

What Is a Pathogen?



Skill Level:

- ▶ Beginner to intermediate

Life Skills:

- ▶ Critical thinking, decision making, disease prevention and healthy lifestyle choices

Setting:

- ▶ An outdoor or indoor space where participants can use craft materials

Time:

- ▶ 45–60 minutes

Materials:

(Zoonotic Disease Educational Kit Supplies provided in pathogen kit are based on creating 3 groups)

- Pathogen kit (one per small group):
 - ▶ 2 pipe cleaners (one whole, eight $\frac{3}{4}$ -inch pieces, two 3-inch pieces)
 - ▶ 15 cotton balls
 - ▶ 1 coffee stir straw (cut into 3 pieces, $1\frac{2}{3}$ inches in length)
 - ▶ One 1-ounce container of modeling clay (such as Play-Doh) or similar crafting clay
 - ▶ 16 photo squares or 16 pieces of double-sided tape
 - ▶ 1 balloon
 - ▶ 10 beans
 - ▶ 1 pencil or other similar-shaped item such as a pen, marker or stick
- If making your own kits, purchase the following items:
 - ▶ 1 package of pipe cleaners
 - ▶ 1 bag of cotton balls
 - ▶ 1 package of coffee stir straws
 - ▶ One 3-pound container (or numerous smaller containers) of modeling clay (such as Play-Doh)
 - ▶ 1 tape dispenser of double-sided tape or package of photo squares
 - ▶ 6 or more balloons
 - ▶ 16 ounces dry beans (any type)
 - ▶ 1 pencil or other similar-shaped item such as a pen, marker or stick per group

Overview:

The *What is a Pathogen?* lesson is designed to introduce participants to the general concepts of the three main types of microorganisms that cause infection. The basic qualities of each related to zoonotic diseases possibly encountered with raising, caring for and being around animals is also discussed. The lesson features a hands-on component to help participants understand how pathogens differ and to help define the abstract concept of a pathogen.

Objective:

After completing this activity, participants will be able to:

- ▶ Describe examples of a pathogen and the problems they can cause.
- ▶ Construct three types of bacteria as well as a virus and a parasite to observe and determine the differences between the three main types of disease agents.
- ▶ Name the general reproductive methods of bacteria, viruses and parasites.
- ▶ Describe common diseases caused by these disease agents and methods to prevent them.

PROCEDURE:

Before the meeting:

1. Review the lesson and gather any supplies you will need.
2. Prepare materials for the three main portions of this activity.
 - ▶ **Bacteria section (first part):** Modeling clay, pipe cleaners, cotton balls, writing utensils or sticks, double-sided tape/photo squares
 - ▶ **Virus section (second part):** Balloons, beans, cotton balls, coffee stir straws, double-sided tape/photo squares
 - ▶ **Parasite section (third part):** Modeling clay
3. Set up an area with materials grouped so you can easily pass them out.
 - ▶ **Bacteria section:**
 - **A.** 1-ounce container of clay, along with the eight $\frac{3}{4}$ -inch pieces of pipe cleaner, and two 3-inch pieces of pipe cleaner
 - **B.** 9 cotton balls, and double-sided tape/photo squares
 - **C.** Whole pipe cleaner and a writing utensil or stick per group
 - ▶ **Virus section:** Balloon, 10 beans, double-sided tape/photo squares, 6 cotton balls, and 3 pieces of coffee stir straws per group
 - ▶ **Parasite section:** Modeling clay re-used from bacteria A section

4. The following table outlines the pathogens the participants will be making:

Types of Pathogens		
Type	What it represents	Example
Bacteria: Rod-Shaped (A)	The modeling clay represents the majority of the bacterium, while the pipe cleaners represent pili and flagella that bacteria can use to sense their environment.	<i>Salmonella</i> <i>E. Coli</i>
Bacteria: Cocci (B)	Each cotton ball represents a bacterium. These bacteria can make different formations and form chains, clumps and more.	Mycoplasma
Bacteria: Spirochete (C)	The pipe cleaner represents the bacterium in its entirety. These bacteria tend to be long and can coil due to increased flexibility.	<i>Borrelia burgdorferi</i> (causes Lyme Disease)
Virus	The balloon represents the outside membrane of the virus, while the beans inside represent the genetic material of the virus. The cotton balls and cotton balls with straws represent two components that help the virus to bind to and to inject their genetic material into other cells.	Influenza
Parasite	The long tubes represent mature worms, while the small balls represent eggs that have not yet hatched.	Roundworm



Models of the Three Main Pathogen Types (Bacteria, Viruses and Parasites)

During the meeting:

1. Introduce the activity by reading aloud or paraphrasing the following:

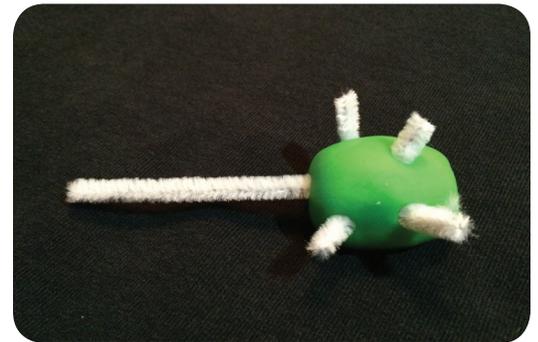
Nearly every animal and human gets sick at some point. When an illness is caused by a pathogen (a virus or bacteria), it can spread quickly through a herd or flock, or from animal to human or human to animal. Some pathogens travel through the air (after a sneeze, for example) and some travel from pen to pen or even farm to farm on people’s shoes or on the tools or equipment they move from one site to another. Today, we’ll determine what a pathogen is by exploring the various kinds of pathogens.

2. Divide the group into three or four-person teams (depending on the size of your group and the number of pathogen kits you've prepared). Have each group form a circle. Then ask one person from each group to collect the first part (the bacteria section) of the pathogen kit for the team.
3. Next, read aloud or paraphrase the following:

Pathogens play an important role in our lives. You may have heard pathogens mentioned often, but what exactly are they? We are going to start off by learning about bacteria. Bacteria come in several different shapes and sizes. When I give the signal, your team will have 2 minutes to create what you believe a bacterium would look like using the supplies provided to your group.
4. Inform participants that they can begin and allow 2 minutes for each team to create a bacterium. Provide them with a 30-second warning that the time will be up.
5. After 2 minutes, or when the teams seem to have finished their creations, call time and tell the teams to stop working. When the participants have returned their attention to the whole group, ask for one volunteer from each team to explain the team's creation. Have each volunteer explain why the team members believe it represents a bacterium. Continue the sharing until all of the teams have had a turn. If time and space allow, have the teams walk around the work space to look closely at the models created by the other teams.
6. Read aloud or paraphrase the following:

Thank you for your imaginative creations. Now we are going to look at the science behind three different types of bacteria. To start, combine all of your modeling clay to form a log shape. (Allow time for each team to construct a log shape.) What you have just created is called "rod-shaped" bacteria. Split the clay model in half and give it to the person next to you. Reproduction took place and now there are two bacteria.
7. Make sure all groups have reached this point and then read or paraphrase the following:

Use the pieces of pipe cleaner and stick them into the two clay logs so they stick out like antennas over the bacterium. You have just created the hair-like projections.
8. Guide and assist participants through making a rod-shaped bacterium. They can do this by using the materials provided, pushing the small pieces in the sides of the now round log of clay. Then take the longer portion and place it at one of the ends. (See photo right.)



Model of Zoonotic Bacteria – Rod-Shaped

9. Read aloud or paraphrase the following:

If we take a look at our bacteria, we see they are long or “rod” shaped. When we split them in half we demonstrated how they reproduce – they create a copy of themselves. The shortest pipe cleaners represent “pili,” small hair-like extensions that help bacteria adhere to cells. The longer pipe cleaner pieces represent “flagella,” which help bacteria to move. Not all rod-shaped bacteria have pili or flagella, but some have pili or flagella, or both. Examples of rod-shaped bacteria are Salmonella and E.Coli. We have successfully made our first type of bacteria.



Model of Zoonotic Bacteria – Cocci

10. Have participants set their rod-shaped bacteria to the side. Read aloud or paraphrase the following:

Next, we will make our second bacteria called cocci (Kok-sigh) bacteria. For this, use your cotton balls and double-sided tape/photo squares. Use the tape/photo squares to stick the cotton balls together into any formation you want. (See photo left.)

11. Allow members to adhere cotton balls together in any formation they want. Encourage them to be creative. Read or paraphrase the following:

As I look around, I see you’ve made many different formations. Does anyone want to share what they made? (Allow for volunteers.) Although you formed many different shapes, each single cotton ball within that shape represents an individual bacterium. These cocci bacteria are round like a ball, but they often like to cluster into interesting shapes. An example of this kind of bacteria is Mycoplasma, which infects pigs and poultry. Mycoplasma gallisepticum in chickens often causes respiratory disease symptoms such as coughing and difficulty breathing.

12. Ask participants to move the cocci to the side. Read aloud or paraphrase the following:

We will now make what is called a spirochete bacterium. Take the single full-length pipe cleaner and wrap it around the pencil (or the similar-shaped object that you gave them). Then slide the pipe cleaner off of the object. (See photo left.) This represents a spirochete bacterium. It is long, can coil and tends to be flexible. This is another commonly found shape of bacteria. Borrelia burgdorferi is one of the largest concerns as it causes Lyme disease.



Model of Zoonotic Bacteria – Spirochete

13. Instruct participants that as a team, they need to compare the three distinct differences of the bacterium they made. Allow two minutes for a brief discussion. Ask for volunteers to report back to the entire group with their findings.

Examples may include: Rod-shaped bacteria have pili and flagella, which help them to sense their environment and move. Cocci can clump together in special ways to form groups. Spirochete are flexible, long and skinny and can maneuver in ways the other two might not be able to.

14. Once the group is ready to move on read aloud or paraphrase the following:

As successful bacterial builders, we can now move on to virus building. Unlike bacteria, viruses need host cells to reproduce. The host cell usually dies when the viruses either take too many resources or explode the host cell.

15. Have a volunteer from each group come up to the supply station to get the second set of supplies (virus section) including the balloon and beans.
16. Each group will need a balloon and 10 beans. As a group, participants should place the beans through the opening of the balloon one by one (with balloon not inflated). This will result in the beans being inside of the balloon. Assist participants as needed.
17. Have one person on each team blow the balloon up and tie it off. Some participants may need assistance.
18. Participants will use double-sided tape/photo squares to adhere cotton balls and cotton-balls-with-straws combination to the outside of the balloon. To create the cotton-balls-with-straws combination, place tape/squares on the end of the straw and stick it into a cotton ball. Spread the cotton ball up around the straw to cover all the tape/squares and attach it well. Use the tape/squares to stick the cotton balls and the cotton balls with straws to the outside of the balloon in a random assortment. Have one group member hold the balloon while other group members carefully tape. The photo right shows how the cotton balls and cotton balls with straws look when attached to the balloon.
19. Once the viruses are complete, ask participants what they think each of the following items represent:
- Balloon
 - Beans
 - Cotton balls
 - Cotton-ball-with-straw combination



Model of Virus

20. Once participants have shared their thoughts, read aloud or paraphrase the following:

Viruses are usually hard to see, but we made ours so that we can clearly identify the various structures. In our case, the balloon represents the outer membrane of the virus. The beans that we put on the inside are its genetic material (DNA or RNA) – that’s what it gives to the cell so the cell has a blueprint for making more viruses. The cotton balls and cotton-ball-with-straw combination that we put on the outside represent the various kinds of proteins found on the outside of the virus. These can have many different purposes: they can help the virus attach to a cell, enter their genetic material or “blueprints” into the cell, help with the release of viral particles and more. An example of a virus is influenza. Influenza is a common virus that is responsible for many different kinds of flu in humans as well as pigs, ducks and other animals.

21. Next, read aloud or paraphrase the following:

To finish our lesson, we are going to now take a closer look at parasites. Parasites also vary greatly in size and structure. When I give the signal, your team will have 3 minutes to create what you believe parasites would look like reusing the clay you have been provided.

22. Inform participants that they can begin and allow them 3 minutes to create their parasite. Provide youth with a 30-second warning.

23. After 3 minutes, or when the teams seem to have finished their creations, call time and tell the teams to stop working. When the participants have returned their attention to the whole group, ask for one volunteer from each team to explain the team’s creation. Have them tell why they believe it represents a parasite or parasites. Continue the sharing until all of the teams have had a turn. If time and space allow, have the teams walk around the work space to look closely at the models created by the other teams.

24. Read aloud or paraphrase the following:

Your parasites are very imaginative and prove just how different parasites can be. Long structures can be similar to a roundworm, which is an internal parasite (found inside of an animal). Other external or outside parasites can include ticks, lice and mites that would be smaller in their structure.

Now, let’s build a roundworm and eggs.

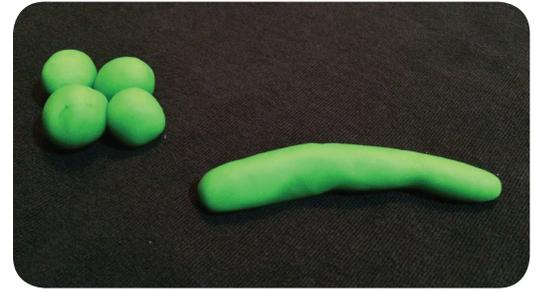
25. Instruct groups to split the clay in half. Half of their clay will be used to make a long worm, and the other half is to be used to make several small round balls. (See photo right.)

26. Read aloud or paraphrase the following:

The worm you created represents a mature roundworm. The round balls represent eggs from which a worm will hatch. Most parasites hatch from eggs.

27. Read aloud or paraphrase the following:

Today, we have made our own versions of these pathogens: bacteria, viruses and parasites. Pathogens are common concerns for those individuals raising animals as well as in everyday life. Humans need to be aware of their surroundings and take precautions to try to avoid pathogens that we may or may not be able to see. Pathogens generally reproduce quickly so taking precautions is important to keeping humans and animals safe and healthy.



Model of a Zoonotic Parasite
(Roundworm and Eggs)

TALKING IT OVER:

Ask the group the following questions.

- ▶ What are the three main types of pathogens that we made today?
- ▶ What differences are there between these three types in how they make more of themselves?
 - Bacteria reproduce by making a direct copy of themselves. Viruses use a host cell to make more viruses. Parasites make eggs, and hatch from these eggs to become mature parasites.
- ▶ What common diseases can these pathogens cause?
 - Bacteria can cause Lyme disease, as well as sickness from *Salmonella* or *E.coli*. Influenza is a common virus that is responsible for many different kinds of flu. Parasites can infest an animal and cause problems such as roundworm.
- ▶ What are some precautions you can take to reduce your interactions with pathogens?
- ▶ How does knowing how each pathogen reproduces impact prevention methods?
- ▶ What precautions can you take to help prevent you and your animals from getting ill?

ALIGNMENT TO SCIENCE & ENGINEERING PRACTICES:

How 4-H Increases Science Literacy

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry-based. The lessons in the *4-H Animal Science Anywhere* series can be used to enhance classroom science education in Michigan and elsewhere. The lesson activities are aligned with the eight Scientific and Engineering Practices (SEP) from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42).

The Michigan State Board of Education adopted a set of new state science standards in late 2015 that are based on the SEP. The activities in the *4-H Animal Science Anywhere: What Is a Pathogen?* lesson were evaluated for their alignment with the SEP by MSU Extension Educator Tracy D'Augustino in 2016.

Table 2. How This Lesson Aligns With the Science and Engineering Practices (National Research Council, 2012, p. 42)

Science & Engineering Practice	Action	Activity Step
1. Asking questions and defining problems	Participants build models of what they think bacteria, viruses and parasites may look like.	3-6, 14-20, 20-24
2. Developing and using models	Participants build models of what they think bacteria, viruses and parasites may look like and describe their models.	3-6, 14-20, 20-24
3. Planning and carrying out investigations		
4. Analyzing and interpreting data	Participants discuss the three types of pathogens and how they reproduce.	Talking It Over
5. Using mathematics and computational thinking		
6. Constructing explanations and designing solutions	Participants discuss precautions they can take to reduce interactions with pathogens.	Talking It Over
7. Engaging in argument from evidence	Participants discuss why it's important to know about pathogens and how pathogens reproduce.	Talking It Over
8. Obtaining, evaluating and communicating information	Participants learn about three types of pathogens, how each type reproduces and how to help keep them all from spreading.	Whole lesson

ADAPTATIONS & EXTENSIONS:

- ▶ To make the lesson more personalized, purchase more materials so each participant can create their own pathogens. Instead of each participant getting clay for the initial rod-shaped bacterium, give clay to every other person. Then have the participant who has the clay split it in half and give half to the person without clay next to him or her to signify bacteria reproducing. All other portions of the lesson would stay the same for an individual.
- ▶ For older or more experienced participants:
 - Have participants brainstorm some common diseases they encounter or have heard of with animals. Then have them research and prepare a presentation on a specific pathogen that causes a zoonotic disease that they could share with the fair board or 4-H livestock or species-specific council.
- ▶ For younger or less experienced participants:
 - Adapt the lesson and save time by creating the cotton ball and straw sections prior to the activity.
 - Have participants draw cartoons on how pathogens look different. Allow them to be as creative as they want.

ACKNOWLEDGMENTS:

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This bulletin was produced by ANR Creative (anrcom.msu.edu) for MSU Extension (msue.anr.msu.edu).

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