

Defining and Understanding Pathogenic Disease: An Engaging Activity that Connects Students' Lived Experiences with their Academic Studies

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Abstract

Contagious diseases are unavoidable realities of life. Thus, understanding pathogens and their respective diseases is important in many biological subfields including evolution, ecology, health sciences, microbiology, and others. While all college students will have encountered pathogenic diseases at some point in their lives, many will not have studied them in a classroom setting. As a result, students may not be able to accurately formulate a comprehensive definition of pathogenic disease on their own. Here, I provide an engaging activity where students construct a definition of pathogenic disease based on their lived experiences using the think-pair-share technique. Students are asked to define pathogenic disease individually, then in small groups, and finally as an entire class. At the end of this activity, the class will have agreed upon one definition for pathogenic disease. Following this, the students are asked to put their new definition into practice by completing a categorization activity where they must sort different diseases into the following categories: genetic, environmental, or pathogenic. This immediate application of new knowledge helps foster long-term learning. Students were highly engaged with the material, and this lesson also fostered a sense of classroom community as it encouraged students to share their knowledge while completing the categorization assignment. An end-of-term review activity showcased that the students were able to recall the information learned during this lesson at the end of the course. This lesson is easy to implement and can help students understand pathogenic disease in both introductory and advanced courses.

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Learning Goals

Students will:

- ◊ practice collaborative problem solving.
- ◊ connect their lived experiences to what they are learning in the classroom.
- ◊ contribute to their peers' understanding of pathogenic disease.
- ◊ understand the difference between genetic, environmental, and pathogenic diseases.

Learning Objectives

Students will be able to:

- ◊ define pathogen.
- ◊ define pathogenic disease.
- ◊ understand what constitutes and environmental or genetic disease.
- ◊ categorize diseases as genetic, environmental, or pathogenic and support their answer.

INTRODUCTION

By the time students enter college most, if not all, have some understanding of pathogenic disease based on their own experiences. These experiences will vary widely within a group, but all students will have experienced the common cold or the flu in their lifetime. However, many students may not have studied the topic formally, and students may not be used to applying their lived experiences within the context of the classroom.

What is a pathogen? A pathogen is an infectious agent that causes disease. If you presented this definition to your students, what would they do? Many students will try to memorize the definition as you have provided it. However, the literature

shows us that memorization rarely leads to long-term learning (1). This is because students often memorize facts in an isolated manner, without making the connections necessary for a complete understanding of the material (2). If students are asked to memorize something but are not given a chance to interact meaningfully with the information, the information is much more likely to be forgotten (3). Thus, if we define learning as the ability to recall and use information after a period of disuse (4), then we must accept that memorization alone is an inefficient learning tool.

Additionally, literature shows collaboration, when used effectively, increases retention, helps students learn problem-solving skills, can increase motivation, and fosters social skills

(5). Biology is a collaborative field and while some students may prefer to work alone, they will likely need to work with others in their future careers. Not only does collaboration encourage learning and engagement in the classroom but it also prepares students for future employment where teamwork is often required (6). Thus, encouraging collaboration can greatly benefit university students.

In this lesson, I use a simple and fun activity to get students to construct their own definition of pathogenic disease based on their own experiences and prior knowledge. I then ask them to immediately apply this new knowledge in a categorization activity that will engage them with this information in a meaningful way. The activity, which can be implemented online, in-person, or in a hybrid classroom, is the basis for a course or course section that focuses on pathogenic or infectious disease. In this article, I describe the activity, which will get students collaborating and helping each other to build an understanding of pathogenic disease in a way that will foster long-term learning and help create community within your classroom.

There is another available lesson that introduces students to different types of pathogens (7). This could be used as a primer to the lesson described here. Additionally, my activity could easily be followed by other published lessons that expand upon the topic of pathogenic disease. For example, there are lessons that focus on Lyme disease (8) and typhoid (9) that both aim to increase student's understanding of specific diseases. By providing an engaging introduction to these topics, my article contributes new materials that are available to help teach classes that cover pathogenic disease such as introductory biology, disease ecology, and microbiology.

Intended Audience

The intended audience is students in an introductory or advanced level biology class that covers topics related to pathogenic disease. It could also be used for high school lessons or non-majors classes. I used this lesson as an introductory activity in an upper-division course that broadly covered disease ecology. While this lesson was tested in a small class (approximately 20 students), I anticipate it could be easily adapted for larger classes. If you are teaching a very large class, you may want to make use of online discussion boards to promote classroom-wide discussion. This lesson can be used in any type of classroom (online, hybrid, and in-person) where students meet synchronously. This lesson would work well for both majors and non-majors.

Required Learning Time

This lesson requires a single 45–60 minute class period. Students do not need to spend time outside of class preparing for this lesson. The optional follow-up activity requires 10–20 minutes of a second class period.

Prerequisite Student Knowledge

Students require a basic familiarity with types of pathogenic diseases. Typically, the knowledge required for this lesson can be pulled from their own lived experiences. By the time students enter college they will likely have experienced many common diseases such as strep throat, the common cold, or the flu. This lesson does not require additional prerequisite knowledge about pathogens. Some students will have more

knowledge about certain diseases than other students. This leads to excellent group and class discussions. Thus, I strongly recommend running this lesson without lecturing about pathogenic diseases ahead of time.

Prerequisite Teacher Knowledge

Teachers require a basic understanding of pathogenic diseases. Balloux and van Dorp (10) provide an excellent overview of pathogens and how they cause disease. Instructors also need to have some knowledge about all the diseases/disorders used in the categorization activity and their causative agents (genetic, environmental, or pathogenic). As given, Supporting File S1 covers six types of pathogens: bacteria, viruses, fungi, prions, protozoa, and metazoans. If the instructor wishes to simplify this section, they could remove fungi and prions, which are the types of pathogens that students will likely be least familiar with. The [Centers for Disease Control and Prevention \(CDC\) website](#) has information for all the diseases used in Supporting File S2, and I include a brief introduction to each disease/disorder below (Table 1).

If preferred, the instructor could alter the activity to include diseases that they are already knowledgeable about. For ease of adaptation, I have included a document that includes information for additional diseases that could be used instead of the diseases described above (Supporting File S3).

SCIENTIFIC TEACHING THEMES

Active Learning

The lesson has three active learning components: a think-pair-share activity, a class brainstorming session, and a small group categorization activity. These active learning techniques are meant to promote engagement and help students construct new knowledge (24). Think-pair-share activities have been shown to increase student motivation and engagement (25) while building confidence and encouraging students to participate in class discussions (26). Additionally, think-pair-share activities are shown to increase critical thinking skills (27). The categorization activity has students discuss and sort different diseases into categories. This helps students apply their previous knowledge to a new task. This is more likely to lead to learning than if students are simply told the answers (28). These activities allow students to engage with all the information required to achieve the learning objectives stated above. All three of these components occur within a single class period.

Assessment

The goal of this activity was to get students engaged with a new topic that they may not have previously discussed in an academic setting. To that end, students were assessed on participation and completion rather than on accuracy. Notecards from the think-pair-share activity and the categorization worksheet were collected and given credit for being complete. Students were able to use the post-activity follow-up discussion and key to self-evaluate their work. The key also allows students to correct themselves and ask questions to clear up any misconceptions. As described, this lesson includes no summative assessment although you could assess the categorization worksheets for accuracy if desired. Instead, the assessment of this lesson is entirely formative. Formative assessments allow students to monitor their learning

as they learn and are correlated to higher scores on subsequent summative assessments, such as exams (29, 30). The optional review activity further illustrates to the students how much they have learned. By having them repeat the think-pair-share portion of the lesson, and then returning the notecard from the first activity, students can self-evaluate how much they have learned throughout the course or course section.

Inclusive Teaching

This lesson is inclusive because it takes advantage of students' diverse lived experiences and incorporates them into the learning process. Connecting classroom topics to personal experiences increases student interest and motivation and leads to more effective learning (31). For example, a student who was born outside of the U.S. might have personal experiences with diseases that U.S.-born students do not (and vice versa). This lesson encourages students to apply their personal or familial history to engage themselves and others with the material. It focuses the students on growth (utilizing what they already know to help them learn new information) rather than on deficit (focusing on what students do not know).

This lesson further fosters inclusivity by allowing students to participate in the activities in a multitude of ways: solo writing, small group discussion, small group problem solving, and whole class discussion. One goal of inclusive teaching is that no student should feel left out, and by providing structure and a multitude of opportunities to engage, all learners can benefit (32). This lesson allows each student to participate in a way that makes them feel comfortable and confident. This helps build a classroom community where students feel valued and heard. In turn, this can help students feel more confident in themselves and encourage them to participate in new ways in the future.

LESSON PLAN

Summary

There are three major components to this lesson: (i) a think-pair-share activity where students individually, and then in groups, define pathogenic disease, (ii) a brainstorming session where students discuss types of pathogens, and (iii) a categorization activity where students use their definition to categorize diseases as genetic, environmental, or pathogenic (all described in Supporting File S1). See the notes section on each slide to help guide you through the lesson. A worksheet for the categorization activity is available in Supporting File S2. The lesson can be completed within one ~45–60 minute class session (see Table 2). This time frame allows ample time for students to discuss the prompts with their peers.

Preparation

Teaching in Person

Gather any of the following materials you plan to use. If using notecards for the think-pair-share, make sure you have notecards for each student. Test out the PowerPoint slides and make sure they are working appropriately on your computer (Supporting File S1). Print out a copy of Supporting File S2 for each student (or one for each group of students if you prefer). Make any changes to the materials that are necessary for the activity to best fit your class. This could include changing the

diseases that you ask students to categorize, adding additional informational slides, or changing the instructional slides to modify the activities.

Teaching Online

I do not recommend posting the supporting slides (Supporting File S1) ahead of time as they are designed to complement the discussion prompts. The Categorization worksheet can be posted to your Learning Management System (LMS) either as a standalone file or as an assignment where students will submit their completed worksheet at the end of class. For having students submit their definitions of pathogenic disease, I recommend creating a discussion board in your LMS. Many LMS discussion boards have a helpful feature where students cannot see the replies of other students until they have posted themselves. This prevents students from copying their peers' definitions while still promoting discussion and collaboration after each student has contributed their own definition.

Be sure to familiarize yourself with the online meeting platform you are using. If you are using Zoom, I would use breakout rooms to facilitate group discussions. Using the breakout room feature, you can assign groups at random, assign groups manually, or allow students to choose their own groups. When using this feature, be prepared to copy any discussion prompts into the chat before you open the breakout rooms. Once in the breakout rooms, the students will not be able to see your shared screen until they rejoin the main room.

In-Class Activity

This activity has been taught as an introductory activity for a class that focused on human pathogenic disease. Students participated using only their background knowledge about the topic and about the diseases presented to them in the activities. Because of this, some students may not be familiar with all the diseases covered in Supporting File S2. While it might be tempting to lecture students on each disease ahead of time, I do not recommend this. Each student brings unique experiences and background knowledge to this activity which enriches the group discussions that take place. For this reason, I recommend students be assessed mainly for participation and completion rather than accuracy for this activity. If your students are already familiar with the diseases you will ask them about, you may choose to assess the worksheet for accuracy instead.

Define Pathogenic Disease Activity

This activity runs as a think-pair-share style activity. Project the prompt and instructions on the board (Supporting File S1). Hand out a notecard to each student (or direct them to a discussion board if collecting responses electronically). Instruct students to answer the prompt, "How do you define pathogenic disease?" without the help of their peers or other reference materials. Allow a few minutes for students to think about the prompt and write down their answer. Give a one-minute warning so students know to wrap up their writing.

When this is done, instruct students to form groups of 2–3 students (if you have a large class you may want to use larger groups). I allowed students to choose their own groups, but you can also assign the groups yourself if you prefer. These

are the groups the students will work with for the entirety of this lesson. Advance to the second slide of the instructions (Supporting File S1) and have the groups come up with a group definition of pathogenic disease that everyone agrees on. Let students know that groups will be expected to share their definition with the class and ask them to designate a speaker. Give students another one-minute warning before asking the class to come back together.

Have each group read off their definition. Write any recurring themes up on the board (Zoom has a built-in whiteboard if teaching online). Once each group has shared, use the group definitions to create a class definition. Write this class definition up on the board so students can reference it throughout the rest of the session. Make sure students have written their name on their notecards and collect the notecards at this time.

What Is a Pathogen?

Project the third slide from Supporting File S1 on the board. This slide lists one possible definition of pathogenic disease: "Diseases that are caused by infectious agents." Ask the students to discuss what these 'infectious agents' are. Allow up to five minutes for students to talk in their groups. When this time has elapsed, ask a few volunteers to share what things might count as infectious agents. Write their answers up on the board. Then advance to the fourth slide of Supporting File S1. This slide lists out six common types of pathogens: bacteria, viruses, fungi, prions, protozoa, and metazoans. Ask students to give examples of a disease caused by each type of pathogen or give examples yourself. This helps students connect the pathogen to disease. Advance to the next slide of where a definition of pathogen is given. Ask for questions here as the students need to understand what a pathogen is to complete the following activity.

Disease Categorization Activity

Briefly discuss the definitions of environmental and genetic disease (on slides 6 and 7 of Supporting File S1). Go over some examples if needed. Environmental diseases can be caused by water or air pollution, chemical pollution, or radiation to name a few. Genetic diseases are caused by mutations in genes or chromosomes. Advance to the first Small Group Work: Classification slide. While students read the instructions, pass out the worksheet (Supporting File S2). Remind students that it is ok if they don't know what one of the diseases is, because another member of their group may know. Ask students to put away their phones and laptops. While it may be tempting to look up the answers, the goal of this activity is to use prior knowledge and discussion to complete the work. When the students are ready to begin the activity, advance to the ninth slide of Supporting File S1. This slide contains the same information as the worksheet. Give students 10–15 minutes to complete the assignment. During this time make yourself available for questions. Collect the worksheets before continuing if you want to assess them for accuracy.

Post-Activity Follow Up

Call on groups to ask them how they categorized each disease from the worksheet. Allow a group to pass if they did not know what the disease was. You may choose to list out their categorizations on the board. Have a discussion for any

diseases that are not agreed upon by the whole class. Do not discuss cancer (or any other challenging disease you choose to use) yet. Cancer is a challenge to categorize as just one of the three options. Begin sharing the eighth slide of Supporting File S1. This slide functions as a key for the assignment for every disease listed on the worksheet except for cancer. Open discussions about where cancer should be categorized. Ask groups how they categorized cancer and why. Give other groups the chance to respond. The instructor should act mainly as a facilitator here. This is a time to get significant discussion occurring between different student groups.

When discussions about cancer (or another challenging disease of your choosing e.g., diabetes) have died down, advance to the next slide. This slide discusses cancer in greater detail. It showcases that cancer is really many different diseases and can have genetic, environmental, or pathogenic causes. Once you have finished going through this slide with the students, advance to the last slide of Supporting File S1. This shows cancer being listed in all three categories. Ask for any questions before concluding the activity. Collect the worksheets before students leave the class if you will assess them for participation.

Optional Review Activity

This part of the lesson is optional. This activity both reviews the material covered previously and demonstrates to the students how much they have learned. It is meant to take place either at the end of the course, or after you have completed the pathogenic disease section of your course. You will need the notecards the students submitted previously, as well as a new notecard for each student. Project the first slide of Supporting File S4. This slide asks students to define pathogenic disease. Hand out a new, blank notecard to each student while they read the directions. Give students a few minutes to write out their answers.

When students have finished writing, hand back the notecards students submitted at the end of the previous activity. Only after each student has their old notecard should you advance to the second slide of Supporting File S4. This is a think-pair-share activity where students are asked to discuss if their answer to this question has changed now that they have learned more about pathogenic disease. They are also asked to discuss if they found the question easier to answer now than when they first completed the activity. Give students 5–10 minutes to discuss these questions. When that time is up, ask students to share their insights with the class.

TEACHING DISCUSSION

General Observations

To date this lesson has been offered in one class of 20 students. Participation was generally high, with all 20 students submitting their notecards at the end of the first activity. Students were engaged with the activity and actively participating throughout. Students approached the definition activity generally in one of two ways: (i) trying to define 'pathogen' first and then defining 'disease' or (ii) just trying to define 'disease' and listing different types of pathogens. Some students wrote very short and general definitions while others wrote very detailed definitions that tried to be all-encompassing.

Summary of Student Responses

During the last part of this think-pair-share activity, student groups shared their agreed upon definitions of 'pathogenic disease'. Students commonly agreed that pathogenic disease had to:

- be transmitted in some way
- have a disease-causing agent involved (students often named bacteria and viruses)
- reduce the overall health of the infected person

Less common responses also discussed:

- the pathogen targeting specific body parts or systems
- the pathogen depending on the host for reproduction or survival
- whether or not the pathogen would attack the immune system

Additionally, we had an interesting discussion about symptoms. Students pondered if symptoms were required to say whether an individual had a disease. Because this lesson was offered in the summer of 2022, asymptomatic COVID-19 cases were discussed, as many students had been hearing about these cases in the news. We continued to discuss the possible differences between 'disease' and 'infection'. No common misconceptions were noted in the student responses. If misconceptions arise, use them as a chance to start a new discussion with your class so you can address and correct the misconceptions in a collaborative and supportive way.

The categorization activity was engaging and led to thoughtful group discussions. While participation was high, some students did not know what all the diseases in the activity were. Cholera was particularly challenging. Some students had never heard of cholera before while others knew it was associated with bad water and thus categorized it as an environmental disease. This led to a discussion about what makes water 'bad' or unhealthy, including waterborne pathogens. Being in groups allowed students to complete the activity even when each individual did not know what each disease was. For most groups, someone knew about each disease listed in the worksheet.

Additionally, including cancer in the disease categorization worksheet led to an engaging class discussion because cancer can be caused by many different agents. Some groups listed cancer as a genetic disease while other groups listed it as environmental. A few groups wanted to list it under both categories. Once HPV was introduced into the discussion, several groups wanted to list it under all three categories. This discussion helped students see that cancer is really several diseases, not just one. Including a challenging disease such as cancer increased student engagement with the whole-class discussion. Through our discussions, and reading through the collected students' materials, it was clear that my students had achieved the lesson's learning objectives.

Observations about the Optional Review Activity

I conducted the optional review activity at the end of my 5-week summer course. I gave each student a new notecard and asked them to define pathogenic disease. When they

were done, I returned their notecard from the beginning of the course. I then had the students discuss the differences between their two definitions with their classmates. I also asked students if completing the activity was easier now compared to at the start of the course. Many students shared that they had changed their answers from the beginning of the course. Students generally wrote much more descriptive definitions and wanted to include a lot of details that they had learned throughout the term. Students often answered that the activity was easier to approach now, because they had the vocabulary necessary to articulate their thoughts. However, their answers were no longer as simple and thus the activity took more effort at the end of the course. Students were excited to receive their notecards from the first day back. By repeating this activity, you can highlight to the students how much they have learned. Students may not realize just how much they have grown! All students participated in the group and class discussions that arose from this think-pair-share activity. Finally, this activity reinforces that the students have met the second learning objective listed for this lesson: "students will be able to define pathogenic disease".

Potential Variations

Although this activity was developed to be done entirely during a single class, it could easily be adapted into an activity that includes a homework assignment. Rather than giving time to complete the categorization activity in class, the students could be assigned to complete the worksheet on their own time. If adapted in this way, a portion of a second class session should be devoted to students discussing their answers with each other in small groups and with the whole class. This would allow the lesson to be completed in two partial class sessions rather than requiring a full class session. If using this adaptation, be aware that many students may just look up the answers rather than completing the activity using only their background knowledge. In this case, it might be useful to ask students to write a little blurb about each disease where they detail their background knowledge first, before categorizing each disease.

This lesson could also be broadened to include additional learning outcomes and could serve as a basis to discuss disease ecology broadly and ask pertinent questions such as "Can we eradicate all diseases?" or "Why is it important to understand the causative agents of disease?". Through discussions or subsequent activities that pose these questions, students could be asked to apply, analyze, or evaluate further information which would expand this lesson across additional categories within Bloom's Taxonomy. For example, you could ask students if it is likely that swine flu, which is common in pigs but occasionally transmits from pigs into humans, could be easily eradicated (*i.e.*, could the virus that causes this illness be eradicated? Why or why not?).

Finally, while the lesson focuses on pathogenic disease, it could be generalized to any core topic or overarching theme that students can apply their own lived experiences or other background knowledge to. This lesson functions as an excellent tool for determining what background knowledge your class already has and can also help instructors identify common misconceptions about core class topics. An instructor may adapt this lesson to ask:

- What is behavior?
- How do we define evolution?
- How do we define climate change?

These could then lead into their own categorization activities. Some examples might include:

- List actions animals or plants do and ask students to determine which ones are 'behaviors'
- List scenarios describing morphological or genetic changes and ask students to determine if 'evolution' has taken place
- List different effects of climate change and ask students to categorize them as human-caused versus natural

SUPPORTING MATERIALS

- S1. Define Pathogenic Disease – Instructional Slides
- S2. Define Pathogenic Disease – Disease Categorization Worksheet
- S3. Define Pathogenic Disease – List of Alternative Diseases
- S4. Define Pathogenic Disease – Optional Follow-up Activity

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Table 1. Descriptions of common pathogenic diseases.

Disease	Description
Influenza	A disease caused by a virus that affects the respiratory tract (11).
Hemophilia	A genetic disorder that affects the blood's ability to clot correctly (12).
Cancer	Several different diseases that are often grouped together and called 'cancer'. Cancer can affect different parts of the body in different ways. Cancer can be caused by environmental, genetic, or pathogenic agents (13).
Cystic Fibrosis	A genetic disorder that affects mucus thickness. This altered mucus can lead to issues in the respiratory and digestive tracts (14).
Malaria	A disease caused by a eukaryotic parasite that is vectored by mosquitoes. It remains a very deadly disease, especially for young children in Africa (15).
Smallpox	A disease that was caused by a virus. It was very contagious and had a significant fatality rate. Thanks to a very successful vaccination program, smallpox has been eradicated (16).
Bubonic Plague	A bacterial infection vectored by fleas. Antibiotic treatments are available which greatly decrease mortality rate (17).
Sickle Cell Disease	A genetic disorder that affects the red blood cells by deforming them into a different shape (18).
Cholera	A bacterial infection that affects the intestines. Cholera can lead to severe dehydration which can be fatal. Treatment focuses on rehydration and drastically lowers the mortality rate (19).
Ebola	An often-fatal disease that is caused by a virus. Infection occurs from contact with an infected person or animal. Recently a vaccine has been developed and approved by the FDA to combat Ebola (20).
Coal Worker's Pneumoconiosis (sometimes called "Black Lung Disease")	A disease that mainly affects coal miners. It is caused by inhalation of coal dust in the mines. Rates of this disease in the United States have decreased because of laws that established higher safety standards (21).
Common Cold	A disease caused by several types of viruses. There is no cure as antibiotics do not work against viruses. The best treatment is rest and drinking lots of water (22).
Strep Throat	A bacterial infection that affects the throat and tonsils. It spreads easily from person to person. Antibiotics are given as a treatment (23).

Table 2. Defining Pathogenic Disease lesson timeline.

Activity	Description	Estimated Time	Notes
Preparation for Class			
Class Materials Preparation	<ol style="list-style-type: none"> 1. A notecard for each student. 2. Print out categorization worksheets if you will use them. 	5 minutes	If you plan to have students submit their responses electronically instead you may want to email the class to remind them to bring a smart device to class.
In-Class			
Define Pathogenic Disease. Individual Work (Think-Pair-Share)	<ol style="list-style-type: none"> 1. Put the directions on the board. 2. Hand out notecards (if using them). 	5 minutes	PowerPoint slides with directions are in Supporting File S1.
Define Pathogenic Disease. Group/Class Work (Think-Pair-Share)	<ol style="list-style-type: none"> 1. In groups of 2–3 have students share their definitions and come up with a definition the whole group agrees on. 2. When groups are done with this, ask each group to read their definitions. 3. Determine a definition the entire class agrees on and write it on the board. 4. Collect student notecards for assessment. 	10–15 minutes	You may want only a handful of groups to read their definitions if the class is very large.
What is a pathogen? Class Brainstorming	<ol style="list-style-type: none"> 1. Discuss what ‘pathogens’ or ‘infectious agents’ are. Have students briefly discuss in their groups and report back to the class. 2. Go over the main types of pathogens and give examples. 	5–10 minutes	PowerPoint slides are in Supporting File S1. I recommend discussing at least one example of each type of pathogen.
Disease Categorization Activity	<p>Put up the instructional slides on the board.</p> <p>Hand out Categorization Worksheet (if using them).</p> <p>Give students time to work and give them a chance to ask you questions.</p> <p>Collect worksheets for assessment, if desired.</p>	10–15 minutes	<p>PowerPoint slides are in Supporting File S1. Worksheet is in Supporting File S2.</p> <p>You can either collect the worksheets to assess for participation or accuracy. If using this to introduce pathogenic disease I would suggest participation-based assessment.</p>
Post-Activity Follow-Up	<ol style="list-style-type: none"> 1. Ask students how they categorized each disease. 2. Allow time for discussion for any diseases that are not agreed upon by the class. 3. Show students the follow-up slides 4. Discuss how cancer can be pathogenic, environmental, or genetic. 5. Give students a chance to ask questions at the end. 	10–15 minutes	<p>There are many ways to gather student responses, voting with hands, cold calling groups, volunteers, electronic polls, etc. This is just to help you know if any of the diseases really tripped them up. Leave cancer or any other challenging diseases you chose for last.</p> <p>Allow for discussion here. This lets students inform and learn from each other. Only once discussion has died down should you show them the correct answers.</p> <p>Follow-up slides are in Supporting File S4.</p>

Activity	Description	Estimated Time	Notes
Optional End of Term Follow-Up			
Review Activity	<ol style="list-style-type: none"> 1. Ask students to define pathogenic disease. Put the directions up on the board. 2. Hand out notecards to each student (if using them). 3. Allow students time to answer the prompt. 4. Hand back the note cards used in the previous activity. 5. Have students discuss the follow-up questions from the slides. 6. Ask students to share what they discussed. 	10–20 minutes	Instructional slides are in Supporting File S4. The purpose of this is to showcase to the students how much they have learned.