

Chapter 21 The Lymphatic and Immune Systems

Incomplete Outline

I. The Lymphatic System

A. Functions

1. Fluid Recovery: fluid continually filters from the _____ into the tissue spaces
 - a. Reabsorbs _____: over the course of the day to return excess fluid in the tissues back to the blood
2. Immunity: picks up foreign cells and chemicals and takes them to the _____ where immune cells can detect if anything is harmful
3. _____ absorption: absorb dietary lipids

B. Lymph and Lymphatic Vessels

1. _____: clear, colorless fluid that is similar to blood plasma
 - a. May contain macrophages, hormones, viruses, cellular debris, traveling cancer cells
2. Lymphatic vessels: lymph flow through a system of these vessels
 - a. Lymphatic _____: the beginnings of lymphatic vessels that are present in nearly every tissue
 - i. They are closed at one end and consist of a sac of thin _____ cells that loosely overlap each other like the shingles of a roof
 - b. Vessel Layers: tunica interna with _____, tunica media, and outer tunica _____
3. Route of tissue fluid back to the bloodstream: lymphatic capillaries -> _____ -> six lymphatic trunks -> two _____ -> _____ veins

C. Lymphatic Cells

1. Natural killer (NK) cells: lymphocytes that attack and destroy bacteria, responsible for _____
2. T lymphocytes (T cells): mature in the _____, several subclasses introduced later
3. B lymphocytes (B cells): mature in the _____, differentiate into plasma cells
4. _____: develop from monocytes, phagocytize tissue debris
 - a. Antigen-presenting cell: displays antigenic fragments of foreign matter in its surface
5. _____ cells: antigen-presenting cells found in the epidermis and mucous membranes
6. Reticular cells: branched stationary cells that contribute to the _____ of the lymphatic organs and act as antigen-presenting cells

D. Lymphatic Tissues: aggregations of _____

1. _____ lymphatic tissue: where lymphocytes are scattered rather than densely clustered
2. Mucosa-associated lymphatic tissue: found in body passages that are open to the _____
 - a. Respiratory, digestive, urinary, and reproductive tracts
3. Lymphatic _____: dense masses of lymphocytes and macrophages that come and go as pathogens invade the tissues
4. _____: lymphatic nodules in clusters found at the distal portion of the small intestine

E. Lymphatic organs

1. Primary lymphatic organs: sites where B and T lymphocytes become

a. Red bone marrow: site of B cell maturation

b. Thymus: site of T cell maturation

ii Reticular epithelial cells: forms a _____ - _____ to isolate developing lymphocytes

2. _____ lymphatic organs: sites populated with immunocompetent lymphocytes only after they have been matured

a. Lymph nodes: cleanses the lymph and is a site to _____ T and B cells

iii Several afferent vessels lead in and only 1-3 efferent vessels lead out to create a bottleneck to slow _____ down to allow for more cleansing time

iv _____: painful swelling of a lymph node when they are under challenge from a foreign antigen

b. _____: lymphatic tissues located at the entrance to the pharynx that guard against ingested and inhaled pathogens

v 3 sets of tonsils

➤ Pharyngeal: single tonsil on the wall of the _____

➤ _____: 2 tonsils on the posterior margin of the oral cavity

➤ Lingual: many tonsils on each side of the root of the _____

vi _____ crypts: deep pits that often contain food debris, dead leukocytes, bacteria, antigenic chemicals

c. _____: the body's largest lymphatic organ

vii Red pulp: consists of sinuses gorged with concentrated _____

viii White pulp: consists of _____ and macrophages aggregated along small branches of the splenic artery

II. _____: guards equally against a broad range of pathogens and the effectiveness does not depend on prior exposure

A. Body's Lines of Defense

1. First Line of Defense: external barriers, _____, mucous membranes

2. Second Line of Defense: leukocytes, macrophages, antimicrobial proteins, immune surveillance

3. Third Line of Defense: the immune systems that leaves the body with a _____ (not nonspecific defense)

B. Leukocytes and Macrophages

1. _____: main function is to kill bacteria by phagocytosis and digestion

a. Produces highly toxic chemicals (like _____) that forms a killing zone destroying surrounding bacteria

ix It also kills the _____ during the attack

2. Eosinophils: stand guard against _____ and _____

a. Promote the action of basophils and mast cells, limit the action of _____

b. Phagocytize and degrade antigen-antibody complexes

3. _____: secrete chemicals that aid in the mobility and action of other leukocytes

a. Histamine: increases blood flow and speeds the delivery of leukocytes to the area

b. _____: anticoagulant that inhibits the formation of blood clots

4. Monocytes: transform into macrophages

a. _____: in the CNS

b. Alveolar macrophages: in the _____

- c. Hepatic macrophages: in the _____
- C. Antimicrobial Proteins
1. _____: proteins that are secreted when certain cells become infected with a virus
 - a. They are the " _____ " that alert neighboring cells and protect them from becoming infected
 2. Complement system: _____ that make contributions to both nonspecific resistance and specific immunity
 - a. Four methods of pathogen destruction
 - x _____
 - xi Immune clearance: binds Ag-Ab complexes to RBCs, so as these RBCs circulate through the liver and spleen, the macrophages of those organs destroy the Ag-Ab complexes
 - xii _____
 - xiii Cytolysis
- D. _____: when NK cells continually patrol the body "on the lookout" for pathogens or diseased host cells
1. Once an NK cells bind to an enemy cell it released _____ that creates a hole in the enemy cells. The hole allows for a rapid inflow of water and salt into the enemy cell to weaken it. The NK cells then releases _____ which destroy cellular enzymes and induce _____.
- E. _____: an adaptive mechanism that does more harm than good in moderation
1. Beneficial aspects
 - a. Promotes interferon activity
 - b. Elevates _____ rate and accelerates tissue repair
 - c. Inhibits reproduction of _____ and viruses
 2. Course of a Fever
 - a. _____: body temperature rises, person has chills
 - b. _____: body temperature oscillates around a new set point
 - c. _____: body temperature returns to normal
 3. Fevers above 105F can make a person delirious and a fever above 111F can result in a coma, death, or brain damage
- F. _____: local defensive response to tissue injury
1. General purposes
 - a. Limit the spread of _____
 - b. Remove debris of damaged tissue
 - c. Initiate tissue _____
 2. Four cardinal signs: _____, swelling, _____, pain
 3. _____: small proteins that regulate inflammation and immunity
 4. Three major processes of inflammation
 - a. Mobilization of Defenses: getting defensive leukocytes to the site quickly
 - xiv _____ chemicals are released to make the blood vessels dilate and become more permeable.
 - xv Leukocytes then adhere to the vessel wall (_____) and crawl through the gaps between the cells (_____)
 - b. Containment and destruction of Pathogens: preventing the spreading of the pathogen
 - xvi _____ prevents clotting in the area of injury so bacteria or other pathogens are trapped

- c. Tissue Cleanup and Repair: _____ are in charge of clean up
- xvii _____ contributes by compressing veins and reducing venous drainage
- xviii _____: a yellowish fluid of dead cells, other tissue debris, and tissue fluid
- xix Platelet-derived growth factor: a secreted agents that stimulates

III. General Aspects of Specific Immunity

A. Differences between nonspecific resistance and immunity

- 1. _____: directed towards a specific pathogen
- 2. _____: develops a memory so when reexposed to the same pathogen the body will react quickly

B. Forms of Immunity

- 1. Cellular (_____ - _____) immunity: employs lymphocytes that directly attack and destroy foreign cells or diseased host cells
- 2. _____ (antibody-mediated) immunity: do not directly destroy a pathogen but mark them for destruction
- 3. Humoral immunity can work only against the _____ stages of infectious microorganisms. But when these microorganisms invade host cells (intracellular stages), they are still vulnerable to cellular immunity, which destroys them by killing the host cell.
- 4. Active/passive and natural/artificial immunity classifications
 - a. Natural _____ immunity: production of one's own antibodies or T cells as a result of natural exposure to an antigen
 - b. _____ active immunity: production of one's own antibodies or T cells as a result of a vaccination
 - c. Natural passive immunity: temporary immunity that results from acquiring antibodies produced by another _____
 - d. Artificial passive immunity: temporary immunity that results from the injection of an _____

C. Antigens: any molecule that triggers an immune response

- 1. Generally complex molecules like proteins, polysaccharides, glycoproteins, glycolipids
- 2. _____: certain region of an antigen molecule that stimulates immune responses
 - a. One antigen molecule can have several different epitopes that can stimulate the production of different antibodies

D. Lymphocytes

- 1. T Lymphocytes: the birth, maturation, and deployment of a T cell is as follows...
 - a. T cells are born in the _____ which then colonize in the _____ to mature to functional T cells
 - b. T cells develop surface antigen receptors and are now considered immunocompetent (capable of recognizing antigens)
 - c. The T cells are then tested to make sure that they are not faulty by presenting self antigens to them
 - xx They can fail the test by not being able to recognize them or reacting to the self antigens
 - d. If the T cells fail the test they must be eliminated by a process called _____. There are two outcomes.
 - xxi _____: the T will die
 - xxii _____: the T cells remain alive but unresponsive
 - e. If the T cells pass the test they undergo positive selection

- xxiii They multiply and form clones programmed to respond to a particular antigen
- f. T cells that are immunocompetent but haven't encountered a foreign antigen is said to be a naïve T cell.
- g. The naïve T cells are now ready to do battle.
- 2. _____: remains in the bone marrow to differentiate into B cells
 - a. They undergo anergy or clonal deletion just like a self-reactive T cell
- E. Antigen-Presenting Cells: help T cells recognize foreign antigens
 - 1. _____ proteins: proteins on the surface of APC that are shaped like hotdog buns that act as ID tags
 - 2. When an APC encounters an antigen, it internalizes it by endocytosis, digests it into fragments, and displays a fragment (its epitopes) in the grooves of the MCH protein
- IV. Cellular Immunity: defense in which T lymphocytes directly attack and destroy diseased or foreign cells
 - A. Four Classes of T cells:
 - 1. _____ T cells: carry out the attack
 - 2. _____ T cells: promote the action of Tc cells
 - a. This is the only type of T cell that is also involved in humoral immunity
 - 3. Memory T cells: responsible for memory
 - B. Recognition
 - 1. Antigen presenting: T cells respond to two classes of MHCPs on antigen presenting cells
 - a. _____ proteins occur on every nucleated cell
 - xxiv They pick up small peptides and display them. If they are viral or abnormal proteins they elicit T cell response to kill the cell.
 - b. MHC-II proteins occur only on APCs and display only foreign antigens
 - c. NOTE: Tc cells respond only to MHC-I proteins and Th cells respond only to MHC-II.
 - 2. T cell Activation: begins when a Tc or Th cell binds to an MHCP displaying an _____ that the T cell is programmed to recognize.
 - a. To make sure that it has really bound to a foreign antigen, it must bind to another for a double check. The double check process is called _____ and is used to make sure the immune system doesn't launch an attack in the absence of an enemy.
 - b. Successful costimulation triggers a process called _____ (when the T cell undergoes repeated mitosis)
 - C. Attack
 - 1. Th cells coordinate roles in both humoral and cellular immunity
 - a. They attract neutrophils and NK cells, they attract macrophages, and stimulate B and T cell _____ and _____
 - 2. Tc cells directly attack and kill other cells
 - a. They deliver a lethal hit of cytotoxic chemicals
 - xxv _____ and _____: kill the target cell
 - xxvi _____: inhibit viral replication
 - xxvii Tumor necrosis factor: kills _____ cells
 - D. Memory: memory cells are long lived and much more numerous than naïve T cells
 - 1. Upon reexposure, memory cells mount a quick attack
- V. Humoral Immunity: a more indirect method of defense
 - A. Recognition: B cell activation begins when an antigen binds to one of several receptors on the B cell surface.
 - 1. The B cell then digests the antigen and displays it on its surface and waits for a T helper cell to bind to the this Ag-MHCP complex

2. Once the Th cell binds, this triggers clonal selection.

a. Most clones differentiate into plasma cells

B. Attack

1. Basic structure of an antibody: composed of two large heavy chains and two light chains.

a. All four chains have a variable region that gives an antibody its uniqueness and a constant region that has the same amino acid sequence in all antibodies

b. Five classes of antibodies

xxviii _____: prevents pathogens from adhering to epithelia

xxix _____: activation of B cells by antigens

xxx IgE stimulates basophils to release _____; attracts eosinophils to sites of _____ infections

xxxii IgG: 80% of circulating antibodies; secondary immune response, crosses the

xxxiii IgM: constitutes 10% of antibodies; primary immune response; very strong

2. Four mechanisms antibodies use to render antigens

a. _____: neutralize an antigen by masking active regions

b. Complement fixation: binding to an enemy cell and change shape, exposing their complement-binding sites

c. _____: sticking enemy cells together so that they are immobilized and prevents them from spreading

d. _____: antibodies link antigen molecules(not whole cells) together

C. Memory: during clonal selection, some clones become memory B cells

1. They mount a very quick secondary response

VI. Immune System Disorders

A. Hypersensitivity: an excessive, harmful immune reaction to antigens that most people can tolerate

1. Type I (_____): allergens bind to IgE on the membranes of basophils and mast cells and stimulate them to secrete histamine and other inflammatory and vasoactive chemicals

a. Asthma: local inflammatory reaction to inhaled allergens

b. _____: severe type I reaction

xxxiii Anaphylactic shock: occurs when an allergen enters the bloodstream of an allergic individual

2. Type II (antibody-dependent cytotoxic): occurs when IgG or IgM attacks antigens bound to cell surfaces

a. Ex: _____

3. Type III (immune complex): occurs when IgG or IgM forms antigen-antibody complexes that precipitate beneath the endothelium

a. Triggers intense inflammation, causing tissue destruction

4. Type IV (_____): a cell-mediated reaction where signs appear 12-72 hours after exposure

a. Begins when APCs display antigens to helper T cells

b. Cosmetics, _____, TB skin tests