Topic 6.3: Defense Against Infectious Disease

Assessment Statements: 6.3.1 – 6.3.8
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  - Bacteria, such as tuberculosis, cholera, botulism, *E. coli*, plague, anthrax, pneumonia etc.
  - Protists, such as *Giardia*, malaria, ameobic dysentery, *Vaginalis* etc.
  - Fungi, such as athlete’s foot, yeast infections, ring worm, black mold, plant diseases etc.
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- The **disease** is the particular set of symptoms that arise after infection by a specific pathogen. Sometimes the disease and the pathogen share the same name, sometimes not.
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• Doctors are now limiting the amount of antibiotics prescribed, and prescribing the most specific antibiotic possible to limit the rate of natural selection of antibiotic-resistance in many bacteria.
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- Despite fears, there is very little risk to vaccination and enormous benefit. The more people are vaccinated in a community, the less risk of disease to all.
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• Generally, intact skin is a good barrier, but tiny abrasions may allow entrance of pathogens. Any opening in the body is vulnerable to invasion by pathogens.
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• **Acquired immunity** refers to the mechanisms that develop in an organism in response to exposure to a specific pathogen or toxin.
  – Includes the production and retention of cells that produce antibodies specific to the pathogen.
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• The acidic environment of the skin (as a result of sweat and oil), saliva and stomach acid also are harmful to many types of microbes, preventing growth.
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- **Phagocytic leukocytes** (also called phagocytes or macrophages) ingest and destroy pathogens:
  - The phagocyte attaches to the surface of the foreign microbe or object
  - The phagocyte engulfs the microbe by extending its cell membrane around the object
  - Lysosomes fuse with the vacuole, releasing hydrolytic enzymes like lysozyme, and nitric oxide, which poisons the microbes.
  - The microbial debris is then removed from the cell by exocytosis.
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- Lymph is eventually drained back into the bloodstream via ducts that enter the vena cava near the shoulders.
Antigens and Antibodies

- **Lymphocytes** (non-phagocytic leucocytes) are white blood cells involved in the process of acquiring immunity.
  - They are in the bloodstream and lymphatic system, and they are concentrated in the spleen and lymph nodes.
  - They are activated by phagocytes that discover a pathogen.

- **Antigens** are any foreign molecule that can be recognized by lymphocytes such as
  - proteins or polysaccharides on the surfaces of pathogens
  - materials that are produced by pathogens, such as toxins.

- **Antibodies** (immunoglobins) are molecules produced by lymphocytes, that recognize and attach to specific antigens, incapacitating them and allowing for easy destruction by the phagocytes.
How antibodies help destroy antigens

Binding of antibodies to antigens inactivates antigens by:

- Viral neutralization (blocks binding to host) and opsonization (increases phagocytosis)
- Agglutination of antigen-bearing particles, such as microbes
- Precipitation of soluble antigens
- Activation of complement system and pore formation

Enhances:

- Phagocytosis
- Cell lysis

Macrophage

Complement proteins

MAC

Pore

Foreign cell

Virus

Bacterium

Bacteria

Soluble antigens
Antibody Production

• Because lymphocytes are so specific, a given antigen will only interact with a few types out of millions.

• Once lymphocyte recognizes an antigen, it immediately divides and produces clones, called effector cells and memory cells.

• Effector cells are short-lived and work to combat that particular antigen by producing antibodies specific to that antigen.

• Memory cells are long-lived and contribute to lasting immunity against that particular antigen, so that when an antigen is encountered again, the immune response is faster and more effective, often preventing the disease from ever manifesting.
The phagocyte digests a microbe and alerts leukocytes by presenting the antigen. Effector cells produce antibodies, which bind to the antigens.

The leukocytes divide to produce effector cells and memory cells.
HIV

• The HIV virus infects and destroys leukocytes (specifically, helper T cells).
  – After initial infection, there may be a long latency period before this happens.

• This results in a reduction in the ability to mount an immune response to other pathogens.

• The cells of the immune system cannot coordinate and antibodies are not produced.
  – This results in the disease called AIDS
  – Death is usually the result of the inability to fight off secondary infections such as colds or pneumonia.
Issues related to AIDS

• HIV is transmitted through blood or bodily fluid, and was originally associated with drug users and homosexuals, who are more likely to have such an exchange.

• This resulted in initial reluctance to devote funds to research, because of the association with “taboo” behaviors. This is no longer the case, AIDS research and education are heavily funded.

• Individuals with HIV may face discrimination in employment, insurance, education, and social acceptance.

• HIV infection rates are exceptionally high in parts of Africa where there is limited medical care and education about how HIV is transmitted, and high rates of unprotected sex.

• The “Global Gag Rule” prohibits the use of US federal funds for AIDS education (in all countries) when it includes education on contraception and abortion.
  – Originated by Regan, recalled by Clinton, reinstated by Bush, recalled by Obama