Teaching Materials on Infectious Diseases

Mission 1: Orientation at ORB

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OVERVIEW

We hope you and your students extend the MEDNYST adventures with the activities designed to cover related learning objectives. The activities described are intended for use both before and after students have "played" Missions of MEDNYST. The files may be printed for classroom use ONLY. They consist of mini-labs that can be done with relatively little equipment or expense.

Rice University and the sponsoring agency cannot be responsible for any accidents or injuries that may result from: 1) the conduct of the activities without proper supervision, 2) the failure to follow the directions provided, or 3) the ignoring of cautions contained in the text.

Feel free to adapt these activities to your own classroom needs. Other resources that we suggest are the National Institutes of Health (NIH) web site at http://www.nih.gov/ and the Centers for Disease Control web site http://www.cdc.gov. They contain excellent resources and teaching materials.

The MEDNYST Team
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MISSION BRIEFING

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ACTIVITY 1: Diary of a Disease ........................................................................13
In this activity, the student will research an infectious disease and write a story from the disease’s perspective.

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In this activity, the student will learn how the structures of different pathogens enable the germs to infect their hosts.

ACTIVITY 3: Microbe Meals ..............................................................................28
In this activity, the student will supply yeast with different food sources and see how this affects the yeast’s ability to grow.
This synopsis is provided as an overview for TEACHERS. We advise teachers NOT to hand this out to the students prior to playing the adventure since much of the suspense will be eliminated.

It is the year 2254, twelve years after the end of the Great Plague that ran through the Earth’s population killing millions and causing the collapse of civilization. An elite group of scientists known as the RECONSTRUCTORS team is charged with preventing the spread of infectious diseases in this bleak time.

Beta, the Reconstructors’ chief medical officer, begins the mission by welcoming the student to the On-line Reconstructor Base (ORB). With her is Eureka, the medical information robot, and Delta, the robot scout. They explain to the student that he/she has been recruited into the Neuropolis Center for Disease Control (NCDC). The student must pass five challenges in order to become a certified NCDC agent.

The student proceeds to a room with five doors. Behind each door is one of the five challenges. The student can access the following five challenges in any order:

**Koch’s Concepts Challenge**
The Germ Theory of Disease holds that germs or microorganisms cause infectious diseases. In this challenge, the student will perform experiments to identify the germ responsible for a fungal disease with the help of a famous scientist, Dr. Robert Koch. He/she will use the following rules or postulates worked out by Dr. Koch in the late 1800s for establishing whether a specific germ causes a particular infectious disease:

1. The suspected pathogen must be present in every case of the disease.
2. The suspected pathogen must be isolated from the host and grown in pure culture.
3. The disease must be reproduced when a pure culture of the suspected pathogen is inoculated into a healthy susceptible host.
4. The same pathogen must be recovered from the newly infected host.

**Enemy Agents Challenge**
The student visits a containment unit that houses the six types of infectious agents or pathogens: bacterium, fungus, helminth, prion, protozoa, and virus. The student sees a cartoon picture of each agent and reads information on diseases caused by that category of germ. Next, the student plays a game in which he/she has to sort infectious diseases by the type of infectious of agent that causes them. Below is a chart of the information that is presented with each germ.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Picture</th>
<th>Interview</th>
</tr>
</thead>
</table>
| Bacterium | ![Bacterium Picture](image) | **Name:** Bacillus anthracis  
**AKA:** “The Powder”  
**Acquired from:** Dead cow  
**Personal Interview:** Yeah, I’m a bacterium. What about it? I cause *anthrax*, so what. It’s not that deadly, if you don’t inhale me. My bacteria relatives can cause *botulism, tuberculosis and typhoid*. Now those are some mean diseases. Come on, let me out! I won’t hurt anyone. |
### Fungus

**Name:** *Tinea pedis*  AKA: “The Itch”  
**Acquired from:** Foot of a 17 year-old football player.

**Personal Interview:** He! He! He! What’s up? I am a fungus. I am one of the fungi that cause athlete's foot, just a little itch between the toes. My fellow fungi are just waiting to cause histoplasmosis, ringworm, and thrush. He! He! He! You just wait; fungi are everywhere!!!

### Virus

**Name:** Influenza Virus Type A  AKA: “The Flu”  
**Acquired from:** Throat of a 12 year-old student.

**Personal Interview:** Hey, it’s cold in this freezer! If I thaw I’ll invade your cells and take them over! You’ll be sorry if my friends find out! They cause trouble worldwide with AIDS, measles, hepatitis, and Ebola. You better be afraid! Not all of us can be prevented with a vaccine!!!

### Protozoan

**Name:** *Trypanosoma cruzi*  AKA: "Chagas disease"  
**Acquired from:** Gut of a Reduvid bug or "kissing bug".

**Personal Interview:** Hi ‘ya, good looking! Would you like a kiss from my friend? One kiss, come on. While he captures your attention with his kiss, he can deposit me on your skin though his feces. If I can make it to your mouth, eyes or an open wound then you’ll get Chagas Disease. Maybe you’d be more interested in getting a disease that my fellow protozoa can cause like amoebic dysentery and malaria. All perfectly parasitic, I assure you.

### Helminth

**Name:** *Enterobus vermicularis*  AKA: “The End”  
**Acquired from:** The sand box in a local park.  
**Personal Interview:** Oh, a victim! I mean a visitor. I am a pinworm. I exit through the back end of people so it’s nice to see a face now and then. My helminth cousins, the tapeworm, roundworm, and hookworm would so enjoy your company. You should give them a call. I promise you’ll never forget a visit from a helminth.

### Prion

**Name:** Prion Protein PrPsc:  AKA “The crazy cow”  
**Acquired from:** Brain of a cow with mad cow disease.

**Personal Interview:** Hello, there. Don’t waste time with the other infectious agents. If you want to see something new, talk to me. I am a prion, discovered in the 1980s. There is no cure for the diseases such as scrapie, Creutzfeldt-Jakob Disease (CJD), and mad cow disease that we prions cause. Doesn’t that just make you mad?

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**Infect-O-Rama Challenge**

The student learns about the different modes of transmission for the different types of infectious agents. The students plays a game in which he/she takes on the role of one of the agents and tries to travel through the environment in order to infect a human. The student must land on items that will allow the agent to spread and avoid those that inhibit spread, such as pills containing...
antibiotics or other antimicrobial drugs. Below is a chart of the different infectious agents and transmission items.

<table>
<thead>
<tr>
<th>Level</th>
<th>Pathogen</th>
<th>Objects that spread disease</th>
<th>Objects that kill infectious agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bacterium</td>
<td>direct contact food</td>
<td>medicine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water</td>
<td>soap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>indirect contact air</td>
<td>vaccine</td>
</tr>
<tr>
<td>2</td>
<td>Fungus</td>
<td>direct contact water</td>
<td>medicine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>animal indirect contact</td>
<td>soap</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>vaccine</td>
</tr>
<tr>
<td>3</td>
<td>Virus</td>
<td>direct contact food</td>
<td>medicine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water</td>
<td>soap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>air</td>
<td>vaccine</td>
</tr>
<tr>
<td>4</td>
<td>Protozoan</td>
<td>food</td>
<td>medicine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Helminth</td>
<td>direct contact food</td>
<td>medicine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water</td>
<td>soap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>air</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Prion</td>
<td>food</td>
<td></td>
</tr>
</tbody>
</table>

**Body Defender Challenge**

The student learns about the different methods the body has to fight off infectious diseases. First, students learn about the names and locations of components of the immune system. Then they progress through an animation of both nonspecific and specific immune response.

**Germ Blaster Challenge**

The student learns about the common treatments and preventatives for infectious disease by playing a game. In the game he/she fights each of the six types of infectious agents by choosing the appropriate treatment/preventative. Below is a chart with each pathogen and its corresponding treatment. Note that prions are not listed because there is no treatment for diseases caused by this agent, a fact that is pointed out in the game.

<table>
<thead>
<tr>
<th>Pathogen:</th>
<th>Treatment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>Antibiotics and Vaccines</td>
</tr>
<tr>
<td>Fungi</td>
<td>Anti-fungal Drugs, Antibiotics</td>
</tr>
<tr>
<td>Viruses:</td>
<td>Anti-viral Drugs, Vaccines</td>
</tr>
<tr>
<td>Protozoa</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>Helminths</td>
<td>Anthelmintics</td>
</tr>
</tbody>
</table>

Once the student completes all five challenges, he/she takes a review quiz. Only after passing the quiz will the student be certified as a qualified NCDC agent.
Scientist Biographies

**Robert Koch (1843 – 1910)** Robert Koch was born at Clausthal in the Upper Harz Mountains of Germany. He earned his MD degree in 1866. Dr. Koch made numerous contributions to early microbiology, working on the human diseases anthrax, tuberculosis, cholera, and malaria. He also studied tropical disease in cattle. In 1905, he received the Noble Prize for his work on tuberculosis.

His major contributions include identifying the cause of each disease along with recommendations to prevent their spread. Koch was very methodical and persistent in his experiments.

To read interviews of contemporary microbiologists talking about how they got into microbiology and what they do, check out [http://www.microbe.org](http://www.microbe.org) under “Careers”. The scientists featured are diverse in background and training. Since some interviews are a little long for middle school students, choose ones that seem particularly appropriate for your students.
### National Science Education Content Standard Correlation

**Grades 5-8**

<table>
<thead>
<tr>
<th>Instructional Objectives “Orientation at ORB”</th>
<th>Science Content Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Koch’s Concepts</strong></td>
<td><strong>Science as Inquiry</strong></td>
</tr>
<tr>
<td>• Simulate an experiment demonstrating Koch’s Postulates.</td>
<td>Content Standard A: All students should develop:</td>
</tr>
<tr>
<td>• Apply the steps of Koch’s Postulates to identification of a disease in humans.</td>
<td>1. abilities necessary to do scientific inquiry</td>
</tr>
<tr>
<td></td>
<td>2. understandings about scientific inquiry</td>
</tr>
</tbody>
</table>

**Enemy Agents**
- Identify the six types of infectious agents and their characteristics.

**Body Defender**
- Describe the role of the immune system in fighting diseases.

**Germ Blaster and Infect-O-Rama**
- Associate modes of transmission with each type of pathogen.
- Distinguish different treatments and preventatives most effective for each pathogen.
- Match types of pathogens to the specific diseases they cause.

**Science in Personal and Social Perspectives**
- **Content Standard F:** All students should develop understandings of:
  1. personal health
  2. natural hazards
  3. risks and benefits
  4. science and technology in society

**History and Nature of Science**
- **Content Standard G:** All students should develop understandings of:
  1. science as a human endeavor
  2. history of science

- **Summarize the storyline.**

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**MedMyst**

7 MISSION ONE: ORIENTATION IN ORB
MISSION BRIEFING: Vocabulary Terms

Vocabulary terms that are fundamental in understanding the concepts included in Mission One are listed below. Some of these words will be encountered while playing Mission One. Teachers should alert the students to the ability to click on the hot-linked words in the game.

**agar (A-gar)** - a jelly-like substance made from seaweed that is used to grow bacteria and fungi.

**Anthelmintic (an-thel-MIN-tik)** - A remedy that is destructive to worms and used for removing internal parasitic worms in animals and humans.

**antibiotic** - a drug that inhibits the growth or kills an infectious agent. Antibiotics are effective against bacteria. Some of these antibacterial drugs can be used to fight certain protozoa and fungi as well.

**antibodies** - molecules produced by a B cell in response to an specific pathogen. Antibodies bind to the pathogen and mark them for destruction.

**antifungal medication** - a drug that kills or slows the growth of fungus.

**antiviral medication** – Drugs that interfere with the ability of a virus to reproduce and cause disease.

**B cell** - a white blood cell derived from the bone marrow. B cells are responsible for the production of antibodies.

**bacterium (singular) bacteria (plural)** - Very small, unicellular microorganisms that multiply by cell division. Cell is typically contained within a cell wall. Found as spherical, rod, and spiral shapes. Bacteria can spread through direct contact, indirect contact, food, water, air, and animals.

**bodily fluids** – liquids associated with the body, such as blood, urine, saliva, and mucus from the nose.

**control** - A standard of comparison for checking or verifying the results of an experiment. It is the part of the experiment in which no change is made.

**fungus (singular) fungi (plural)** - an organism that has a cell wall and a cell membrane.

They include molds (filamentous multicellular type) and yeast (unicellular spherical type). Fungi can spread through direct contact, indirect contact, water, air, and animals.
MISSION BRIEFING: Vocabulary Terms

helminth - Multicellular worms that can be parasites in the intestine, blood, or body tissue.

   Helminths can spread through direct or indirect contact, food, water, and air.

immune system - a complex network of specialized cells, tissues, and organs that defends the body against attacks by disease-causing microbes.

immunity - resistance to a specific pathogen.

infectious agents - Organisms or particles that cause an infectious disease. Bacteria, viruses, fungi, protozoa, helminthes, and prions are infectious agents.

inoculate – a. introduce a substance into a person or animal to produce immunity; b. to pass on a disease from one organism to another by passing on the pathogen.

Koch’s Postulates - A set of rules for proving that a microorganism causes a specific disease.

Lymphoid (lim-FOID) organs – organs concerned with the growth, development and deployment of white blood cells (lymphocytes). Examples include the spleen, thymus, lymph nodes, and appendix.

Mucous (MYOO-kuhs) membrane – the moist inner lining of the mouth, nose, vagina, and urethra.

nonspecific defense - immune system response where a white blood cell constantly patrols the body, gobbling up many different types of pathogens.

Pathogen (PATH-o-gen) - disease-producing agents.

Penicillium italicum - Penicillium italicum is a type of fungus called a mold. Molds can cause plant diseases and food spoilage. Some molds can be used to make antibiotics.

phagocytes (FAG-uh-sites)- cells that surround and gobble up invading microbes. These cells are used in the nonspecific defense by the immune system.

prion (PRAHY-on or PREE-on) - Extremely small particles that consist only of protein. Prions are resistant to heat and disinfectants and can only be spread through food.

protozoan (singular) protozoa (plural) - Simple, single-cell organisms such as the amoeba and paramecium. Some have flagella or cilia and are capable of rapid movement. Protozoas can spread though food, water, and animals.

specific defense – immune system response where white blood cells mount a directed attack against a specific pathogen.
**virus** – Extremely small particles that can only reproduce and survive by taking over a living cell. They consist of nucleic acid enclosed in protein. Viruses can spread through direct contact, indirect contact, food, water, air, and animals.

**white blood cells** – also known as lymphocytes. Cells of the immune system involved in defending the body against pathogens.
### TEACHER VERSION

**TEACHER DIRECTIONS:** Ask the students to fill in the ANSWER column as they proceed through the mission.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. In the Enemy Agents challenge, you meet up with six different infectious agents. Name them.</strong></td>
<td>A. bacterium, virus, protozoan, fungus, prion, and helminth</td>
</tr>
<tr>
<td><strong>B. Which type of infectious agent are a tapeworm, a roundworm, and a hookworm?</strong></td>
<td>B. helminth</td>
</tr>
<tr>
<td><strong>A. In the Koch’s Concepts challenge, why is it necessary to wash the orange before infecting it with the fungus?</strong></td>
<td>A. To sterilize the oranges (kill other germs that may be on the orange).</td>
</tr>
<tr>
<td><strong>B. Who worked out the four-step procedure scientists use to determine if a specific germ causes a particular disease?</strong></td>
<td>B. Dr. Robert Koch</td>
</tr>
<tr>
<td><strong>A. In the Germ Blaster challenge, which types of infectious agents can be killed by antibiotics?</strong></td>
<td>A. bacterium, fungi, and protozoan</td>
</tr>
<tr>
<td><strong>B. Which pathogen has no treatment?</strong></td>
<td>B. prions</td>
</tr>
<tr>
<td><strong>A. In the Infect-O-Rama challenge, what are the ways in which viruses can be spread?</strong></td>
<td>A. Viruses can be transferred by hand, food, water, doorknob, mosquito (animal), and a sneeze.</td>
</tr>
<tr>
<td><strong>B. Which two modes of transmission are common to five of the infectious agents?</strong></td>
<td>B. food and water</td>
</tr>
<tr>
<td><strong>A. In the Body Defender challenge, what two body parts make up the first line of defense against pathogens?</strong></td>
<td>A. skin, mucous membranes</td>
</tr>
<tr>
<td><strong>B. What is the name of the proteins made by B cells that can bind (connect) to a specific pathogen?</strong></td>
<td>B. antibodies</td>
</tr>
</tbody>
</table>
STUDENT INSTRUCTIONS: Record your observations by finding the clue that correctly matches each description. Write down the clues as you proceed through the mission.

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<td>B.</td>
</tr>
</tbody>
</table>
Activity 1: Diary of a Disease

In this activity, students will take on the role of an infectious disease or an infectious agent. The student will then research his/her assigned disease in the library, on the web, or even by interviewing a health professional, and then create a story from the disease or pathogen’s point of view.

Background

The world of infectious disease is complex and confusing. It covers many areas of science as well as medicine. To add to the problem, these diseases affect everyone, everywhere, every day. According to the World Health Organization, every hour, 1,500 people die from an infectious disease worldwide. Many of the victims are under the age of five years old.

Luckily, there are teams of physicians, scientists, epidemiologists, and other health care workers who treat, research, and track diseases daily. But despite our ability to combat these diseases, one thing still remains, the infectious agents who cause these diseases are very good at what they do.

Viruses, like prions, are not living things, yet they can cause the deadliest infectious diseases. In fact, it only takes one complete virus particle to cause the viral disease hepatitis B. On the other hand, bacterial infections have been something modern medicine has been able to fight with antibiotics, but even then, bacteria continually change and mutate to resist even the most potent of drugs. These pathogens are smart, and we must learn all their tricks if we want to win the war against them.

In this activity, students will delve into the world of infectious agents and see what life is like through the eyes of a pathogen. Maybe by “humanizing” these diseases, we’ll get a better understanding of how and why they are so dangerous.

This activity is has been modeled after the stories found on the web site: http://schools.ci.burbank.ca.us/~luther/science/disease/
Diary of a Disease

Learning Objectives

The student will:
1. perform research on an infectious disease.
2. create a story about a specific infectious disease.

Materials

1. computer with Internet access for research purposes
2. *Diary of a Disease Student Activity Sheet*

Procedure

1. At the beginning of class, hand out the *Disease Diary Student Activity Sheet*.
2. Tell the students that they are going to research an infectious disease and document the facts that they think would accurately describe the “life” of the disease.
3. The students can work in groups or alone to help each other discuss the information that they believe is important.
4. Inform students that they will use these facts to create a story from the disease’s perspective.
5. Assign each student or student group an infectious disease. Suggested research topics are:

   A. Examples of infectious diseases that affect the gut: *Escherischia coli* 0157 infection, hookworm infection, salmonellosis (salmonella), cholera, and shigellosis
   B. Examples of infectious diseases that affect the central nervous system: botulism, meningococcal disease (meningitis), and rabies
   C. Examples of infectious diseases that affect the respiratory system: influenza, strep throat, and tuberculosis
   D. Examples of infectious diseases that affect more than one system: anthrax, chickenpox, legionellosis (Legionnaire’s Disease), Lyme disease, measles, and mononucleosis

Have each student present a finished story to the class.

Example

See the example of a story on the second page of the *Student Guide Sheet*. 
Extension Activities

- **Language Arts**: Interview a scientist or physician about their job, their role in fighting infectious disease, or a specific disease.
- **Social Studies**: Create a timeline of the history of a specific infectious disease. Include information on where the disease originated, scientists who studied the disease and their findings, and where the disease occurs today.
- **Social Studies**: Draw a map with the locations and dates of an infectious disease outbreak.
- **Language Arts**: Write a poem about an infectious disease and its consequences.
- **Mathematics**: Calculate the percent of infected population of different infectious diseases.

Standards

National Science Education Standards, Grades 5-8

- Science Content Standard C: All students should develop understanding of structure and function in living systems.
- Science Content Standard F: All students should develop understanding of personal and community health.

Books


Web Sites

Starred sites are written more towards students.

- Center for Disease Control  
- World Health Organization  
  [http://www.who.int/](http://www.who.int/)
- The Plumber: Plagues and Epidemics*  
- History of Diseases: *Karolinska Institute*  
  [http://www.mic.ki.se/HistDis.html](http://www.mic.ki.se/HistDis.html)
Diary of a Disease

Nobody wants an infectious disease. They can be painful, dangerous, and even deadly. But how do infectious diseases feel about us? Learn more about an infectious disease by researching the disease and then writing a story from the disease’s point of view.

Do the Research
Gather information on the infectious disease assigned to you. You can search for information from the library and/or using Internet sites and classroom reference materials. Record the name of the source of the information. Interesting facts you may explore are:

- infectious agent that causes the disease
- method of spread (water, food, insect, or person)
- risk of infection
- symptoms
- body’s defenses to fight the disease
- method of diagnosis
- treatment
- prevention
- who discovered it

Write the Story
Write a story from a disease’s point of view. Here are some suggestions about how to begin:

1. Write a diary entry of an infectious agent entering its host.
2. Write a story about how the disease progresses once inside the host.
3. Write a story about how the body fights the infectious agent when it enters the body.
4. Write a news article of how an infectious agent successfully infected many people.

Use your imagination! Be creative! Add drawings or pictures!

Don’t know where to begin? Check out the sample story “The Adventures of Bert the Bacterium” on the next page!
Hi my name is Bert, short for *Borrelia burgdorferi*. It’s a family name. I was born after my parents had a long argument. I think it was somewhere around 14 hours! Then they split up. Oh well, they sure did produce one handsome bacterium! The lady bacteria love my spiral shaped physique and especially my eight flagella. Of course, my shape and size not only make me handsome, but make me good at infecting different animals.

I was born inside the gut of a tick. When I was a teenager, I stayed inside and got strong. One day, I was hanging out when I got the call from the command center saying that the tick that I was traveling in had bitten a little boy named Jimmy. Here was my chance! I wiggled as fast as I could towards the tick’s mouth. I wiggled for close to 37 hours (It’s a long way from the stomach to the mouth!). I was almost there, faster and faster I swam towards the tick’s mouth. Closer, closer . . . WHEW! I was through. Right behind me, I heard the cry of the tick, my first host, scream as my Jimmy picked him off with tweezers, but left behind his mouth, still sucking to the skin. I just made it through.

And now I am just waiting for a few days while I get big and strong. After about seven days, I should be able to make a rash on Jimmy’s skin. I hope that I can be as great of a rash artist as my Aunt Martha. She used to make the most amazing red radial patterns on her victim’s skin.

Wait, one of my buddies from a neighboring blood vessel just came by yelling something…Oh no! The human took the dreaded antibiotics doxycycline and amoxicillin. The medicine is marching quickly towards our blood vessel. It has already killed hundreds of my next door bacteria neighbors.

Here they come, there are so many . . . Jimmy must have taken the medicine for two weeks already, there are so many here. Closer, closer. AAAACK! The pain has gotten to me - it won’t be long now. I wish I could have lived to see the rash that I was preparing to make on the skin. It would have been so beautiful. But it’s too late.
Activity 2: Super Agent

In this activity, students will learn about the complex structure of a bacterium, virus, protozoan, and helminth and the unique functions associated with each microbe. Each student will then create a "Super Agent" from what they have learned about the structure and function of the microbes.

Background

Infectious diseases are caused by the invasion of infectious agents or pathogens. The invading pathogen begins to grow within the host and, as a consequence, tissue function is impaired. Each infectious agent has developed, through time, its own distinctive traits that allow it to live and prosper in the host. Even if the host is able to mount an attack against the invading pathogens, the infectious agents have ways to avoid these attacks.

Bacteria
Bacteria are unicellular prokaryotic organisms that have no membrane-bound organelles. Their genomes (genetic material) are circular, double-stranded DNA, and most divide by binary fission. Despite these characteristics, there is a wide range of diversity among the bacteria. This diversity helps bacteria avoid attack from the host. Other examples of structures that help bacteria survive are the cell wall, plasmid DNA, and flagellum.

Viruses
Viruses are unique molecules of nucleic acid surrounded by a protein coat. Viruses are not considered living because they have no metabolism and cannot reproduce without a host. Viruses are extremely small, which helps them evade the body’s defenses. Viruses can mutate in order to survive, and some viral genes code for toxic proteins that help to break open the host cell and release the virus.

Protozoa
Protozoa are unicellular, heterotrophic eukaryotes. They do not have a cell wall and thus are capable of flexible movements. Protozoa have many structural devices that help them survive, such as the pellicle.

Helminthes
Helminthes are simple invertebrate animals. Because they are animals, their physiology is similar to ours; therefore, the drugs that kill parasitic helminthes may also affect the humans they invade. Some parasitic worms can grow as large as 40 feet. In their larval and egg stage, they are very small and can easily be ingested by a human host. Many of these invaders have adapted very well to living in humans, and people can have them for years without knowing they are there.

Learning Objectives
MISSION DEBRIEFING: Teacher Guide

The student will:
1. learn about the structure and unique functions of various infectious agents.
2. create an imaginary infectious agent that is made of different structures from various infectious agents.

Materials
1. Overheads of virus, bacterium, protozoa, and helminth (or use pictures from your classroom text)
2. Make student copies of Super Agent Student Guide (Structure and Function Table and Super Agent Bio)
3. Make a class set (to be reused) of virus, bacterium, protozoa, and helminth overheads (or use pictures from your classroom text). Re-collect at the end of class.
4. Craft supplies such as toilet paper rolls, pipe cleaners, crepe paper, cotton balls, toothpicks, Q-tips, yarn and glue, tape, or glue guns. (Asking students to bring a variety of recycled items works well also.)

Procedure
1. Using the overheads, review the characteristics of a virus, bacterium, protozoa, and helminth. (Note: Prions and fungi are infectious agents as review in MedMyst, but they are not included in this activity.) Point out the characteristics (adaptations) of each infectious agent that allow it to survive and reproduce itself.
2. Tell the students that they will be creating a Super Agent; it will be a new infectious agent that has structures from each of the four different infectious agents we reviewed.
3. When working with their groups (2-4 students recommended), students will first discuss what structures their Super Agent will have, making sure to include at least one from each of the four infectious agents we reviewed. Students should review their plan for their Super Agent, making sure it has a way to metabolize (food in and food out), reproduce, and a way to infect a host. They should work as a team to complete the Structure and Function Table. (The greatest learning will happen when you have students begin brainstorming independently, and then break into groups to share ideas and compromise on the actual Super Agent design.)
4. Once the groups have decided on the structures their Super Agents will have, they may proceed to the craft supply area to get materials to actually create the pathogen. (It is sometimes helpful to have groups get pre-approval before being allowed to proceed to insure they have spent time on the design process.)
5. A good estimate of the time needed for students to plan and then build their Super Agents is 40 minutes.
6. Each group should present their creation with each student sharing one outstanding characteristic and what pathogen that characteristic resembled.
7. Additional options are as follows: students reference a Latin root word list as they make up a scientific name for their pathogen; groups are given the option of choosing one “creative option” for an adaptation on their pathogen that is not based on anything found in the four model pathogens; students draw their created pathogen using paper or computer design options.
Extension Activities

- **Language Arts**: Write a description of the disease that your super agent would cause and how to treat the disease.
- **Science**: Investigate how microbes have been altered for use in biotechnology.
- **Health**: Discuss what environmental factors have affected the structure and functions of infectious agents.

Standards

National Science Education Standards, Grades 5-8

- Science Content Standard A: All students should develop abilities necessary to do scientific inquiry.
- Science Content Standard C: All students should develop understanding of structure and function in living systems.
- Science Content Standard C: All students should develop understanding of diversity and adaptations of organisms.

Books


Web Sites

- Stalking the Mysterious Microbe
- CELLS Alive!
- The Bad Bug Book
  [http://vm.cfsan.fda.gov/~mow/intro.html](http://vm.cfsan.fda.gov/~mow/intro.html)
MISSION ONE: ORIENTATION IN ORB

Bacterium:

Capsule:
- Outer covering of some bacteria
- Keeps it from drying out
- Makes it harder for other microorganisms to eat

Cell Wall:
- Holds pili and flagella
- Gives cell its shape
- Keeps cell from bursting in some environments

Cell membrane:
- Thin layer of fats
- Regulates what goes in and out

Pilus (plural pili):
- Present on some bacteria
- Help bacterium stick to host
- Some bacteria can’t infect hosts if they have no pili
- Special pili can link bacteria to each other to share plasmid DNA

Cytoplasm:
- Gel-like contents of cell

Plasmid DNA:
- Not all bacteria have these
- Small circles of DNA
- Contain optional information
- Can help bacteria be resistant to antibiotics
- Can be shared with other bacteria

Chromosomal DNA:
- Large, circular DNA
- Has all the information to make new bacterium

Ribosomes:
- Small organelles floating in cytoplasm
- Make protein

Flagellum (plural flagella):
- Present on some bacteria
- Hair-like
- Allows bacteria to move away from toxins
- Allows bacteria to move toward food or light
MISSION DEBRIEFING: Overhead

Helminth

Helminths:
Disease-causing worms have three main body segments.

![Helminth diagram](image)

Hooks:
- On the head
- Helps worm to stick to the wall of the intestine

Suckers:
- On the head
- Helps worm to stick to the wall of the intestine

Proglottids:
- Body segments
- Worm grows by adding body segments. New ones are added near the head.
- Each segment contains male and female organs, so they often fertilize themselves.
Protozoa

Nucleus:
- Contains DNA
- Has all the information to make a new organism

Anal Pore:
- Ejects waste from the cell.

Cytoplasm:
- Gel-like contents of cell

Pellicle:
- Found in some types
- Protects and strengthens the outside

Food Vacuole
- Food enters through gullet
- Food is digested inside the food vacuole
Virus

**Genetic Material:**
- Either DNA or RNA
- Much smaller than in other organisms
- Contains all of the information required to make a new virus

**Capsid:** (yellow):
- Protein covering
- Protects genetic material

**Envelope:** (blue)
- Not present in all types of viruses
- Taken from infected cell when virus leaves the cell

**Spikes:** (red)
- Some spikes help the virus stick to its host cell
- Some spikes help virus put its genetic material into host cell
- Some spikes help virus leave host cell
MISSION DEBRIEFING:  Student Guide

Super Agent

In this activity, you will learn about the complex structure of a bacterium, virus, protozoan, and helminth and the unique functions of these microbes. Then you will create a “super agent” which has your favorite features and characteristics.

Materials

1. Copies of Super Agent Structure (to be reused): bacterium, virus, protozoan, helminth
2. Super Agent Structure and Function Chart and Super Agent Bio Page
3. Craft supplies

Procedure

1. Review the structures of a bacterium, virus, protozoan, and helminth from the photocopies
2. If you were designing a brand new pathogen, what characteristic structures would it have? What functions would it need to be able to do to stay alive and infect a host in some way? Complete the Structure and Function chart with your ideas basing at least one characteristic on each of the four pathogens that were reviewed.
3. Once you join a group, share your ideas with them and compromise to decide what pathogen the group will create.
4. Using the craft supplies provided, build the pathogen you have designed.
5. Name the pathogen and complete its description at the top of the page.
6. Be prepared to share your pathogen with the class with each team member sharing one of the structures, its function, and what pathogen this characteristic resembled.

Super Agent
Name(s) ______________________________________________________
Super Agent Name___________________________________________
Description________________________________________________
______________________________________________________________________________

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
<th>This is similar to a structure in which of the infectious agents?</th>
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Super Agent Bio
Directions: Complete the following questions based on the Super Agent you built. Use complete sentences please.

1. What characteristics of a virus does this Super Agent have?

2. What characteristics of a bacterium does this Super Agent have?

3. What characteristics of a protozoan does this Super Agent have?

4. What characteristics of a helminth does this Super Agent have?

5. What structures allow this Super Agent pathogen to metabolize (take in food, break down food, absorb the energy from food, get rid of wastes)?

6. Describe the life cycle of this Super Agent (reproduction, growth stage, introduction to host and the method by which it infects the host, etc.).

7. Do you think antibiotics would work against this Super Agent? Why or why not?

8. Scientists sometimes mention their fear of a pandemic (world wide outbreak of a disease) caused by a new infectious agent. What are your thoughts about this occurring?
Activity 3: Microbe Meals

In this activity, the students will determine which foods are the best sources of energy for yeast.

Background

Fungi are often confused with plants because their cells have cell walls and some of them grow above ground. Fungi, however, differ from plants in one very important way. They cannot make their own food; they are consumers. Some fungi are parasites, obtaining their food from living hosts and causing disease in the process. Other fungi feed off dead organisms or the wastes of living things and are called decomposers.

Yeast is a fungus whose feeding habits have proven to be beneficial to humans. These unicellular microbes can produce the energy they need by breaking down sugar in a process called fermentation. Fermentation of sugar yields the energy needed to grow as well as two byproducts—carbon dioxide gas and alcohol:

\[ (C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2 + \text{energy}) \]

Fermentation is the reason humans can use yeast to make wine and other spirits. It is also the reason why yeast is used to make bread. The release of carbon dioxide gas during fermentation of the sugar makes bread dough rise.

Sugars and starches are excellent sources of energy for yeast. We know this because fermentation experiments have shown that there is a positive correlation between the amount of energy and the amount of byproducts produced. Both sugar and starch produce large amounts of carbon dioxide and alcohol when they are fermented.

Unlike sugar, some sweeteners are not good sources of energy for yeast. For example, yeast cannot break down the artificial sweetener, saccharin. Fungi, specifically yeast can metabolize aspartame, but its breakdown produces very little energy.

This activity was adapted from one at http://www.microbeworld.org/home.htm entitled: Can Microbes Tell the Difference? : The American Society for Microbiology: MicrobeWorld.

Learning Objectives

The student will:
1. Observe the effects of fermentation using varying sources of energy.
2. Conduct an experiment to determine which foods are the best sources of energy for yeast.
Materials for each group of 3-4 students

1. *Microbe Meals Student Guide*
2. 4 tsp (20g) rapid rise yeast
3. microwave or hot plate
4. measuring cup with half cup division
   (large graduated cylinder)
5. thermometer
6. metric ruler
7. microwave safe cups/containers or glass beakers
8. 1 teaspoon measuring spoon
9. Warm test solutions (foods). The solutions are: (see right column)
10. Four quart sized plastic freezer bags *It is recommended that you use quality bags to prevent leakage.*
11. Surgical masks (students may be allergic to the yeast)
12. Gloves
13. Stopwatch, time device

a. half cup (240ml); (½ can of regular cola)
b. half cup (240ml); (½ can diet cola, with saccharin)
c. water with sugar (1 teaspoon per half cup of water)
d. water with aspartame – Equal®(1 teaspoon per half cup of water)
e. water with white flour (1 teaspoon per half cup of water)
f. water with wheat flour (1 teaspoon per half cup of water)

Procedure

1. Review how fungi get their food and the process of fermentation.
2. Divide the class into groups of three or four, and then distribute to each group the *Microbe Meals Student Guide Pages, four freezer bags, and one packet of yeast.*
3. Have each group select four foods to test as energy sources. One of the foods must be the water with sugar solution (control that will indicate a positive test).
4. Assign each group a number and tell the students to label each bag with their group number and the name of the test food.
5. Have each group warm the tests solutions to approximately 115°F (46.11° C) in containers in the microwave or in beakers on a hot plate (or provide the solutions already warmed).
6. Next, the students should add half a cup of solution to the appropriate bags. Add one teaspoon of yeast to each bag and gently mix by rocking the bag back and forth.
7. Before sealing the bags, students should push out as much air as possible.
8. Next, the bags are placed in a warm area of the classroom (can use an overhead projector or if it is warm outside, lay the bags in the sun).
9. The students monitor the bags every 10 minutes to make sure that the bags are producing carbon dioxide gas. The students measure the width of the bag with a ruler and record the size on the *Microbe Meals Data Sheet.* A graph can also be made plotting width versus time (x-axis) vs. width (y-axis). A line graph using four different colors for their chosen foods would be effective.
10. After 30 minutes, have each group collect the bags and make the final measurements.
11. Have the students complete the *Microbe Meals Analysis Sheet* and review their findings with the class.
MISSION DEBRIEFING: Teacher Guide

Microbe Meals

Extension Activities

- **Visual Arts**: Create models of different types of yeast.
- **Science**: Use bacteria to make yogurt.
- **Math**: Calculate the amount of CO$_2$ produced using the constant 3.4mmol/g hr (the amount of CO$_2$ produced from 1 gram of yeast in 1 hour)
- **Language Arts**: Research a disease-causing fungus and create a story from its perspective.
- **Language Arts**: Write a “how to paper” that describes how to perform an experiment that tests the fermentation rate of a fungus.

Standards

National Science Education Standards, Grades 5-8

- Science Content Standard A: All students should develop abilities necessary to do science.
- Science Content Standard C: All students should develop understanding of the structure and function of living systems.
- Science Content Standard C: All students should develop understanding of regulation and behavior.

Books and Articles


Web Sites

Starred sites are geared toward students.

- The American Society for Microbiology: MicrobeWorld [http://www.microbeworld.org/home.htm](http://www.microbeworld.org/home.htm)
- Stalking the Mysterious Microbe [http://www.microbe.org/](http://www.microbe.org/)
Microbe Meals

Although some fungi look like plants, they cannot make their food as plants do. Instead, fungi must take in food to get energy. For this reason, they are known as consumers. In this activity you will learn how yeast (*Saccharomyces cerevisiae*), a type of fungus, breaks down food for energy. You will test different foods to determine which ones are the best sources of energy for yeast.

Materials

1. *Microbe Meals Student Guide Pages*
2. rapid rise yeast
3. microwave or hot plate
4. measuring cup
5. thermometer
6. metric ruler
7. microwave safe cups/containers
8. teaspoon measuring spoon
9. four plastic freezer bags (quart size)
10. Warm test solutions (foods), the group needs one half cup of each. The solutions are:(see right column)
11. Surgical masks
12. Gloves
13. Stopwatch, time device

A. Regular cola (½ can)
B. Diet cola (½ can)
C. water with sugar (1 teaspoon per half cup of water)
D. water with aspartame (1 teaspoon per half cup of water)
E. water with white flour (1 teaspoon per half cup of water)
F. water with wheat flour (1 teaspoon per half cup of water)

Procedure

1. Pick four foods to test as a source of energy for yeast. One of these foods must be the water with sugar solution- this food source will serve as your control.
2. Label the bags with the group number assigned by your teacher and the name of each food that you selected.
3. Warm the test solutions (approximately 115°F = 46.11°C) in cups/containers in the microwave or in beakers on a hot plate.
4. Add half a cup of test solution to the proper bags.
5. Add one teaspoon of yeast to each bag and gently mix by rocking the bag back and forth.
6. Push all the air out of each bag before sealing it.
7. Place the bags in a warm area of the classroom.
8. Monitor the bags every 10 minutes to make sure they are producing carbon dioxide gas. Measure the width of the bag with a ruler and record the size on the *Microbe Meals Data Sheet*. Graph the results on the same sheet by plotting width versus time (x-axis) vs. width (y-axis). A line graph using four different colors for their chosen foods would be effective.
9. After 30 minutes, collect the bags and make the final measurements.
10. Complete the *Microbe Meals Analysis Sheet*. 
MISSION DEBRIEFING: Student Guide

Name_______________________ Class_________ Date_______

Microbe Meals
Data Sheet

Yeast Growth Table

<table>
<thead>
<tr>
<th>Bag #</th>
<th>Food Source</th>
<th>10 minutes</th>
<th>20 minutes</th>
<th>30 minutes</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Water + Sugar</td>
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</table>

Yeast Growth Graph
Microbe Meals Analysis Sheet

1. a. Which food produced the most carbon dioxide (CO₂)?

   b. Why do you think it produced the most?

2. a. Which food produced the least amount of CO₂?

   b. Why do you think it produced the least?

3. a. Why do you think warm solutions were used for this experiment?

   b. What might have happened if cold solutions were used instead?

4. What is the purpose of the control (the water with sugar solution)?