2.9 Fighting Disease

BACKGROUND INFORMATION

The human immune system is an elegant, effective tool for protection against invaders. When functioning normally, the immune system is invisible. When the immune system functions abnormally, the body is in trouble. In severe combined immunodeficiency (SCID), lack of an enzyme means that toxic waste builds up inside immune system cells, killing them and thus devastating the immune system. An underactive immune or weakened system makes the body vulnerable to illness. Anything from excessive exercise, through chemotherapy to aging can cause the immune system to break down. Most immune disorders result from either an excessive immune response or an autoimmune attack. Asthma, Crohn's disease (an inflammatory bowel disease), and lupus all result from an overreaction of the immune system. Arthritis and some aspects of diabetes result from the immune system attacking its own cells and molecules. A key part of the immune system's role is to differentiate between invaders and the body's own cells. When this distinction is not made, autoimmune diseases result.

A newborn's immune system is poorly developed as the womb is sterile. Substances such as lactoferrin in breast milk help babies build resistance to a germ-filled world. A person's immune system's effectiveness peaks in the mid twenties, coinciding with the peak in hormone activity. With age, most immune systems are compromised by poor lifestyles and exposure to chemicals. Whereas the immune system recognizes potential pathogens and produces antibodies when they multiply above a level of equilibrium, chemical toxins place demands on the immune system that are not as easily met. The condition of the immune system has great bearing on health in seniors and chronically ill people. Many cancer patients die not from the cancer but from opportunistic illnesses that the immune system cannot overcome.

The rate at which a disease spreads in a population and the number of people involved is determined partly by the immunity of the population. Long-lasting protection against certain diseases is provided by vaccination and by natural infections. People with immunity will block the spread of infectious agents as they will not be re-infected and are not likely to be carriers of the infection. Avoiding contact with infected people will protect a person from contracting a communicable disease. Providing immunity to an infectious disease through vaccinations prevents the rapid spread of the disease to the general population, even if some people are not vaccinated.

Misconceptions

In 1969, the Surgeon General of the United States declared, "The war against infectious diseases has been won!" At that time, antibiotic drugs were thought to be able to cure most bacterial diseases. In the past 30 years, bacterial resistance to antibiotics has created super bugs, and viral diseases such as HIV/AIDS are endemic in some parts of the world. Realization is growing among medical researchers that the body's immune system is the most important part of the fight against diseases and that drugs are not the answer. Stress, diet, and activity are the three pillars of the immune system.

Related Background Resources

- The Microbiology Information Portal: http://www.microbes.info/resources/Medical_Microbiology/
- The Immune System: http://www.niaid.nih.gov/final/immun/immun.htm
- Immune System (2001): http://uhaweb.hartford.edu/BUGL/immune.htm
- Understanding the Immune System: http://rex.nci.nih.gov/PATIENTS/INFO_TEACHER/immune_sys/frame2.html
- Virtual Museum of Bacteria: http://www.bacteriamuseum.org/niches/hwfbacteria/immunesystem.shtml
- ACES-Autoimmune Support Group: http://aces_autoimmune.tripod.com/diseases.htm
- National Geographic video: *Our Immune System*, 1988, 25 min, no. WE51310

ASSESSMENT PLANNING

Overall Skills Expectations

SIS.04
SIS.05
SIS.06

Overall Expectations

M.03

Specific Expectations

M3.01 evaluate the impact of viral, bacterial, and fungal infection on the health of host organisms, and on humans in particular

Achievement Chart Categories	Assessment/Evaluation Opportunities (Evidence)	Assessment Tools
Knowledge/Understanding	Understanding Concepts, q. 1–8 M3.01	Rubric 1: Knowledge/Understanding
Making Connections	Making Connections, q. 9 M3.01	Rubric 4: Making Connections

Assessment Opportunities

Knowledge/Understanding Collect student answers to Understanding Concepts questions 1 to 8 and compare to answers provided in the Solutions Manual. To determine their level of achievement, use *Assessment Rubric 1: Knowledge/Understanding* assessment criteria:

- Understanding of concepts, principles, laws, and theories (identifying assumptions, communicating misconceptions, providing explanations)
- Knowledge of facts and terms
- Transfer of concepts to new contexts
- Understanding of relationships among concepts

Making Connections Collect student work for Making Connections question 9. To determine their level of achievement, use *Assessment Rubric 4: Making Connections* assessment criterion:

- Proposing courses of practical action in relation to science- and technology-based problems

INSTRUCTIONAL PLANNING

Suggested Time
Narrative/Section Questions—70 min

TEACHING SUGGESTIONS

- Open the class with the following questions: What happens when a person has the flu? What symptoms does he or she usually have (fever, cough, runny nose, swollen glands, fatigue)? Ask why these symptoms occur (the body is fighting the illness, and the cells are fighting the viruses or bacteria). Finally, ask the students how the body fights disease (with the immune system). Distribute slips of paper and have each member of the class write a definition of the human immune system. Collect the responses and redistribute them randomly around the class. Ask for volunteers to read the definition from the paper they have. Once all the definitions have been read, give the following definition: The immune system is a collection of cells and tissues spread throughout the body that defend the body against pathogens.
- As an analogy, ask students to imagine that their body is a fort under attack from viruses and bacteria. Use a concept map or table to show students the different lines of defence. Headings can include Type, Method, and Protects Against. Alternately, refer students to **LSM 2.9-1: Overview of the Body's Defences**, which will be a helpful study aid for this section. You can also use an orchestra analogy. Each group of instruments (organs, tissues, or cells) has a part to play, although on its own, it doesn't appear important.
- It seems obvious to state that the best way to promote effective immune system function is to stay healthy. What does that mean? **LSM 2.9-2: How Immune Is the Immune System?** is a spider diagram listing immune system stressors. All contribute in some way to weakening the immune system. After short research and consideration, students are asked to rank the importance of these stressors. The ranking isn't the important aspect here; students should realize that humans are not helpless pawns in the war against pathogens.
- Explain to students that cancer patients often die from opportunistic infections that the human system cannot overcome. This is especially true for people with leukemia, a cancer of the blood. Have students hypothesize why this happens. (An opportunistic infection can be defined as "an infection by a microorganism that normally does not cause disease but becomes pathogenic when the body's immune system is impaired and unable to fight off infection.") Teachers should be sensitive to students who may have lost someone to cancer.
- Some people have their amalgam dental fillings replaced with synthetic fillings because amalgam fillings are made with mercury. Explain that mercury is a heavy metal and some studies show that it can leach into body cells, acting as an immune system irritant. As an enrichment project, a student can research this issue and present the findings to the class.
- Simulate the action of macrophages with a large, partially inflated balloon: show how your fist can be completely engulfed by the balloon when you punch it. Direct students to answer Understanding Concepts question 8 immediately following this activity.
- Autoimmune diseases result when the body's immune system targets its own tissues as foreign invaders. In the research assignment, **Workbook 2.9: Autoimmune Diseases**, students choose four diseases from a list and summarize the symptoms of and immune system involvement for each disease in point form. A longer answer is required in Making Connections question 9, with information available on the *Nelson Science* Web site.

- Discuss pregnancy as a special adaptation of immunity. During pregnancy, a woman's immune system does not reject the fetus, even though it is genetically different from her. A woman's ability to suppress one part of her immune system while retaining the rest of it is an area of active research. It may be possible to use some of this research for organ transplants, to help recipients not to reject a new organ.
- Students are familiar with the concept of "infection" and can probably list several infectious diseases. But do they understand how readily infections are spread? A relevant Try This Activity appears in Unit 3, Section 3.17 (p. 226 of the Student Text). If students perform this activity here, discuss the following as a class:
  - Relate the activity to the following real-life situations:
    (i) Shaking hands in an office where someone has a cold
    (ii) Eating restaurant food that has been prepared by a hepatitis B carrier
    (iii) Sharing an airline row with a person who has tuberculosis
    (iv) Sharing needles with an HIV carrier
  - Identify three more examples of situations in which you are at risk of spreading or contracting an infection.
  - Create a poster or fact sheet to educate people about disease transmission.
- Ask students to guess how many bacteria are typically found on each square centimetre of healthy human skin. They may be surprised to hear that the answer is about 100 000 bacteria. Studies done over the past century have repeatedly shown that thorough and frequent hand washing can prevent the transmission of infectious microbes, particularly in hospitals. The American Society of Microbiology's Clean Hands Campaign recently revealed that although 95% of people surveyed say they wash their hands after using a public restroom, only 67% actually do. Direct students to a Don't Get Caught Dirty-Handed brochure at http://www.washup.org/brochure.pdf. To illustrate the effect of hand washing, assign the alternative activity, **Workbook 2.9 Activity: My Hands Are Not Dirty!**
- Remind students that throughout history cleanliness and hygiene were not considered important. In Europe, people wore wigs and heavy perfumes to help mask hair and body odour problems. Washing too frequently was believed to be unhealthy. These practices resulted in the rapid spread of many diseases. One of the most famous cases of disease transmission involved a cook known as "Typhoid Mary." This woman showed no symptoms of typhoid but spread it to those who ate the food she prepared. This case study is outlined in **LSM 2.9-3: Disease Transmission Case Study: Typhoid Mary**. Students read facts on typhoid and its transmission and answer questions that also review other concepts presented in this unit.
- Review the effect of human pathogens by outlining several viral (Section 2.3) and bacterial (Section 2.8) diseases. Some suggestions are listed on the next page.

Viral diseases: organism takes over the host cell and alters its function so that the viral DNA or RNA is reproduced and new viruses are formed	**Bacterial diseases:** organism produces toxins that affect cells and prevent them from functioning normally
common cold - caused by airborne rhinovirus and others - transmitted by droplets from sneezing or coughing - symptoms include cough, congestion, mild fever - duration is about 1 week	**strep throat** - caused by *Streptococcus* bacteria - transmitted by droplets from coughing or sneezing - symptoms include high fever, very sore throat - duration is 1–2 weeks; no long-lasting effects
hepatitis B - caused by an enterovirus - transmitted in the exchange of body fluids - most people are initially asymptomatic, but symptoms will appear 1–3 months after infection; loss of appetite, fatigue, abdominal discomfort, nausea, and jaundice - long-term effects include liver cancer, cirrhosis of the liver, and acute chronic infection	**tetanus** - caused by *Clostridium tetani* bacteria - transmitted through deep puncture wounds to the body: bacteria produce a neurotoxin that attacks neurons - symptoms include rigid muscle contractions, especially in the jaw (common name: lockjaw) - if not caught early, can result in paralysis or death
HIV/AIDS - caused by a retrovirus - transmitted in the exchange of body fluids - symptoms include the appearance of opportunistic diseases (rare diseases that only show up in people with weak immune systems) - 100% fatal, although treatments do exist that can prolong life for up to 15 years	**botulism** - caused by *Clostridium botulinum* bacteria - transmitted through improperly sterilized food that contains the bacterial spores - symptoms include blurred vision, difficulty swallowing and breathing, muscle weakness, nausea, vomiting - 1/3 of patients will die, all within a few days of initial symptoms

- Disease in the body is recognized by symptoms. These symptoms include pain, swelling, infected wounds, poor digestion, stiff joints, weakened bones, or just general debilitation. Symptoms are not diseases in themselves but function as the body's early warning system. If we neglect these warnings, or worse, turn them off with drugs such as painkillers that suppress the symptoms, the disease remains. An analogy would be turning off a smoke detector because the sound is annoying. The result could be that the house burns down unless you find the cause of the smoke and extinguish it. Have students think of examples of symptoms that, if ignored over a long period, could be irreversible (smoker's cough → lung cancer or emphysema).
- Fever occurs when white blood cells release endogenous pyrogens that work on the hypothalamus to raise body temperature. Most pathogenic viruses and bacteria can't thrive in hot environments. Some doctors suggest *not* taking fever reducers unless your temperature is very high (more than 39°C). Ask students whether they would take this advice.
- Creative students will enjoy **LSM 2.9-4: Design-a-Bug**. The only restriction is that the new pathogen must be a prokaryotic organism, requiring some review of characteristics presented in Section 2.4. Through this alternative exercise, students consider the structural and cellular functions of the immune system, as well as the strategies used to provide immunity.