

## Chapter 36 – Defense against disease

Mechanisms of Defense against disease

Microbes – bacteria, protists, fungi, viruses

- When microbes cause disease, they're pathogens

Vertebrates have 3 major lines of defense:

- Nonspecific external barriers - prevents most disease
  - o Two surfaces:
    - Skin – dead cells filled with tough proteins
    - Mucous membranes of the digestive, reparatory, urogenital tracts
      - Sweat and sebaceous glands secrete natural antibiotics, lactic acid
      - Antimicrobial secretions – mucus and ciliary action
        - o Mucous membrane secretions trap microbes
        - o Lysozyme - kills bacteria by digesting their cell walls
        - o Cilia sweep of mucus
      - if swallowed, they are killed in stomach acid
      - urine inhibits bacterial growth
- Nonspecific internal defenses – innate immunity
  - o White blood cells – leukocytes or phagocytes
    - engulf foreign particles or infected cells and murders viciously
    - 3 important phagocytes – travel though blood steam, patrol body, eliminate
      - macrophages
      - neutrophils
      - dendritic cells
    - natural killer cells - kill body's own cells that have become invaded or cancerous
      - Kills any nonself cell, major histocompatibility complex (MHC)
  - o Inflammation – recruits leukocytes/phagocytes, seals of injured area
    - Promotes clotting
    - Initiates protective behavior by causing pain
    - Begins when damaged cells release chemicals causing mast cells to release histamine
      - Histamine – relaxes smooth muscle, capillary walls become leaky
      - Other chemicals are also released by mast cells, initiate blood clotting
  - o Fever – Combats large scale infections
    - Combats large scale infections
    - Endogenous pyrogen – released by macrophages, travels to hypothalamus and raises body temp
    - slows microbial reproduction and enhances bodies fighting abilities
    - stimulates cells to produce interferon – makes surrounding, non-infected cells more resistant to infection
- Specific internal defenses – final line of defense (particular organism)

- Adaptive immune response - immune cells selectively destroy specific invading microbes and toxins and then remember the invader
  - Allows rapid response if it reappears in the future
  - 3 major components:
    - immune cells
      - macrophages and dendritic cells
      - B cells - stem cells completing their development in bone marrow
      - T cells - migrate from marrow to thymus
    - tissues and organs - immune cells are produced and reside in the following
      - lymphatic system
        - lymph - extracellular fluid flows through lymph nodes
          - contain masses of macrophages and lymphocytes
      - thymus - gland beneath breastbone
        - essential in development of some immune cells
      - spleen - abdomen
        - filters blood - kills pathogens and aged red blood cells
    - secreted proteins
  - adaptive immune responses include three steps
    - lymphocytes recognize an invading microbe and distinguish it
    - launch attack
    - retain memory of invader

#### Adaptive immune system recognition system

- recognize complex molecules - antigens (antibody generating)
- lymphocytes generate antibodies and T-cell receptors recognize and bind to antigens
  - antibodies - produced by B-cells
    - can be receptors (binders) or effectors (killers)
    - Y-shaped - made of two peptide chains, one heavy, one small
    - Consist of a constant region similar to all antibodies and variable region that differ among individual antibodies
      - Variable regions form sites that bind antigens
    - Multiple modes of action:
      - Bind to pathogen and neutralize it
      - Coat surface of pathogens to make it easier for phagocytic cells to destroy
      - Interact with complement proteins in blood
        - Punch holes in plasma membranes
        - Promote phagocytosis
  - T-cell receptor - produced by T cell
    - Recognize invaders and trigger immune response
    - T-cell receptors are never released into blood stream and don't contribute to destruction of invading microbes or toxic molecules
      - Binds to antigen
- Launches two types of attacks:

- o Humoral immunity – provided by B-cells and antibodies that they secrete into the blood that attack pathogens outside the body's cell, large
    - Antibodies found on only a few B cells bind to antigens
      - Only binded cells divide rapidly
    - Daughter cells differentiate into two cell types
      - Memory B cells – play important role in figure immunity to invader
      - Plasma cells – produce high quantity of specific antibodies in blood stream
  - o Cell-mediated immunity – produced by cytotoxic T cell that kills cell and any pathogens inside it
    - Cytotoxic T cell receptors bind to viral/cancer protein, punch holes in it
    - Helper T cells – enhance cell-mediated immune response
      - Impossible without them
      - Bind to proteins on surfaces of dendritic cells or full macrophages
      - Stimulates production of more B and cytotoxic T cells
- 1-2 weeks to mount a strong immune response after first exposure to invading microbe
  - HIV kills helper T cells

#### Adaptive Immune memory

- Cells differentiate to memory B and T cells

#### Antibiotics/vaccines

- Antibiotics - Chemicals that combat infection by slowing down multiplication
- Vaccines – stimulate development of memory cells
  - o Mostly weakened or killed microbes of some pathogens antigens

40% of U.S. citizens get cancer