

the science of  
**MICROBES**

Activity: Infectious Disease Case Study  
from *The Science of Microbes Teacher's Guide*

by Nancy P. Moreno, Ph.D., Barbara Z. Tharp, M.S., Deanne B. Erdmann, M.S.,  
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# BioEd<sup>SM</sup>

## TEACHER RESOURCES FROM THE CENTER FOR EDUCATIONAL OUTREACH AT BAYLOR COLLEGE OF MEDICINE

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# Microbial Challenges

**I**nfectious diseases have plagued humans throughout history. Sometimes, they even have shaped history. Ancient plagues, the Black Death of the Middle Ages, and the “Spanish flu” pandemic of 1918 are but a few examples.

Epidemics and pandemics always have had major social and economic impacts on affected populations, but in our current interconnected world, the outcomes can be truly global. Consider the SARS outbreak of early 2003. This epidemic demonstrated that new infectious diseases are just a plane trip away, as the disease was spread rapidly to Canada, the U.S. and Europe by air travelers. Even though the SARS outbreak was relatively short-lived and geographically contained, fear inspired by the epidemic led to travel restrictions and the closing of schools, stores, factories and airports. The economic loss to Asian countries was estimated at \$18 billion.

The HIV/AIDS viral epidemic, particularly in Africa, illustrates the economic

For an emerging disease to become established, at least two events must occur: 1) the infectious agent has to be introduced into a vulnerable population, and 2) the agent has to have the ability to spread readily from person to person and cause disease. The infection also must be able to sustain itself within the population and continue to infect more people.

and social effects of a prolonged and widespread infection. The disproportionate loss of the most economically productive individuals within the population has reduced workforces and economic growth in many countries, especially those with high infection rates.

This affects the health care, education, and political stability of these nations. In the southern regions of Africa, where the infection rate is highest, life

expectancy has plummeted in a single decade, from 62 years in 1990–95 to 48 years in 2000–05. By 2003, 12 million children under the age of 18 were orphaned by HIV/AIDS in this region.

Despite significant advances in infectious disease research and treatment, control and eradication of diseases are slowed by the following challenges.

- The emergence of new infectious diseases
- An increase in the incidence or geographical distribution of old infectious diseases
- The re-emergence of old infectious diseases
- The potential for intentional introduction of infectious agents by bioterrorists
- The increasing resistance of pathogens to current antimicrobial drugs
- Breakdowns in public health systems



Baylor College of Medicine, Department of Molecular Virology and Microbiology, [www.bcm.edu/molvir/](http://www.bcm.edu/molvir/).

## USING COOPERATIVE GROUPS IN THE CLASSROOM

**C**ooperative learning is a systematic way for students to work together in groups of two to four. It provides organized group interaction and enables students to share ideas and to learn from one another. Students in such an environment are more likely to take responsibility for their own learning. Cooperative groups enable the teacher to conduct hands-on investigations with fewer materials.

Organization is essential for cooperative learning to occur in a hands-on science classroom. Materials must be managed, investigations conducted, results recorded, and clean-up directed and carried out. Each student must have a specific role, or chaos may result.

The Teaming Up! model\* provides an efficient system for cooperative learning. Four “jobs” entail specific duties. Students wear job badges that

describe their duties. Tasks are rotated within each group for different activities so that each student has a chance to experience all roles. For groups with fewer than four students, job assignments can be combined.

Once a model for learning is established in the classroom, students are able to conduct science activities in an organized and effective manner. Suggested job titles and duties follow.

### Principal Investigator

- Reads the directions
- Asks the questions
- Checks the work

### Maintenance Director

- Follows the safety rules
- Directs the cleanup
- Asks others to help

### Reporter

- Records observations and results
- Explains the results
- Tells the teacher when the group is finished

### Materials Manager

- Picks up the materials
- Uses the equipment
- Returns the materials

\* Jones, R.M. 1990. *Teaming Up!* LaPorte, Texas: ITGROUP.

**TIME****Setup:** 30 minutes**Activity:** 45–60 minutes**SCIENCE EDUCATION  
CONTENT STANDARDS**

Grades 5–8

**Inquiry**

- Develop descriptions, explanations, predictions and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.

**Life Science**

- Disease is a breakdown in structures or functions of an organism. Some diseases are the result of infection by other organisms.



This transmission electron microscope image shows several influenza virus particles. CDC\8432 C. Goldsmith, F. Murphy.

## Overview

Students will use evidence to determine whether a patient has a cold, flu or strep infection. In the process, they also will learn about the differences between bacterial and viral infections.

**I N F E C T I O U S   D I S E A S E**

# Case Study

**M**any different microorganisms can infect the human respiratory system, causing symptoms such as fever, runny nose or sore throat. Even the common cold, which may range from mild to serious, can be caused by any of more than 200 viruses! Colds are among the leading causes of visits to physicians in the United States, and the Centers for Disease Control and Prevention (CDC) report that 22 million school days are lost in the U.S. each year due to the common cold. Usually, cold symptoms appear within two to three days of infection and include: mucus buildup in the nose, swelling of sinuses, cough, headache, sore throat, sneezing and mild fever (particularly in infants and young children). The body's immune system, which protects against disease-causing microbes, almost always is able to eliminate the viruses responsible for a cold.

Flu (or influenza) often is more serious than the common cold. Caused by one of three types of closely related viruses, flu can come on quickly, with chills, fatigue, headache and body aches. A high fever and severe cough may develop. Flu may be prevented in some cases through a vaccine. However, since the viruses that cause flu change slightly from year to year, a new vaccine is required each flu season. Influenza was responsible for three pandemics (worldwide spread of disease) in the 20th Century alone.

A disease can be any change in the body or mind that causes discomfort, loss of function, distress or death. Some diseases are caused by microorganisms that invade or infect the body. Examples of infectious diseases are colds (virus), strep throat (bacteria), and malaria (protozoa).

Other diseases, such as most kinds of heart disease, are not considered to be caused by infection (although microbes may be involved indirectly) and cannot spread from one person to another.

Antibiotics do not kill viruses, and therefore, are not helpful in fighting the common cold or flu. But these diseases can make a person more susceptible to bacterial infections, such as strep throat, a common infection by a *Streptococcus* bacterium. Symptoms of “strep” infections include sore throat, high fever, coughing, and swollen lymph nodes and tonsils. Diagnosis should be based on the results of a throat swab, which is cultured, and/or a rapid antigen test, which detects foreign substances, known as antigens, in the throat. Strep infections usually can be treated effectively with antibiotics. Without treatment, strep throat can lead to other serious illnesses, such as scarlet fever and rheumatic fever.

Symptoms similar to those of a cold



## COLD OR AIRBORNE ALLERGY?

SYMPTOM	COLD	ALLERGY
Cough	Common	Sometimes
Itchy eyes	Rare	Common
Sneezing	Usual	Usual
Sore Throat	Common	Sometimes
Runny Nose	Common	Common
Stuffy Nose	Common	Common
Fever	Rare	Never
Length	3–14 days	Weeks

can be caused by allergens in the air. Health experts estimate that 35 million Americans suffer from respiratory allergies, such as hay fever (pollen allergy). An allergy is a reaction of an individual's disease defense system (immune system) to a substance that does not bother most people. Allergies are not contagious.

### MATERIALS

#### Teacher (see Setup)

- 90 letter-size plain envelopes
- 6 sheets of white, self-stick folder labels, 3-7/16 in. x 2/3 in., 30 labels per sheet (Avery™ #5366, 5378 or 8366)
- Overhead projector
- Overhead transparency of *Disorders & Symptoms* student sheet

#### Per Group of Students

- Set of prepared envelopes (15 envelopes per set)
- Copy of *What is Wrong with Allison?* and *Disorders & Symptoms* student sheets
- Group concept map (ongoing)

### SETUP

Photocopy *What is Wrong with Allison?* and *Disorders & Symptoms* sheets (one copy of each per student), to be distributed in order (see Procedure).

Photocopy the label template sheet onto six sheets of white, self-stick labels, such as Avery™ #5366, 5378 or 8366, which contain 30 labels per sheet.

Use one page of photocopied labels to create each set of envelopes. Place a Question label on the outside of one envelope and stick the corresponding Clue label on the inside flap of the same envelope. Close the flap, but do not seal the envelope. Make six sets of 15 envelopes (one set per group).

Make an overhead transparency of the *Disorders & Symptoms* sheet.

Have students work in groups of four.

**Optional:** Instead of using self-stick labels, copy the label template page onto plain paper and cut out each question and clue. Tape one question to the outside of an envelope and the corresponding clue to the inside flap of the envelope.

### PROCEDURE

1. Begin a class discussion of disease by asking questions such as, *How do you know when you are sick? What are some common diseases? Are all diseases alike? Are all diseases caused by a kind of microbe? Do some diseases have similar symptoms?*
2. Tell your students that in this class session, they will be acting as medical personnel trying to diagnose a patient. Give each group a copy of the *What is Wrong with Allison?* sheet. Have one student read the case to the group, and then have groups discuss it. The reporter should record each group's ideas about what might be wrong with Allison.
3. Have each student group list four possible questions that a doctor might ask a patient like Allison. Write these questions on the board and discuss with the class.
4. Have groups identify three possible diseases that Allison may have, based on the story, class discussion and their own experiences.

*Continued*

## ANTIBIOTIC RESISTANT BACTERIA



The emergence of multidrug-resistant tuberculosis represents a large and growing threat to TB control programs. NIAID, NIH\ C. Barry, E. Fischer.\*

Overuse and inappropriate use of antibiotics (to treat the common cold, for example) have contributed significantly to the evolution of antibiotic-resistant bacteria.

When bacteria are exposed to an antibiotic, a few may survive. The hereditary information of these survivors is just a little different from the rest, and it provides an advantage that allows them to live. The surviving bacteria reproduce and pass the resistant characteristic on to future generations. The original antibiotic will not kill bacteria that have acquired the resistant trait.

\* Image courtesy of the National Institute of Allergy and Infectious Diseases (NIAID), NIH. Image taken at the Rocky Mountain Laboratories, NIAID, NIH.






## WHAT IS A VECTOR?

“Vector” is more than a term used in physics and mathematics. In medicine, a vector is an organism (often an insect or rodent) that carries and transmits disease-causing agents like bacteria, viruses or parasites to a host. Microbiologists use this term to describe viruses or bacteria that transport genes into a host cell. U.S. Environmental Protection Agency.

5. Give each student a copy of the *Disorders & Symptoms* sheet and briefly introduce the four illnesses to the entire class. Compare these illnesses to the ones that students suggested. Ask, *Are there any similarities?* Have students follow the instructions on the sheet to complete the exercise.
6. Give each group of students a set of envelopes. Warn students not to open the envelopes until they are instructed to do so. Tell students that each envelope contains information that a medical doctor might need about a patient. All information is important to the diagnosis, but only certain information will help to distinguish among the four possible respiratory disorders. Tell students their task is to decide which envelopes contain information that will help them determine Allison’s illness.

Once a group has agreed on question choices, it may open as many envelopes—one at a time—as needed. The challenge is to use as few envelopes as possible to diagnose Allison’s illness. Each group should keep a tally of the number of envelopes opened. Remind students that in real life, a physician would conduct a complete examination and gather all possible information before making a diagnosis.
7. Allow time for groups to work. Provide assistance to students who may not understand the information contained in the envelopes. If the medicine and body temperature envelopes have been opened, make sure students understand that some medications, like Tylenol™, will mask the presence of mild fevers.
8. Have each group present its diagnosis and the reasoning used to arrive at its decision. (Allison’s disease is a common cold. If students have arrived at other conclusions, discuss the evidence they used. Mention the challenges of diagnosing respiratory diseases.)
9. Expand the discussion to address the importance of not taking antibiotics for viral diseases. Ask, *Since Allison has a cold, should her doctor prescribe antibiotics? Would it be okay to take leftover antibiotics?* Help students understand that antibiotics are effective for bacterial infections, but do not help against viral infections like colds.

Also, mention that if antibiotics are prescribed for a bacterial infection, it is important to follow the doctor’s instructions and to take all the medication, even if symptoms start to improve before the medicine is gone. Otherwise, the disease may reoccur. Taking antibiotics incorrectly, or using them inappropriately (such as taking leftover medicine without a doctor’s guidance) can contribute to the development of antibiotic resistant forms of bacteria, which cannot be killed by existing antibiotics (see Antibiotic Resistant Bacteria, sidebar, p. 2).
10. Have student groups add information to their concept maps. 



# What is Wrong with Allison?

Allison is an active, healthy girl. She loves to play outside with her dog. She missed only one day of school last year. But when she woke up this morning, Allison had a headache and a sore throat. She wasn't hungry, so she just had juice for breakfast.

Allison's mom felt her forehead, and said Allison seemed a little too warm. Her mom decided to take Allison to their family doctor, because Allison's cousin had a strep throat infection.

What do you think could be causing Allison's symptoms?

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Acting as Allison's doctor, your team will use clues to figure out what is making Allison ill. List four questions that you think Allison's doctor might ask.

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

3. \_\_\_\_\_  
\_\_\_\_\_

4. \_\_\_\_\_  
\_\_\_\_\_

Based on class discussion, what are three likely diseases Allison may have?

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

3. \_\_\_\_\_  
\_\_\_\_\_



# Disorders & Symptoms

ILLNESS	SYMPTOMS	CAUSES	TREATMENT
<b>Common Cold</b>	<ul style="list-style-type: none"> <li>• Headache</li> <li>• Cough</li> <li>• Sore throat</li> <li>• Sneezing</li> <li>• Clear mucus in the nose</li> </ul>	Viruses	Resting, drinking plenty of fluids
<b>Flu</b>	<ul style="list-style-type: none"> <li>• Headache</li> <li>• Sore throat</li> <li>• Muscle aches</li> <li>• Tiredness (fatigue)</li> <li>• Dry cough</li> <li>• Diarrhea and/or vomiting</li> <li>• High and sudden fever</li> </ul>	Viruses	Resting, drinking plenty of fluids (if caught early, flu can be treated with special antiviral medication)
<b>Strep Throat</b>	<ul style="list-style-type: none"> <li>• Red, painful throat</li> <li>• White patches on tonsils</li> <li>• Fever</li> <li>• Headache</li> <li>• Stomach pain</li> <li>• Vomiting</li> </ul>	Bacteria	Resting, drinking plenty of fluids, taking antibiotics prescribed by a doctor
<b>Nasal Allergy</b>	<ul style="list-style-type: none"> <li>• Itchy eyes and throat</li> <li>• Clear mucus in nose</li> <li>• Frequent sneezing or coughing</li> <li>• Irritated or sore throat</li> <li>• Headache</li> </ul>	Reaction by the body to substances in air, such as pollen or dust	Taking medications recommended by a doctor

1. Study the table above to familiarize yourself with the four illnesses listed. Allison has one of these four illnesses.
2. Read the question on the outside of each envelope, but do not open the envelopes yet. On the inside flap of each envelope is a clue, or answer, to the question on the outside. However, only some of the questions and clues will help you.

As a group, try to select the fewest number of questions (and clues) possible to help you distinguish among the illnesses above and diagnose Allison’s illness. Open only one envelope at a time.

- a. According to your group’s analysis, Allison has \_\_\_\_\_.
- b. How many questions/clues did your group use? \_\_\_\_\_
- c. Which question numbers (1 through 15) did your group select? \_\_\_\_\_

3. On the back of this sheet, answer the following questions.
  - a. Which information helped you to diagnose Allison’s illness? Explain why or how this information helped.
  - b. Why would it be important to know if Allison had been given aspirin or Tylenol™?
  - c. Would antibiotics be helpful to Allison? Why or why not?



**QUESTIONS — OUTSIDE OF ENVELOPE**

1. Does Allison have a headache?
2. What is Allison's body temperature?
3. What is Allison's weight?
4. What is Allison's height?
5. What is Allison's blood pressure?
6. What is the condition of Allison's nose?
7. What is the appearance of Allison's throat?
8. Are bacteria that cause strep throat present?  
(A doctor or nurse would swab her throat and run a rapid antigen test for bacteria.)
9. Does Allison have a cough?
10. Does Allison's body ache?
11. Has Allison vomited in the past 24 hours?
12. Has Allison taken any medicine?
13. What did Allison eat yesterday and this morning?
14. What is the weather like outside?
15. Have any of Allison's friends or family members been sick?

**CLUES — INSIDE OF ENVELOPE**

1. Yes, she has a headache.
2. Her body temperature is 98.6°F (normal).
3. She weighs 104 lbs.
4. She is 59 inches tall.
5. Her blood pressure is 120 over 80 (normal).
6. She has lots of clear mucus (runny nose) and difficulty breathing through her nose.
7. She has no redness or white patches.
8. There are no disease-causing bacteria present in her throat.
9. Yes. She has a congested cough (a cough with mucus).
10. No. Her body does not ache.
11. No. She has not vomited.
12. No. She has not taken any medicines. (This is important because medications, like Tylenol™, can mask symptoms.)
13. Yesterday, she ate waffles, syrup, milk, pizza, apple juice, tacos, tortilla chips, beans, candy and ice cream. Today, she had orange juice.
14. The weather is cold and rainy.
15. Her cousin had strep throat two weeks ago. Two classmates have colds. Her Dad has a headache and her brother vomited last night.