Microorganisms

Name_____

Science Notes

Kingdoms

Animalia

Plantae

Fungi

Protista

Monera

Famous People

Louis Pasteur

Alexander Fleming

Anton Van Leeuwenhoek

Food Preservation Techniques

Uses for bacteria

Viruses

Terms

1. Algae
2. bacteria
3. culture
4. producer
5. decomposer
6. fungi
7. microoganism
8. organism
9. protozoan
10. single-celled

Properties and Classification of Microorganisms

Background

Just what are microorganisms? They are small living forms of life, which we cannot see with the naked eye. Bacteria, yeasts, and molds are three types of microorganisms. Some people often confuse, and almost always misunderstand, their functions, but they are just as real and alive as you are. They eat and grow. They reproduce and die.

Have you ever wondered just how small microorganisms really are? Molds can be seen with only slight magnification and use of an ordinary magnifying glass. Yeasts must be viewed through a microscope that magnifies several hundred times. Bacteria can best be seen when studied with a more powerful microscope that enlarges 1,000 times.

Bacteria, yeasts, and molds can be found everywhere. Scientists have gathered them from clouds above mountain tops and in the deepest parts of the ocean. They are present on animals, people, and even in the air we breathe.

Microorganisms have a direct impact on our daily lives. Some are helpful. They aid our bodily processes by helping break down complex foods into simpler substances. Some, called germs, are harmful to us by the role they play in causing diseases.

The Universal Cell

All living organisms, large and small, have one thing in common; the cell. This is a tiny living factory capable of converting simple food substances into energy and new cell material and of reproducing itself.

Large organisms, including people, are composed of billions of cells with many different roles. They make up your body's parts from your brain to your big toe. Microorganisms, on the other hand, are made up of a very few or even a single cell capable of carrying on all of life's processes. So a basic understanding of cell structure and function is essential to understanding the actions of bacteria, yeasts and molds.

Microorganisms in the Macrocosm

The "Kingdoms" of Microorganisms

Characteristics of the organism that classifies its kingdom: cell type, body form, cell wall composition, mode of nutrition, nervous system, and locomotion.

Monera: bacteria, most do not photosynthesize (parasitic) except for the blue-green bacteria.

Protista: protozoa, some are motile and feed upon bacteria and other organic matter. Algae are part of this kingdom. Algae photosynthesizes and live in water.

Fungi: molds, yeasts, mushrooms, rusts, and smuts. Parasites or decomposers. Fungi contain no chlorophyll and cannot synthesize food. Instead they secrete enzymes that digest food material outside the organisms.

Plantae: non-microscopic

Animalia: non-microscopic

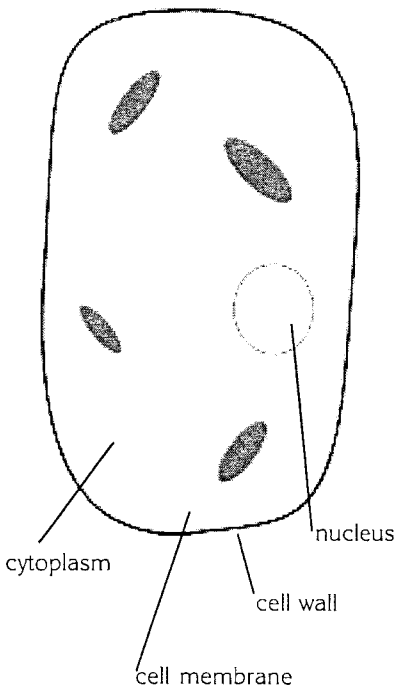
Characteristics of the Five Kingdoms

Characteristic	Kingdom				
	monera	protista	fungi	plantae	animalia
cell type	prokaryotic (cells lacking distinct membrane-bound nuclei)	eukaryotic (cells containing membrane-bound nuclei)	eukaryotic (cells containing membrane-bound nuclei)	eukaryotic (cells containing membrane-bound nuclei)	eukaryotic (thick cell wall
body form	most unicellular; some colonial	most unicellular; some simple multicellular	most multicellular	multicellular	multicellular; organs, and organ systems
cell wall composition	polysaccharides and amino acids	present in some composition varies	usually chitin	cellulose	no cell wall
mode of nutrition	photosynthesis, chemosynthesis absorption	photosynthesis, ingestion, or absorption	absorption	photosynthesis	ingestion
nervous system	absent	absent	absent	absent	present
locomotion	present in some	present in some	absent	absent	present

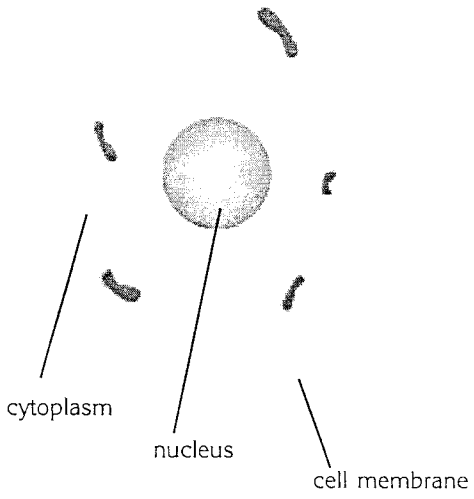
Since the cell is the basic unit of all living things, you might think it is a simple structure. Nothing could be further from the truth. The cell is complex in its makeup and its function. Many scientists have spent their lives studying it. The main parts of the cell are the nucleus, cytoplasm, and the cell wall. *(There are other organelles found in the cell. For an interesting look at all the cell parts visit these web sites http://www.brigadoon.com/~schaffer/biology/, http://www.clarityconnect.com/webpages/cramer/pictureit/cells.htm, http://www.purchon.co.uk/science/cells.html, http://personal.tmlp.com/Jimr57/index.htm, http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookCELL2.html#Table of Contents, http://manateemiddle.org/manateemiddle/newpage211.htm, http://www.channelone.com/fasttrack/science/biology/cells.html, http://www.nyu.edu/education/mindsinmotion/individual/bg243/, or http://ampere.scale.uiuc.edu/~m-lexa/scripts/cell.cgi)*

The nucleus is the control center. It directs cell division or the formation of new cells. The cytoplasm contains the parts which convert food material into energy and new cell material. The cell wall or membrane holds everything together and controls the passage of material into and out of the cell. Looking at onionskin cells and cheek cells under a microscope will help students to see cell parts. (Procedures for making these cell slides are found in teh Utah 6th Grade Elementary Science Teacher Resource Book).

Plant Cell



Animal Cell



Cell Walls

The cells of most microorganisms and all plants are enclosed by a rigid ***cell wall,*** which lies just outside the cell membrane. The cell wall gives the cell its shape and provides protection for the cell. In plants, this wall is composed largely of *cellulose*. The cell wall has many small openings that allow materials to pass to and from the cell membrane. Thin strands of cytoplasm sometimes extend through the walls of neighboring cells, which allow materials to pass directly from one cell to another. Animal cells do not have cell walls, just a cell membrane.

Cell Membrane

The **cell membrane,** or *plasma membrane,* separates the cell from its surrounding environment. The membrane controls the movement of materials into and out of the cell, which makes it possible for the cell contents to be chemically different from the environment. The membrane keeps the internal conditions of the cell constant.

Cell Nucleus

The cell **nucleus** (plural, nuclei), is a round, membrane-bound structure that serves as the control center or brain of the cell. If it is removed, the cell dies. It is the largest organelle (a cell structure in the cytoplasm that has a specific function).

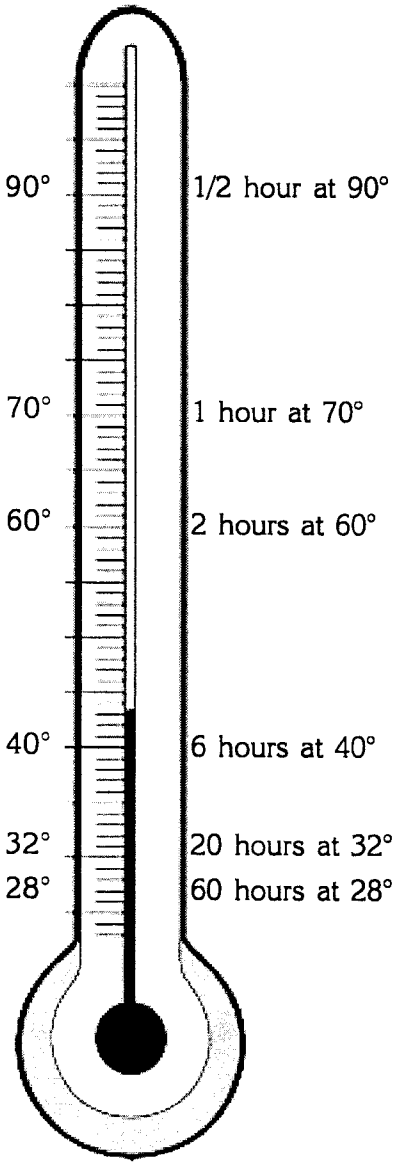
Cytoplasm

The watery material in the cell between the cell membrane and the nucleus is the cytoplasm. Many of the substances involved in cell metabolism (chemical reactions for life, including growth) are dissolved in the cytoplasm. The cytoplasm also contains a variety of organelles that have specific functions in cell metabolism.

Monera

Bacteria (monera) make up the largest group of microorganisms. People often think of them only as germs and the harm they do. Actually, only a small number of bacteria types are *pathogenic* (disease causing). Most are harmless, and many are helpful. There are thousands of different kinds of bacteria. Some differ only slightly, and it takes a highly trained person to identify them. There are also groups that differ greatly in growth habits and appearance and are quite easily identified. But regardless of minor differences, most bacteria can be classified according to five basic cell shapes.

In addition to their different shapes, their cell arrangement varies. For example, some cocci are always



grouped in pairs *(diplococci).* Others are arranged in chains *(streptococci).* Still others are bunched *(staphylococcl). Diplococci* are the kind which cause pneumonia. *Streptococci* are often associated with "strep throat." *Staphylococci* are familiar to many because of their role in "staph infections" and some types of food poisoning.

Bacteria also vary somewhat is size, but average about 1/25,000 inch. In other words, 25,000 bacteria laid side by side would occupy only one inch of space. One cubic inch is big enough to hold *nine trillion* average size bacteria—about 3,000 bacteria for every person on earth. Bacteria multiply by binary fission or cell division. Bacteria double every 1/2 hour at 90° F, 1 hour at 70° F, 2 hours at 60° F, 6 hours at 40° F, 20 hours at 32° F, 60 hours at 28° F.

Microorganisms, including bacteria, can also be grouped according to their requirement for oxygen. Some grow only in the presence of oxygen *(aerobes).* Others grow only in the absence of oxygen *(anaerobes).* Some are able to grow with or without oxygen *(facultative anaerobes).*

Bacteria and other microorganisms need food in order to grow and multiply. They vary in their food needs, but nearly everything we consider as food can also be used as food by some types of bacteria. To be used by bacteria, a food substance must pass into the cell where it can be processed into energy and new cell material. Because most foods are too complex to move into a bacterial cell, they must be broken down into simpler substances. *Enzymes* do this by increasing the rate of biochemical reactions. Produced within the bacterial cell, enzymes move through the cell wall to break down the food on the outside into a form bacteria can use.

Factors that Affect Bacterial Growth

Moisture
Oxygen
pH
Temperature
Presence of inhibitors

Bacteria Thought Questions

1. What are six things bacteria need to survive?
   food, water, proper temperature, proper acid (pH), no inhibitors present, host

2. Why is it important for yogurt and cheese to set at a certain temperature?
   to allow good bacteria to grow

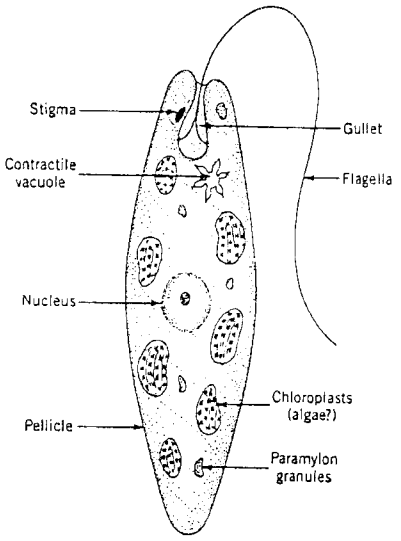
3. What does "active cultures" mean on a yogurt container?
   "active cultures" mean that the bacteria is alive and will grow if placed in the right environment

4. Why do we keep fresh food in the refrigerator or freezer?
   slow bacterial growth

5. What might happen if the milk were too hot when you put in the bacteria (yogurt culture)?
   die

6. What if the milk were too cold?
   the bacteria wouldn't multiply and the milk would not get thick (convert from lactose, milk sugar to lactic acid)

7. Why does yogurt keep better than fresh milk?
   good bacteria turn the milk sugar to lactic acid, the acid environment prevents the growth of harmful bacteria



Protists

Scientists estimate that the protists first evolved about 3 billion years after the monerans (bacteria) were established. Since most protists require oxygen, it is thought that the earliest protists could not have evolved until the "blue-green" bacteria had been producing oxygen for billions of years.

The kingdom Protista contains many species and a greater variety of organisms. Although most protists are unicellular, some are multicellular organisms and may be quite large. Some protists are heterotrophic (get their food from their environment) others are autotrophic and make their own food. Protists may live

on land or in water. Because they are so diverse, the members of the kingdom Protista are difficult to classify. They are divided into three main groups: the animal-like, plant-like, and fungus-like protists.

Animal-like Protists

The animal-like protists are single-celled or colonial organisms called ***protozoa***. They live in fresh and salt water, in the soil, and in the bodies of other organisms. All protozoa are heterotrophic. Some absorb nutrients through their cell membranes, whereas others engulf larger particles of food. Most protozoa are motile.

Amebas are unicellular organisms that continually change shape and engulf food particles. Amebas reproduce asexually by binary fission (cell division). They are commonly found in freshwater ponds, lakes, and streams.

Another group of the animal-like protista is called zooflagellates. *Trypanosoma gambiense* is the protista responsible for African sleeping sickness in humans. These microorganisms are spread by the tsetse fly.

Plasmodium is a protozoa that is parasitic and causes malaria. The spores from this parasite invade the red blood cells of the human host, multiply there, then break out and invade new cells. The destruction of the red blood cells releases toxic cell wastes into the bloodstream. These waste products cause fever, chills, and other symptoms of malaria. Malaria is a serious, sometimes fatal, disease. Although it can be treated with drugs, one method of prevention is to eliminate the *Anopheles* mosquito. In spite of the widespread use of pesticides in many countries, millions of people are still infected with malaria, especially in tropical areas.

Plant-like Protists

The plant-like protists, commonly called algae, resemble plants because they are all photosynthetic. Like the protozoa, algae are very diverse. Some are tiny, single-celled organisms with flagella. Others are large, multicellular organisms like seaweed. Like plants,

algae have chloroplasts, which contain the photosynthetic pigment chlorophyll.

Another group in this category is called the *euglenoids*. These single-celled protists have both plant-like and animal-like characteristics. Like plants, they contain chloroplasts and photosynthetic pigment. However, they do not have cell walls. Like some of the protozoa, euglenoids move by means of flagella. One typical euglenoid is *euglena,* an organism common in pond water.

The euglena is a single-celled organism having two flagella. The cell has a large, central nucleus and numerous chloroplasts, which contain chlorophyll. Chlorophyll gives euglenas their grass-green color. Euglenas are primarily photosynthetic. However, in the absence of light, they live as heterotrophs, absorbing dissolved nutrients from the environment.

Fungi

Yeast

Yeasts are small, single-cell organisms. They are members of the family *fungi* (singular, fungus), that also include mushrooms. Fungi differ from other plants in that they have no chlorophyll. Thus they have been useful to man for centuries in the production of certain foods and beverages. They are responsible for the rising of bread dough and the fermentation of wine, whiskey, brandy and beer. They also play the initial role in the production of vinegar. Most yeasts can live only on sugars and starches. From these they produce carbon dioxide gas and alcohol. Yeasts reproduce by a method called *budding.* A small knob or bud forms on the parent cell, grows and finally separates to become a new yeast cell. Although this is the most common method of reproduction, yeasts also multiply by the formation of spores.

Some yeasts are *psychrophilic* and so they can grow at relatively low temperatures. In fact, the fermentation of wines and beer is often carried out at temperatures

near 40° F. Because some kinds are psychrophiles, they can create a spoilage problem in meat coolers and other refrigerated storage areas.

Because they can grow under conditions of high salt or sugar content, they can cause the spoilage of certain foods in which bacteria would not grow. Examples are honey, jellies, maple syrup and sweetened condensed milk. Foods produced by the bacterial fermentation process, such as pickles and sauerkraut, can also be spoiled by yeasts which interfere with the normal fermentative process. Certain yeasts are pathogenic. However, yeast infections are much less common than are bacterial infections.

Molds

Molds are probably the best known of the microorganisms. They are widely distributed in nature and grow under a variety of conditions in which air and moisture are present. They are also plants and a part of the fungi family. 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.

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 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. Molds can also cause problems in foods. Certain kinds 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.

Club Fungi: Mushrooms, Rusts and Smuts

Mushrooms, toadstools, bracket fungi, shelf fungi, puffballs and other various parasites such as rust and smuts are club fungi. Club fungi reproduce by spores. The mushroom is the fruiting body. The "roots" which are really the mycelium grow in very fertile soil or other plant and/or animal organic matter. The mycelium may live for years, slowly growing underground. Only when the conditions are favorable do mushrooms (the fruiting body) grow up above the surface. The spores are formed in the gills located within the "cap." Under close examination the spores are produced in an area of the gills that are shaped like "clubs."

Rusts are club fungi that produce rust-colored spores during one phase of their life cycle. Rusts are parasites on wheat, barley, oats, and other crops. Each year they cause millions of dollars of damage to crops. Smuts are similar to rusts. Their name refers to the black dusty-looking mass of spores they form within the tissues of the host plant. Smuts attack corn, wheat, oats, barley, and rye.

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.

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.

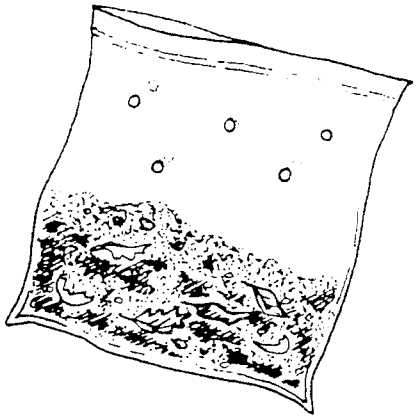
Molds appear flat, fuzzy, and shapeless. They are actually multicellular. Mold cells form a "fruiting body." The fruiting body produces the spores, which detach and are carried by air currents and deposited to start new mold colonies whenever conditions are favorable. Mold spores are quite abundant in 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!"

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.

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