Good Guys or Bad Guys

Utah Science

Materials

Activity 1—Decay and Decomposition

- Quart Ziploc bag for each team of two
- Clear tape
- Markers
- Decay buffet (including grass, vegetable peeling, straw, dry leaves, etc.)
- Water mister bottle
- Food handlers gloves
- Magnifying glasses

Activity 2—Microbes in my food!

- Grocery store newspaper advertisement
- Bread wrapper
- Label from a box of cereal
- Beef jerky package label
- Yogurt container
- Package from dried fruit
- Copies of Microbe Grocery List

Background

Yes, it's true; decomposition is a fundamental process on which all life depends. We'd all be knee deep in garbage without it. Bacteria, fungi, and other microscopic organisms that live in the soil, air, and water are responsible for turning once living plants, animals and other organisms into nutrients that can be used again and again. Think of them as nature's recyclers. These tiny creatures have the ability to produce special enzymes, which allow them to break down dead plant and animals and use them as food. No job is too big as they enlist the help of friends and family. As they eat, they grow and multiply at an amazing rate. In just 4 hours, one bacterial cell can grow to a colony of 5,096. And at days end there are millions and billions of them working together. Why, in 1 teaspoon of soil, there are more bacteria and fungi than all the people on Earth!

Despite their microscopic size, you've probably seen evidence of them right in your own homes. Remember that orange with blue-green mold in the back of the refrigerator? Or that black or white fuzzy slice of bread? Or those damp old gym socks that you left in a plastic bag, newly spotted with black and pink? These are colonies of our microbial friends hard at work at the fine art of decomposition.

Some microorganisms are harmful and cause disease while others are benevolent, neutral, or even helpful. Some help us to produce certain foods, break down toxins in our environment, while others can kill us. For example; Protozoa cause amoebic dysentery, fungi cause athlete's foot and ringworm, bacteria cause pneumonia, legionnaire's disease, strep throat, tetanus and other diseases. Contaminants in food like E. coli or Salmonella can also make us very sick. The second activity in this lesson will focus on helpful and harmful microorganisms.

Agriculture in the Classroom
UtahStateUniversity
COOPERATIVE EXTENSION

Time: Three or four 50-minute class periods

Grade Level: 6

Science, Standard 5
Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 3
Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.
b. Identify how microorganisms are used as food or in the production of food.
c. Identify helpful uses of microorganisms and the role of science in the development of understanding that led to positive uses.
e. Observe and report on microorganisms' harmful effects on food.

Molds

Molds are probably the best known of the microorganisms (see bread mold activity in previous lesson). They are widely distributed in nature and grow under a variety of conditions in which air and moisture are present. They are members of the kingdom fungi. Nearly everyone has seen mold growth on damp clothing and old shoes. The mold we see with the naked eye is actually a colony of millions of mold cells growing together. Molds vary in appearance. Some are fluffy and filament-like; others are moist and glossy; still others are slimy.

Molds are made up of more than one cell. Vegetative cells sustain the organism by taking in food substances for energy and the production of new cell material. Reproductive cells produce small "seed" cells called spores. Unlike bacterial spores, mold spores are the source of new mold organisms. Bacterial spores generally form only when environmental conditions are unfavorable.

Molds appear flat, fuzzy, and shapeless. They are actually multicellular. Mold cells form a "fruiting body." The fruiting body produces the spores, which detach and are carried by air currents and deposited to start new mold colonies whenever conditions are favorable. Mold spores are quite abundant in the air. So any food allowed to stand in the open soon becomes contaminated with mold if adequate moisture is present. Some types of molds are also psychrophiles (grow in cool temperatures) and can cause spoilage of refrigerated foods.

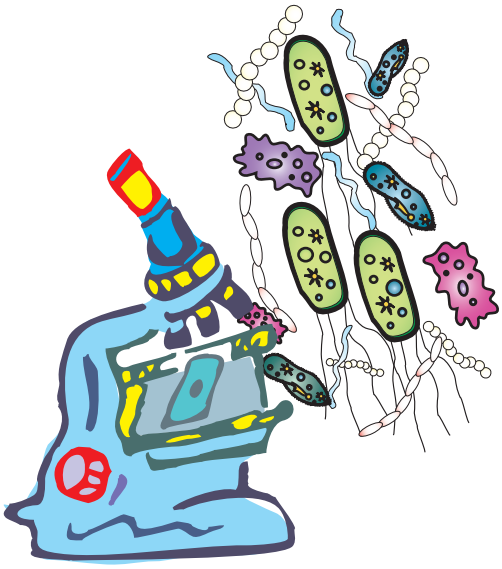
Molds are decomposers meaning that they obtain food from non living organisms. Decomposers help to recycle materials from dead organisms.

Molds (and other microorganisms) are important to the food industry. Among their many contributions are the flavor and color they add to cheeses, and the making of soy sauce. They also play a role in making chemicals such as citric and lactic acid and many enzymes. Sour cream, buttermilk, yogurt, and hard cheeses (cheddar, Swiss, jack, feta, etc.) are all cultured with a bacteria. Other cheeses such as blue, Roquefort, are cultured by fungi. Processed cheeses, like American cheese, are not cultured with microorganisms.

Some ice cream contains a thickener made from seaweed. Seaweed–or algae–is everywhere in our food nowadays. Chunks of it float around in Korean soups, paper-thin sheets of it are wrapped around Japanese rice balls, and it lies hidden in the alginates and carrageenans in hamburgers, yogurt and ice cream. Seaweed-based food additives are now so commonly used in prepared and fast food that virtually everybody in Europe and North America eats some processed seaweed every day.

Sometimes microorganisms spoil food. Most of your students will have seen rotten, spoiled, moldy food in their refrigerators. Food that is spoiled by bacteria may not be seen with the naked eye, but the food will probably taste bad and will probably make you sick. Molds are more visible. Certain kinds of mold can produce poisons called mycotoxins. Mycotoxins have only recently been discovered and little is known about what causes molds to produce them. Probably the best known use of molds is in the drug industry, where they help produce such antibiotics as penicillin.

The old adage for dealing with questionable food is the best advice "when in doubt...throw it out!"



Activity Procedures

Activity 1—Decay and Decomposition

1. Divide the class into pairs.
2. Provide each pair of students with a Ziploc quart bag and ask them to write their names on some tape and then stick the tape on the bag.
3. Set up a "Decay Buffet" of items noted in the list of materials to be placed in the bags. The ingredient ratio 2-parts dry (brown or the carbon containing ingredients) and 1-part wet (green or nitrogen containing ingredients) is **VERY IMPORTANT**.
4. Students should place one small piece of each item at the "Decay Buffet" into their bags. Have them cut up items, if necessary. **Stress that they not add any meat to their bags as potentially harmful bacteria could grow**.
5. One student can place the items in the bag and the other student can record the exact contents.
6. The recorder should also note his or her partner's predictions as to what will happen to each item over time. Will the item rot? Smell yucky? Remain the same?
7. **Optional:** You may want the students to switch roles and create a second compost bag with a list of contents and predictions.
8. Ask the students to add about 1/2 cup of soil to their bags and to lightly mist the contents with a plant mister. (Adding a teaspoon of water and mixing the contents will work the same way.)
9. Have the students blow into the bags (to inflate slightly) and carefully seal the bags.

Once the bags are sealed, leave them for 2-8 weeks. You may decide to keep the bags together, or place them in various locations with differing conditions. (If you let the students choose their compost bag's location, be sure to have everyone register their locations on a class master list or you may be unpleasantly surprised when a missing bag finally makes its presence known.)

10. Have students create compost bag journals. Ask them to observe their bags periodically and record what they see happening inside. Do they see fuzzy masses? **Remind students that they are not to open the bags until the designated date**.
11. On the designated date, have the students take their bags outside. Distribute plastic gloves to the students to wear while sorting through the contents of their bags with their partners. They may need magnifying glasses to "see" the original items. **Caution: students with known allergies to mold or fungus should not participate!**
12. Record any items still identifiable and in their present state. Provide misters or water bowls so items can be cleaned off for closer observation and identification.
13. Are any items missing? Check the list and note the items missing.
14. How did the results compare with the predictions?
15. Define and discuss the process of decomposition or decay.

You may want to ask your students some questions:

- What are some things you have thrown away over the past couple of days? What happens to these things? Do they disappear? Decompose? Remain in the same form forever?
- Will placing the bags in various conditions have an effect on what occurs in the bags?
- Can you think of any other types of compost containers that would get the decomposition job done?

"Bottle Biology" published by Kendall/Hunt Publishing, includes plans for making compost tumblers, the "Decomposition Column," out of 2-liter bottles. Pickling bottles "vats," making your own microscope, and other great science projects are included in this book. See the Resource section for ordering information.

Making compost can be very educational whether you are studying soils, plant growth, gardening, microbiology, or just trying to reduce waste.

Activity 2—Microbes in my food!

1. Arrange the students in to groups of two.
2. Provide each group with a grocery store advertisement and the "Microbe Grocery List."
3. Instruct them to find all the foods in the ad that have a relationship to microorganisms, and write down the sale price of each item. Remember foods like spaghetti sauce may contain mushrooms and foods containing dough have yeast.
4. Ask each group to share what the food products they found in their ad with the class. Did they miss any? Did other groups find the same products? Are they cheaper? Can these foods be spoiled by other microbes and make us sick?
5. Explain to students that virtually all foods can spoil or be contaminated. That is why you find food additives, or inhibitors, or preservatives in food, to keep them fresher or viable longer.
6. Read the labels of the food items listed in the materials list.

Ask the following questions:

- Can you identify an ingredient that might be a food additive or preservative? (Sometime sugar, salt, or vinegar is added to a product to inhibit the growth of microorganisms, a chemical preservative may be added to do the same thing but will little effect on the flavor of the food. For example, jelly is so sweet that few additives need to be added to preserve freshness, the sugar acts as a "natural" preservative, the same with pickles and vinegar.)
- Is the food preservative the same from item to item? (No because some food additives or inhibitors only work on certain microbes, see the Food Preservation Techniques Information page.)

Questions for Investigation or Assessment:

How does bacteria and mold decomposition help the soil environment? (Decomposition breaks down dead plants and animals making their nutrients available for plant growth. Microorganisms are great recyclers!)

Extensions, Adaptations, Integration
Activity 1a—Stomach Microorganisms
Why Can a Cow Eat Grass?

Cows are ruminants. Ruminants are herbivores that have a four compartment stomach. The first stomach compartment is called the rumen is the largest compartment and can hold over 50 gallons of food. Any foreign nonfood item (like nails, wire, etc.) then drop into the reticulum, the second compartment. Food passes through the third compartment called the omasum and the final digestion takes place in the abomasum. Cows and other ruminants can regurgitate their food (cud) and chew it again for further breakdown. This aids in digestion. Each stomach compartment contains billions of bacteria, anaerobic fungi, and protozoa that help to break down the proteins and carbohydrates. Without these microorganisms, ruminants would be unable to digest cellulose, the fiber that makes up the bulk of plant cell walls found in grass and hay.

The rumen is like a giant fermentation vat. Ruminants belch to expel the build up of carbon dioxide produced by the billions of microbes in their stomach.

What other animals are ruminants? (elephants, zebras, sheep, and other animals that eat forages such as grass and hay. Horses are not ruminants. They have a large cecum, "blind stomach," between the small and large intestine that helps them to digest the cellulose.)

Borrow the video "Why Can a Cow Eat Grass?" from Utah AITC (see resource section). The video is complete with an educators guide and microscopic views of the microorganisms in the stomach.

Activity 2a—Good, the Bad, and the Ugly

Ask students to make two lists—one, the good things about microorganism, second, the bad things about microorganism. Ask students to add to the list and make changes, as they continue to learn about microorganisms.

Additional Resources
Bottle Biology

Free loan from Utah Agriculture in the Classroom (www.agclassroom.org/ut) or order from Kendall Hunt Publishing (www.kendallhunt.com).

Materials adapted from materials provided by Utah State University Extension and Utah Agriculture in the Classroom, www.agclassroom.org/ut.

Name _____ Date _____ Class/Hour _____

Microbe Grocery List

Look through a grocery store advertisement and see how many foods you can find that contain microorganisms or were produced with the help of microorganisms. Be sure to make the connection between vinegar and salad dressing. Many salad dressings may also include a thickener from algae. Pizza has dough, so it has yeast, etc. Are there any foods on sale that without proper handling may make you sick?

Common Microbes found in foods
Bacteria: Cheddar cheese, Swiss cheese, feta, sour cream, buttermilk, yogurt, vinegar
Fungi: Blue Cheese, Mushrooms
Algae (Protista): Ice Cream, salad dressings
Yeast: Bread, and other dough products

Food Item	Microbe Responsible	Price	Microbe that may cause illness from improper handling

Food Preservation Techniques

Canning first destroys bacteria through heating and then the food is placed in a sterilized container and sealed.

Drying removes water from the food that's required by spoilage bacteria to grow and reproduce.

Freezing slows down the spoilage process by changing that some essential water into ice, a form that the bacteria cannot use.

Pasteurization destroys most of the existing spoilage organisms by heating the food to a high temperature for a short duration.

Pickling or fermentation (culturing) leaves the food with a higher level of acid, making it an inhospitable environment for spoilage bacteria.

Vacuum packaging uses a vacuum sealed, abrasion-resistant moisture-impermeable film that inhibits molds, yeasts, and bacterial growth on the surface of the things such as meat. Since there is no air in the package, vacuum-packaged meat will have a darker, purple color before being opened. Once the meat is exposed to oxygen, it will turn the familiar bright red color, because of the natural reactions within the package. Fresh vacuum-packaged meat will give off a slight odor upon opening. The smell will dissipate within a few minutes—this should not be confused with spoilage.

Smoking adds smoke-born chemicals to food that help destroy potential spoilage organisms.

Chemical additives are designed to destroy spoilage organisms or inhibit their growth. Sugar and salt are examples of additives that have been in use for centuries. Both of these work by drawing water out of the spoilage organisms, thus preventing their growth.

UHT - ultra-high temperature, higher than pasteurization, and pressure is applied resulting in a sterile product.

Irradiation - process like pasteurization that pasteurizes food by using energy, just like milk is pasteurized using heat. Irradiation DOES NOT make food radioactive. The food never touches a radioactive substance. Irradiation destroys insects, fungi, and bacteria. Fewer nutrients are lost during irradiation than in cooking and freezing. Food irradiation has been approved in 37 countries for more than 40 products. Astronauts have eaten irradiated foods for years.

Food additives - a food additive is any substance added to food. Sugar, salt, and corn syrup are the most commonly used food additives. Food additives keep foods fresh, slow microbial growth, give desired texture and appearance, and aid in processing and preparation.