Notes

Biology 103
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Topic: Immunity

Reading: Chapter 36

Main concepts:

- The immune system is our line of defense against disease and infection.
- Nonspecific responses consist of physical structures and barriers that resist invasion by bacteria and viruses (skin, mucus), and generalized internal responses such as inflammation, fever, and phagocytosis (phagos = eat, cytos = cell) by macrophages (literally "big eater," a type of white blood cell).
- Specific defenses involve teamwork between white blood cells, where "team members" specialize in remembering invaders, hunting down and killing invaders, producing antibodies against invaders, or coordinating the efforts of the other "team members."
- Specific immune response involves:
  - Recognition of the invader: T cells are able to recognize the difference between "self" and "non-self." Macrophages may "show" a scrap of suspect protein to a T cell to have it identified.
  - If the protein is something new, the immune system will piece together antibodies to tag and disable the invader. B cells will produces the antibody in quantity. If it is something that has been seen before, B memory cells will produce the antibody that was produced the last time the invader was encountered.
  - Cytotoxic T cells ("killer" T cells) attack the tagged invaders. T memory cells will remember the invader and recognize it if it invades again.
  - T cells signal when the immune response should stop.
- Medical assistance to the immune response
  - Antibiotics (do not confuse these with antibodies) can slow bacterial reproduction, or may cause the bacteria to make weak cell walls.
  - Vaccinations use killed viruses or bacteria. Our immune system recognizes the protein as foreign and launches an attack, which ends quickly because the "invaders" are already dead. The immune system then remembers the invader and can kill it quickly and efficiently if we are exposed to the same disease again.
- Immune system problems
  - Allergies: Sometimes our immune system attacks foreign proteins that are harmless, such as pollen proteins or protein fragments from digested food. (Usually fragments that large are not absorbed by the digestive system, but some conditions, such as certain illnesses, can make the intestines "leaky.") The next time the protein is encountered, the immune system attacks it, and we feel ill.
  - Autoimmune diseases: If something goes wrong with the T cells' ability to distinguish "self" from "not-self," the immune system may decide that some body tissues are "not-self" and launch an attack. Rheumatoid arthritis, lupus, and multiple sclerosis are examples of autoimmune diseases.
  - Cancer: The immune system is able to recognize and destroy cancerous body cells. But cancers can grow too rapidly for the immune system to keep up with.
  - Immune deficiency: Some children inherit a defective gene for one or more enzymes needed by the immune system, and are born without an immune system (Severe Combined Immune Deficiency, or SCIDS). The HIV virus specifically attacks T cells and disables the immune system, making its victims vulnerable to the symptoms of AIDS (Acquired Immune Deficiency Syndrome). Research on AIDS has yielded a great deal of new information on how the immune system works and has benefitted research on cancer and autoimmune diseases.

Common misconceptions:

- The word "immune" is often misunderstood or misused to mean, "Something one no longer reacts to." Vaccines and other types of exposure give us immunity not by suppressing the immune response, but because the immune response is so swift and efficient that we do not notice its effects. An example of misuse of the term: "Flies that are sprayed with pesticide become immune to it." This is incorrect. The presence of the pesticide selects for flies that are most able to metabolize the toxin. Most of the flies die. The resistant survivors produce offspring, which may inherit the genes for resistance. This is an example of natural selection, not of immunity.

- The words “antibody” and “antibiotic” are often confused. An antibiotic is a medicine we take that consists of a substance that is toxic to bacteria but not to humans. These are often derived from soil microbes that use these chemicals to battle one another for territory. An antibody is a protein produced by our own immune system that tags and may disable invading bacteria. Taking antibiotics does not interfere with our ability to produce antibodies. Antibiotics do not make us “less immune” to diseases, nor do they weaken our defenses.
- “Antigen” is another term that confuses students, who often mix up “antibody” and “antigen,” or believe that the immune system produces antigens. An antigen is a protein that causes an immune response. For example, proteins on the surface of an invading bacteria are antigens.
- Many students think that “antibiotic resistance” is something our own bodies do: that if we take antibiotics too long, our bodies are somehow “desensitized” to them or “become immune” to their effects. Since we do become desensitized to psychoactive and addictive drugs, it is easy to see where this idea would come from. In fact, it is not people who become resistant to antibiotics; it is the bacteria themselves. Different individual bacteria have different abilities to resist the effects of an antibiotic or to metabolize the antibiotic. If we take an antibiotic for too short a period of time, some bacteria may survive. Those that do will most likely be the most resistant bacteria, which will multiply, producing an antibiotic-resistant colony. This is an example of natural selection in action.

Reading notes:

- Suppose a disease-causing bacteria lands on the skin. List the defenses that would 1) prevent the bacteria from invading the body in the first place, 2) immediately respond to the bacteria. If the bacteria survives these sets of defenses, what is triggered next?
- Describe the roles of the following in nonspecific defenses: lysozymes, mucus, ciliary action, phagocytic cells, fever, inflammatory response.
- Describe the roles of mast cells and histamines in immune response.
- Distinguish between the terms antibody, antigen, and antibiotic.
- Describe what antibodies are and how they are produced.
- Describe the interaction between the macrophage and the helper T cell when an antigen is discovered.
- The T cell signals clonal selection among B cells. Describe this process and its function.
- Describe the role of cytotoxic T cells (“killer T cells”) in the immune response.
- Describe the role of memory T cells and memory B cells in long-term immunity. What happens if the same antigen is encountered again?
- Describe how antibiotics and vaccines assist the immune response.
- How do new strains of influenza (“the flu”) develop?
- Describe how malfunctions of the immune system produce allergies and autoimmune diseases.
- Describe how the HIV virus disables the human immune system and how cancer overwhelms the immune system.

Useful websites:

- “Introducing the bloody characteristics of specific immunity” http://science.nhmccd.edu/biol/inflam.html is an animated tutorial of the immune response.
- “Immune system” http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter48/animations.html# has several audio-visual tutorials about immunity.
- “HIV in Action” http://www.pbs.org/wgbh/nova/aids/action.html is a series of online films from PBS with animations to show how HIV infects human immune cells.