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the science of MICROBES

Activity: Defending Against Microbes

from *The Science of Microbes Teacher's Guide*

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RESOURCES

Free, online presentations of each activity, downloadable activities in PDF format, and annotated slide sets for classroom use are available at www.bioedonline.org/ or www.k8science.org/.

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USDA NATURAL RESOURCES CONSERVATION SERVICE
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HIV virus particle. L. Howard, C. Daghlian, Dartmouth College.

INTRODUCTION

Microbial Challenges

Infectious 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 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.

> 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.

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/.

Using Cooperative Groups In The Classroom

Cooperative 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.

Overview

Students will be introduced to the immune system through an overview of how the body protects and fights against microbes. They will use this information to solve a crossword puzzle featuring vocabulary related to the immune system and microbes (see Answer Key, p. 4).

Flexispira rappini bacteria. CDC\5709 J. Carr, P. Fields, C. Fitzgerald.

TIME

Setup: 10 minutes
Activity: 45 minutes

DEFENDING AGAINST

Microbes

We are surrounded by potential disease-causing microbes, yet most of us remain remarkably healthy. How do our bodies protect themselves against infections by microorganisms and viruses? The answer lies with the remarkable immune system, which consists of many types of proteins, cells, organs and tissues—all working together to identify and destroy foreign invaders (primarily microbes) and abnormal cells (such as tumor cells) within the body.

A healthy immune system can distinguish between the body's own cells (including helpful microbes inside the body) and foreign cells. When immune system cells detect foreign cells or organisms, they quickly attack. Anything that triggers this immune response is called an "antigen." An antigen can be a microbe, a part of a microbe, or even cells from another organism (such as from another person). Parts of the immune system also can remember a disease-causing agent (or pathogen) and mount an attack if the pathogen reappears. These immunological memories are the basis of vaccination. Vaccines "teach" the immune system to recognize a specific pathogen by mimicking a natural infection by that pathogen.

MATERIALS

Per Group of Students

- Set of colored highlighters (at least one marker per student)
- 4 copies of each student sheet
- Group concept maps (ongoing)

SETUP

Make copies of the student sheets.

Have students work individually or in groups of four.

PROCEDURE

1. Ask students, *If microbes are everywhere, why aren't we sick all the time?* Conduct a class discussion or make a list of students' ideas on the board. If not mentioned by students, introduce the idea that the body's defense system—called the immune system—helps to find and destroy microbes.
2. Distribute a copy of the *Germ Defense* article to each student. Have students read the article individually and then discuss it within their groups. Students should use their markers to highlight new words or concepts they find in the article.
3. Within their groups, have students discuss the words or concepts they highlighted. Encourage groups to search the Internet for additional, related information. Reliable websites include the National Institutes of Health (www.nih.gov) and the Centers for Disease Control and Prevention (www.cdc.gov).
4. Have students use what they have learned to complete the crossword puzzle, individually or in groups.
5. Allow time for students to add to their concept maps.

SCIENCE EDUCATION CONTENT STANDARDS

Grades 5–8

Inquiry

- Communicate scientific procedures and explanations.

Life Science

- Living systems at all levels of organization demonstrate the complementary nature of structure and function.
- The human organism has systems for protection from disease.
- Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the systems. Others are the result of damage by infection by other organisms.

VIRAL GENETICS

Many disease-causing microbes, including the viruses that cause colds, mutate frequently during reproduction. This genetic process yields constantly changing virus strains that are not recognized by the immune system.

ANSWER KEY

Answers to the crossword puzzle are on page 4.

Flexispira rappini bacteria. CDC\5709. J. Carr, P. Fields, C. Fitzgerald.

Germ Defense

Some microbes, known as "pathogens," can make you sick. Luckily, your body has several ways to fight these microbes before they can cause disease or infection. Your skin and the moist linings of your nose, eyes and mouth are the first lines of defense. They keep potential invaders outside the body. Mucus in the respiratory and digestive passages traps some microbes. Coughing and sneezing help to eliminate microbes. Crying and urination both flush microbes out of the body. In addition, tears and saliva have germ-killing proteins. In the stomach, strong acids destroy many pathogens.

And if bacteria or viruses get past these defenses, your body has a built-in system—the immune system—to find and kill the invaders. A healthy immune system is able to tell the difference between the body's own cells and foreign substances. Anything that the body identifies as "foreign" will cause the immune system to spring into action. Materials that trigger an immune system response are called "antigens." An antigen can be a microbe, like a bacterium, part of a microbe, or other molecule.

The billion-cell army of the immune system is always on guard. The soldiers of the immune system are several dozen different kinds of white blood cells, each with a special job. Some cells attack any foreign particle from outside the body. For example, some "eating" cells gobble up invaders or infected cells in the bloodstream. Other white blood cells target and destroy specific invaders. Some white blood cells make products, called antibodies, that tag invaders so that they can be destroyed. The immune system "remembers" invaders, so it is better prepared to defend against them in the future.

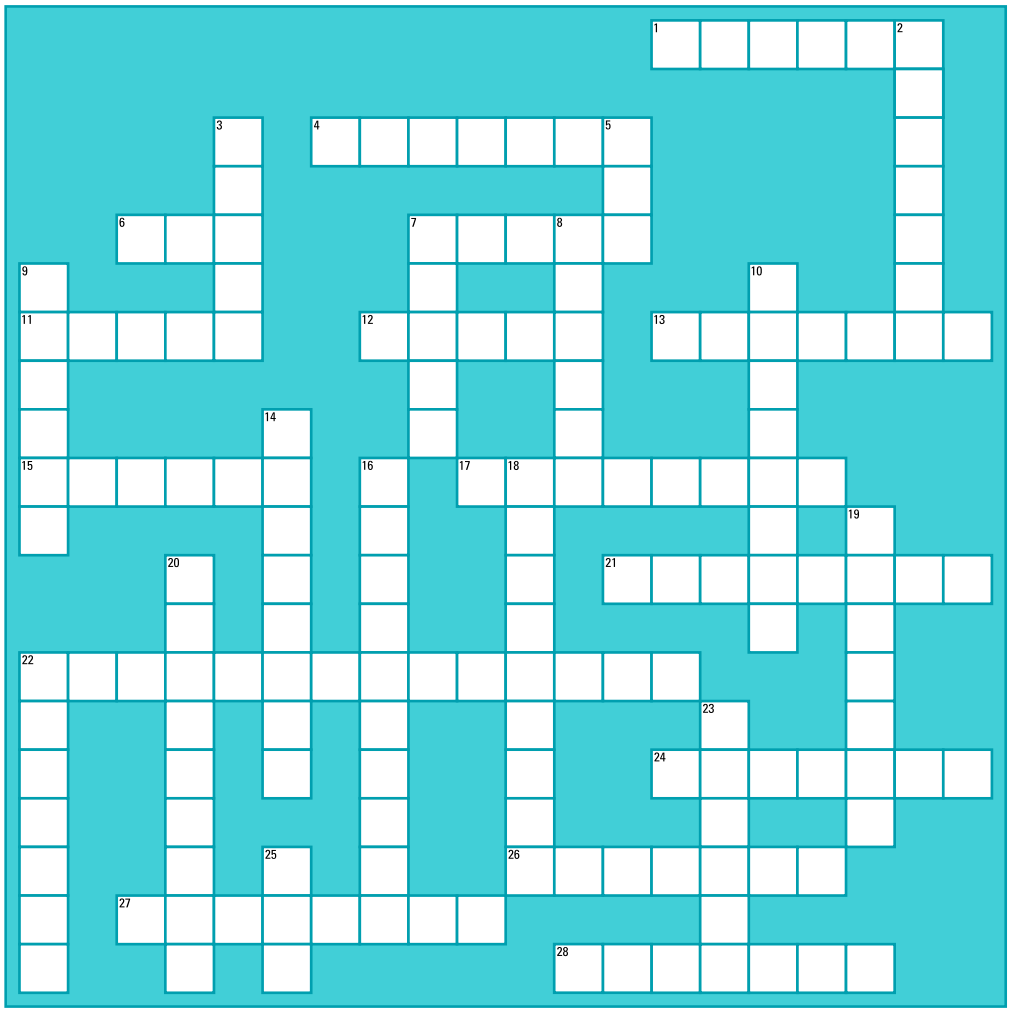
Vaccines use the body's immune system to protect against diseases, such as polio, measles and tetanus. Vaccines contain dead or weakened microbes, which are recognized as invaders and attacked by the immune system. Because the immune system remembers information about the weakened microbe in the vaccine, it is able to fight off future infections—even if a new invader is a stronger version of the one contained in the vaccine. Vaccines are effective only against microbes that don't change (mutate) very much. Microbes that change constantly, such as viruses that cause colds, don't match the immune system's memories of previous infections, so they are able to cause illness.

Sometimes, the immune system itself becomes damaged or weakened. This is what happens when HIV, the virus that causes AIDS, infects the body. HIV attacks a certain kind of white blood cell, called a "T cell," and weakens the body's ability to defend itself.

In other cases, the immune system makes a mistake and attacks the body's own cells or tissues. This kind of response causes diseases like arthritis and Type 1 diabetes. These illnesses are called "autoimmune disorders." Sometimes, the immune system reacts to a seemingly harmless foreign substance, like tree pollen. The result is called an allergy. Hay fever, which is a reaction to several different kinds of pollen, actually is an allergy, rather than an infection, like a cold.

Flexispira rappini bacteria. CDC\5709. J. Carr, P. Fields, C. Fitzgerald.

Attackers & Defenders



ACROSS

1. The immune _____ can be triggered by fragments of organisms or by entire organisms.
4. There are about this many cells in the immune system.
6. The body has many ways to tell invaders, "Keep _____!"
7. The linings of your nose and mouth are not dry or completely wet; they are _____.
11. You have a lot of these in your nose to trap germs.
12. This immune system cell is destroyed by HIV.
13. This childhood illness, which causes a red, blotchy rash, can be prevented with a vaccine in most cases.
15. Some immune system cells _____ up invaders as if the invaders were chocolate candy.
17. The Type 1 form of this disease is caused when the body's own immune system makes a mistake.
21. An _____ helps to tag and destroy invaders before they are able to spread throughout the body.
22. There are many kinds of this defender cell (three words).
24. An _____ is something that triggers an immune response.
26. This structure is in the center of many cells.
27. The immune system attacks _____ that enter the body from outside.
28. This happens when the immune system reacts to a seemingly harmless substance.

DOWN

2. Also called microorganism.
3. Some microbes enter the body when an insect _____ a person.
5. Once you are vaccinated against a disease, you probably will _____ get it.
7. Microbe-trapping slime in the nose is called _____.
8. This liquid, found in the mouth, has germ-killing properties.
9. It is difficult to create vaccines for microbes that mutate or _____ easily.
10. This kind of microbe does not have a defined nucleus.
14. After it has fought a certain invader once, the immune system can _____ that invader the next time it enters the body.
16. A _____ is a useful tool for observing microbes.
18. When a harmful microbe invades and starts reproducing in the body, it causes an _____.
19. From somewhere else; not belonging to the body.
20. Disease-causing agents are called _____.
22. An HIV infection reduces or _____ the body's ability to defend against disease.
23. Ah-choo! When you _____, it helps to get germs out of your body.
25. This is a kind of fever that you can't catch.

Answer Key