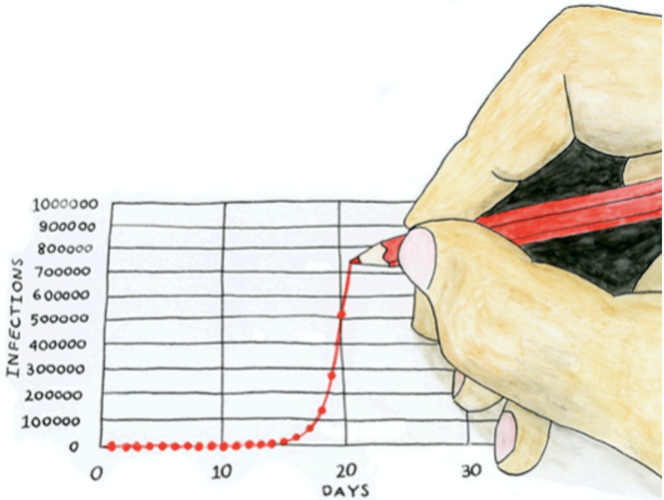

1000000
900000
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INFECTIONS
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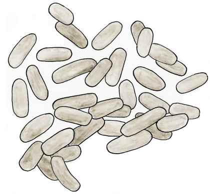
DAYS

Going Viral

Going Viral

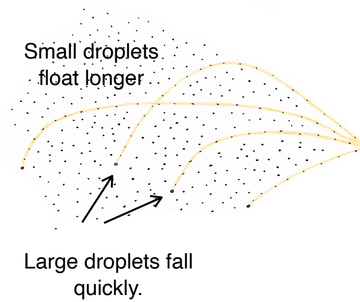


Germs

GERMS make us sick! Many agree with this statement, but have you ever thought about what "germs" really are, how you get them, or why some make us sick? In this kit, we will explore the microscopic world in which "germs" reside to gain an understanding of these tiny organisms, also known as **microbes**. A microbe is simply an organism that is not visible to the naked eye. It is important to know that *not all microbes make us sick.*

Microbes that cause disease or illness are called **pathogens**. When pathogens invade our cells and multiply, they can cause an infection, damage our cells, and make us feel sick. Fever, pain, swelling, redness, and coughing can be symptoms of an infection.

One way for a pathogen to spread is through saliva. When someone sneezes or coughs, they launch tiny droplets of saliva and mucus into the air. These saliva droplets act as a shuttle for the pathogen to catch a ride to another person.



We are going to model the spread of an ***imaginary*** pathogen that is very contagious and can be easily spread from person to person by saliva. This pathogen causes the infected person to sneeze and cough a great deal. One human in our population has been unknowingly infected.

Let's observe how the pathogen is able to spread through our class!

STEPS

1 Put on a pair of safety glasses. This activity includes the use of dilute sodium hydroxide (NaOH). If it comes into contact with your skin or eyes, tell your teacher right away.

2 Take out the small plastic vial labeled "1." This vial will represent a human body. You and your lab partner will be responsible for one "human" throughout this activity.

3 Take out the bottle labeled "Solution 1." This fluid will represent the saliva of your human. Transfer fluid from this bottle to the human vial until the vial is approximately half full.

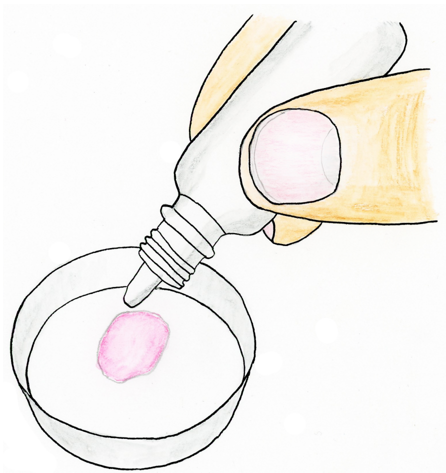
Now you will begin to exchange saliva droplets with the other "humans" in the classroom.

4 Using pipet #1, transfer 2-3 drops of saliva from your human to another group's vial and receive 2-3 drops of saliva from them.

5 Use the pipet to stir your human's solution.

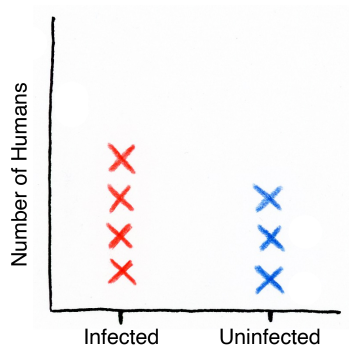
6 Repeat steps 4 and 5 with three different groups and return to your seats.

7 Remove the dropper bottle labeled "Sickness Indicator" and the mini petri dish from your kit. Transfer 1-2 drops of "saliva" from your human into the dish using the pipet and add one drop of sickness indicator to the dish.



If the test turns pink, that means that your human was infected by the pathogen and became sick. If your test remains clear, that means your human did not get exposed to the pathogen.

8 Draw an X on the graph (like the one below) on the whiteboard in the appropriate column to indicate whether your human became infected or not.

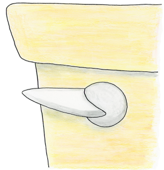


Science Notebook

Once all the groups have put up their data, copy the graph from the board into your science notebook. Calculate the percentage of people who became infected using the following equation.

$$\frac{\text{Total Infected}}{\text{Total Tested}} \times 100 = \text{\% Infected}$$

9 At the sink, rinse out the vial, petri dish, and pipet.

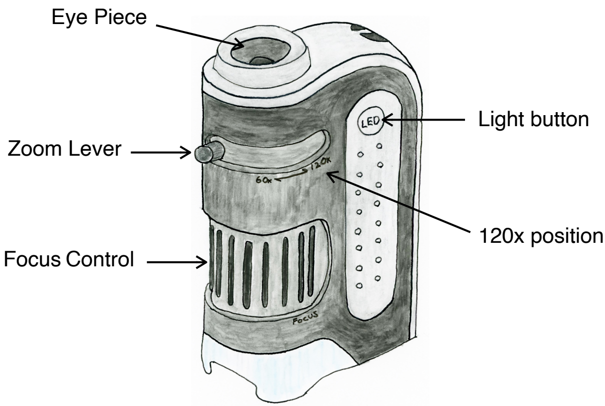


How Invisible are Microbes?

BLOOD is red because it is composed of small red cells floating in a pale yellow liquid called **plasma**. To get a sense of the size of microbes, let's first estimate the size of red blood cells.

STEPS

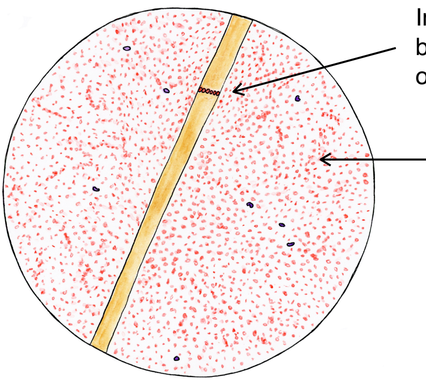
1 Take out the microscope and turn on the light and set the zoom lever to 60x. Place it on top of the slide and try to focus it carefully. It takes some patience!



2 Increase the zoom to 120x using the lever. You might need to adjust the focus again *just slightly*.

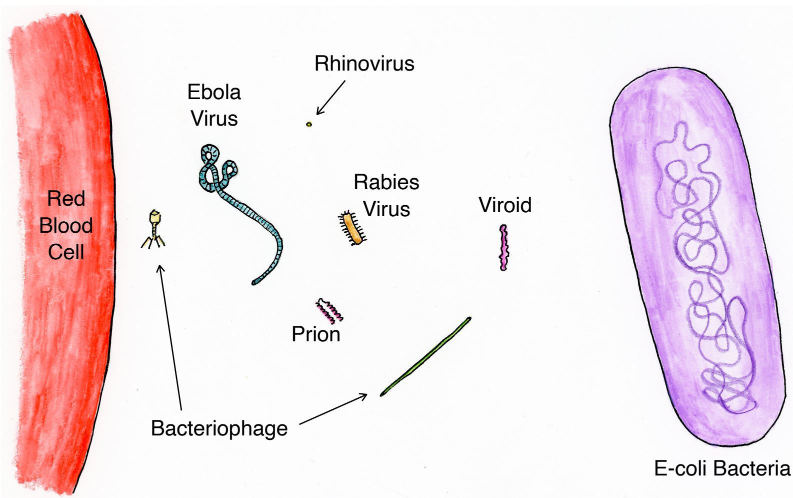
You should see preserved red blood cells on the slide with a human hair on top.

3 Estimate how many blood cells could fit across the width of the hair.

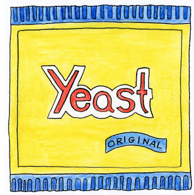


The hair is 50 µm in width. Divide 50 by the number of blood cells you estimated would fit across the hair to get the width of a single blood cell. Show your work in your science notebook.

Human blood cells range in size from 6.2 to 8.2 µm. They are fairly easy to see with a plastic pocket microscope! It would be nice if microbes were this easy to see, but they are not. They are a thousand times (1000x) smaller!



Microbes are indeed invisible to the naked eye, but you can see them under a much more powerful microscope!



Effects of Microbes

THERE are many different kinds of microbes, some good and others bad. **Bacteria** are single-celled microorganisms that can reproduce independently. Some, but not all, cause disease or illness. Bacteria are **prokaryotes (*pro-carry-oats*)**, a class of microbes that do not have a membrane bound nucleus and organelles.

In contrast, animals, plants, protists, and fungi are **eukaryotes (*you-carry-oats*)** because they have membrane bound nuclei and organelles. Some eukaryotes also have the capability to cause disease or illness.

Viruses, are non-cellular microbes that must be inside a cell to replicate. They can infect both prokaryotic and eukaryotic cells; however, only some of them cause disease or illness. Viruses are smaller than cells and have spike proteins on their exterior.

We will now compare different microbes by sorting them by shape first and then by size.

STEPS

1 Remove only the small microbe cards from their pouch and arrange them on your desk face up.

2 Sort the different microbes based on their **shape** and **structure** into 3 separate groups.

3 Remove the remaining cards from the pouch. Identify your three groups as virus, bacteria, or eukaryote using the three category cards.

4 Now use the **size** chart card to improve your sort selections. **Hint: Nanometers (nm) are 1000 times smaller than micrometers (µm).**

Science Notebook

Choose a virus and compare its size to a human red blood cell. How many viruses would fit along the diameter of a red blood cell? Hint: ***Be sure to use the same units when you divide the red blood cell size by the virus size.***

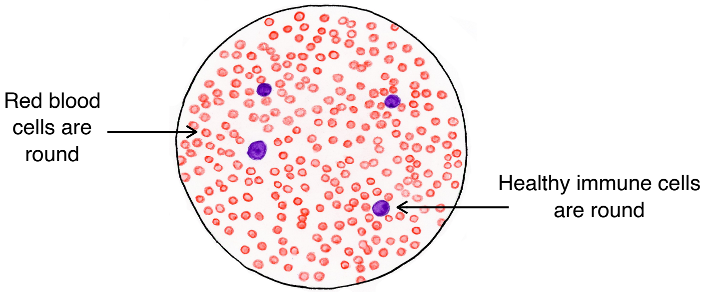
Some microbes are beneficial. For example, we might not have pizza crust without yeast! Microbes found in the hot springs of Yellowstone National Park have helped cure human diseases.

Science Notebook

Identify a beneficial microbe in each category.

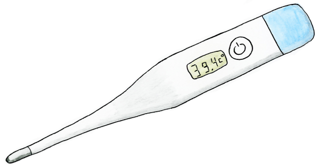
5 Return the microbe cards to their pouch.

Other microbes are harmful. The microscope slide in your kit is of preserved blood that has been infected by the Epstein Barr virus which damages the larger immune cells. Biologists use stains to make it easier to see certain things under a microscope. In this case, the immune cells have been stained purple.



6 Inspect the purple cells in your slide at 120x using the microscope. Healthy immune cells will appear perfectly circular while damaged cells will not be circular.

Draw and label a diagram of both normal and damaged cells in your science notebook.



Immune Response

As we learned before, a pathogen is any microbe that can cause disease or illness. We feel sick when a pathogen invades our body, multiplies and begins to damage our tissues. Though tiny, pathogens can severely affect cells that are much larger.

Fortunately, our bodies have a way to fight back against pathogens called the **Immune System**. It is very complicated, so we will simplify the process by using some game pieces to help visualize how it works.

STEPS

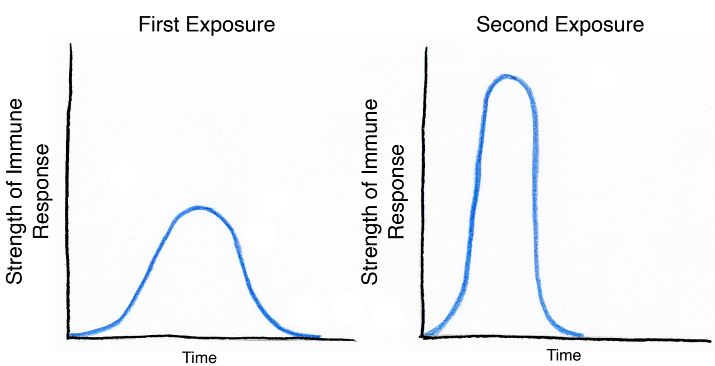
1. Find the immune response simulation board, cards and game pieces in the kit.

2. Use the game pieces to animate each step in the immune response following the instructions on each card.

Science Notebook

What initially triggered the immune response? Explain what the difference is between T cells and memory cells. How does the immune response change when a person gains memory cells?

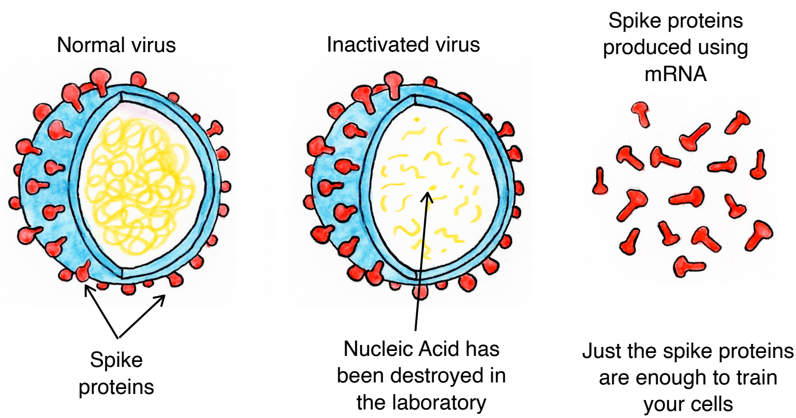
An important thing to note about memory cells is that they help the body respond more quickly the next time you encounter a pathogen. The response from memory cells is also stronger. This allows your body to fight off the infection more quickly than the first time you encountered the pathogen. This can be seen in the graphs below.



Science Notebook

Copy these graphs into your science notebook. How does the strength of the immune response change when someone is exposed to a pathogen for the second time? How does the shortened response time with memory cells help prevent the spread of the disease?

Now let's consider what happens when we introduce a **vaccine** into our body. When a person receives a vaccine, they are being injected with either an inactivated pathogen or mRNA code from the pathogen that stimulates your body to produce spike proteins that match the spike proteins of the virus.

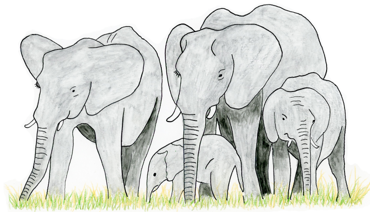


The inactivated pathogen or mRNA generated spike proteins are not capable of causing disease but simply train your body to fight future infections by triggering the same immune response that an active, naturally occurring pathogen does by producing vital memory cells.

In summary, a vaccine is simply a safe way to prepare your immune system to deal with encountering a pathogen by teaching your memory cells to recognize that pathogen without risking the chance of getting the disease.

Science Notebook

Draw two new graphs showing how you expect the immune response to look when the body is exposed to a pathogen with and without receiving a vaccine.



Herd Immunity

LET'S simulate the spread of the same pathogen as before; however, this time, 80% of the humans in our population have been vaccinated against the sickness. If your human has received a vaccine, they will not become sick when they come into contact with the pathogen that spread through our classroom in the last round.

Predict what you think will happen now that the majority of the population has received a vaccine. How will this change the pathogen's ability to spread?

STEPS

1 Put on your safety glasses if you took them off.

2 Take the vial labeled “2” and the bottle labeled “Solution 2” out of your kit. This will again represent the saliva of your human.

3 With the pipet labeled “2,” transfer the fluid from the Solution 2 bottle into the vial. Again, the vial should be approximately half full.

4 Now exchange saliva droplets with 3 other “humans” in the room, following the same procedure as before (steps 4-7 on pages 5-6).

5 Add your data to the Solution 2 graph on the whiteboard.

What is the ratio of infected humans from the vaccinated simulation to infected humans from the unvaccinated simulation? How did the introduction of a vaccine change the spread of the pathogen?

The more people in a population who receive a vaccine, the more protected the entire population is because the pathogen cannot spread easily from person to person. This phenomenon is referred to as **herd immunity**. Herd immunity is *really important* because some people are unable to receive vaccines since their immune systems are not strong enough. This includes people who are very young, very elderly, and/or immunocompromised individuals. **Immunocompromised** means that a person's immune system is permanently or temporarily unable to protect them at normal levels. If people belonging to these populations are exposed to some pathogens, it could be life threatening.

To prevent the spread of pathogens to young, elderly, and immunocompromised individuals in our community, we can:

- **Get vaccinated and get annual flu shots.**
- **Wash our hands often.**
- **Wear a mask and cover our coughs and sneezes. This prevents moisture droplets from carrying the pathogen into the air.**

CLEAN UP

1. Go to the sink and without splashing, pour the liquid in your vials down the drain, then rinse with water and dry with a paper towel.

2. Clean the pipets by flushing with clean water three times.

Interview with a Microbiologist

Was there a moment when you began thinking about becoming a scientist?

Growing up, I actually thought that I wanted to be a veterinarian! Science, especially biology, was interesting to me because I could see how it connected back to animals. I didn't realize I wanted to be a scientist until I came to college! Studying biology in college helped me understand that, more than anything, I love learning about how living organisms work and interact with the world around us.

Who was your favorite teacher when you were growing up?

My favorite teacher growing up was Mrs. Lamb, my 4th grade science teacher! I would always stay after school on Tuesdays to work on science kits with her. She was always so excited to teach us about science, which got me interested in it too!

Why did you choose to come to college?
I chose to come to college because there are so many diverse research opportunities here! I got the chance to explore many different aspects of biology, so I could decide what area interested me the most. College also has a really supportive community. I love how the faculty members here are always willing to help you find your passion.

What are you working on in the lab?
I work in a virology lab on a variety of projects. I track the infection rates of Dengue Virus to help determine how the virus is being spread by mosquitos. I also use DNA samples collected from mosquitos in Guatemala to identify what different animals the mosquitos feed on. I have found samples from ducks, wild boars, horses, and even humans so far!

Do you have any advice for students who want to pursue a career in science?
Take time to explore your options and get hands-on experience in the field! It's hard to know whether a career will be right for you unless you get out there and see what it's like.