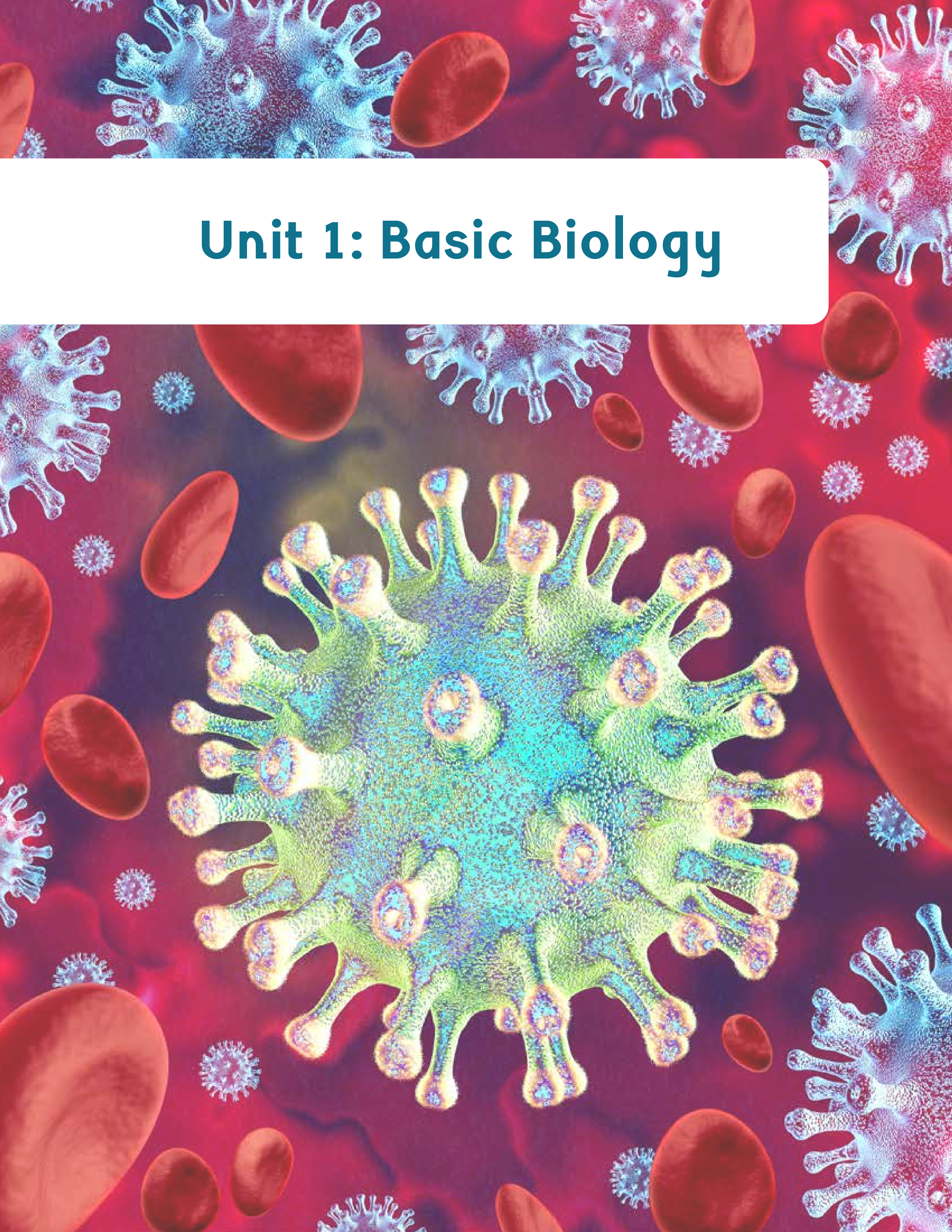
# Unit 1: Basic Biology



## Chapter 1

# What Is Microbiology?

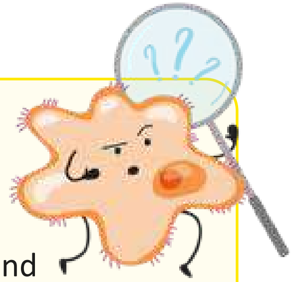
Before you continue reading, take a moment to go outside and look at all the **organisms**, or living beings, that you can see. Think of all the organisms you have ever seen, in person or on a video. This course is not about any of them. In *this* course you will learn about organisms that are so small you need a microscope to see them. Microscopic organisms are called **microorganisms** (or **microbes** for short).

## Watch

**Life in a Drop of Pond Water**

**As you watch the video, think about the answer to this question. Based on movement, size, and color how many types of microbes are in the video?**

Because you can't see them, you might think there are not very many microbes. In fact, the number of microbes is so HUGE it is difficult to comprehend. Scientists estimate that there are 1 trillion types of bacteria, archaea, and microscopic fungi, which is a common type of microbe[1]. The number of individual bacteria is larger than the number of stars in the known universe. This number does not include viruses which are even more numerous than bacteria! Microbes are everywhere on Earth. They are in soil, water, air, all organisms (including you), and on surfaces everywhere you go.



## Check & See

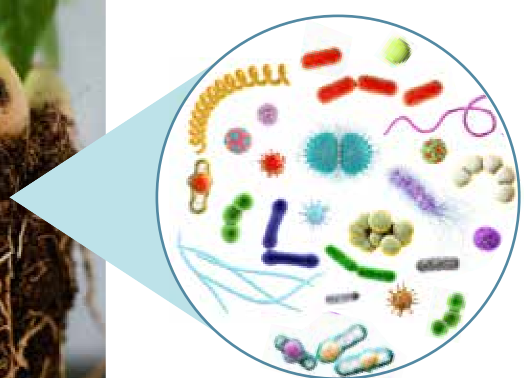
You probably have edible microbes in your kitchen right now. Yeast, bacteria, and mold are all microbes. Yeast is used to make bread. Bacteria is found in most yogurt. Mold is used to make soy sauce. You must be ready for a snack by now.

Go to the kitchen and look at the ingredients list for bread or yogurt. Find where it says "yeast" on the bread label. Yeast is used to make bread fluffy. The types of bacteria in yogurt are listed as "live active cultures". Bacteria is used to turn milk into yogurt.

# Your Microbiome

You have trillions of microbes inside you right now. They are not just inside you either. Look at your skin. Grab a magnifying glass if you have one. Do you see microbes moving along it? Whether you see them or not, they are there. The microbes that live inside and on you make up your **microbiome.**

That might make you nervous. The Coronavirus pandemic made us aware of how one type of microbe—a virus—can be bad for people's health. But you have been eating, drinking, breathing, and living with microbes your entire life. That is a good thing, too. Some microbes can make you sick, but microbes are essential for your good health. They digest your food and fight microbes that can make you ill. If you feel healthy today, you should say, "Thank you microbes!"



Plants have a microbiome, too. Plants also need a healthy microbiome inside their tissues and cells, and in the soil around them. If the microbes around a plant's roots are killed, the plant will also die. You cannot see it, but the soil is teeming with microbes.

# The Study of Very Small Organisms

**Microbiology** is the study of very small living beings. You have probably heard of bacteria and viruses. In this course, you will also learn about microscopic fungi, protozoa, algae, and archaea.

The science of microbiology began in the 1670s when Antonie van Leeuwenhoek discovered protozoa and bacteria through his microscope. The science of microbiology has come a long way since then. As scientific equipment and procedures become more advanced, scientists are coming to new understandings of Earth's smallest organisms.

Microbes like the archaea that make this yellow mat might be too small to see, but they can group together to make things that are bigger than you.

# Microbiology and the Definition of Life

There is a definition of life that has been used for decades. This definition holds true for most types of organisms. First, you will learn the standard definition and then you will learn why many scientists think it is time for a new definition for life.

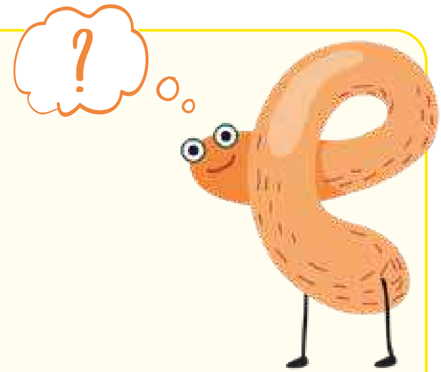
## THE STANDARD DEFINITION OF LIFE

### Traits All Organisms Share

According to the standard definition of life, from the smallest to the largest organisms there are eight characteristics, or **traits**, that all organisms share. All organisms

- grow
- respond to their environment
- take in energy
- get rid of waste
- have some type of circulation
- have some type of respiration
- move on their own
- reproduce
- and evolve

## Check for Understanding

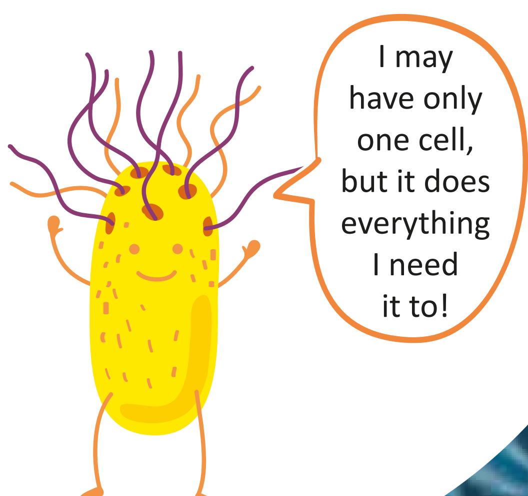



- **You are alive. Let's check your traits.**
- Have you **grown** since you were born?
- If someone tickled you, would you **respond**?
- How do you **take in energy**?
- How do you **get rid of waste**?
- What **circulates** through your body?
- Jumping requires energy. **You get that energy from respiration**, where energy is released from food. Jump right now to make sure you have respiration and that you can move.
- Humans reproduce, which means one day you could be a parent.

## All Organisms Are Made Of Cells

**Another characteristic all organisms share is that they are made of one or more cells.** This statement is based on a **scientific theory** called the **cell theory**. A **cell** is the smallest building block of life. **Cells are the basic unit of structure and function of organisms.**

Most microbes are made of one cell. They are **unicellular**. This is also called single-celled. When an organism is unicellular, all structure and function must come from their one cell. Some organisms, like people, are **multicellular**, made of more than one cell.





Bacteria Cells

**A scientific theory is a fact-based explanation for why or how something happens in science. The cell theory is one of the basic principles of biology. It explains the relationship between cells and organisms. Scientists develop scientific theories by doing many experiments using the steps in the scientific method.**

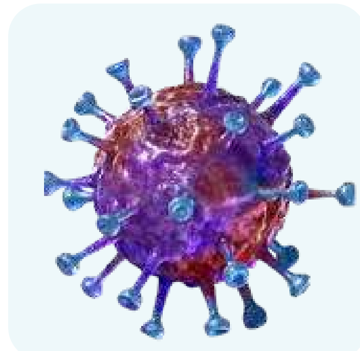
# Does Science Need a New Definition for "Life?"

**There are over 100 scientific definitions of "life," and none might be accurate outside of Earth. ~ Alison Koontz, Caltech**

One area of study that has grown in recent years is **virology**, the scientific study of viruses. There is a debate among scientists about whether viruses are alive or not. Viruses do not have many of the traits shared by other organisms, but they do have some of them.

## Viruses Do Not

- grow,
- take in energy,
- get rid of waste,
- have some type of respiration,
- have some type of circulation,
- and they are not made of cells.



Influenza Virus

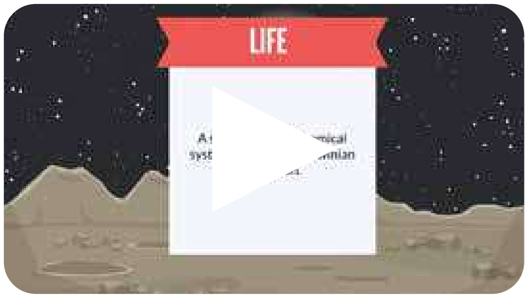
For some scientists, that means viruses are not alive. Many scientists, including those at NASA who are looking for life on other planets, agree with Alison Koontz, the scientist quoted at the top of this page. They feel the scientific definition of life is too Earth-centric. Alien life might look totally different than life on Earth. Many scientists think the standard definition for life doesn't even account for all organisms on Earth!

To solve this problem, scientists at NASA developed a new definition for life that will be used in this course.

**Life: A self-sustaining chemical system capable of Darwinian evolution. ~ NASA**

This definition includes all beings considered alive by the old definition. Using this definition, viruses are also alive.

- Viruses are **self-sustaining**. They live because of their own effort.
- Viruses are a chemical system. A chemical system is a chemical mixture made of interacting particles called **molecules**. All organisms, even you, are a chemical system.
- Darwinian evolution states that through natural selection populations of organisms can change over time, meaning that they **evolve**. These changes are passed to offspring giving rise to new types of organisms. Even the same type of virus can have different traits. Viruses pass these traits on, which leads to **evolution**.




# Watch

**Defining Life**

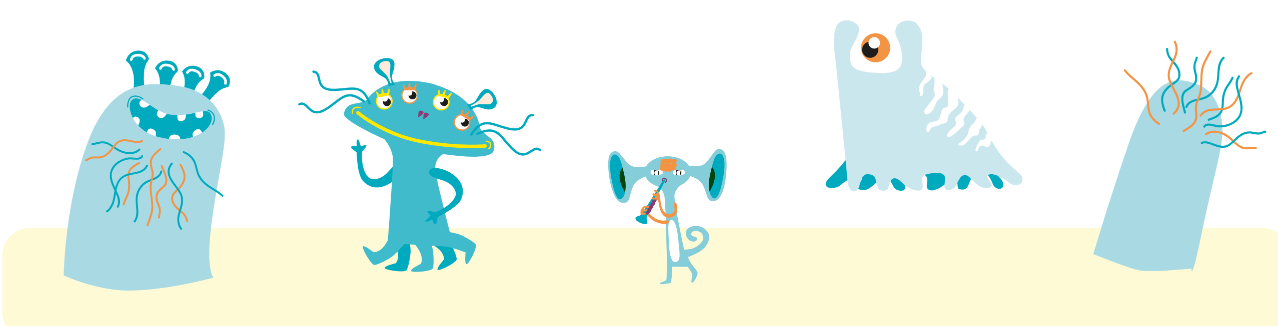
## VOCABULARY CHECK:
## Draw a line from the word to the correct definition.

| | |
|---|---|
| Organism | Characteristic |
| Micro | Made of one cell |
| Microorganism | Very small living being |
| Microbiology | The basic unit of structure and function of organisms |
| Cell | Made of many cells |
| Unicellular | Very small |
| Multicellular | The study of very small living beings |
| Trait | Living being |
| Evolution | Change over time |

## THOUGHT QUESTIONS

Do you think a new definition for life is needed? Why or why not?

Imagine a life form from another planet. Think of the characteristics it needs to live and then draw a picture of it labeling its parts and how it functions and lives.



# LAB:

# If Viruses Were the Size of a Pepper Flake...

## How Micro Are Microbes? Modeling Lab

Have you ever been told not to touch a surface that looked clean? Could it be covered in microbes? Microbes are not invisible, but they are so small you cannot see them.

In this lab, you will make a scientific model to help you understand the size and scale of microbes. This model is both a **visual model** and a **math model**. Visual models show how living and nonliving things are structured to help you understand them. The sizes of the microbes will be made to scale. A model that is **made to scale** is a **math model**. The models of the microbes will be larger than the microbes are in real life, which is a good thing, otherwise you couldn't see them! They will be scaled so they are the correct size when compared to each other.

**Scientific models** are used to help understand science. Scientific models describe and/or predict things in the real world. There are three types of scientific models: visual models, math models, and computer models.

In this course, you will learn about organisms that are types of viruses, bacteria, archaea, fungus, algae, and protozoans. You will also learn about how your body uses special cells, called human white blood cells, to keep you from getting sick. You will learn more about these later in the course. Today, you will learn how big (or teeny-tiny) they are compared to one another.


## Watch

**Lab 1: Purpose, Practices, and Techniques**

## MATERIALS

- ☐ 1 piece of pepper
- ☐ Glue
- ☐ Small piece of paper
- ☐ A ruler with centimer markings
- ☐ Tape measure
- ☐ Another person
- ☐ A space to measure 500 cm, 16 ½ feet
- ☐ Camera (the one on a phone will work)
- ☐ Scissors
- ☐ The labels with blue type from the Lab Sheet, cut out and kept in order. These are in the PDF appendix.

## CHOOSE ONE OF THE TWO OPTIONS BELOW

### Option 1: Coloring markers and poster board

### Option 2: You can use items in your 3D model until the distances get too large.

**Suggested items for your models are:**

- **Bacteria -** 2 cm ball of Playdough
- **Fungus -** Grapefruit
- **Human white blood cell -** basketball
- **Algae -** something that measures 5 feet
- **Protozoa -** a hallway that measures 5 meters in length

## PROCEDURE

1. Cut the labels from the lab sheet, keeping them in order for the model.
2. Glue the piece of pepper to the piece of paper or to the poster board. Glue the label, "If virus were the size of a piece of pepper," above it.

### If using markers and a poster board

3. Draw a circle with a diameter of 2 cm on the poster board. Color the circle. Glue the label, "Then bacteria would be this big. If bacteria were this big," above it.
4. Draw a circle with a diameter of 10 cm. Color the circle. Glue the label, "Then fungus would be this big. If fungus were this big," above it.
5. Draw a circle with a diameter of 25 cm. Color the circle. Glue the label, "Then a human white blood cell would be this big. If a human white blood cell were this big," above it.
6. Use the tape measure to measure a length of 150 cm, about 5 feet. Take a photo with a person in the photo to help with the perspective of how long this measurement is when compared to a human white blood cell. Print the photo and glue the photo to the poster board. Glue the label, "Then algae would be this big. If algae were this big," above the photo.
7. Use the tape measure to measure a length of 500 cm, about 16 ½ feet. Take a photo with a person in the photo to help with the perspective of how long this measurement is when compared to algae. Print the photo and glue the photo to the poster board. Glue the label, "Then protozoa would be this big." above the photo.

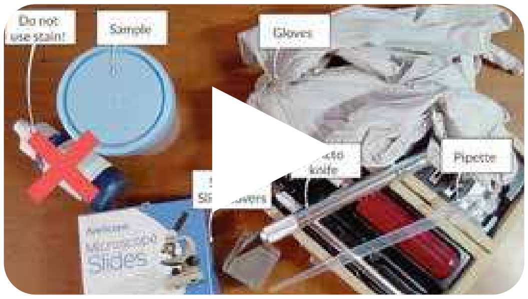
## If Making a 3D Model

3. Make a ball of Playdough with a diameter of 2 cm and glue it to the poster board. Glue the label, "Then bacteria would be this big. If bacteria were this big," above it.
4. Use a grapefruit with a diameter of 10 cm. Place it on the poster board. Glue the label, "Then fungus would be this big. If fungus were this big," above it.
5. Use a basketball with a diameter of 25 cm. Place it on the poster board. Glue the label, "Then a human white blood cell would be this big. If a human white blood cell were this big," above it.
6. Use the tape measure to measure a length of 150 cm, about 5 feet. Take a photo with a person in the photo to help with the perspective of how long this measurement is when compared to a human white blood cell. Print the photo and glue the photo to the poster board. Glue the label, "Then algae would be this big. If algae were this big," above the photo.
7. Use the tape measure to measure a length of 500 cm, about 16 ½ feet. Take a photo with a person in the photo to help with the perspective of how long this measurement is when compared to algae. Print the photo and glue the photo to the poster board. Glue the label, "Then protozoa would be this big." above the photo.

# MICROSCOPE LAB:

## Microbes in Pond Water

*This optional lab is for those who have a microscope.*




## Watch

**Microscope Lab: Microbes in Pond Water**

Microbes are microscopic. If you have a microscope, now is the time to use it. Freshwater organisms are easy to collect, too. Simple collecting methods include dipping a small, sealable cup into pond water, and squeezing moist moss and aqueous plants.

An important part of science is keeping records of what you have done. As you investigate the microbes in pond water, make notes and sketches, and answer the questions on the lab sheet.

### MATERIALS

- ◻ Small sample of pond water
- ◻ Glass slide
- ◻ Slide cover
- ◻ Pipette
- ◻ Microscope
- ◻ Microbes in Pond Water Lab Sheet
- ◻ Internet access (optional)
- ◻ Disposable gloves

### PROCEDURE

1. Collect the sample(s) of pond water.[2]
2. Use the pipette to place a drop of the water in the center of the slide.
3. Take the slide cover and set it at an angle to the slide so that one edge of it touches the water drop, then carefully lower it over the drop so that the slide cover covers the specimen without trapping air bubbles underneath.
4. Use the corner of a paper towel to absorb any excess water at the edges of the slide cover.
5. View the slide with your microscope, starting at the lowest magnification.
6. Find the best magnification for viewing and draw the views on page 2 of your lab sheet. Label this view.
7. Optionally, use the internet to help you identify the microbes you see.

# Microscopic View Lab Sheet:

## MICROBES IN POND WATER LAB SHEET

1. Do you see anything in the pond water? Describe what you see. Make a note that tells the best magnification for viewing the microbes that are present.

Follow a microbe and sketch it. Use a dotted line to show the direction it is moving. Label it if you can identify what it is.

Follow a second microbe and sketch it. Use a dotted line to show the direction it is moving. Label it if you can identify what it is.

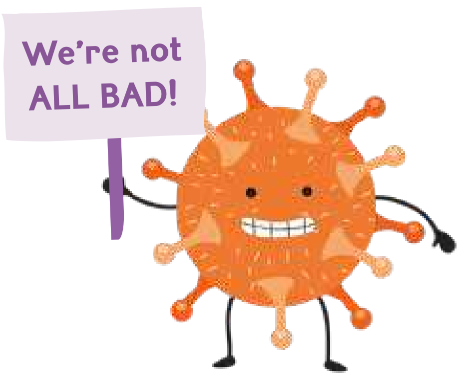
Follow a third microbe and sketch it. Use a dotted line to show the direction it is moving. Label it if you can identify what it is.

2. Do all the organisms swim in the same way? Make note of any differences.

3. Did you see anything that was not moving? What do you think it is?

Chapter 5

# The Good and the Bad of Bacteria

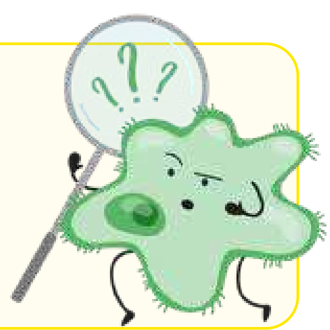



Inside your body, a war is being waged. Can you feel it? Can you feel the bacteria, archaea, fungi, and viruses that are at war with each other? Whether you can feel it or not, 24 hours a day, 7 days a week, every single day of the year, the battle rages on!

## Watch

**Your Microbiome**

## Vocabulary Check



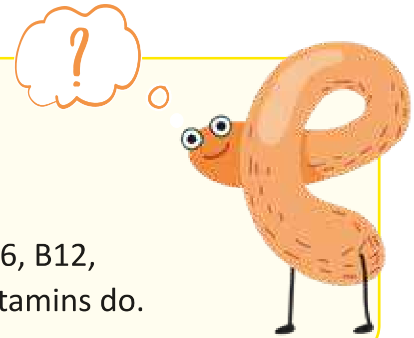
Do you remember what the microbes inside you are called?
**Hint:** They are an important part of your immune system.

## Your Health and the Good and Bad of Bacteria

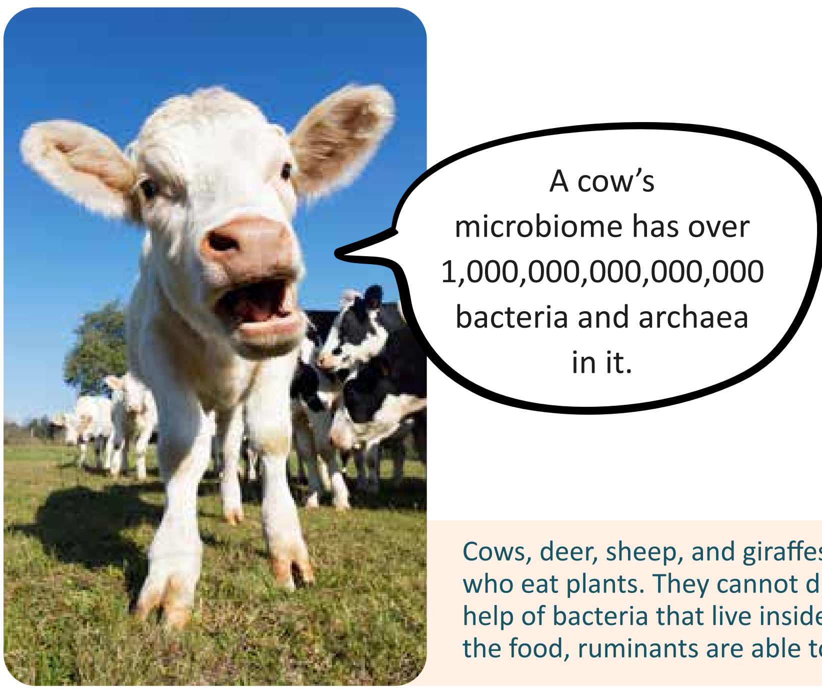
The bacteria that keep you healthy are **beneficial**. Those that make you sick **harmful**. If you are feeling healthy today, that means the beneficial bacteria are winning. Bacteria do not set out to be be beneficial or harmful. They are just doing what they need to live.

Beneficial bacteria do more for you than fight harmful bacteria. Bacteria that live inside you are decomposers. They are essential for helping you digest food. There are bacteria inside you right now munching away on what you ate for breakfast. In addition to helping you digest food, the bacteria in your gut also make the vitamins your body needs to be healthy.

## Research to Learn More



Some of the essential vitamins made by bacteria in your gut are B6, B12, K, folic acid, and niacin. Use the internet to find out what these vitamins do.




Cows, deer, sheep, and giraffes are ruminants. Ruminants are herbivores who eat plants. They cannot digest most of what they eat without the help of bacteria that live inside them. After bacteria has broken down the food, ruminants are able to absorb what the bacteria doesn't use.

### BACTERIA DIGESTION: IT'S A GAS

Bacteria are one of the reasons why you fart. When bacteria break down food, they make gas. According to Dr. Eamonn Quigley, the gas needs to escape your body, or you would explode! Something I am sure you do not want to have happen.

### 10 FUNNY FART FACTS (JUST BECAUSE)

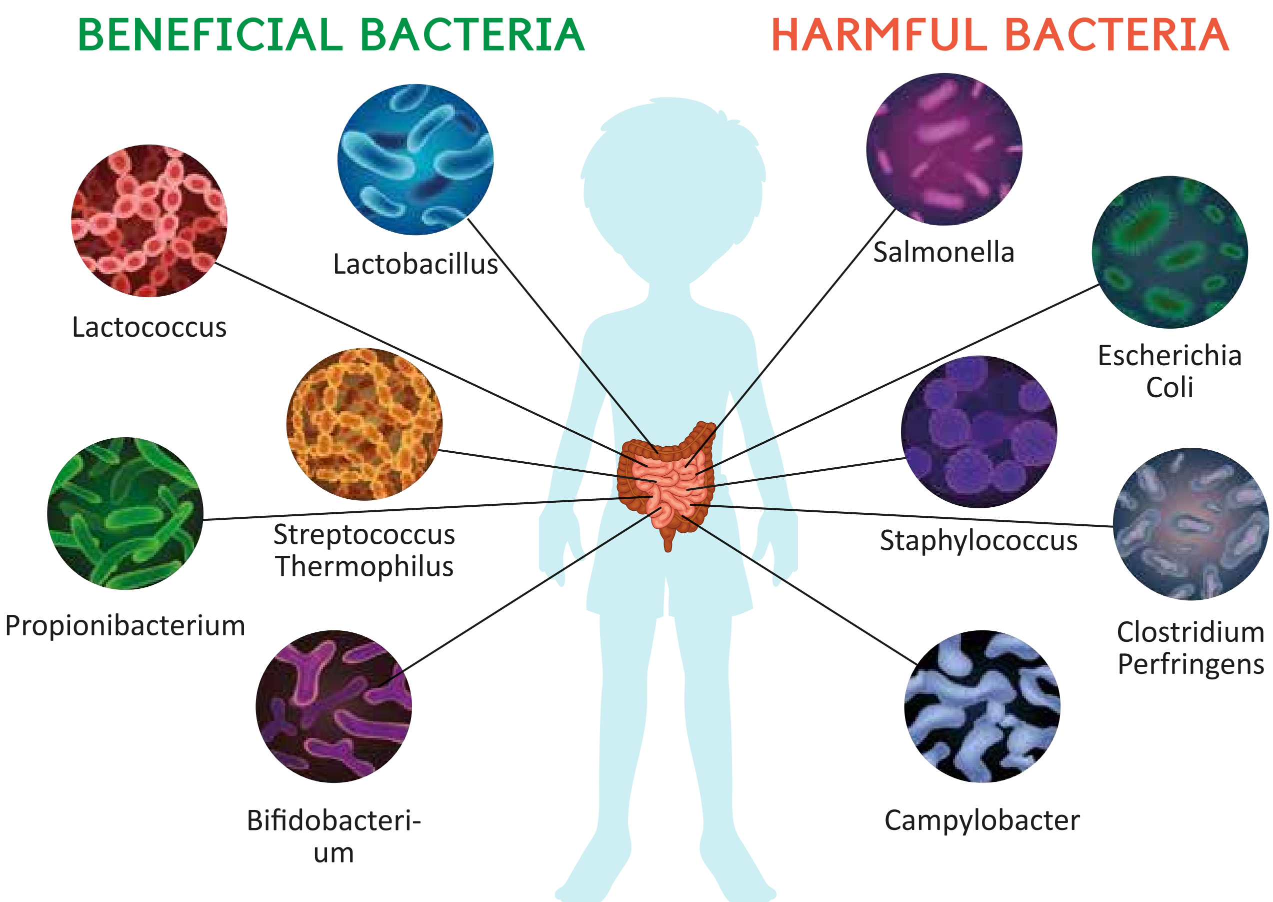
1. NASA conducted a scientific study to determine if it was a fire hazard when astronauts farted in their spacesuits. The suits are equipped with a filter that removes gases like those in your farts.
2. Several astronauts tried to use farts to propel themselves at zero gravity. They were unsuccessful.
3. After they die, people continue to fart.
4. Jonathan Swift, the author of *Gulliver's Travels*, claimed that holding in your farts can cause illness. He also claimed there exist at least five "different species of farts" which are perfectly distinct from each other both in weight and smell.
5. Some fish, like herring, use farts to communicate with each other.
6. Only 1% of your farts smell.
7. Most people fart 14 to 22 times a day.
8. Farts leave your body traveling at 7 miles per hour.
9. Nerve endings in your butt can tell the difference between farts and poop.
10. There are products you can use to cut down on gas production. They work by starving fart-producing bacteria. Fart-producing bacteria are good bacteria, so starving them is not a good idea. If you harm your good bacteria, it is easier for bad bacteria to grow.

## Toxins: How Bacteria Make You Sick

Harmful bacteria do not mean to make you sick. Like all organisms, bacteria get rid of waste. The bacteria that make you sick have waste with **toxins** in it. Toxins are chemicals that make you sick. Toxins can cause coughing, sneezing, and even vomiting. The bacteria that do not make you sick do not have toxins in their waste.

The yellow bacteria are Staphylococcus aureus bacteria. The toxins they release cause skin infections.

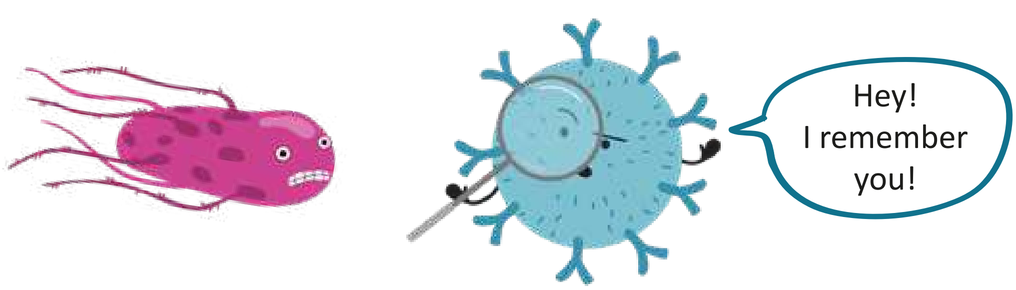
Bacteria have a fast and simple lifecycle. Once they find a food source, bacteria grow quickly, consume food, reproduce, grow quickly, consume food, reproduce, and do this over and over again until they run out of food. When that happens, the bacteria die. As they consume food, they also get rid of waste. Some of their waste contains vitamins you need to be healthy. Some of their waste contains toxins that can make you sick. We consider bacteria beneficial if their waste contains nutrients and vitamins we need. We consider bacteria harmful if their waste is toxic to us.




This graphic shows beneficial bacteria and harmful bacteria that can survive inside you. Just because all these types of bacteria CAN survive, does not mean they are all in you now. Yogurt, sauerkraut, and kimchee have beneficial bacteria, called probiotics, in them. Eating foods with probiotics in them helps keep your microbiome healthy, which helps keep you healthy.

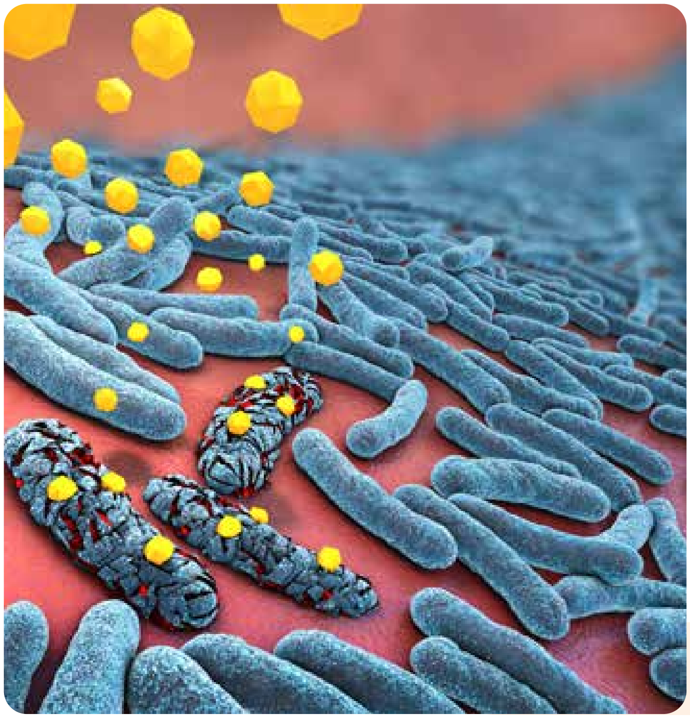
## How Your Immune System Fights Bacteria

The good news is that bad bacteria need to grow in number to make you sick. When your immune system recognizes the harmful bacteria, your B cell and T cells fight the bacteria before you get sick.



# When Your Immune System Needs Help

## ANTIBIOTICS



Antibiotics, like those pictured in yellow, kill bacteria by destroying their cell walls.

Bacteria reproduce quickly, and they mutate quickly. If your immune system does not recognize bacteria, it gives them more time to reproduce. When this happens, your doctor might prescribe antibiotics. **Antibiotics** are a type of medicine that kills bacteria.

Antibiotics have saved many lives since they were discovered in 1928. Some antibiotics kill bacteria by destroying their cell walls. Other antibiotics work by stopping bacteria from growing or reproducing.

Before the discovery of antibiotics, even a minor infection could be deadly. Small cuts, childbirth, and even a splinter could kill by bacterial infection.

If an infection becomes bad, it can cause sepsis. Sepsis is blood infection caused by bacterial toxins. Prior to the discovery of antibiotics, fifty percent of the people who got sepsis died from it. Nowadays, infections are treated with antibiotics before sepsis can set in.

### Things Antibiotics Do Not Do

- Antibiotics do not kill viruses.
- Antibiotics do not kill archaea or fungi.

### Too Much of a Good Thing

Antibiotic use can be a problem, too. Antibiotics do not kill just one type of bacteria. They kill beneficial bacteria needed for good health along with the harmful bacteria. Sometimes, a doctor will advise a person to take probiotics to increase the beneficial bacteria in their body after antibiotic use. Another issue happens when people do not finish all the medicine prescribed to them. This can benefit bacteria that have mutated, leading to antibiotic resistant bacteria. **Antibiotic resistant bacteria** are bacteria that are no longer killed by antibiotics. Instead, they continue to grow and make people sick.


## Watch

**Antibiotic Resistance**

## CHECK FOR UNDERSTANDING

Antibiotics stress bacteria out! That makes sense because you are trying to kill them. Bacteria that are stressed out are more likely to mutate. In this activity you will make a simple model showing how mutation leads to antibiotic resistance.

### Materials

- ☐ Two colors of pencil.

### Instructions

Follow the instructions for each numbered step below.

1. In the ovals below, draw a circular strand of DNA using one color. This is the bacteria that can be killed with the antibiotic.

2. These bacteria make you sick, so you take antibiotics. This stresses the bacteria out and one of them mutates. Draw circles in the same color as before in two of the ovals. Use a different color for the DNA in the third oval.

3. The antibiotics kill the bacteria that *did not* mutate but does not kill the bacterium that *did* mutate. Put an X over the two bacteria that died.
4. If that bacterium starts to reproduce, will the same antibiotics work the next time?

# LAB:

## Let's Grow and Kill Bacteria


### Watch

**Lab 5: Purpose, Practices, and Techniques**

You might not be able to see them, but microbes are all around, everywhere you go. When a piece of fruit or bread has mold growing on it, when you catch a cold, and when the sponge in your sink starts to smell: these situations are caused by microbes. We make these inferences about microbes based on evidence and our previous knowledge.

After this lab, you will no longer have to infer that microbes are all around you. You will know. You will conduct a lab where you grow and then kill bacteria. First, you will make the **growth medium**. This is a source of food designed to support the growth of a population of bacteria. Next, you will find bacteria, put them on the growth medium, and let them grow. Don't get too attached though, because after growing them, you will try to kill them.

Writing **lab reports** is an important science skill. They are not complicated to write, as they follow a predictable format. The **hypothesis** goes at the beginning, followed by the **procedure**, then come the **observations**, followed by the **results** and **conclusions**.

Even with the predictable format, many students struggle with writing them. To help, use the template on the following page. You can pull this out the next time you need it to help you remember the parts of a lab report.

There are other parts that are sometimes in the report, depending on the lab. For example, labs with a control group will include information about that in the lab report. Some lab reports require you to write down the materials used and the procedure. These are not required in this lab report. If you follow the written procedure closely, it will be as laid out in the instructions. However, if you use alternate materials or make changes to the procedure, those changes should be included in your lab report.

# Part 1: Let's Grow Bacteria Lab

## Materials

- ◻ 1 cup water
- ◻ 1 teaspoon sugar
- ◻ 2 ½ teaspoons (7 grams, 1 packet) unflavored gelatin
- ◻ 1 teaspoon beef stock powder (1 bouillon cube)
- ◻ 1 container for boiling water
- ◻ 4 x Petri dishes or small custard dishes with plastic wrap
- ◻ Spoon
- ◻ Cotton swabs
- ◻ pencil
- ◻ Warm spot behind fridge, near a heater, box with a desk lamp inside or on top
- ◻ Sticky tape
- ◻ Felt-tip pen for labeling dishes
- ◻ Camera (optional – the camera on a Smartphone works)
- ◻ Bleach + water
- ◻ Rubber gloves and antibacterial soap
- ◻ Mask
- ◻ Lab sheets

## PROCEDURE: Part 1

*Note: The mask and gloves are optional. However, they are good lab practice, as you want to minimize the risk of contaminating your samples with bacteria from your hands and breath.*

1. Two hours before you are ready to make the growth medium, soak the Petri/custard dishes (if they are not already sterilized) in a sink that is very clean with water and antibacterial soap.
2. Wear a face mask so that you do not contaminate the growth medium. Wash rubber gloves with antibacterial soap. Wearing these gloves to protect your hands, after soaking the petri dishes, rinse them and air dry.
3. Boil 1 cup of water on a stove or in the microwave. <u>Be careful. Boiling water can burn.</u> Remove the water from the heat source.
4. Add sugar, gelatin, and beef stock to the water and stir until all are dissolved.
5. Cover and let the mixture cool for 10 minutes.

6. Wear a face mask and gloves. Half-fill the Petri dishes with the hot mixture. Put the lids on them. If using custard dishes, cover them with plastic wrap.
7. Put the dishes in the refrigerator overnight or up to 48 hours before using them. Do NOT touch or uncover the growth medium or you risk contaminating it.
8. Watch the *Mythbusters* video for some ideas of where to collect samples if you need some tips. To watch the entire episode, *click on this link*. If the link doesn't work, use the internet to search for "Mythbusters: Dirtier than a Toilet Seat."
9. When collecting samples, wear a mask and gloves. Use a clean cotton swab each time. After rubbing with a swab, lightly rub it across the growth medium in the Petri dish in a zig-zag pattern. Do not put any sample on one of the Petri dishes. This is your control.

**More tips:** In addition to the suggestions on *Mythbusters*, you can collect samples from inside your nose (just swab a bit and add it to the growth medium). You can also: touch the growth medium with a finger; scrape under your fingernails or inside your mouth before brushing your teeth; or lightly touch a pet's paw to the growth medium.

10. Put the lids back on the Petri dishes, label them, tape them closed and place them in a warm location for 3-4 days. If using custard dishes, press the plastic wrap down so that it is touching the growth medium. Tape the wrap around the edges on the outside of the custard dishes. Label the dishes with information about where the sample was collected.
11. Once you have nice colonies growing, you are ready to conduct part 2 of this lab.
12. Fill in your lab sheet and take photos before and after using bactericides.

# Part 2: Let's Kill Bacteria Lab

*Do not use bleach. Bleach is an effective antimicrobial agent. However, bleach can be toxic when mixed with other chemicals.*

You grew them, now it is time to experiment as you investigate how to kill them. You will drip two things known to kill bacteria into each of the Petri dishes. Then you will choose two liquids to test and see if they are good **bactericides**, or things that kill bacteria. Bactericides are an important first line of defense. Bactericides, like bleach, work by **denaturing**, or unfolding, the proteins that make bacteria.

## Materials

- ☐ The 4 Petri dishes from Part 1 of this Lab
- ☐ 1 tablespoon hand sanitizer
- ☐ 1 tablespoon liquid hand soap
- ☐ 5 pipettes, 1 eye dropper that you clean out very well between liquids, or something else that allows dripping
- ☐ 2 tablespoons of liquids you choose to investigate if they kill bacteria
- ☐ Camera (optional – the camera on a Smartphone works)
- ☐ Rubber gloves
- ☐ Mask
- ☐ Lab sheets, pencil

## PROCEDURE: Part 2

13. Fill in the Hypothesis Section of your lab sheets. Write the names of the two liquids you chose.
14. Put one drop of each liquid, including the two you are testing, on microbial growths in each Petri dish. Spread them out. Do not use too much liquid.
15. Make notes about where each type of liquid was dripped, so that you can track how effective each is compared to the others.
16. Put a lid on each dish and let them sit for 24 hours.
17. Use the lab sheet to record your observations.
18. Answer all questions.

# LAB REPORT

## LET'S KILL BACTERIA LAB SHEET: HYPOTHESIS SECTION

| Name of Chemical | Hypothesis: Answer this question as a full sentence. Do you think this liquid will be a good bactericide? |
|---|---|
| Hand Sanitizer | |
| Liquid Hand Soap | |
| | |
| | |

## LET'S GROW BACTERIA LAB SHEET

### Instructions:

For each circle below, write the location where you collected your sample.
Write the number of days from collection until you first saw bacterial growth, how many colonies (groupings) you observe, and note the color of each. Inside the circle, draw or tape a picture of the colonies in the dish right before you kill them.

## LET'S KILL BACTERIA LAB SHEET

### Instructions:

For each circle below, mark where each drop of the bactericide went, along with its name. Inside the circle, draw or tape a picture of the colonies 24 hours after exposure to the bactericide. Write your observations in the space below.

## LAB REPORT: LET'S GROW AND KILL BACTERIA

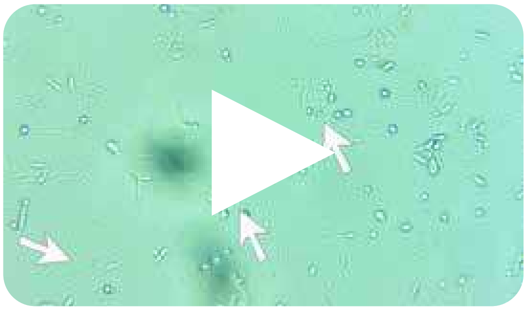
### Procedure for Writing this Lab report

1. Write the title of the lab.
2. Briefly describe the purpose of the lab.
3. Write your hypothesis. This should be based on your knowledge and understanding of the science in the lab.
4. On your lab sheets, document the information about where you collected each sample. Describe the growth of microbes as you observe it.
5. Next, you will use chemicals to kill the microbes. Add to your hypothesis about the chemicals you are using and how effective you think they will be. Write why you think that about their effectiveness.
6. Add to the observations portion the information about what happened when you used these on the microbes. The lab sheets can be used for this.
7. Write your conclusions. Include information about:
    - The collection locations and the cultures that grew from each of these.
    - And which chemicals were most and least effective at killing microbes.

# MICROSCOPE LAB:

## A Close Look at the Good Guys: Bacteria Under the Scope

*This optional lab is for those who have a microscope.*



## Watch

**Microscope Lab: Bacteria Under the Scope**

Do you eat yogurt? If you said yes, then you eat bacteria, and it is good for you! Yogurt is a **probiotic**, a food that contains good microbes that you want in your microbiome. With your microscope, you can see those good microbes moving around.

### Material

- ☐ Plain flavor, active culture yogurt (Yoplait custard is a good choice)
- ☐ Microscope
- ☐ "Microscopic View Lab Sheet: Good Bacteria"
- ☐ Glass slide
- ☐ Slide cover
- ☐ Water
- ☐ Toothpick
- ☐ Paper towel
- ☐ Dropper

### PROCEDURE: Day 1

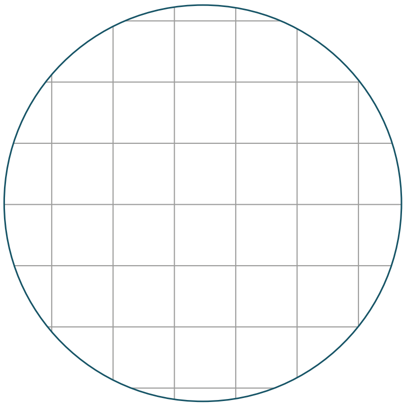
1. Use the toothpick to smear a small sample of yogurt on the slide. Put a drop of water on it.
2. Set the coverslip on the slide so that one edge of it touches the water drop, then carefully lower it over the drop so that the coverslip covers the specimen without trapping air bubbles underneath it.
3. Use 100-x magnification to locate a sample with a good number of bacteria. Use 400-x magnification to find a sample to sketch.
4. In its original container, put about ¼ cup of yogurt in a dark, warm location for 24 hours.
5. Answer the questions for "Day 1: Comments" on your lab sheet.

## PROCEDURE: Day 2

1. Use the toothpick to smear a small sample of the yogurt that has been sitting in a dark, warm location on the slide. Put a drop of water on it. Set the coverslip on the sample.
2. Use 100-x magnification to locate a sample with a good number of bacteria. Use 400-x magnification to find a sample to sketch.
3. Answer the questions for "Day 2: Comments" on your lab sheet.

## MICROSCOPIC VIEW LAB SHEET: GOOD BACTERIA

### Day 1: Comments



Magnification

______________

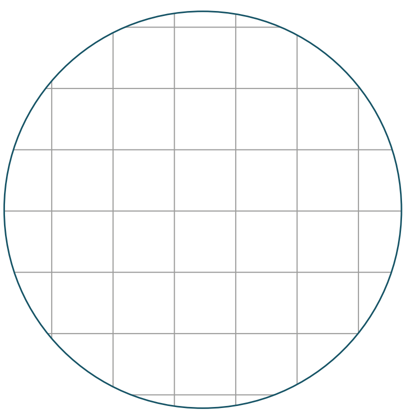
Based on the label on the carton, what bacteria are present in the yogurt?

Look for self-directed movement. These are bacteria. Do you see any bacteria?

If yes, what shape and grouping do you observe?

Use the chart in your book and the name of the bacteria on the carton's label to identify what you see.

### Day 2: Comments



Do you see more, less, or the same amounts of bacteria today compared to yesterday?

Look for self-directed movement. These are bacteria. Do you see any bacteria?

If yes, what shape and grouping do you observe?

Use the chart in your book and the name of the bacteria on the carton's label to identify what you see.