

2-3
40- to 50-minute sessions



ACTIVITY OVERVIEW

A history of the scientific discoveries leading to the germ theory of disease is examined as students read, discuss, and role-play the contributions of different scientists. Scientific advancements based on the germ theory, such as the use of chemical disinfectants, are presented. Students construct a timeline of events from notes taken during the role plays of other groups.

KEY CONCEPTS AND PROCESS SKILLS

(with correlation to NSE 5–8 Content Standards)

1. All living things are composed of microscopic units called cells. (LIFE SCIENCE: 1)
2. Scientific knowledge and scientific ways of thinking about the world influence society. (PERSPECTIVES: 5)
3. Science and technology have advanced through contributions of many different people in different cultures at different times in history. (PERSPECTIVES: 5)
4. Many individuals have contributed to the traditions of science. (HISTORY AND NATURE OF SCIENCE: 3)
5. The history of science shows how difficult it was for scientific innovators to break through the accepted ideas of their time to reach conclusions that we take for granted. (HISTORY AND NATURE OF SCIENCE: 3)

KEY VOCABULARY

cell
cell theory
disease
germ theory of disease
infectious
magnify/magnification
microbe
multicellular

MATERIALS AND ADVANCE PREPARATION



For the teacher

- 1 Transparency 37.1, “Key to the Timeline of the Germ Theory of Disease” (optional)
- 1 Literacy Transparency 2, “Oral Presentations”
- 1 Scoring Guide: COMMUNICATION SKILLS (CS)
- 1 Scoring Guide: UNDERSTANDING CONCEPTS (UC)
- 1 Scoring Guide: GROUP INTERACTION (GI)



- * 1 overhead projector
- * 1 video camera

For each group of four students



- * miscellaneous props
- 1 Student Sheet 37.1, “Role Play Guide” (optional)
- 1 Sample Role Play (optional)
- * large index cards (optional)

For each student

- 1 Student Sheet 37.2, “Timeline of the Germ Theory of Disease”
- 1 Scoring Guide: COMMUNICATION SKILLS (CS) (optional)
- 1 Scoring Guide: UNDERSTANDING CONCEPTS (UC) (optional)
- 1 Scoring Guide: GROUP INTERACTION (GI) (optional)

**Not supplied in kit*

Masters for Literacy Transparencies are in the Literacy section of Teacher Resources II: Diverse Learners. Masters for Scoring Guides are in Teacher Resources III: Assessment.

Plan in advance how many days your students will require to complete the activity. It is a good idea to allow an extra class period between the skit planning and skit presentation to allow students to practice their skits during class or after school. Alternatively, if developing role plays is either too difficult or time-consuming for your class, provide students with copies of the Sample Role Plays included at the end of this activity in this Teacher’s Guide.

If you wish, obtain some props that students can use in their presentations.

Arrange to have a video camera if you plan to tape the students’ skits.

■ **Teacher’s Note:** If you choose to do the optional demonstration in Activity 40, put eggs in vinegar now. The egg shells take 3–4 days to dissolve.

TEACHING SUMMARY

Getting Started

1. Prepare students to work together to develop a role play.

Doing the Activity

2. (GI ASSESSMENT) Student groups work together to develop a role play.
3. (CS, UC ASSESSMENT) Students complete Student Sheet 37.2 as each group presents a role play to the class.

Follow-Up

4. The class discusses the activity.

Extension

Students can go to the *Issues and Life Science* page of the SEPUP website for links to more information on Robert Hooke and some of the other scientists in the activity.



BACKGROUND INFORMATION

Microbes and Infection

Most infectious diseases are caused by microbes. These include microscopic organisms such as bacteria, protists, fungi, or animals, and a special class of infectious agent—viruses—that are not generally considered alive, but are capable of inserting themselves into cells and being reproduced by the cell. Non-living things, such as dirty air, odors, or the weather, cannot cause *infectious* diseases such as colds or the flu.

Ancient Ideas on Infectious Disease

In ancient and medieval Europe, only a very few people had access to doctors. The vast majority were ministered to by older members of the community, often women (hence the word “midwives”). They tended to use herbal remedies and passed on knowledge from generation to generation in an informal way (“old wives’ tales”). Some of their remedies survive today with greater or lesser efficacy: consider the phrases “feed a cold” and “starve a fever,” and the use of chamomile tea for stomach trouble.

Medicine as practiced by doctors was also quite different from today. One theory was that disease was caused by an imbalance of four humors in the body. This theory of imbalance led to the practice of blood-letting, often accomplished by leeches. Another theory held that disease was spread by bad air.

The miasma theory, or the theory that bad air spread disease, was held by a large number of learned people well into the late 1800s. One 19th century doctor was so convinced that bad air spread cholera that he refused to believe evidence that cholera was spread by a microscopic organism. He drank an entire beaker full of the bacteria to demonstrate that it was not germs that caused the disease! (By chance, he did not become sick. As is often the case, a sample size of one was insufficient to provide good evidence. This doctor must have been immune to cholera.)

The germ theory was bolstered when Pasteur presented his famous, bent-necked flask experiment in Paris. His experiment demonstrated that when air, even “bad air,” could get into a flask, the dust and germ particles were trapped in the S bend, and the broth in the flask would remain clear. The clear broth did not contain any microorganisms when examined under the microscope. The broth in a straight-necked flask also open to the air did turn cloudy and spoil and contained microorganisms. It was this evidence, coupled with Pasteur’s strong scientific reputation, that eventually changed people’s view of infectious diseases.

Cell Theory

The work of Schleiden and Schwann (and many others, including the oft-maligned Jean-Baptiste de Lamarck) advanced the **cell theory**. Not only do single-celled organisms exist, but all multicellular creatures (plants, animals, fungi) are also made of cells. The major components of the cell theory can be expressed as

1. all living things are composed of cells (and cellular products);
2. all cells arise from other cells; and
3. all cells contain the hereditary information of the organism of which they are a part.

In the “Micro-Life” unit, the emphasis is on the first statement: all living things are composed of cells. The other aspects of the cell theory are addressed in the next unit on genetics and heredity. The focus of this unit is the universality of cells and common subcellular structures. In particular, the objective of this activity is to see that individual cells are the building blocks that make up multicellular bodies, and that microscopes can be used to observe microbes and cells in humans and other organisms.

TEACHING SUGGESTIONS

■ GETTING STARTED

1. Prepare students to work together to develop a role play.

■ **Teacher’s Note:** Consult the Group Work Appendix for suggestions on facilitating group work and encouraging reading for understanding. The “Self-Evaluation Form” in the appendix is appropriate for this activity. You may wish to assess students on either element (“Task Management” and “Shared Opportunity”) of the GROUP INTERACTION (GI) variable. The skits (or the student sheets) can also be assessed with the UNDERSTANDING CONCEPTS (UC) variable. Prepare students for any assessment you decide to use.

Ask students, *How do you think people in ancient times explained illness?* While student responses will vary, explanations for disease included evil behavior and theories that illness was caused by bad air or odors. Ask students, *Why didn’t people know about germs or microbes before the mid-1800s?* While students may be puzzled at first, through discussions they should connect the discovery of the microscope with acceptance of the germ theory of disease. Explain that in ancient times (and even today) it is difficult for people to believe in something they cannot see. Without microscopes, people cannot see microbes.

Have students read the Introduction and Procedure in the Student Book. Divide the class into groups of approximately four students each. Assign each group to read and present one of the sections in the Cast of Characters provided in the Student Book.

Students should discuss their assigned section within their groups of four and agree on what the main ideas are. Circulate among the student groups and make sure that each group is identifying the key ideas from their passage. Have students decide on the setting and the perspective of the characters in their skit. Will they portray a current news reporter who has traveled back in time to interview a famous scientist and his assistants? Will they take on the identity of the cells that a scientist

is discovering? Next students should create the characters. Each person in the group must have a role. You may wish to use Student Sheet 37.1, “Role-Play Guide,” to help students plan their skits.

Each skit should present the important contributions of the scientist(s) described in the passage. Encourage students to emphasize how this led to or resulted from the germ theory of disease. You may wish to tell students to include a specific number of points from the passage in their skits. Explain that their skits will be “historical fiction,” intended to provide correct information, but in an imagined setting and with imaginary details and characters. If you use the sample role plays provided, be sure students understand that the skits are intended to be amusing, while providing basic information about the scientists.

■ DOING THE ACTIVITY

2. (GI ASSESSMENT) Student groups work together to develop a role play.

Each group should read and discuss its assigned section. Be sure students understand the content and key points before beginning their skits. Depending on your student population, you may need to assist students in understanding the text.

You may wish to provide each group with Student Sheet 37.1, “Role Play Guide,” to assist them in writing their role plays. Each group should work together to plan and rehearse their presentations. Give students a copy of Student Sheet 37.2, “Timeline of the Germ Theory of Disease,” so that they are aware that they will be expected to provide date(s) of key discoveries or events.

Emphasize that each student must have a significant role in the presentation. Students need to be creative in developing other roles when necessary. These other roles may be scientists, doctors, or family or community members. Each group should develop the setting, story, and characters for their skit. Each student can further develop his/her own character.

You may wish to provide students with large index cards. Students can use index cards to record the

lines to be read during the presentations. Make sure students distinguish between dialogue and stage direction.

Use the transparency of Literacy Sheet 2, “Oral Presentations,” to give students guidelines on oral presentations. You may assess their role plays using the COMMUNICATION SKILLS (CS) Scoring Guide and/or the UNDERSTANDING CONCEPTS (UC) Scoring Guide. The work students do together in a group may be assessed with the GROUP INTERACTION (GI) Scoring Guide. For more information on facilitating group work, see the Facilitating Group Interaction section of Teacher Resources II: Diverse Learners. Distribute and review the scoring guides as needed. Encourage students to relay the facts but to make the skits entertaining as well. Allow them to bring props or costumes to make it more fun. You might even work with your school’s drama teacher to enhance the quality of students’ skits.

3. (CS, UC ASSESSMENT) Students complete Student Sheet 37.2 as each group presents a role play to the class.

Distribute Student Sheet 37.2. Have students complete the timeline based on the presentations. Encourage supportive behavior by the student audience. You may wish to videotape student presentations.

A key for Student Sheet 37.2 is provided on Transparency 37.1, “Key to the Timeline of the Germ Theory of Disease.” You may wish to use the key (or a transparency of Student Sheet 37.2) to summarize the key points of each presentation.

You may also wish to have students add other milestones to their timelines. Events that have been discussed in various units of *Issues and Life Science* include the discovery of the cause of pellagra, treatment of diabetes with insulin, development of the polio vaccine, development of heart surgery, discovery of the cause of the bubonic plague, quarantining of Hansen’s disease patients, etc.

■ FOLLOW-UP

4. The class discusses the activity.

Begin a class discussion to synthesize and summarize the important points of the activity. Analysis Questions 1 and 2 are provided for this purpose.

Discuss with students how the germ theory of disease came to be accepted. Two questions that may prompt the discussion are: ***How has the germ theory of disease affected modern medicine and health?, and What effect has the knowledge of the germ theory of disease had on prevention and treatment of infectious diseases?*** You may need to prompt students to consider medical procedures they are familiar with through visits to the doctor, television, or other experiences. They may suggest sterilization of medical instruments, preparations made for surgery and the use of sterile gowns, modern procedures for disinfecting, and thorough hand washing. The development of modern vaccines and the development of antibiotics also depended on the development of a germ theory of disease and will be treated in depth in the last part of the unit.

■ Teacher’s Note: Many students think that spontaneous generation, especially of microscopic life forms, can occur under special circumstances. Some students hold tenaciously to this idea despite extended instruction. The reading material on “The Theory of Spontaneous Generation” provided in the Student Book can be used to address evidence against spontaneous generation. However, this may not be sufficient to convince every student that spontaneous generation does not occur. This can be further addressed in high school, as students become more sophisticated in their understanding of scientific processes and theories.

SUGGESTED ANSWERS TO QUESTIONS

1.  Why is the germ theory of disease important in understanding infectious diseases?

The germ theory of disease proposes that an infectious disease is caused by microbes, which can be spread by people. This was a significant advancement in the understanding of infectious diseases. Historically, people believed a disease to be caused by dirty air, odors, weather, and many other factors.

■ **Teacher's Note:** You may wish to refer back to the Introduction of Activity 36, "Looking for Signs of Micro-Life," in the Student Book, which lists many of the kinds of beliefs that were held as recently as the early 1900s. Only after people realized that an infectious disease was caused by microbes were they able to develop methods for reducing the spread of infections.

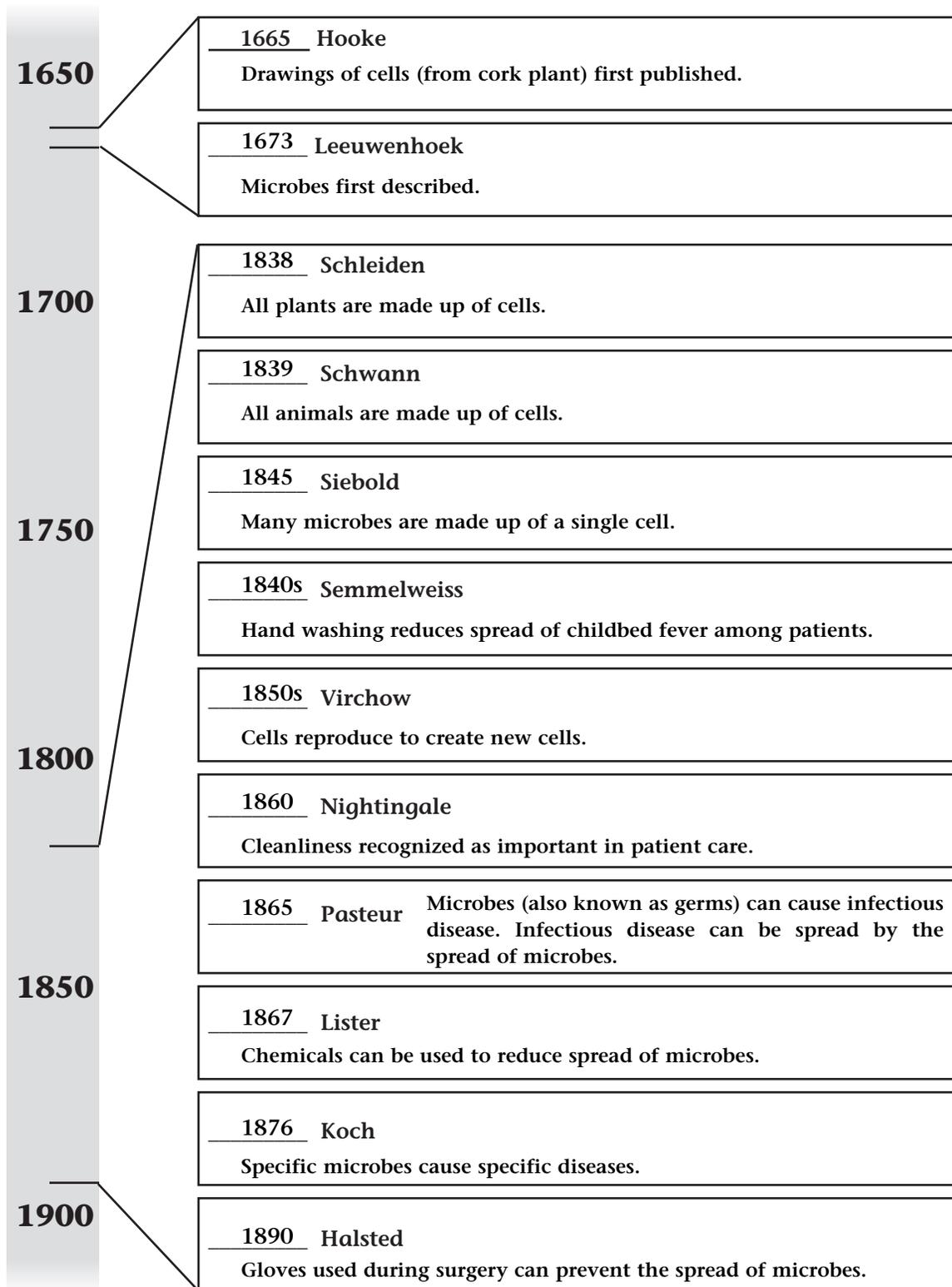
2.  How important was the development of the microscope in discovering the cause of infectious diseases?

The microscope was important because it demonstrated that microbes existed. Knowledge of microbes allowed people to develop the idea that they could accidentally spread microbes and increase infections. The story of Semmelweis is a good example of how more evidence was needed before people would change their behavior. Although Semmelweis could reduce infections among his patients through hand washing, other doctors refused to change their habits without knowing why hand washing helped. The knowledge of microbes helped Pasteur develop the germ theory of disease and answer that question.

3. **Reflection:** Imagine that each of the scientists in this activity wanted to hire an assistant. With which scientist would you most like to work? Why?

This question encourages students to envision themselves as scientists and to identify areas of interest. You may want to spend more time on this question in order to focus on career education.

Key to the Timeline of the Germ Theory of Disease



Name _____

Date _____

Role Play Guide

Characters _____

Setting

Time Period

Additional Props or Material Required _____

Important Contribution(s) to Science _____

Timeline of the Germ Theory of Disease

Provide the date and a short summary of the contribution provided by each person named on the timeline below.

A vertical timeline on the left side of the page, with a grey background and white text. The years 1650, 1700, 1750, 1800, 1850, and 1900 are marked. Lines connect these years to boxes on the right. Each box contains a name and a blank space for a date. The names listed are Hooke, Leeuwenhoek, Schleiden, Schwann, Siebold, Semmelweiss, Virchow, Nightingale, Pasteur, Lister, Koch, and Halsted.

1650	_____ 1665 Hooke
	_____ Leeuwenhoek
1700	_____ Schleiden
	_____ Schwann
1750	_____ Siebold
	_____ Semmelweiss
1800	_____ Virchow
	_____ Nightingale
1850	_____ Pasteur
	_____ Lister
	_____ Koch
1900	_____ Halsted

Sample Role Play 1: Robert Hooke (1635–1703)

Characters: Robert Hooke, two friends, and Hooke's publisher.

Setting: Hooke's apartment

Time Period: Late 1600s

Important Contribution(s) to Science: Hooke was the first person to describe cells.

Script:

Hooke: (looking out the window) The moon looks very interesting tonight, almost as if it has shapes on it.

Friend 1: You're always looking at something in nature. Don't you ever get bored?

Friend 2: I don't think he does. After all, he wrote a whole book about his observations!

Hooke: I can't help it. There is so much to see in nature. I was able to use two lenses to create a compound microscope, and now I can see even more. Have you ever looked through my microscope?

Friend 1: I can't say that I have. It seems a waste of time.

(Publisher enters.)

Publisher: I heard that! Now, don't go distracting my prize author. His book *Micrographia* has been very successful. Even though it was published in 1665, many people still refer to the microscope drawings that he included in that book.

Friend 2: Amazing that a piece of dead plant could cause so much interest. After all, that's all cork is. And all Hooke did was look at it under his microscope.

Friend 1: —And draw it and publish it so that others could learn about it too.

Hooke: Yes, but without my microscope I wouldn't have been able to observe the detailed structure of the cork. Under the microscope, cork looks different. It looks like a bunch of small rooms. Let me show you.

(Hooke draws or holds up a picture of what cork cells look like.)

Publisher: And because they reminded you of little rooms, you decided to call them cells. Boy, has that word become popular.

(Hooke takes a little bow.)

Hooke: My contribution to science: The first recorded observation of cells!

Sample Role Play 2: Anton van Leeuwenhoek (1632–1723)

Characters: Mr. Leeuwenhoek, Mrs. Leeuwenhoek, and customer and child

Setting: Leeuwenhoek's fabric store

Time Period: Late 1600s

Important Contribution(s) to Science: Leeuwenhoek was the first person to describe microbes.

Script:

(Leeuwenhoek is in his fabric store and holding a large magnifying glass, examining pond water in a small dish. A customer enters with her young child.)

Customer: Helloooo, Mr. Leeuwenhoek, can you help me? Hello? I'm looking for some fabric for a dress for the New Year; 1674 will be here soon you know.

(Mrs. Leeuwenhoek enters.)

Mrs. Leeuwenhoek: Sorry, it's impossible to get him away from his microscope. How can I help you?

Customer: I am interested in some fabric for making a new dress for my daughter.

(Mr. Leeuwenhoek lifts his head up for a moment.)

Mr. Leeuwenhoek: Ah yes, fabric. I have looked at many different cloths under my microscope. But they are not as interesting as what I see in a drop of water.

Child: What is that man saying?

Mrs. Leeuwenhoek: Oh don't worry about him. What kind of fabric did you want to buy?

Mr. Leeuwenhoek: In just a drop of water, you can see "wretched beasties. They stop, they stand still...and then turn themselves round...they [are] no bigger than a fine grain of sand."

Customer: Could we move this along, please?

Mrs. Leeuwenhoek: Here's some good quality fabric in red. Did you have a particular color in mind?

Mr. Leeuwenhoek: I'm describing the small creatures you can see in a drop of water using my microscope. Would you like to have a look?

Child: Yes! (looking) What else can you see?

Mrs. Leeuwenhoek: We have lots of other colors too!

(Mr. Leeuwenhoek holds up a toothpick.)

Mr. Leeuwenhoek: Here, let me just scrape your teeth first.

Sample Role Play 2 (continued)

(Child opens mouth to allow Mr. Leeuwenhoek to scrape teeth.)

Customer: What are you doing?

Mr. Leeuwenhoek: How else will you see “many very little living animalcules, very prettily a-moving”?

Customer: But I just want to buy some fabric.

Mrs. Leeuwenhoek: Yes, look at these. We have so many good fabrics.

Child: What does the fabric look like under your microscope?

Mr. Leeuwenhoek: (placing some fabric on his microscope) See—not what you expected, eh?

Customer: Here, I will take this fabric. Mr. Leeuwenhoek, thank you for amusing my child.

(Customer and child leave.)

Mr. Leeuwenhoek: I don’t think anyone else has ever seen such creatures before 1673!

Mrs. Leeuwenhoek: I suppose you think you’ll become famous one day for observing and recording microbes.

Mr. Leeuwenhoek: (laughing) Who knows?

Sample Role Play 3: Matthias Jakob Schleiden (1804–1881), Theodor Schwann (1810–1882), and Karl Theodor Ernst von Siebold (1804–1885)

Characters: Matthias Jakob Schleiden, Theodor Schwann, Karl Theodor Ernst von Siebold, and another professor

Setting: University office of Professor Schleiden

Time Period: 1830s–1840s

Important Contribution(s) to Science: Schleiden proposed that all plants are made of cells. Schwann said that all animals are made of cells. Together, this is considered the cell theory. Siebold stated that microbes are made of one cell.

Script:

(Schwann walks into Professor Schleiden’s office. Schleiden is stacking bricks into a pile.)

Schwann: Those don’t look like plants! I thought you were a professor of botany.

Schleiden: I am. I am thinking about an idea I had. I’ve looked at the tissues of many plants under the microscope and I see some similarities. They often look like they’re divided into rooms, called cells. Robert Hooke first described these cells in cork over 150 years ago.

(Another professor walks in.)

Professor: I don’t know why you find looking at plants under the microscope so interesting. There are so many different plants that have never been described or named by science.

Schleiden: Humph!

Schwann: So why are you stacking bricks?

Schleiden: I’ve studied so many plants. In 1838, I came to the conclusion that all plants are made of cells.

Schwann: Well, it’s only 1839 now.

Professor: What does any of this have to do with stacking bricks?

Schleiden: They help me model and think about my ideas. Imagine each of these bricks as a cell and this entire stack as a plant...

Professor: That’s a revolutionary idea!

Sample Role Play 3 (continued)

Schwann: Hmm, that gives me an idea. I've been studying animals. I've spent a lot of time dissecting and examining the digestive system. I've noticed a lot of similarities.

Professor: You too? Doesn't anybody study entire plants or animals anymore?

Schleiden: So Professor Schwann, what is your idea?

Schwann: I think that all animals are made of cells as well. In your model, each brick would represent a cell, but the entire stack could represent an animal—

Schleiden: Or a plant!

Professor: That's a revolutionary idea!

(Siebold enters the office.)

Siebold: Eh? What's that? Similarities among plants and animals? What's going on?

Professor: These two are proposing revolutionary ideas! They are suggesting that both plants and animals are made of cells.

Siebold: Sounds like a cell theory to me.

Professor: Yes, that's it. They've proposed the cell theory: that all living organisms are made of cells.

Siebold: I've got to go think about that...

(Siebold puts his head down and everyone else freezes in position. Siebold lifts his head but everyone else remains frozen in position.)

Siebold: I think I have an idea! (He looks at his watch.) It took me some time, I guess. It's now 1845! But I believe my idea was worth the wait. I propose that microbes are made of cells too. But not many cells, like plants and animals, but just one cell. So one brick would represent one microbe. (He waves one brick in the air.)

Professor: That's a revolutionary idea!

Sample Role Play 4: Rudolf Carl Virchow (1821–1902)

Characters: Rudolf Virchow and three other scientists

Setting: A science conference

Time Period: 1850s

Important Contribution(s) to Science: Cells reproduce to create new cells.

Script:

Virchow: I have treated many patients during the 1850s. And my study has shown that all cells arise from cells.

Scientist 1: What do you mean by that?

Virchow: (with emphasis on each word) All cells arise from cells.

Scientist 2: I think that he means cells grow from other cells.

Scientist 3: You mean that cells reproduce?

Virchow: Exactly. Cells grow, then reproduce and produce new cells.

Scientist 1: Based on Schleiden's and Schwann's work, we know that all living organisms are made of cells.

Scientist 2: Including microbes, of course.

Scientists 3: Many microbes are made of just one cell.

Scientist 1: What does that mean for larger organisms, like people? If they are made of cells too, are they just one big cell?

Scientist 2: Not at all. Humans must be made of millions of cells!

Scientist 1: So all living organisms are made of cells, but some are made of more cells than others.

Virchow: Correct. Some organisms are multicellular—

Scientist 3: Meaning that they are made of many cells.

Scientist 2: Hmm, that means that people, plants, and animals are all multicellular.

Scientist 1: Dr. Virchow, I commend you on your statement of this idea: all cells arise from cells. Very clever.

Sample Role Play 4 (continued)

Virchow: Thank you. I have some other ideas too. As you may know, I have studied leukemia, a cancer of the blood. From this work, I think that all diseases are caused by cells that don't work properly. I think that these diseased cells come from healthy cells.

Scientist 2: That sounds like a good idea.

Scientist 3: But not for every disease! What about infectious diseases? I don't think every disease could be caused by cells that don't work properly. I think some diseases are caused by cells that invade the body.

Scientist 1: I think that we will have to discuss the idea more at our next conference. Maybe we will know more by then...

Sample Role Play 5:

Ignaz Philipp Semmelweiss (1818–1865)

Characters: Ignaz Semmelweiss, 2 doctors, and pregnant woman with baby

Setting: A hospital

Time Period: 1840s

Important Contribution(s) to Science: Hand washing reduces spread of childbed fever among patients.

Script:

(Two doctors are performing an autopsy. Dr. Semmelweis is observing. A woman with a baby is on one side, as if in another room.)

Doctor 1: So you say that this person died from old age?

Doctor 2: Yes. We were lucky that the family decided to give the body to science.

Doctor 1: It is the 1840s. We are learning more about the human body and about what causes people to die.

Doctor 1: I have many more patients to see. I'll come back later.

(Doctor 1 places the instruments down and makes an exaggerated gesture of wiping hands on a towel. Doctor 1 leaves the room, closes the door, and walks over to the woman.)

Doctor 1: I see that you and the baby seem healthy. Lucky that I was so close by when you were ready to deliver.

Woman: Yes, that's true, Doctor. But I don't feel well right now...

Doctor 1: (Doctor feels patient's pulse and forehead.) Hmmm, I wonder what is wrong.

Woman: I don't know, but I think a nurse should take the baby for a while.

Doctor 1: I can help you there. I'll take the baby to the nurse.

(Doctor 1 takes the baby and walks around the room, pretending to take a long walk to find the nurse. The baby is given to someone in the audience. Doctor 1 takes the long walk back to the woman. Doctor 1 feels pulse at the wrist of woman's arm. As Doctor 1 shouts, Doctor 2 hears the exclamation and jumps, cutting him- or herself with an instrument.)

Doctor 1: (shouting) I can't believe it! She seemed fine just a while ago, but it looks as if she won't make it.

Doctor 2: Ow!

Sample Role Play 5 (continued)

(Doctor 2 and Dr. Semmelweis hurriedly walk over to Doctor 1.)

Doctor 2: What is it? Your loud shouts startled me. I cut myself with the scalpel during the autopsy.

Doctor 1: I helped deliver this woman's baby yesterday. They both seemed healthy then. You must remember—we were working together on the autopsy.

Doctor 2: Yes, that's right. You went right out to help her.

Doctor 1: Her pulse is getting very weak. She may not make it.

(Doctor 2 appears to look woman over.)

Doctor 2: She appears to have childbed fever.

Doctor 1: Yes, I think you're right. I wonder how she got it?

(A few days go by. Dr. Semmelweis and Doctor 1 are talking.)

Semmelweis: The doctor died? It was so sudden.

Doctor 1: Yes, his symptoms were just like the symptoms of childbed fever. One of my patients died from childbed fever this week too.

Semmelweis: I noticed that both of you were doing autopsies. You never washed your hands between patients. And I believe the doctor received a cut while doing an autopsy.

Doctor 1: What does that matter?

Semmelweis: I think that something that you are touching while doing the autopsies can cause childbed fever, and you spread it when you go from patient to patient.

Doctor 1: I have never heard of anything so ridiculous!

Semmelweis: I will wash my hands between patients and show you.

(Years go by.)

Semmelweis: I've reduced death rates among my patients from 12% to 1%, but still no one will listen. No one believes hand washing can reduce the spread of childbed fever! This is driving me crazy! (He shouts in frustration.)

Sample Role Play 6: Louis Pasteur (1822–1895)

Characters: Louis Pasteur, business owner, and two government officials

Setting: Pasteur's laboratory

Time Period: 1860s

Important Contribution(s) to Science: Heating foods can kill microbes, a process known as pasteurization. Infectious disease can be caused by microbes, which are easily spread by people.

Script:

(Pasteur is working alone in his laboratory when he hears a knock at the door.)

Pasteur: Please come in.

Business owner: (looking around) I wanted to see where the great Louis Pasteur works. The vinegar and wine industries of France rely on you, you know.

Pasteur: Very kind of you, thank you.

Business Owner: So you figured out that different microbes cause different kinds of spoiling, huh? Accomplished a lot, I would say. Maybe you will discover a way to prevent food spoilage.

Pasteur: It's only heat. Many microbes are killed by higher temperatures. You have to heat milk only to 71°C for 15 seconds to kill the microbes that cause tuberculosis.

Business owner: No one else thought of it. I bet they'll name that process after you some day. What could they call it? The Louis Process? Louis-ization? Pasteurization? That's it! Pasteurization: the process of using heat to kill microbes.

(Another knock is heard at the door. Two government officials enter.)

Official 1: We are looking for Mr. Pasteur. We represent the French government.

Business Owner: (pointing) That's him right there.

Pasteur: How can I help you?

Official 2: The silk industry in France is having trouble. We have come to ask for your help.

Pasteur: I received your letter requesting my help several weeks ago. I have already begun investigating the problem.

Official 2: Excellent. What have you found out?

Pasteur: It appears that a germ is infecting the silkworms. I recommend that the silkworms and their food source be destroyed.

Sample Role Play 6 (continued)

Official 1: A germ?

Business Owner: I've also heard them referred to as *microbes*.

Official 2: No matter—the silk industry will be saved!

Business Owner: Do you have any other ideas that could help my business?

Pasteur: I have been thinking about the fact that some diseases are infectious. I think that germs cause infectious disease.

Business Owner: Will that help you figure out a way to stop these diseases?

Pasteur: I believe diseases are caused by different germs. People can easily spread the germs and infect other people.

Official 2: That is brilliant! Do you have a name for your ideas?

Pasteur: I call it the germ theory of disease.

Official 1: The germ theory of disease...the idea that infectious diseases are caused by germs which can be spread by people. Interesting. Perhaps we should tell the Health Department.

Sample Role Play 7: Robert Koch (1843–1910)

Characters: Scene One: Robert Koch, a diseased cow, and two mice

Scene Two: Robert Koch, Mrs. Koch, and two mice

Setting: Scene One: A farm

Scene Two: Koch's apartment

Time Period: 1876

Important Contribution(s) to Science: Koch proved that different microbes cause different infectious diseases. He also developed agar.

Script:

Scene One

(Koch is walking around a farm. The animals are roaming about.)

Koch: It is not enough to claim that a particular microbe causes a particular disease. There must be evidence that can prove this...Boy, that cow looks sick. It appears to be infected with anthrax....That gives me an idea...

(The cow collapses and dies. Koch kneels by the cow to examine it.)

Koch: Yes, it appears to have died of anthrax. I will confirm that fact in my lab, of course. But first, I'll need some of this cow's tissue.

(Koch stands up and looks around.)

Koch: I'll also need some tissue from a healthy cow...and some healthy mice.

(Koch captures two mice who are scampering around the farm. He carries the tissue samples and the mice back to his apartment.)

Scene Two

Mrs. Koch: What have you brought with you? Some bread to go with dinner?

Mr. Koch: Sorry, I'm afraid that I brought more specimens to study.

Mrs. Koch: You know that I find your work very interesting. But please don't put your specimens on the dinner table, dear. What are you planning to do?

Mr. Koch: Here, I'll show you. (Koch carries out his actions as he speaks.) I will take tissue from an animal that died of anthrax. First, I will use it to grow more of the anthrax microbes.

Sample Role Play 7 (continued)

Mrs. Koch: Using the agar that you invented?

Mr. Koch: Exactly. That will give me a pure culture of the microbes. Then I will inject the microbes into some healthy mice. I also have this tissue from an animal that is healthy. I will inject it into another group of healthy mice.

Mrs. Koch: What does that prove?

Mr. Koch: We will watch to see what happens over the next few days.

(A few days pass...)

Mrs. Koch: Robert, some of your mice are dying.

(Koch examines a mouse.)

Mr. Koch: It appears to have died of anthrax. I will examine its tissues under the microscope to see if I can find evidence of the same microbes.

(Koch looks through a microscope.)

Mrs. Koch: Let me see. (Mrs. Koch looks through the microscope.) Yes, you're right. They look identical to the microbes that you collected from the dead animal.

Mr. Koch: This proves that this microbe causes anthrax. The healthy mouse did not die when injected with healthy tissue, but the other mouse died of anthrax when injected with microbes taken from an animal that died of anthrax.

Mrs. Koch: It's 1876—you're only 33 years old! And you've already thought of a way to prove that a specific microbe causes a particular disease. I wonder what you'll think of next?

Mr. Koch: Well, I am interested in studying tuberculosis and cholera...

Sample Role Play 8: Florence Nightingale (1820–1910), Joseph Lister (1827–1912), and William Stewart Halsted (1852–1922)

Characters: Florence Nightingale, Joseph Lister, William Halsted, and master of ceremonies (MC)

Setting: Awards ceremony

Time Period: 1905

Important Contribution(s) to Science: Nightingale recognized that cleanliness was important in patient care. Lister developed the use of chemicals to reduce the spread of microbes. Halsted was among the first to use gloves during surgery to prevent the spread of microbes.

Script:

(MC is at the podium. Everyone else is sitting among the audience.)

MC: Welcome, everyone. Tonight we are here to honor some people who have contributed greatly to reducing the spread of infectious diseases. Many of us now realize that germs spread disease. That's why it's a good idea to use disposable tissues instead of handkerchiefs—you can avoid spreading germs. In fact, our first honoree emphasized the importance of cleanliness in 1860! Florence Nightingale, please come accept your award.

(Nightingale comes up and accepts award from MC. She steps up to microphone to make her speech.)

Nightingale: Thank you, everyone. It's true. As a nurse, I recommended that we try to keep things clean. Not everyone agreed with me. I'm glad to see that we have come so far. Now everyone knows that cleanliness helps reduce the spread of germs and saves lives.

(Nightingale walks back to her seat.)

MC: A round of applause for Ms. Nightingale, please. (clapping) It was just a few years later, in 1867, that Dr. Joseph Lister came up with the idea of using chemicals to kill microbes. Please join me in congratulating Dr. Lister. (clapping)

(Lister comes up to the microphone.)

Lister: Thank you. I was worried about the number of patients that died after surgery. About 45% of my patients died of infections after the surgery was over. That's when they should have been recovering. Luckily, I heard of Pasteur's germ theory of disease. I realized that if microbes cause disease, perhaps I could kill them with chemicals. I began cleaning my surgical instruments with chemical solutions. I also sprayed the air and required hand washing and clean aprons. As a result, the death rates of my patients after surgery dropped to 15%. I'm glad that my techniques have been successful at saving lives.

Sample Role Play 8 (continued)

(Lister walks back to his seat.)

MC: Our last honoree of the evening is Dr. William Halsted, who, in 1890, introduced the idea of doctors wearing rubber gloves in surgery. He is being honored for his work in preventing the spread of microbes and improving patient health. As one of the first doctors to use rubber gloves during surgery, he reduced the likelihood that the doctor would introduce microbes into the patient. Dr. Halsted!

(Halsted comes up to the microphone.)

Halsted: Thank you. I noticed that many people had excellent ideas for killing microbes. I wondered, "Why not try to prevent microbes from being there in the first place?" Of course, it's not possible to use strong chemicals or high temperatures on your hands. That's why gloves are so handy. They can be sterilized between patients. This helps prevent spreading microbes among patients.

(Halsted walks back to his seat.)

MC: Thank you, Dr. Halsted. (clapping) These are all of the honorees for tonight. Join us next month, when we recognize the contributions of Robert Hooke and Louis Pasteur!

