

MICROORGANISMS

CHAPTER 5

WHAT ARE THE CHARACTERISTICS OF MICROORGANISMS?

Standard 5, Objective 1

Grade 6

Text structure: Description (Information)

All **microorganisms**—living things too small for the human eye to see—are **organisms**—living things. **Microorganisms** may be unicellular or **single-celled**—any living thing that has only one cell. Some microorganisms are multicellular, having more than one cell. Microorganisms require food, air, water, ways to dispose of waste and an environment in which they can live. Some microorganisms are **producers**—living things that make their own food from simple substances usually using sunlight, as plants do. Some microorganisms eat other **organisms** to get their food. Most microorganisms do not cause disease and many are helpful. There are many different kinds of microorganisms. Scientists observe and classify microorganisms just as they do plants and animals. These classifications are determined by the microorganism’s shape, structure, how they get food, where they live and how they move. The microorganisms you will study in this unit include bacteria, fungi, and protists.

BACTERIA



Can you guess which organisms are pictured here?

Are they fat green worms on a red leaf? Here's a clue: There are more organisms like these than any other on Earth. Here's another clue: Each organism consists of a single cell without a nucleus.

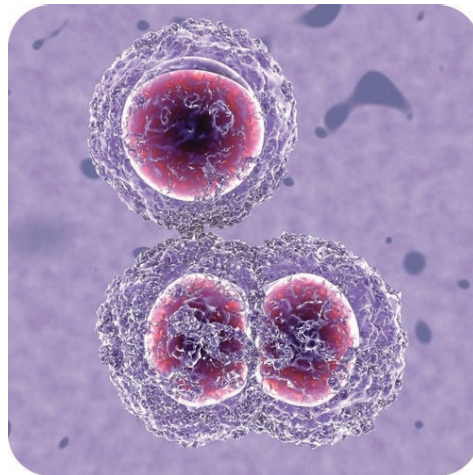
The organisms are bacteria—the smallest and simplest type of living thing, single-celled, and having no nucleus—called *Salmonella*. If the word *Salmonella* rings a bell, that's probably because *Salmonella* causes human diseases such as food poisoning. Many other types of bacteria also cause human diseases. But not all bacteria are harmful to people. In fact, we could not survive without many of the trillions of bacteria that live in or on the human body.

Bacteria are the most diverse and abundant group of organisms on Earth. They live in almost all environments. They are found in the ocean, the soil, and the intestines of animals. They are even found in rocks deep below Earth's surface. Any surface that has not been sterilized is likely to be covered with bacteria. The total number of bacteria in the world is amazing. It's estimated to be 5×10^{30} , or five million trillion trillion! You have more bacteria in and on your body than you have body cells!

Thousands of species of bacteria have been discovered, and many more are thought to exist. The known species can be classified on the basis of various traits.

Where do you find lots of bacteria?

Are bacteria living things? Bacteria are individual living cells. Bacteria cells are similar to your cells in many ways; yet, they also have distinct differences. Bacteria have many unique adaptations allowing them to live in many different environments. Bacteria have a wide range of metabolism, and this determines where they live. They live in a particular habitat because they are able to “obtain energy” from whatever is around them. Bacteria can live and grow in practically any environment. It is this ability that has made bacteria the most numerous species on the planet.



How do bacteria reproduce?

Bacteria grow to a fixed size and then reproduce through binary fission. Binary fission is a type of asexual reproduction. It occurs when a parent cell splits into two identical daughter cells. This can result in very rapid population growth. For example, under ideal conditions, bacterial populations can double every 20 minutes. Such rapid population growth is an adaptation to an unstable environment.

FUNGI

What exactly is a fungus?

Ever notice blue-green mold growing on a loaf of bread? Do you like your pizza with mushrooms? Has a physician ever prescribed an antibiotic for you? If so, then you have encountered **fungi**—a group of organisms that absorbs its nutrients from its surroundings. **Fungi** are organisms that belong to the Kingdom Fungi. They're not animals or plants, so they cannot photosynthesize or eat, they absorb!

Most fungi are multicellular, but some exist as single cells. They are much more than mushrooms.

Yeasts, molds, and mushrooms are all different kinds of fungi. There may be as many as 1.5 million species of fungi. You can easily see bread mold and mushrooms without a microscope, but most fungi you cannot see. Fungi are either too small to be seen without a microscope, or they live where you cannot see them easily—deep in the soil, under decaying logs, or inside plants or animals. Some fungi even live in, or on top of, other fungi.

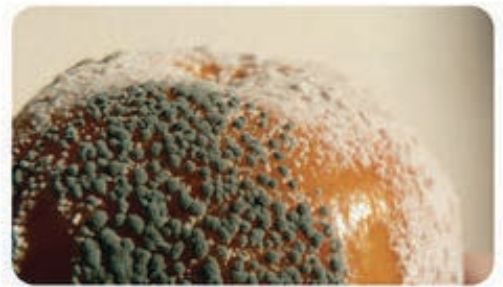




Mushrooms



Yeast



Mold

[Several examples of fungi are pictured here.](#)

Molds growing on foods are some of the most common fungi in our everyday lives. These organisms may seem useless, gross, and costly. But fungi play very important roles in almost every ecosystem on Earth.



The mold growing on this bread is a common fungus.

Our environment needs fungi. Fungi help decompose matter to release nutrients and make nutritious food for other organisms. Fungi are all around us and are useful in many ways.

Habitats of Fungi

Fungi are found all around the world, and grow in a wide range of habitats, including deserts. Most grow in land environments, but several species live only in aquatic habitats. Most fungi live in soil or dead matter and in symbiotic relationships with plants, animals, or other fungi. Fungi, along with bacteria that are found in soil, are the primary decomposers of organic matter on earth. The decomposition of dead organisms returns nutrient to the soil, and the environment.



Bracket fungus

What does this fungus have in common with mold?

This colorful bracket fungus doesn't look much like mold. But they have a lot in common. They both break down organic matter to obtain nutrients. They both reproduce by spores. They are both **eukaryotic**—cells that contain a nucleus and other cell parts—, but they are not plants, and they are definitely not animals. They are both fungi.



These many different kinds of organisms demonstrate the huge diversity within the Kingdom Fungi.

Fungi are Good Consumers

The main difference between plants and fungi is how they obtain energy. Plants are **autotrophs**—organisms that make food for themselves and other organisms usually through photosynthesis—or producers. Fungi are **heterotrophs**—organisms that obtain their "food" from outside of themselves—or consumers. In other words, they must consume their food like animals do. But they don't really eat, they absorb their nutrients.

Fungi can grow fast because they are such good eaters. Fungi have lots of surface area, and this large surface area "eats" or absorbs. Surface area is how much exposed area an organism has, compared to their overall volume. Most of a mushroom's surface area is actually underground. If you see a mushroom in your yard, that is just a small part of a larger fungus growing underground.

These are the steps involved in fungi "eating":

- Fungi squirt special enzymes into their environment.
- The enzymes help digest large organic molecules, similar to cutting up your food before you eat.
- Cells of the fungi then absorb the broken-down nutrients.

So what do fungi consume?




Fungi consume just about anything. This includes things from dead plants to rotting fruit. Shown here are fungi sprouting from dead material in the woods. Fungi perform an essential role in the decomposition of organic matter and have fundamental roles in recycling nutrients back into the environment.

Fungi obtain nutrients in three different ways:

- They decompose dead organic matter.
- They feed on living hosts.
- They live mutualistically, in a mutually beneficial relationship, with other organisms.





Type of Fungi	Examples
Molds Common Types of Fungi	 Penicillium
Mushrooms	 Morels, Shitake, Cremini, Oyster
Single-celled yeasts	 baker's yeast

PROTIST KINGDOM

Animal? Bacteria? Plant? Fungi?

Protists are none of the above! These organisms may be **single-celled** like bacteria, and they may look like a fungus. They also may hunt for food like an animal or photosynthesize like a plant. And, yet, they do not fit into any of these groups. These organisms are **protists**— a large and diverse group of **eukaryotic** organisms.

Kingdom Protista

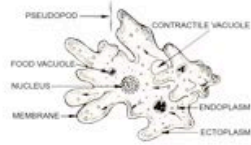


Protists are a group of all the eukaryotes that are not fungi, animals, or plants. As a result, it is a very diverse group of organisms. The eukaryotes that make up this kingdom, Kingdom Protista, do not have much in common except that they don't fit the classifications of other kingdoms. They are relatively simple and the rule breakers in the other kingdoms of life. Protists can look very different from each other. Some are tiny and unicellular, like an amoeba, and some are large and multicellular, like seaweed. However, multicellular protists are structurally simple compared to plants.

Protist Habitats

Most protists are aquatic organisms. They need a moist environment to survive. They are found mainly in damp soil, marshes, puddles, lakes, and the ocean. Some protists are free-living organisms. Others are involved in symbiotic relationships. They live in or on other organisms, including humans.

The Movement of Protists

Most protists have the ability to move. Protists have three types of appendages for movement. They may have **flagella**, **cilia**, or **pseudopods**. There may be one or more **flagella**—whip-like structures used to propel an organism through water. **Cilia**—small, hair-like structures used to move—are similar to **flagella**, except they are shorter and there are more of them. They may completely cover the surface of the protist cell. **Pseudopods**—temporary, foot-like extensions of the cytoplasm—are also used to help an organism move.

Type of Protozoa	How It Moves	Example (Genus)
Amoeboid	pseudopods	<p><i>Amoeba</i></p> 
Ciliate	cilia	<p><i>Paramecium</i></p> 
Flagellate	flagella	<p><i>Giardia</i></p> 

Animal-like Protists

Protozoa—animal-like protists—are single-celled eukaryotes that share some traits with animals. Like animals, they can move, and they are **heterotrophs**—consumers. That means they eat things outside of themselves instead of producing their own food.

Different Kinds of Animal-like Protists

There are many different types of animal-like protists. They are different because they move in different ways.

- **Pseudopods**, which are like temporary feet. The cell surface extends out to form feet-like structures that propel the cell forward.
- **Ciliate** are thin, very small tail-like projections that extend outward from the cell body. Cilia beat back and forth, moving the protist along. *Paramecium* has cilia that propel it.
- Flagellates have long flagella, or tails. Flagella rotate in a propeller-like fashion, pushing the protist through its environment

Plant-like Protists

Plant-like protists are known as algae. They are a large and diverse group. Like plants, plant-like protists are autotrophs or producers. This means that they produce their own food. They perform photosynthesis to produce sugar by using carbon dioxide and water, and the energy from sunlight, just like plants. Unlike plants, however, plant-like protists do not have true stems, roots, or leaves.

Most plant-like protists live in oceans, ponds, or lakes. Protists can be unicellular (single-celled) or multicellular (many-celled). Seaweed and kelp are examples of multicellular, plant-like protists. Kelp can be as large as trees and form a "forest" in the ocean.

Plant-like protists are essential to the ecosystem. They are the base of the marine food chain, and they produce oxygen through photosynthesis for animals to breathe. They are classified into a number of basic groups.



Diatoms



Seaweed

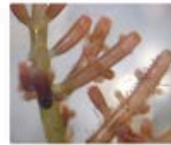
Diatoms are single-celled algae. Other forms of algae are multicellular.

ALGAE

Why is algae considered plant-like? The main reason includes the presence of chloroplasts and production of food through photosynthesis. However, they lack many other structures of true plants. For example, algae do not have roots, stems, or leaves. Some algae also differ from plants in being able to move. They may move with pseudopods or flagella. Although not plants themselves, algae were probably the ancestors of plants. Types of algae include red and green algae, euglenids, and dinoflagellates.

Type of Algae

Red algae



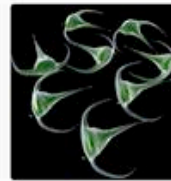
Green algae



Euglenids



Dinoflagellates



FUNGUS-LIKE PROTISTS

What's shrouding this dead insect? The thin filaments growing out of this dead insect look a little like a fungus. Also this mystery organism, like a fungus, is feeding on decaying matter. However, this is not a fungus. This organism is a type of fungus-like protist, known as water mold.

Fungus-like Protists

Fungus-like protists share many features with fungi. Like fungi, they are heterotrophs or consumers, meaning they must obtain food outside themselves. They also have cell walls and reproduce by forming spores, just like fungi. Fungus-like protists usually do not move, but a few develop movement at some point in their lives. Two major types of fungus-like protists are slime molds and water molds.



This slime mold, shown growing on dead wood, is a fungus-like protist. Though this mold does not have a mouth, essentially it is still "eating" this decaying material.



Fungus-like protists are absorptive feeders on decaying organic matter. They resemble fungi, and they reproduce with spores as fungi do. However, in other ways, they are quite different from fungi and more like other protists.

VIRUSES

Many people may assume that a virus is a microorganism, but they are not. A virus is essentially genetic material surrounded by protein. That's it. Viruses are tiny particles that may cause disease. Human diseases caused by viruses include the common cold and flu. Viruses are not cells at all. Viruses contain DNA but not much else. They lack the other parts shared by all cells, including a plasma membrane, cytoplasm, and ribosomes. Therefore, viruses are not cells, but are they alive? All living things not only have cells; they are also capable of reproduction. Viruses cannot reproduce by themselves. Instead, they infect living hosts, and use the hosts' cells to make copies of their own DNA. For these reasons, most scientists do not consider viruses to be living things.

SCIENCE LANGUAGE STUDENTS NEED TO KNOW AND USE

- **algae:** a plant-like protest without roots, stems, or leaves
- **autotrophs:** organisms that make food for themselves through photosynthesis, also known as producers
- **bacteria:** the smallest and simplest type of living thing, single-celled, and having no nucleus
- **cilia:** small, hair-like structures used to move
- **eukaryotic:** cells that contain a nucleus and other cell parts
- **flagella:** whip-like structures used to propel an organism through water
- **fungi:** a group of organisms that absorbs its nutrients from its surroundings
- **heterotrophs:** organisms that obtain their "food" from outside of themselves, also known as consumers
- **microorganisms:** a living thing too small for the human eye to see
- **organism:** a living thing
- **producers:** living things that make their own food from simple substances usually using sunlight, as plants do
- **protists:** a large and various group of eukaryotic organisms
- **protozoa:** animal-like protists
- **pseudopod:** temporary, foot-like extensions of the cytoplasm
- **single-celled:** any living thing that has only one cell

ADDITIONAL LANGUAGE FOR ELL

1. **decompose:** to break things down into simpler materials
2. **mutualistically:** a relationship in which two different species both benefit

THINK LIKE A SCIENTIST

3. Compare and contrast the characteristics of bacteria, fungi, and protists.
4. What is the difference between an autotroph (producer) and a heterotroph (consumer)?
5. What are the three main types of protists?
6. Why are viruses not considered to be a living thing?

ADDITIONAL RECOMMENDED RESOURCES

- HippoCampus.org, <http://www.hippocampus.org/Biology> Biology for AP*
Search: Characteristics of Fungi
- For a discussion of exponential growth and bacteria see <http://goo.gl/8EvBiU>

ARE MICROORGANISMS GOOD OR BAD FOR US?

Standard 5, Objective 2

Grade 6

Text structure: Description (Information)

Bacteria and humans have many important relationships. Bacteria make our lives easier in a number of ways. In fact, we could not survive without them. On the other hand, bacteria can also make us sick.

Can we survive without bacteria? Could bacteria survive without us? No and yes. No, we could not survive without bacteria. And yes, bacteria could survive without us.

Foods

Bacteria can be used to make cheese from milk. The bacteria turn the milk sugars into lactic acid. The acid is what causes the milk to curdle to form cheese. Bacteria are also involved in producing other foods. Yogurt is made by using bacteria to ferment milk. Fermenting cabbage with bacteria produces sauerkraut.

Medicines

In the laboratory, bacteria can be changed to provide us with a variety of useful materials such as a medicine to treat diabetes, antibiotics, and vaccines.

Digestion

There are billions of bacteria inside the human intestines. They help digest food, make vitamins, and play other important roles. Several species of bacteria, such as *E. coli*, are found in your digestive tract. In fact, in your gut, bacteria cells outnumber your own cells!

Decomposers

Bacteria are important because many bacteria are **decomposers**—organisms that break down dead or decaying things into simpler substances. They break down dead materials and waste products and recycle nutrients back into the environment. This recycling of nutrients, such as nitrogen, is essential for living organisms. Organisms cannot produce nutrients, so they must come from other sources.

We get nutrients from the food we eat; plants get them from the soil. How do these nutrients get into the soil? One way is from the actions of **decomposers**. Without

decomposers, we would eventually run out of the materials we need to survive. We also depend on bacteria to decompose our wastes in sewage treatment plants.

Other Benefits of Bacteria

Humans also use bacteria in many other ways, including:

- Creating products, such as ethanol and enzymes.
- Making biogas, such as methane.
- Cleaning up oil spills and toxic wastes.
- Killing plant pests.
- Transferring normal genes to human cells in gene therapy.

Fermented Foods



Pickled Vegetables



Sauerkraut



Cheese



Yogurt

Fermentation is a type of respiration that doesn't use oxygen. Fermentation by bacteria is used in brewing and baking. It is also used to make the foods pictured here.

Harmful Bacteria

With so many species of bacteria, some are bound to be harmful. Harmful bacteria can make you sick. They can also spoil food and be used to hurt people.

Diseases

You have ten times as many bacteria as human cells in your body. Most of these bacteria are harmless. However, bacteria can also cause disease. Bacteria are responsible for many types of human illness, including:

- Strep throat
- Tuberculosis
- Pneumonia
- Leprosy

Lyme disease

Luckily most of these can be treated with antibiotics.

Bacteria may spread directly from one person to another. For example, they can spread through touching, coughing, or sneezing. They may also spread via food, water, or objects.

Food Contamination

Bacterial contamination of foods can lead to digestive problems, an illness known as food poisoning. Raw eggs and undercooked meats commonly carry the bacteria that can cause food poisoning. Food poisoning can be prevented by cooking meat thoroughly and washing surfaces that have been in contact with raw meat. Washing your hands before and after handling food also helps prevent contamination.

Weapons

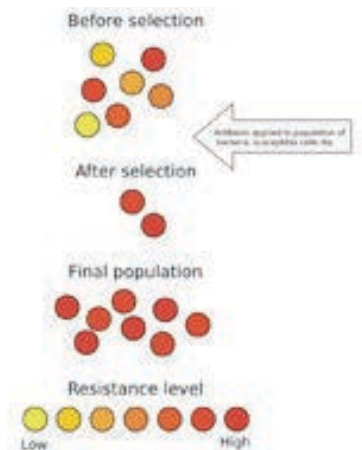
Some bacteria also have the potential to be used as biological weapons. An example is anthrax, a disease caused by the bacterium *Bacillus anthracis*. Inhaling the spores of this bacterium can lead to a deadly infection, and, therefore, it is a dangerous weapon. In 2001, an act of terrorism in the United States involved *B. anthracis* spores sent in letters through the mail.

Controlling Bacteria

Bacteria in food or water usually can be killed by heating it to a high temperature (generally, at least 71°C, or 160°F). Bacteria on many surfaces can be killed with chlorine bleach or other disinfectants. Bacterial infections in people can be treated with antibiotic drugs. For example, if you have ever had “strep” throat, you were probably treated with an antibiotic.

Antibiotics have saved many lives. However, misuse and over-use of these medicines have led to antibiotic resistance in bacteria. Some strains of bacteria are now resistant to most common antibiotics. These infections are very difficult to treat once the bacteria becomes resistant to an antibiotic.

Evolution of Antibiotic Resistance in Bacteria. This diagram shows how antibiotic resistance evolves by natural selection.



HELPFUL FUNGI



What's growing on this lemon?

Would you believe penicillin? Penicillin is a mold, which of course is a fungus, one that has helped millions, if not billions, of people.

Fungi for Food

Humans have collected and grown mushrooms for food for thousands of years.

Whenever you eat pizza, you eat fungi, even if you don't like your pizza with mushrooms. That's because pizza dough contains yeast. Yeasts are used in bread baking and brewing alcoholic beverages. Other fungi are used in fermenting a wide variety of foods, including soy sauce and cheeses. Blue cheese has its distinctive appearance and flavor because of the fungus growing through it.



These are just a few of the many species of edible mushrooms consumed by humans.



Blue Cheese. The dark blue strands running through this cheese are a fungus. In fact, this cheese is moldy! The fungus is *Penicillium Roqueforti*, a type of mold.

Fungi for Pest Control

Harmless fungi can be used to control pathogenic bacteria and insect pests on crops. Fungi compete with bacteria for nutrients and space, and they parasitize insects that eat plants. Fungi reduce the need for pesticides and other toxic chemicals.

Other Uses of Fungi

Fungi are useful for many other reasons.

- They are a major source of citric acid (vitamin C).
- They produce antibiotics such as penicillin, which has saved countless lives.
- They can be genetically engineered to produce insulin and other human hormones.
- They are model research organisms. To see how one lab is using yeast in cancer research, watch the video at this link: <http://goo.gl/4cLwgb>

HARMFUL FUNGI



Would you eat these mushrooms?

I would not recommend it. But certain red mushrooms, *Ganoderma Lucidum*, have been found to be good for you. Red Mushrooms comprise a family of more than 200 mushroom species, which are good for our health. Of these, 6 species have a particularly high therapeutic effect.

Fungi and Human Disease

Fungi cause human illness in three different ways: poisonings, parasitic infections, and allergic reactions.

Fungal Poisoning

Many fungi protect themselves from parasites and predators by producing toxic chemicals. If people eat toxic fungi, they may experience digestive problems, hallucinations, organ failure, and even death. Most cases of mushroom poisoning are due to mistaken identity. That's because many toxic mushrooms look very similar to safe, edible mushrooms.

Poisonous or Edible?



“Destroying Angel”
Mushrooms



Edible Puffball
Mushrooms

Poisonous or Edible? The destroying angel mushroom on the left causes liver and kidney failure. The puffball mushroom on the right is tasty and harmless. Do you think you could tell these two species of mushrooms apart?

Fungal Parasites

Some fungi cause disease when they become human parasites. Two examples are fungi in the genera *Candida* and *Trichophyton*.

- *Candida* are yeast that cause candidiasis, commonly called a “yeast infection.” The yeast can infect the mouth or the vagina. If yeast enter the blood, they cause a potentially life threatening illness. However, this is rare, except in people with a depressed immune system.
- *Trichophyton* are fungi that cause ringworm. This is a skin infection characterized by a ring-shaped rash. The rash may occur on the arms, legs, head, neck, or trunk. The same fungi cause athlete’s foot when they infect the skin between the toes. Athlete’s foot is the second most common skin disease in the U.S.



Ringworm



Athlete’s Foot

Ringworm produces a ring-shaped rash, but it isn’t caused by a worm. It’s caused by the same fungus that causes athlete’s foot.

Fungal Allergies

Mold allergies are very common. They are caused by airborne mold spores. When the spores enter the respiratory tract, the immune system responds to them as though they were harmful microbes. Symptoms may include sneezing, coughing, and difficulty breathing. The symptoms are likely to be more severe in people with asthma or other

respiratory diseases. Long-term exposure to mold spores may also weaken the immune system.

Molds grow indoors as well as out. Indoors, they grow in showers, basements, and other damp places. Homes damaged in floods and hurricanes may have mold growing just about everywhere. Indoor mold may cause more health problems than outdoor mold because of the closed, confined space. Most people also spend more time indoors than out.



The mold growing on the walls and ceiling of this storm-damaged home may be harmful to human health.

PROTISTS AND HUMAN DISEASE

Can such little creatures make you sick?

They sure can. Not all of them, but some of them. And without proper medical treatment, the person may never recover. Most protist diseases in humans are caused by animal-like protists, or protozoa. Protozoa make us sick when they become human parasites. Several diseases caused by Protists include *Giardia*, African Sleeping Sickness, and Malaria.

SCIENCE LANGUAGE STUDENTS NEED TO KNOW AND USE

- **Decomposers:** organisms that break down dead or decaying things into simpler substances.

THINK LIKE A SCIENTIST

1. What are some positive and negative effects of microorganisms?
2. Explain why you should never eat mushrooms you find in the woods unless you know for certain which type of mushrooms they are.
3. Why are decomposers important?
4. Compare and contrast ringworm and athlete's foot.
5. Describe two ways that humans use bacteria and fungi.

ADDITIONAL RECOMMENDED RESOURCES

- Kids Health, <http://goo.gl/uJvw1g>
- HippoCampus.org, <http://www.hippocampus.org/Biology-Non-Majors-Biology-Search-Fungi-and-People>
- QUEST-Science on the SPOT: Fungus Fair, <http://goo.gl/7w690U>

