safety concerns are listed in alphabetical order.

- Disease--causing microorganisms
- Environmental contaminants (lead poisoning for example)
- Food additives
- Naturally occurring toxins (poisonous plants for example)
- Pesticide residue
- Poor nutrition

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 2: Problems with Food Deterioration

Objective

The student will be able to describe problems resulting from food deterioration.

I. Study Questions

- A. What physical changes result from food deterioration?
- B. What chemical changes result from food deterioration?
- C. What environmental conditions favor bacterial growth in foods?
- D. What organisms contribute to food deterioration?
- E. What are some of the organisms found in food that can cause human diseases?

II. Reference

Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 2: Problems with Food Deterioration

TEACHING PROCEDURES

A. Review

Review the factors that contribute to food deterioration. They are: microorganisms, natural enzymes, insects, parasites, rodents, temperature, moisture, air, light, and time.

B. Motivation

Imagine you are in the military overseas and it is your birthday. You have anticipated receiving food packages from family back home. You can taste the chocolate chip cookies, caramel popcorn, homemade apple cider and dinner rolls.

Unfortunately, your platoon is involved in field exercises and it will be two weeks before you get back to base. You can only hope the birthday box will still be there when you get back. You are looking forward to the goodies more than ever. Hopefully, the box will be refrigerated until you get back.

The last day of field exercise has passed as you tiredly return to the base. Your hunger pains can only be satisfied with the contents of your birthday box.

To your surprise, the box is resting on your bunk. Unopened, but also unrefrigerated. You can only hope the food has not molded nor grown stale. You quickly cut the strings and dig into the box where you find four packages, individually wrapped in tin foil. In just a few seconds you will satisfy your taste buds. In fact, your mouth is watering.

The first package is chocolate chip cookies, but they are all green with mold. You decide the next package will surely be all right, but the rolls have circular molds on them, and are as hard as hockey pucks. Your disappointment grows deeper as you taste the apple cider's bitter flavor and the caramel corn's staleness. What caused all of this?

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the physical changes from food deterioration.

What physical changes result from food deterioration?

- a. Dehydration - excessive heat, cold, or exposure to air
 - b. Cracked skin - fruit frozen then thawed
 - c. Broken emulsion - liquid foods frozen then thawed
 - d. Texture degradation - frozen milk will curdle
 - e. Off-color (surface)
 1. Fruits and vegetables stored at too low a temperature
 2. Light causes surface discoloration of meat pigments
 3. Insufficient oxygen to cut meat surfaces reduces oxymyoglobin to metmyoglobin (brownish-red color)
 4. Mold growth causes a variety of color development
 - f. Internal browning - apples stored at too low a temperature
 - g. Lumping/caking/crystallization - excessive moisture
 - h. Surface pitting - fruit stored at too low a temperature
2. Discuss the chemical changes that result from food deterioration.

What chemical changes result from food deterioration?

- a. Sugars ferment
 - b. Starches hydrolyze
 - c. Fats hydrolyze (lipolysis) - causes rancidity
 - d. Proteins are denatured or digested - ammonia-like odors
 - e. Toxin production
 - f. Enzymatic reactions
 - g. Pigment conversion
3. Discuss what environmental conditions favor bacterial growth.

What environmental conditions favor bacterial growth in foods?

- a. Warm temperature; although some bacteria grow at very high or at very low temperatures
 1. Psychrophilic - grow in temperatures as low as 32°F
 2. Mesophilic - 60°-100°F, most bacteria are this type
 3. Thermophilic - grow in temperatures as high as 180°F
 - b. Moist conditions
4. Discuss what organisms contribute to food deterioration.

What organisms contribute to food deterioration?

- a. Bacteria
 - b. Fungi - yeasts and molds
5. Discuss what human diseases may be caused by unsafe food.

What are some of the organisms found in food that can cause human diseases?

- a. Campylobacteri
- b. Clostridium botulism
- c. Escherichia coli (E. coli)
- d. Hepatitis A Virus
- e. Listeria
- f. Salmonella
- g. Staphylococcus
- h. Toxoplasma
- i. Trichinella
- j. Vibrio parahaemolyticus
- k. Yersinia

F. Other activities

1. Make kimchee to study lactic acid fermentation. A detailed procedure can be obtained from Bottle Biology Program, University of Wisconsin-Madison, (608) 263-5645.
2. Invite a health department official to present a program on food-borne diseases.

G. Conclusion

Food deterioration is a continual problem for the food industry. Physical and chemical deterioration result from microbial and environmental influences. Unsafe food can thus cause a multitude of human diseases.

H. Competency

Describe problems resulting from food deterioration.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. a
2. b

Food Science and Technology-Unit III

3. a
4. a
5. b
6. a
7. a
8. b
9. b
10. b
11. Warm temperatures, moisture
12. b
13. a
14. a
15. b
16. b
17. a
18. b
19. d
20. a
21. c
22. e

Unit III-The Biochemistry of Foods: Lesson 2

UNIT III - THE BIOCHEMISTRY OF FOODS

Name _____

Lesson 2: Problems with Food Deterioration

Date _____

EVALUATION

Is the type of deterioration on the left a physical change or chemical change? Write the correct letter in the blank.

- | | |
|---------------------------------------------------------------------------|--------------------|
| 1. ___ Dehydration | a. Physical change |
| 2. ___ Starches hydrolyze | b. Chemical change |
| 3. ___ Off-color | |
| 4. ___ Internal browning | |
| 5. ___ Acid production | |
| 6. ___ Surface pitting | |
| 7. ___ Lumping, caking | |
| 8. ___ Pigment conversion | |
| 9. ___ Lipolysis | |
| 10. ___ Toxin production | |
| 11. List the 2 environmental conditions needed for most microbes to grow. | |

Match the microbial characteristic on the left with the appropriate type of microbe on the right.

- | | |
|-----------------------------------------------|--------------------------|
| 12. ___ Used to ripen certain types of cheese | a. Bacteria |
| 13. ___ Unicellular | b. Fungi (molds, yeasts) |

Food Science and Technology-Unit III

- 14. ___ Prokaryote
- 15. ___ Grow by mycelia
- 16. ___ Require oxygen
- 17. ___ Classified based on shape

Match the disease on the right with the description on the left.

- | | |
|---------------------------------------------------------------------------------------|-----------------------|
| 18. ___ Transmitted by improperly processed or unrefrigerated low acid foods | a. Salmonellosis |
| 19. ___ Leading cause of gastroenteritis in humans | b. Botulism |
| 20. ___ Caused by salmonella bacteria | c. Trichinosis |
| 21. ___ Raw pork from hogs fed uncooked garbage | d. Campylobacteriosis |
| 22. ___ Meat animals can be infected by cats, which are a common host of this disease | e. Toxoplasmosis |

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 3: Nutritional Properties of Foods

Objective

The student will be able to describe the nutritional properties of foods.

I. Study Questions

- A. What are the major food groups?
- B. What are the six classes of nutrients?
- C. What are the nutritional characteristics of each food group?
- D. What are the functions for each nutrient class?
- E. What are the sources for each nutrient class?

II. References

- A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
- B. Activity Sheet
AS 3.1: Identify Basic Food Nutrients

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 3: Nutritional Properties of Foods

TEACHING PROCEDURES

A. Review

The previous lesson discussed the physical and chemical changes from food deterioration and food-borne diseases and their causes. This lesson takes a look at the nutritional properties of food, including diseases caused by a nutrient deficiency.

B. Motivation

Bring a baked potato and french fries to class. Poll the class on their preferences, then compare french fries to a baked potato. Analyze nutritional data using the table below.

| Nutrition of French Fries versus Baked Potato | | | | | | | | |
|-----------------------------------------------|-------|-----------------------|-------------------|----------------|--------|--------|---------|------|
| | | | | % Daily Values | | | | |
| | Grams | #Calories Food Energy | Calories from fat | Protein | Vit. A | Vit. C | Calcium | Iron |
| French Fries | 70 | 220 | 100 | 3 | 0 | 10 | 2 | 2 |
| Baked Potato | 70 | 80 | 1 | 2 | 0 | 15 | 0 | 6 |

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the major food groups. Use the new Food Pyramid. Discuss where fats and sweets fit into the Food Pyramid.

What are the major food groups?

- a. Meats
- b. Breads & cereals
- c. Fruits
- d. Vegetables

- e. Dairy products
2. Discuss the six classes of nutrients.

What are the six classes of nutrients?

- a. Carbohydrates
 - b. Proteins
 - c. Fats
 - d. Vitamins
 - e. Minerals
 - f. Water
3. Discuss the nutritional characteristics of each food group.

What are the nutritional characteristics of each food group?

- a. Meats - protein primarily, also carbohydrates, fats, vitamins, and minerals
 - b. Breads and cereals - carbohydrates primarily, also protein, fat, vitamins, and minerals
 - c. Fruits - vitamins and minerals, also protein and carbohydrates
 - d. Vegetables - minerals and vitamins primarily, also protein, and carbohydrates
 - e. Dairy foods - excellent source for all five nutrient categories
4. Discuss the functions of each nutrient class.

What are the functions for each nutrient class?

- a. Carbohydrates - 4 Calories per gram of energy; 98 percent are digested and completely oxidized
 - 1. Needed for body heat
 - 2. Synthesis of tissue
 - 3. Energy to work and play
 - 4. Increase fat utilization efficiency
 - 5. Spare proteins from being converted to a major energy source
 - 6. Provide fiber
 - 7. Promote vitamin B synthesis
- b. Proteins - 4 Calories per gram of energy; 70 percent are digested and completely oxidized
 - 1. Primary role is to supply nitrogen-based molecules necessary for tissue synthesis and provide essential amino acids

2. Source of essential amino acids: leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine plus histidine for childhood growth
3. Secondary role is to supply energy
- c. Fats - 9 Calories per gram of energy; 95 percent are digested and completely oxidized
 1. Supply necessary polyunsaturated fatty acids
 2. Aid in absorption of fat-soluble vitamins A, D, E, and K
 3. Source of phospholipids
 4. Insulate and protect body
 5. Reserve source of energy
- d. Vitamins - needed for enzyme systems which are required for protein, fat, and carbohydrate metabolism, needed in relatively small amounts except vitamin D.
 1. Vitamin A - needed to prevent: night blindness, abnormal bone and tooth development, diseases of skin, fat-soluble
 2. Vitamin D - increase Ca & P absorption, reduces bone defects, fat-soluble
 3. Vitamin E - favors Fe absorption; antioxidant, fat-soluble
 4. Vitamin K - essential for normal blood clotting, fat-soluble
 5. Vitamin C - prevents scurvy, bone joint disease, teeth loosening, and fragile capillary walls; needed for normal protein collagen formation, water-soluble
 6. Vitamin B complex - water-soluble
 - a. B₁ (thiamine) - needed to oxidize glucose
 - b. B₂ (riboflavin) - needed for cellular growth and tissue maintenance
 - c. Niacin - needed for tissue respiration and glucose oxidation
 - d. B₆ - needed for enzyme systems
 - e. Pantothenic acid - needed for mental health
 - f. B₁₂ - needed for nucleic acid formation; helps prevent anemia
 - g. Folic acid - helps prevent anemia; used for nucleic acid production
 - h. Biotin - helps metabolize fatty acids & amino acids
- e. Minerals - needed in relatively small amounts.
 1. Ca - needed for blood clotting, bone & tooth development, enzyme function; control of fluid through membranes
 2. P - needed for metabolism, controls acid-alkaline reactions in blood, phospho-lipid production
 3. Mg - needed for enzyme systems, electrical potential in nerves; muscle contraction, Ca & P metabolism
 4. Fe - needed for blood hemoglobin & muscle myoglobin
 5. Cu - helps utilize Fe & synthesis of hemoglobin

Food Science and Technology-Unit III

6. Co - part of vitamin B₁₂
 7. Zn - needed for enzyme production
 8. Na - needed for osmotic equilibrium and body fluid volume
 9. Cl - exists in chloride form; helps produce hydrochloric acid
 10. K - helps regulate osmotic pressure, equilibrium, and pH; enzyme production
 11. I - needed for thyroid hormone
 12. F - needed for sound teeth
 13. Mn - bone structure, central nervous system function, reproduction
 14. Cr - glucose metabolism
 15. Mo - protein metabolism
 - f. Water - 60 percent of body weight
 1. Solvent for chemical reactions in body
 2. Transport media to cells
 3. Removes body waste
 4. Regulates body temperature and metabolism rate
5. Discuss the sources for each nutrient. Point out that each nutrient comes from other sources as well. Divide class into small groups to complete AS 3.1. The instructor should demonstrate the tests before students complete the activities.

What are the sources for each nutrient class?

- a. Carbohydrates - potatoes, rice, flour, dairy products
 - b. Proteins - meat, poultry, fish, eggs, dairy products, legumes
 - c. Fats - meat, poultry, grain oils, nuts, dairy products
 - d. Vitamins - fruits, vegetables, dairy products
 - e. Minerals - meat, fruits, vegetables, dairy products
 - f. Water - beverages, high water-content foods
- F. Other activities
1. Assign each student to plan a complete meal. This meal must contain 2 servings of breads/cereals, 1 serving of fruits, 1 serving of vegetables, 1 serving of meat, 1 serving of dairy products, and 1 serving of a beverage. They are to research what nutrition is provided per serving and then complete the following chart.

Unit III-The Biochemistry of Foods: Lesson 3

| % Daily Value Nutrition/ Serving | Breads/ Cereals | Meats | Fruits | Vegetables | Dairy Products | Beverage |
|-------------------------------------|--------------------|-------|--------|------------|-------------------|----------|
| Protein | | | | | | |
| Vitamin A | | | | | | |
| Vitamin C | | | | | | |
| Calcium | | | | | | |
| Dietary Fiber | | | | | | |
| Fat | | | | | | |
| Iron | | | | | | |
| Sodium | | | | | | |
| # Servings | 2 | 1 | 1 | 1 | 1 | 1 |
| Total % Achieved | | | | | | |

- Assign oral reports on: Iron in diet, zinc in diet, types of iron, types of cholesterol, fiber value in diet, calcium in diet, vegetarian diet, nutrient density.

For information on Activity 2, write: National Live Stock and Meat Board, 444 North Michigan Ave., Chicago, IL 60611. Ask for: Percent U.S. R.D.A. Chart Exploring Meat and Heath, Zinc, Iron

- Students are to select a balanced meal from items on the menu at a local McDonald's. Students can only spend \$5.00. Students will need to get nutrient information from local McDonald's restaurants.

G. Conclusion

Foods are divided into meats, breads/cereals, fruits, vegetables, and dairy products. These food groups supply carbohydrates, proteins, fats, vitamins, and minerals. Water is also a necessary nutrient. A healthy diet consists of items from all food groups.

H. Competency

Describe the nutritional properties of foods

Related Missouri Core Competencies and Key Skills: None

Food Science and Technology-Unit III

I. Answers to Evaluation

1. a
2. b
3. d
4. e
5. a
6. b
7. e
8. c
9. f
10. f
11. e
12. c
13. b
14. b
15. c
16. c
17. b
18. d
19. a
20. Teacher's discretion

J. Answers to Activity Sheets

AS 3.1

1. Answers will depend on types of food tested. Answers for foods listed in materials list follow:
 - a. raw potato, rice kernels, croutons, milk
 - b. sucrose, honey, jam
 - c. cheese, milk, chicken, beef or pork, bacon, hamburger, dry beans, egg white
 - d. cheese, whole milk, egg white, bacon, hamburger, mayonnaise, butter, margarine
 - e. potato, rice, cheese, croutons, milk, meat, beans
 - f. orange
2. Answers will vary.
3. By determining the nutrients (components) in various foods, we can become more aware of how well we are feeding our bodies.

Unit III-The Biochemistry of Foods: Lesson 3

UNIT III - THE BIOCHEMISTRY OF FOODS

Name _____

Lesson 3: Nutritional Properties of Foods

Date _____

EVALUATION

Match the nutrient class on the right with its role on the left.

- | | |
|-------------------------------------------------------------------------------------|------------------|
| ___1. Supply the majority of your energy | a. Carbohydrates |
| ___2. Protein synthesis | b. Proteins |
| ___3. Regulates body temperature | c. Vitamins |
| ___4. Provide fatty acids | d. Water |
| ___5. Major source of fiber | e. Fats |
| ___6. Source of nitrogen | f. Minerals |
| ___7. Insulate body | |
| ___8. Prevent scurvy; night blindness | |
| ___9. Major source for blood hemoglobin, bone development, osmotic equilibria | |

Match the nutrient class on the right with the examples on the left.

- | | |
|----------------------------------|------------------|
| ___10. Ca, P, K, Mg, Zn, Fe | a. Carbohydrates |
| ___11. Riboflavin | b. Proteins |
| ___12. A, B complex, C, D, E, K | c. Vitamins |
| ___13. Lysine | d. Water |
| ___14. Threonine | e. Fats |
| ___15. Thiamine, niacin, folacin | f. Minerals |

Food Science and Technology-Unit III

Circle the letter that corresponds to the best answer.

16. Which nutrient is the most energy rich compound?
- a. Proteins
 - b. Vitamins
 - c. Fats
 - d. Minerals
17. Which nutrient class is divided into fat-soluble and water-soluble?
- a. Proteins
 - b. Vitamins
 - c. Fats
 - d. Minerals
18. Which nutrient class makes 60 percent of the human body's weight?
- a. Carbohydrates
 - b. Proteins
 - c. Minerals
 - d. Water
19. Which nutrient class is 98 percent digested and utilized in the body?
- a. Carbohydrates
 - b. Proteins
 - c. Minerals
 - d. Water
20. List two reliable sources for each of the six nutrient classes.

Identifying Basic Food Nutrients

Objective: To determine the presence of complex carbohydrates, simple carbohydrates, protein, fat, minerals, and vitamin C in common foods.

Activity Length: 2 days

Materials and Equipment (for each group):

Lab apron (1 per student)

Safety glasses (1 per student)

15 foods divided into 6 small amounts (suggestions below)

½ small raw potato

60-90 rice kernels

1-inch cube cheese

6 croutons

1 tablespoon sucrose (table sugar)

1 tablespoon honey

1 tablespoon whole or skim milk

1 tablespoon jam or jelly

1 tablespoon cooked chicken (no skin), beef or pork

1 cooked egg yoke or white (note which)

1 small leaf of lettuce

1 tablespoon raw bacon or hamburger

1 tablespoon mayonnaise

¼ orange or 2 tablespoons orange juice

1 tablespoon butter or margarine

Pulverized dry beans or any pulverized food

1 tablespoon water

Lugol's iodine with dropper

Biuret solution

Benedict's solution

Source of gas flame

Eyedropper

Paring knife

Cutting board

Heavy duty aluminum foil

Brown paper

Food Science and Technology-Unit III

Paper cups
2 small paper plates
Tongs or tweezers
Graduated cylinder
100-ml beakers
Stirring rod
Pipette
Test tubes
Test tube holder
Distilled water
Cornstarch
Aluminum foil pie tin or shaped foil container

Procedure:

1. Since you will be working in small groups for this activity, read the instructions for each experiment and determine who will assume responsibility for each part.
2. Assemble foods (only small amounts are needed) to be tested on small paper plates and label as needed.
3. Carefully follow instructions for each test.
4. Record observations for each experiment.
5. Analyze data, determine conclusion, and complete laboratory report.

CAUTION: Do not eat any of the foods being tested.

TEST #1 for COMPLEX CARBOHYDRATE (starch)

1. Supplies:

Aluminum foil
Eyedropper
Lugol's iodine
Foods to test

2. Procedure:

- a. Cut the aluminum foil into squares 4 cm on each side (one square for each food type). Place the 4-cm squares of aluminum foil on the table, and place a small amount of each food sample on a square.

- b. In the data table indicate the test results you expect for each food in this test.
- c. With an eyedropper, add one drop of iodine test solution onto each sample. A blue-black color indicates the presence of a complex carbohydrate.

CAUTION: Handle iodine very carefully, it stains if dropped on skin, clothes, or surfaces.

- d. Record results for the test as positive (turns blue-black) or negative in the data table.

TEST #2 for SIMPLE CARBOHYDRATE (sugar)

1. Supplies:

Safety glasses
A rack test tube holder
1 test tube for each food to be tested
1 oz. Benedict's Solution for each test tube
Foods to test

2. Procedure:

- a. PUT ON YOUR SAFETY GLASSES.
- b. Place a small amount of a food in separate test tubes and label each with the name of the food.
- c. In the data table, indicate the test results you expect for each of the foods in this test.
- d. Add 1 oz. Benedict's Solution to each test tube and heat in a water bath. If solution changes from blue to red-orange, a simple carbohydrate is present.
- e. Record results as positive (turns red-orange) or negative in the data table.

TEST #3 for PROTEIN

1. Supplies:

Safety Glasses

Food Science and Technology-Unit III

Tongs or tweezers
15 100-ml beakers
Distilled water
Stirring rod
Pipette
Test tubes
Biuret solution
Foods to test

2. Procedure:

- a. PUT ON YOUR SAFETY GLASSES.
- b. Using tongs, put a piece of each food into separate 100-ml beakers and label. (Some foods might need to be ground or chopped before being added to the beaker.)
- c. Add enough distilled water to each beaker to just cover the pieces of food. Mix with a clean stirring rod until food is thoroughly moistened.
- d. Allow the solutions to stand for at least three (3) minutes.
- e. In the data table, indicate the test results you expect for each food for this test.
- f. Pipette 1 ml of each food solution into a test tube. Add five (5) drops of Biuret solution to each tube. The appearance of a pink or violet color will indicate the presence of protein (amino acids).

CAUTION: Do not handle the bottle containing Biuret solution. Only touch the rubber bulb of the eyedropper. Biuret can burn your skin and eyes.

- g. Record results of the test for protein as positive (turns pink or violet) or negative in the data table.

TEST #4 for FAT

1. Supplies:

4-cm squares of brown paper
Foods to test

2. Procedure:
 - a. Cut the brown paper into squares 4 cm on each side (1 square for each food.) Lay the pieces of paper on the table.
 - b. In the data table, indicate the test you expect for each food for this test.
 - c. Place and rub a small amount of each food on a square and label.
 - d. Remove food from square and discard.
 - e. After 10 minutes, examine each square by holding it up to a light source. A grease spot will indicate the presence of fat.
 - f. Record results for the test for fat as positive (grease spot appears) or negative in the data table.

TEST #5 for MINERALS

1. Supplies:

Aluminum foil pie tin or shaped foil container
Tweezers
Foods to test
2. Procedure:
 - a. Place a small amount of one food on the tin or shaped container.
 - b. In the data table, indicate the test result you expect from the test.
 - c. Heat the food on the tin over a gas flame until burned. If gray powdery ash remains, minerals are present. (Minerals do not burn.)

CAUTION: Tin will become hot, handle carefully.

- d. Repeat steps a-c for the other foods.
- e. Record results for the test as positive (gray powdery ash remains) or negative in the data table.

TEST #6 for VITAMIN C

1. Supplies:

2 cups water and
2 tablespoons cornstarch boiled together for 3 minutes and cooled (this may be done in advance by teacher)
Paper cups
Iodine with dropper
Foods to test

2. Procedure:

- a. Chop or grate a small amount of one of the foods into a clean paper cup.
- b. In the data table, indicate the test result you expect from this test.
- c. Place 1 teaspoon of cornstarch mixture into the same cup. Add 1 drop iodine at a time, swirling to mix between each addition. If the solution turns clear, vitamin C is present. The more drops of iodine needed to clear the solution, the less vitamin C there is in the food.
- d. Record results for the test as positive (solution turns clear) or negative in data table.
- e. Repeat steps a, b, c, and d for other foods to be tested.

Unit III-The Biochemistry of Foods: Lesson 3

| Food | Test for Complex Carbohydrate (+/-) | | Test for Simple Carbohydrate (+/-) | | Test for Protein (+/-) | | Test for Fat (+/-) | | Test for Minerals (+/-) | | Test for Vit. C (+/-) | |
|------|-------------------------------------|--------|------------------------------------|--------|------------------------|--------|--------------------|--------|-------------------------|--------|-----------------------|--------|
| | Pred | Result | Pred | Result | Pred | Result | Pred | Result | Pred | Result | Pred | Result |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Key Questions:

1. Based on your tests and observations, which foods are sources of the following nutrients:
 - a. Complex carbohydrates
 - b. Simple carbohydrates
 - c. Protein

Food Science and Technology-Unit III

- d. Fat
 - e. Minerals
 - f. Vitamin C
2. How accurate were your predictions compared to your tests?

 3. How can you apply the things you learned in this lab to your own eating habits?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition*. The National Council for Agricultural Education, 1993.

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 4: Processing Influences Nutritional Value

Objective

The student will be able to describe how processing techniques influence the nutritional value of food.

I. Study Questions

- A. How does temperature affect nutrient availability in foods?
- B. How does light affect nutrient availability in foods?
- C. How does water content affect nutrient availability in foods?
- D. How does oxidation affect nutrient availability in foods?
- E. What process can be used to maintain or enhance the nutritional value of foods?

II. References

- A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
- B. Activity Sheet
AS 4.1: How Processing Affects Vitamin C

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 4: Processing Influences Nutritional Value

TEACHING PROCEDURES

A. Review

Review the six classes of nutrients and their functions in the human body.

B. Motivation

Compare nutritional values of fresh (posted at the grocery store), frozen (on the container), and canned (on the container) fruits and vegetables. Check the list of ingredients to see if Vitamin C (Ascorbic Acid) was added.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how temperature affects nutrient availability in foods.

How does temperature affect nutrient availability in foods?

- a. Room or elevated temperatures allow enzymes to degrade tissue and break down vitamins.
 - b. Blanching stops enzyme activity.
 - c. Proteins toughen when exposed to high cooking temperatures.
 - d. High cooking temperatures and long cooking times destroy vitamins.
2. Discuss how light affects nutrient availability.

How does light affect nutrient availability in foods?

- a. Fluorescent and ultraviolet light can destroy riboflavin.
 - b. Vitamins, in general, break down in the presence of light.
3. Discuss how water content affects nutrient availability in foods.

How does water content affect nutrient availability in foods?

Water-soluble vitamins are a part of a food's juice and are easily lost.

Food Science and Technology-Unit III

4. Discuss how oxidation affects nutrient availability. Oxidation is the breakdown of nutrients in the presence of oxygen. BHA and BHT are antioxidants.

How does oxidation affect nutrient availability in foods?

- a. Overcooked or burned foods have been partially oxidized to carbon and oxygen gas and are not useful to the body.
 - b. Protein molecules release their nitrogen as nitrous oxide.
5. Discuss what processes are used to enhance the nutritional value of foods.

What processes can be used to maintain or enhance the nutritional value of foods?

- a. Enrichment - nutrient levels are increased
- b. Fortification - add nutrients that may not have originally been found in foodstuff
- c. Supplements - nutrients added to a level in excess of 50 percent RDA
- d. Cooking method and length
- e. Quick cooling post harvest
- f. Waxing/packaging

F. Other activities

Have students bring food labels from home that indicate enriched or fortified foods. Compare the labels.

G. Conclusion

Processing does influence the nutritional value of foods. Critical aspects are: temperature, light, water content, and exposure to the air or oxidation. There are several processes that are used to maintain or even enhance a foods nutritional value.

H. Competency

Describe how processing techniques influence the nutritional value of food.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. d
2. d

3. a
4. b
5. b
6. c
7. a

J. Answers to Activity Sheet

AS 4.1

1. Vitamin C is lost when foods are heated.
2. There is a time dependant relationship between heating and Vitamin C destruction.
3. Answers will vary but should indicate that most of the Vitamin C will

UNIT III - THE BIOCHEMISTRY OF FOODS

Name _____

Lesson 4: Processing Influences Nutritional Value

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following can cause nutrient loss in foods?
 - a. Light
 - b. Heat
 - c. Boiling in a water bath
 - d. All of the above

2. Light, especially fluorescent and ultraviolet, promotes the breakdown of:
 - a. Vitamin C
 - b. Water
 - c. Carbohydrates
 - d. Riboflavin

3. Cooking food in a water bath would increase the loss of:
 - a. Water-soluble vitamins
 - b. Fat-soluble vitamins
 - c. Minerals
 - d. Proteins

4. Oxidation is defined as:
 - a. The binding of protein molecules in the presence of O₂
 - b. The chemical reaction in the presence of O₂
 - c. The addition of a carbon atom
 - d. Inhaling oxygen

Food Science and Technology-Unit III

Match the word on the right with the definition of the left.

- | | |
|------------------------------------------------------------------------------------|---------------|
| ___5. Nutrients added to a level that exceeds 50 percent of the RDA | a. Enrich |
| ___6 .Nutrient levels returned to levels present before processing | b. Fortify |
| ___7. Nutrients are added to a food that may or may not have been there originally | c. Supplement |

How Processing Affects Vitamin C

Objective: The student will be able to identify how processing affects Vitamin C retention in vegetables.

Activity Length: One class period

Materials and Equipment:

- Blender
- Knife
- Scale
- Cheesecloth or filter paper (a coffee filter will work, but may be a little slow)
- Hot plate or stove
- Microwave
- 1 - 200-ml beaker or other heat-resistant container (1 cup Pyrex measuring cup will work in the microwave)
- 6 - 150-ml beakers (clear disposable plastic drink cups work well)
- 60 grams of 2 different kinds of fresh vegetables (green beans, broccoli, potato, tomato, etc.)
- Water
- 6 test tubes
- Eyedropper
- Indolphenol blue dye
- Test tube rack
- Labels (masking tape will work)
- Hotpads

Procedure:

1. Cut the vegetables into uniform pieces, no larger than 3 cm in any dimension.
2. Weigh out 3 portions of each vegetable (total of 6 portions). A portion should weigh about 20 grams.
3. Label the 150-ml beakers with A, B, C (control first vegetable), D, E, and F (control second vegetable).
4. Place 20 grams of one vegetable in beakers A, B, and C.
5. Place 20 grams of the other vegetable in beakers D, E, and F.
6. Add 100 ml water to each beaker.

Food Science and Technology-Unit III

7. Pour the contents of beaker A into the 200-ml beaker. Heat in the microwave until the water boils. Pour the contents back into beaker A.
CAUTION: Use hotpads when handling the hot beakers.
8. Wash the 200-ml beaker. Then repeat step 7 with beaker D.
9. Heat beaker B on stove or hot plate for about 30 minutes.
10. Heat beaker E on stove or hot plate for about 30 minutes.
11. Allow beakers to cool.
12. Transfer the contents of beaker A to the blender. Process at high speed until the sample is well blended.
13. Pour the contents of the blender through cheesecloth or filter paper to filter out the liquid. (If you have access to a centrifuge, centrifuge sample for 10-15 minutes.) The sample does not have to be clear. (With some vegetables this step can be eliminated, as long as the sample is liquid enough to pour easily into a test tube.)
14. Measure 60 ml of the filtrate back into beaker A.
15. Rinse the blender thoroughly after filtering the liquid.
16. Repeat Steps 12 -15 for the contents of beakers B, C, D, E, and F.
17. Using the eyedropper, measure 10 drops of indophenol blue dye into 6 test tubes. Label test tubes A, B, C, D, E, and F. Clean eyedropper.
18. Using the eyedropper, carefully add contents of beaker A into test tube A one drop at a time, counting the number of drops needed to make the blue color disappear. Stop adding drops when the color disappears. Record the number of drops added to the test tube.
19. Clean eyedropper before moving to next beaker.
20. Repeat steps 18 and 19, using beaker B with test tube B, so on, with beakers C, D, E, and F.
21. Vitamin C bleaches the blue color out of indophenol blue. This lab will make qualitative distinctions between the different processing techniques based on the amount of vitamin C they possess. The fewer the number of drops needed to make the blue color disappear, the greater the percentage of vitamin C in that sample. If the blue color does not disappear, the beverage is said to contain no vitamin C.

Key Questions:

1. What is the effect of heating on the vitamin C content of vegetables?

2. Why is there a difference between the microwaved vegetables and the vegetables cooked for 30 minutes on the stove.

3. What would you predict would happen if the vegetables were roasted at 350 F for 3 hours (like being cooked in a pot roast)?

Variations:

All kinds of processing treatments could be evaluated using this procedure. For example:

What is the effect of peeling on vitamin C levels?

What about adding salt or vinegar to the liquid?

Freeze the vegetables

Store vegetables for a week at different temperatures

This procedure would also work using fruits, but the amount of material titrated in step seven may have to be adjusted (vitamin C levels in fresh fruit is much higher than in processed juices.)

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 5: Biotechnology in the Food Industry

Objective

The student will be able to describe the role of biotechnology in the food industry.

I. Study Questions

- A. What is biotechnology?
- B. How has biotechnology affected food production?
- C. What are examples of bioengineered foods?
- D. What business enterprises are involved in biotechnology research?
- E. How will biotechnology influence the food industry in the future?
- F. What factors influence new developments in food biotechnology?

II. References

- A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
- B. Activity Sheet
AS 5.1: A Bioengineered Food Product

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 5: Biotechnology in the Food Industry

TEACHING PROCEDURES

A. Review

In Unit 2, Lesson 2, you studied new food product development. It was stated that new products are developed to enhance the food's convenience and nutritional value. Unit 3, Lesson 1, examined the use of food additives in regard to food safety. Biotechnology in food science encompasses all of these ideas, from bioengineered new food products to bio-designed additives. This lesson looks at biotechnology, specifically in the food industry.

B. Motivation

A package of cheese is a good example of biotechnology in food. The rennet was developed using biotechnology. Begin class with the students writing the many ways technology has worked to produce other products. A visual example would be helpful. Examples - chicken sticks, Miracle Whip®, Cool-Whip®.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss what biotechnology is.

What is biotechnology?

- a. The use of living organisms to make commercial products
 - b. The use of microorganisms, animal cells, plant cells, or components of cells such as enzymes to produce products or carry out processes for human benefit
2. Discuss how biotechnology has affected food production.

How has biotechnology affected food production?

- a. Greater variety of foods
- b. Increased shelf life/safety of food
- c. Greater efficiency in production of food

3. Discuss examples of bio-engineered foods.

What are examples of bioengineered foods?

- a. Enzymes
 1. Rennet - naturally found in a calf stomach, can be synthetically produced and immobilized
 2. Lactase - cleaves lactose to glucose and galactose, can be immobilized
 3. Low-calorie foods - Non-nutritive sweeteners - aspartame, thaumatin, and monellin are taste active proteins. The genes that code for these proteins may be isolated and transferred to bacteria and produced through fermentation.
 4. Waste management - certain yeast strains can produce a grape aroma when they consume whey, a cheese-making by-product. This could be used as a flavor component for the wine and food industries.
 5. Biological monitoring - DNA fragments from disease-causing microorganisms have been coded and hybridized to probe for the presence of these organisms in food.
 6. Cellulose and collagen casings and co-extruded casings
4. Discuss the types of businesses involved in biotechnology research.

What business enterprises are involved in biotechnology research?

- a. USDA
 - b. Universities
 - c. Food processing companies
 - d. Commodity organizations
 - e. National Live Stock and Meat Board
 - f. Other food/agricultural related companies
5. Discuss how biotechnology will influence the food industry in the future.

How will biotechnology influence the food industry in the future?

- a. A growing population will necessitate a growing food supply on less acres.
- b. Greater weed control, less insect damage, enhanced nutritional quality and safety, greater disease resistance, improved genetics
- c. Longer shelf life, new vaccines, less dependence on petroleum oil, soy- and corn-based product expansion, biological insect control, resistant varieties, more hydroponic-grown food

- d. Round-up resistant corn, non-fixing grasses, soy coatings, natural antifreeze
6. Discuss what factors influence new developments.

What factors influence new developments in food biotechnology?

- a. Needs of the people
 - b. Finances
 - c. Talent pool of researchers
 - d. Facilities/equipment
 - e. Weather
 - f. Time
- F. Other activities
- 1. Have students complete a report on George Washington Carver's advances with the peanut.
 - 2. Show the video, "The Nature of Change," from Monsanto Company, 800 N. Lindberg Blvd., St. Louis, MO 63167, (314) 694-1000.
 - 3. Read and report on "Of the Earth: Agriculture and the New Biology," from the Monsanto Company, 800 N. Lindberg Blvd, St. Louis, MO 63169, (314) 694-1000.
 - 4. Evaluate a news article on biotechnology.
 - 5. Prepare a tissue culture using the Wisconsin fast plants tissue cultures, available from Carolina Biological Supplies.

G. Conclusion

Biotechnology is changing the production and processing of foods. New foods are routinely being developed like the non-nutritive sweeteners: aspartame, thaumatin, and monellin. Biotechnology is also being used to develop synthetic nonfood products like insulin.

H. Competency

Describe the role of biotechnology in the food industry.

Related Missouri Core Competencies and Key Skills:

Food Science and Technology-Unit III

- 9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.
- 10D-1: Describe general ways in which human activities affect environmental quality.

I. Answers to Evaluation

1. a
2. c
3. d

4. The use of microorganisms, animal cells, plant cells, or components of cells to produce products or carry out processes for human benefit.

5. Two of the following: greater variety, increased shelf life/safety, greater efficiency in food production.

6. USDA
Universities
Food processing companies
Commodity organizations
National Live Stock and Meat Board
Other food/agricultural related companies

7. Teacher's discretion.

J. Answers to Activity Sheets

AS 5.1

1. Too high or low a temperature will render the enzyme inactive or it will not coagulate the curd. (You may want to allow some groups to form curd using high and low temperatures.)

2.

| | |
|----------------------------------------------|--------------|
| Function | Enzyme |
| hydrolysis of starch to glucose | glucoamylase |
| coagulation of milk for cheese production | rennet |
| clarification and production of fruit juices | pectinase |

UNIT III - THE BIOCHEMISTRY OF FOODS

Name _____

Lesson 5: Biotechnology in the Food Industry

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is a non-nutritive sweetener that has been bioengineered?
 - a. Aspartame
 - b. Corn syrup
 - c. Cane sugar
 - d. Beet sugar

2. What enzyme is used during cheese making?
 - a. Glucose
 - b. Lactose
 - c. Rennet
 - d. Thaumatin

3. What type of casing has been bioengineered to replace natural casings?
 - a. Biocasings
 - b. Digestive tract casings
 - c. Fatty casings
 - d. Cellulose casings

Complete the following short answer questions.

4. Define biotechnology.

5. Name two ways biotechnology has affected food production.

Food Science and Technology-Unit III

6. What are two business enterprises involved in biotechnology research?

7. Use the terms: biotechnology, herbicide-resistant varieties, shelf life, soy coatings, food safety, increased efficiency, in an essay that discusses biotechnology's future role in food production.

A Bioengineered Food Product

Objective: Process hard curd (the primary step in cheese production) using rennin.

Activity Length: 1 class period

Background Information: Chymosin, also known as rennin, is an enzyme that is used in cheese making. When added to milk at the beginning of the cheese-making procedure, it causes the milk to coagulate, or "set," within 30 minutes so that it can be separated into curds and whey. The only source of chymosin for many years was from calf rennet, the extract from stomachs of calves which were slaughtered for veal production. The extract contained, besides chymosin, many impurities. The supply of chymosin also depended on the supply of veal calves (as the cow gets older, its stomach stops producing chymosin). The gene for chymosin has been isolated from cells of calves and inserted into a bacterium. The resultant product, recombinant chymosin, is produced by bacterial cultures in large and controllable quantities. Also, because its production can be highly controlled, it can be easily purified and therefore used without impurities. Chymosin is the first recombinant product to be approved by the FDA for use in food and is now being produced and sold commercially. This procedure demonstrates hard curd production. Hard curds are used in the production of many cheeses, such as, cheddar, Swiss, and Gouda. (Purdue University Cooperative Extension Service, 1992)

Materials and Equipment:

Thermometer
Skim milk - 1 c.
Double boiler
Hot plate
Cups
Plastic spoons and knives
Safety glasses
Rennet solution*
Water

*rennin (rennet solution: crush one junket tablet and dissolve in a tablespoon of water. If material does not dissolve completely, be sure that it is thoroughly dispersed

Food Science and Technology-Unit III

immediately before adding to milk. Junket tablets can be purchased in most grocery stores.)

Procedure:

1. Put on your safety glasses.
2. Place 1 cup of skim milk into the top half of the double boiler.
3. Place water in the bottom of the double boiler on a hot plate. Heat the milk to 95°F-113°F (do not allow the thermometer to rest on the bottom of the pan).
4. With constant stirring, slowly add the rennet solution.
5. Allow the milk to remain at 95-113°F for 15-20 minutes, until a firm gel is formed.
6. Cut the gel into small pieces with a plastic knife.
7. Increase the heat slowly to 113-122°F to firm the curd.
8. Allow the curd to settle.
9. The liquid in the boiler pan is called sweet whey. Pour the sweet whey into a clean cup. Taste when cooled.
10. Examine the curd. Determine the texture/consistency of the curd by squeezing it between your thumb and fingers. You may place a small piece of curd in your mouth and chew it.

Key Questions:

1. What effect does temperature have on this process?
2. What are some major industrial uses of enzymes to produce and process food?

Credit: Frick, Marty. *Food Science, Safety and Nutrition*. The National Council for Agricultural Education, 1993.