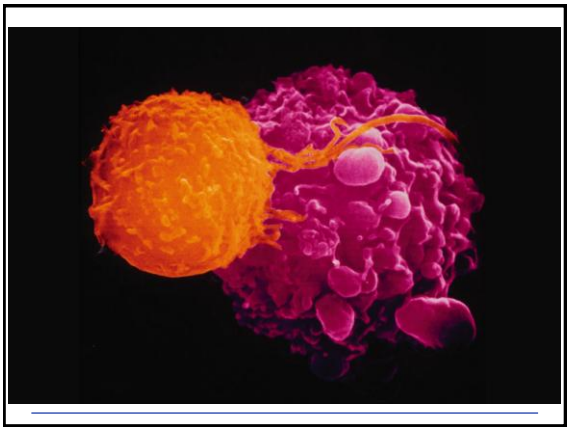
The Immune System

Chapter 43



Three Defenses Against Pathogens

1. Epithelial barriers (nonspecific)
   - **First line of defense**
   - Skin (tight junctions)
   - Mucous membranes
   - Ciliated cells
   - Stomach acids and digestive enzymes
   - Lysozymes

Three Defenses Against Pathogens

2. Innate immunity (nonspecific)
   - Second line of defense
   - Inherited mechanisms
   - Defends against pathogens and toxins that penetrate the first line
   - Specialized cells engulf or kill pathogens and infected cells
   - **Inflammation**

Three Defenses Against Pathogens

3. Adaptive (acquired) immunity (specific)
   - Third and most effective line of defense
   - Recognizes and eliminates particular pathogens
   - Retains memory of exposure and responds rapidly if pathogen is encountered again
   - Carried out by lymphocytes (specialized group of leukocytes)

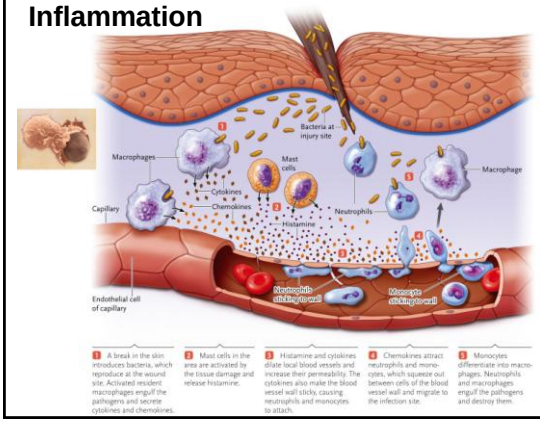
Innate Immunity

- Innate immunity provides an immediate, general defense against invading cellular pathogens
- Molecules on surfaces of pathogens are recognized as foreign (“non-self”) by receptors on host cells
- Pathogen is combated by antimicrobial proteins, inflammation and complement systems

Antimicrobial Peptides

- Epithelial surfaces secrete defensins
- Secreted by epithelial cells of skin and lining of gastrointestinal tract, nasal passages, and lungs
- Defensins disrupt the plasma membranes of pathogens, killing them

Inflammation

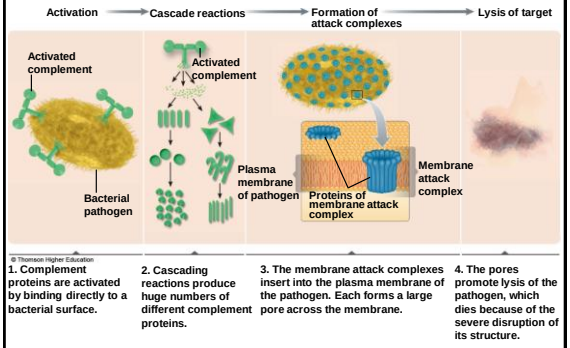


Major Leukocytes and their Functions

TABLE 43.1 Major Types of Leukocytes and Their Functions

Type of Leukocyte	Function
Monocyte	Differentiates into a macrophage when released from blood into damaged tissue
Macrophage	Phagocyte that engulfs infected cells, pathogens, and cellular debris in damaged tissues; helps activate lymphocytes carrying out immune response
Neutrophil	Phagocyte that engulfs pathogens and tissue debris in damaged tissues
Eosinophil	Secretes substances that kill eukaryotic parasites such as worms
Lymphocyte	Main subtypes involved in innate and adaptive immunity are natural killer (NK) cells, B cells, plasma cells, helper T cells, and cytotoxic T cells. NK cells function as part of innate immunity to kill virus-infected cells and some cancerous cells of the host. The other cell types function as part of adaptive immunity: they produce antibodies, destroy infected and cancerous body cells, and stimulate macrophages and other leukocyte types to engulf infected cells, pathogens, and cellular debris
Basophil	Located in blood, responds to IgE antibodies in an allergic response by secreting histamine, which stimulates inflammation

The Complement System



Three Nonspecific Defenses to Combat Viral Pathogens

- Two main strategies to provide some immediate protection against viral infections:

1. Interferons (cytokines)
   - Degrade cellular RNA
   - Inhibit protein synthesis

2. Natural killer (NK) cells (lymphocytes)
   - Perforin ruptures infected cells
   - Proteases trigger apoptosis

Adaptive (Acquired) Immunity

- Adaptive immunity is specific and retains memory
- Triggered by antigens (antigen = "antibody generator")
  - **Exogenous** or **endogenous** macromolecules (proteins or polysaccharides)
- Recognized by B cells and T cells
  - Produced from stem cells in bone marrow
  - T cells carried to thymus
- Targets particular pathogens or toxin molecules

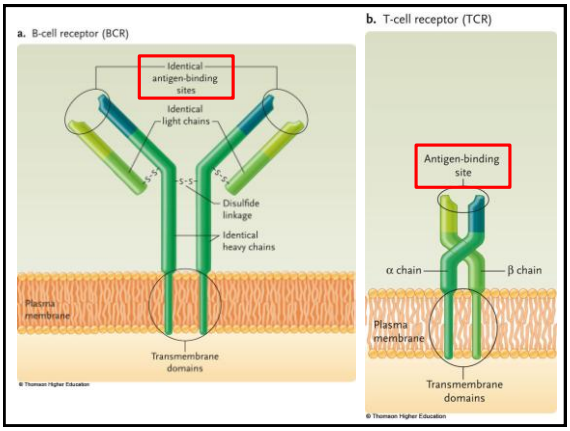
Two Types of Adaptive Immunity

1. Antibody-mediated immunity
   - **Plasma cells** (**B-cell derivatives**) produce **antibodies** that bind to antigens
   - Involves the activation and proliferation of **helper T cells** that mediate the response
2. Cell-mediated immunity
   - Activated **cytotoxic T cells** attack and **kill foreign or infected cells, or cancer cells**

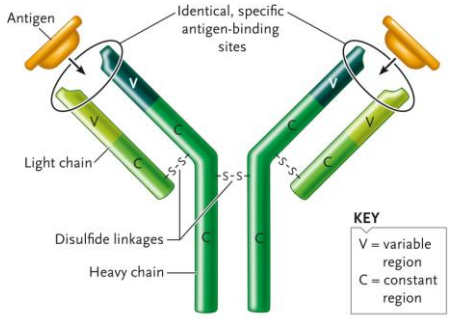
- Both develop memory cells for immunological memory

General steps of the adaptive immune response

- ***Antigen encounter and recognition***
- ***Lymphocyte activation***
- ***Antigen clearance***
- ***Development of Immunological memory*** through production of **memory cells**



Antibody Structure



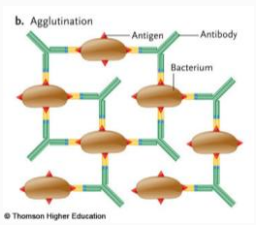
Immunoglobins: Five Classes of Antibodies

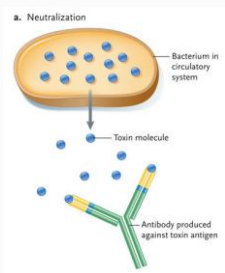
TABLE 43.2 Five Classes of Antibodies

Class	Structure (Secreted Form)	Location	Functions
IgM		Surfaces of unstimulated B cells (as monomer); free in circulation (as pentamer)	First antibodies to be secreted by B cells in primary response. When bound to antigen, promotes agglutination reaction, activates complement system, and stimulates phagocytic activity of macrophages.
IgG		Blood and lymphatic circulation	Most abundant antibody in primary and secondary responses. Stimulates phagocytosis and activates complement system. Crosses placenta, conferring passive immunity to fetus.
IgA		Body secretions such as tears, breast milk, saliva, and mucus	Blocks attachment of pathogens to mucous membranes; confers passive immunity for breastfed infants.
IgE		Skin and tissues lining gastrointestinal and respiratory tracts (secreted by plasma cells)	Stimulates mast cells and basophils to release histamine; triggers allergic responses.
IgD		Surface of unstimulated B cells	Membrane receptor for mature B cells; probably important in B-cell activation (clonal selection).

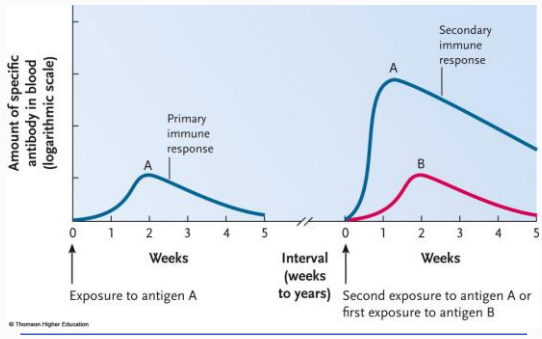
Clearing the Body of Foreign Antigens

- Neutralization, agglutination, or aiding innate immune response





Immunological Memory



Active and Passive Immunity

- Active immunity
  - Production of antibodies in the body in response to an antigen
- Passive immunity
  - Acquisition of antibodies by direct transfer from another person