FACS: From Milk to Cheese & Seed to Shelf (Ag)

Summary

Students will observe cheese making as an introduction to a detailed exploration of career possibilities and opportunities in science-based agriculture and biotechnology.

Time Frame

2 class periods of 45 minutes each

Group Size

Large Groups

Life Skills

Thinking & Reasoning, Communication

Materials

Activity 1: Making Cheese, Old and New

Computer Lab or Computer & Projector for Presentation
Computer Speakers or Headphones
Computer Internet Access or Agricultural Technologies and Edutainment Software (available from Utah AITC)

- Biotech Cheese Kit
  (available from Utah AITC)
  2 Crockpots
  Rennet
  Thermometer
  Large Spoon
  Large Knife
  Colander
  8 Cups Powdered Milk
  2 Quarts Buttermilk
  Salt
  2 Small Bowls
  Crackers
  Herbs *(optional)*
- Bringing Biotechnology to Life
  available from Utah AITC *(optional)*

Activity 2: From Seed to Shelf

Computer Lab or Computer & Projector for Presentation
Computer Speakers or Headphones
Computer Internet Access or Agricultural Technologies and Edutainment Software (available from Utah AITC)

Activity 3: No Fear Food Safety First

- Science in Your Shopping Cart
  (Available from Utah AITC)
  5 Sets of Specialist Fact Cards
  5 Sets of Specialist Matching Cards
  5 Consumer Facts Information Boards

Background for Teachers

Food production, processing, and preservation techniques have changed drastically in the United States over the last 200 years. This lesson looks at three major agricultural changes—science of biotechnology, science of food preservation, and business of processing and distribution—through three classroom activities.

Intended Learning Outcomes

Examine and describe how agriculture and natural resources impact our quality of life.

Recognize and explain how the agricultural system works (production to consumption) and identify related corresponding careers in agricultural and forestry production, education, communication and government services, management and business, and scientific and engineering opportunities, including career educational requirements and salary ranges.

Students will explore and identify emerging technologies and careers in agriculture (e.g. biotechnology, cloning, GIS/GPS applications such as precision agriculture and livestock identification, bioenergy—fuels, and other manufacturing processes—environmental monitoring, nutrition, new technologies for food safety and security).

Instructional Procedures

Activity 1: Making Cheese, Old and New

Biotechnology is a relatively new term that is defined as "techniques that use living organisms or parts of organisms to produce a variety of products (from medicines to industrial enzymes) to improve plants or animals or to develop microorganisms to remove toxins from bodies of water, or act as pesticides." With this definition, humans have been practicing "biotechnology" since the dawn of civilization. Over time, humans have wanted access to more high quality food and have sought out methods or techniques to improve agricultural production and food preservation. Today, we also want quantity and quality, but we also want food to be inexpensive.

As science has advanced, the ability to modify organisms through the tool of biotechnology has resulted in "genetically modified organisms" or GMOs. Some of these GMOs are controversial, especially if the GMO has caused or has the potential to cause a change in the environment.

A positive example of biotechnology and the resulting GMO can be found in cheese making. According to legend, cheese was "discovered" thousands of years ago by a traveler who placed milk into a pouch made from a sheep stomach. During the journey, the sun's heat and the enzymes in the lining of the stomach pouch changed the milk into curds and cheese whey.

Scientists later discovered that the enzyme rennin (produced in calf stomach lining cells) would coagulate the protein (casein) in milk, forming curds and whey. Because the enzyme reacts with a protein, the enzyme is called a protease. Commercial rennin products, available in most grocery stores sold as "Junket" or "Rennet," are made from the enzymes found in the fourth stomach of calves. Through biotechnology, the gene from the calf stomach cell which makes the cell produce the enzyme, rennin, is removed and inserted into a bacteria or yeast cell. This causes the organism (bacteria or yeast) to produce the enzyme. Yeast replicate and grow rapidly, so yeast is often used to duplicate the enzyme. In the past, a large number of milk fed calves have been slaughtered to use their stomachs as a supply of rennin for cheese manufacturing. Through biotechnology, the enzyme-producing gene can be extracted, purified and concentrated--no calves necessary. This creates an endless supply of the humanmade enzyme with the commercial name of "Chymosin." Today in the United States, about 80 percent of cottage cheese and 50 percent of all other cheeses are made with the enzyme Chymosin which has been isolated from a microorganism which has been genetically engineered through biotechnology.

Cheese making is really the removal of water from milk; milk is 87% water and 13% solids. This is done by coagulating the protein in the milk. Coagulation changes the chemical makeup of protein so it is no longer water-soluble.

Cheese making can be divided into two stages: coagulation and aging. The rennin enzyme splits kappa-casein, a major milk protein, causing the milk to coagulate or curdle. Chymosin and rennin work best at 90°F and in an acidic environment. The resulting curds and whey (milk liquid) are separated. The curd is used to make cheese. Some cheeses are used without much further processing and no aging. Cottage cheese is an example of a cheese that isn't aged. For proper aging, the action of specific bacteria and fungi are needed. Different strains of microbes are used for each type of cheese, e.g., Swiss, cheddar, and blue cheese.

In the Biotech Cheese Kit, available from Utah AITC, buttermilk is added to the experiments to help with the flavor and increase acidity. The kit does not contain bacteria. Bacteria is not required for making cottage cheese, and using bacteria for making cheese requires more time in preparation and aging to see and taste the results. To compare a non-aged cheese like cottage cheese to cheese from rennin and Chymosin, obtain a Biotech Cheese Kit from Utah AITC and ask your students if they can see and taste the difference between "old" (rennin) and "new" (Chymosin) cheese. (Instructions are included with the kit.)

Discussion Questions:

List the various careers associated with dairy farming and dairy processing.
(Dairy farmer, veterinarian, feed specialist, machinery operator, feed store manager, agricultural engineer, implement dealer, milk truck driver, milk plant manager, manufacturing engineer, graphic artist, marketing manager, food scientist, etc.)

List the various careers associated with food science.
(Nutritionist, food scientist, food manufacturing engineer, food chemist, food inspector, food marketer, graphic artist, dietician, processor, etc.)

What are two types of cheese not aged or made with bacteria?
(Cottage cheese and American cheese.)

What are the advantages of being able to produce chymosin?
(It is faster and the cheese production does not require calf stomachs.)

If you have watched the first segment of Bringing Biotechnology to Life do you think biotechnology and genetically modified organisms will be part of the 21st Century?
(Answers will vary, however the most probable answer is probably. GMOs that have direct environmental implications will be the most regulated and scrutinized.)

Activity 2: From Seed to Shelf

Access the "From Seed to Shelf" computer program either online (streaming from the web) at https://utah.agclassroom.org/htm/ag_games or by purchasing the media from the same site and installing the program on your lab computers. Utah teachers will receive a password for free access. Request this password 24 hours prior to accessing the site. The game is easy to play but you may want to demonstrate how to use the "Seed to Shelf" program in front of the entire class using an LCD projector. Speakers are also required. If only one computer is available for the activity, divide the class into teams and play the game as an entire class. Ask each team to complete the worksheet. If you have a computer lab, proceed with the following activity.

Provide each group of 2-4 students with a computer that allows access to the "From Seed to Shelf"

program (web or CD). There are two parts to the game, processing and marketing. (The tasks are the same for each group, however, the number dial spins randomly.) The player who produces the greatest number of cracker boxes and sells at a profit wins! The following questions and instructions are read aloud to students when they launch the program:
"Where do all the crackers on the grocery store shelves come from? What occurred between the time the farmer planted the seeds and you bought the box of crackers? In this activity you will try your hand at producing boxes of crackers and distributing them to grocery stores across the country. As in real life you will encounter problems and surprises during the manufacturing process. Once you reach distribution, you will need to decide how quickly you can get the crackers to the stores. If you tell the distributors a time faster than you can deliver, you will lose some of your profit. However, if you take too long to deliver, they will not pay as much for your product. Carefully weigh your options before you decide. Good luck!"

Activity 3: No Fear Food Safety First

Most consumers have little understanding of production agriculture and the process of getting food from the farm to the fork. They often question whether advances in technology such as pesticides, chemicals, and biotechnology are really necessary to feed our country and others around the world.

Consumers can be assured that we have a safe food supply. It is estimated that over $3 billion is spent by 12 federal agencies to ensure food safety and quality inspection. In addition, it is estimated that private and state agencies spend an additional $6 billion annually. These educational, regulatory, and monitoring efforts help ensure the food we eat is safe.

Consumers often are confused by production practices used by farmers. Many questions and fears arise about the use of chemicals and pesticides. Studies reviewed by the FDA each year continue to show that the levels of pesticides in the U.S. food supply are low. According to Food and Drug Administration, about 75% of our foods contain no human-made pesticide esidues. The human-made pesticide residues detected in 24% of FDA amples are well within the Environmental Protection Agency's very strict tolerance levels. In the remaining 1%, where human-made residues are outside legal limits, most often it's because the chemical product isn't registered for use on that particular crop. For example, a product may be registered for use on bell peppers, but not on chili peppers. This is a legal violation, not necessarily a health hazard. Pesticides in the environment are of greater concern than crop residues.

Consumers often ask, why must agriculture use chemicals and other technologies at all? Additionally, it is questioned whether the foods brought home from the supermarket would be safer to eat if farmers didn't use crop protection chemicals. Pesticides used in production agriculture help assure fungus-free grain, worm-free apples, leafy vegetables without aphids, and berries and fruits without mites or disease. Plants also generate substantial quantities of natural pesticides to ward off enemies such as insects, molds and fungi. Scientists believe that the vast majority of the pesticide residues we eat are naturally occurring.

Farmers face some great challenges in putting food on the consumer's table. Two of the biggest pests, which a farmer has to combat, are insects and weeds. For example, the average acre of land contains approximately a million weed seeds. If that does not boggle your mind, it is also estimated that farmers nationwide lose 33 percent of their harvest to insects. Without agricultural chemicals, pesticides, or other biological controls, farmers would be hard pressed to maintain our abundant and economical food supply. In other words, the supply would probably decrease and prices for food would increase. A question for discussion here might be, "What are you willing to pay for organic food?" "Will a large number Americans be willing or able to pay?"

With such an abundant food supply here in America, it is hard to imagine a food shortage. By the year 2050, it is estimated that the world population will be about 9 billion people. To feed this immense population, farmers will be asked to produce nearly as much food as it has produced in the entire 12,000-year history of agriculture.

Many people do not know exactly how vulnerable our food supply is. Our nation actually has only a surplus of a few commodities, such as corn and wheat. But this excess could be quickly diminished if bad weather or devastating crop failures occur. In fact, the USDA Economic Research Service estimates that our reserves could only last a mere two years.

Advances in biotechnology will continue to play a major role in helping farmers to control operating costs and produce a more bountiful and reliable harvest--if consumers will accept that science and biotech crop production doesn't adversely affect the environment. Agricultural science and production efficiency is largely responsible for the relatively low cost that consumers in the U.S. pay for food. In fact, statistics show that only about 10 percent of a family's disposable (U.S. average) income is spent on food. This compares to consumers in Japan, Mexico, and India who spend about 26, 33, and 51 percent, respectively, on food.

Indeed our food system is complex and many times misunderstood. Today's food supply is not only abundant but also very safe. The key to our agricultural success in the future will center on our ability as producers and consumers to work together to keep our food system ecologically sound, ustainable, and safe, and delivering high quality, varied, and inexpensive food.

As a result of participating in the activities, students learn about food preservation techniques and some of the associated illnesses. Students will be able to sort out the facts concerning irradiation, ecoli, Salmonella, hormones, and pesticide residues.

- Divide your students into groups of five.
- Distribute to each group a plastic Ziploc® bag with the cut apart Specialist Fact Cards, Specialist Matching Cards, and Consumer Facts Information Board.
- Students should take one of the Specialist Fact Cards. This will designate them as a "Food Science Specialist" in the area of irradiation, e-coli, Salmonella, hormones, and pesticide residues.
- (Option 1 - Each student reads their Specialist Fact Card before they begin matching or Option 2 - the matching begins and if the student player needs a clue to complete a match, one Specialist may read their card until a match can be made.)
- Students should mix up or shuffle the Specialist Matching Cards and then place them upside down in a pile.
- Each student takes a turn picking a Specialist Matching Card and trying to match the card to the appropriate place on the Consumer Facts Information Board. If they do not know where to match the card, the "Specialist" reads their pecialist Fact Card down to the place where the student says stop, because they have determined a match on the Consumer Facts Information Board.
- The activity is finished when the Consumer Facts Information Board is complete. Answers can be posted on the overhead at the end of the activity.

Discussion Questions:

Create a bar graph depicting the percentage of disposable income (dollars) spent on food by the following countries.

10% United States

16% Finland
26% Japan
26% Israel
33% Mexico
51% India

Locate these countries on a world map.

Why is food in the U.S. so inexpensive?

(Free market system, plant, soil, animal science increasing production and efficiency.)

Additional Activities

Watch the first segment (21 minutes) of the video Bringing Biotechnology to Life. Invite discussion and questions.

After the matching activity has been completed once, take away the Specialist Fact Cards and see which group can correctly match the items in the fastest time.

Utilizing the booklet and DVD Science in Your Shopping Cart, bring in a bag of grocery items mentioned in the booklet. Ask the students to pair up. Pass one item to each team. Ask each team to guess and write down what "science" has been used in the production of their food item. Ask them to draw a line under their guesses. Next, view the Science in Your Shopping Cart DVD and ask the students to add any additional "science" techniques/processes that went into the production of the item. After they view the DVD, ask each team to share their "before and after" list. This is a good time for class discussions about new technologies and careers.

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