Chapter 22: Lymphatic System and Immunity

I. Lymphatic System
   A. Functions of the Lymphatic System - list and describe:
      1. ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
      2. ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
      3. ______________________________________________________________
         ______________________________________________________________
         ______________________________________________________________
   B. Lymphatic Vessels
      1. What are lymphatic capillaries? _________________________________
      2. Lymphatic capillaries differ from blood capillaries in that:
         a. Lack ________________________________________________
         b. Cells of the epithelium _____________ & ____________________
      3. Because of the structure of lymphatic capillaries:
         a. Far more ____________________________________________
         b. Nothing ______________________________________________
         c. Epithelium functions as ________________________________
      4. Lymphatic capillaries join to form larger _________________________
         a. These resemble ____________________ in structure
      5. Lymphatic vessels contain ____________________ similar to those in veins
      6. When a lymphatic vessel is compressed _________________________
         as a result the lymph moves _________________________________
      7. What three factors are responsible for the compression of lymphatic vessels?
8. Lymph Nodes
a. Describe the shape of a lymph node ________________
   b. Functionally lymph nodes ________________

9. After passing through the lymph nodes the lymphatic vessels converge to form larger vessels called ________________
   a. Indicate what part of the body is drained by each of the lymphatic trunks:
      1. Jugular trunks ________________
      2. Subclavian trunks ________________
      3. Bronchomediastinal trunks ________________
      4. Intestinal trunks ________________
      5. Lumbar trunks ________________
   b. Lymphatic trunks:
      1. Connect to ________________ OR
      2. Join to form yet larger vessels called ________________

10. The two major lymphatic ducts are:
   a. Right lymphatic duct that is ________________ in length and drains:
      1. Right side ________________
      2. Right ________________
      3. Right ________________
   b. Thoracic duct that is ________________ in length and drains:
      1. Right side of the body inferior ________________
      2. Entire left ________________

11. What are cisterna chyli? ________________________________

C. Lymphatic Tissues and Organs
   1. Lymphatic tissue consists primarily of ________________ but also includes ________________, ________________, & ________________
   2. In response to microbes or foreign substances, the lymphocytes:
      a. ________________
b. Increase ____________________

c. Part of the __________________________________________________

3. What are reticular fibers? ________________________________
   a. Lymphocytes and other cells ______________________________
   b. The fiber network ____________________ & ______________________

4. What are mucosa-associated lymphoid tissues (MALT)? ________________

5. Diffuse Lymphatic Tissue and Lymphatic Nodules
   a. Contains ____________________, ______________, & ______________
   b. Has no clear ____________________ and ______________________
   c. It is located:
      1. Deep to ______________________________
      2. Around ______________________________
      3. Within the ____________________ & ____________________
   d. What are lymphatic nodules? ________________________________

       1. Where are they numerous? ________________________________
       2. What are Peyer's patches? ________________________________
       3. What are lymphatic follicles? ________________________________

6. Tonsils
   a. What are tonsils? ________________________________

       b. Tonsils provide protection against __________________________
   c. Where are the palatine tonsils? ______________________________
   d. Where are the pharyngeal tonsils? ______________________________
   e. Where are the lingual tonsils? ______________________________

7. Lymph Nodes
   a. Where are superficial lymph nodes? __________________________
   b. Where are deep lymph nodes? ________________________________
c. A capsule composed of ____________________ surrounds a lymph node
d. What are trabeculae? ________________________________
e. Reticular fibers ________________________________
f. What are lymphatic sinuses? ________________________________
g. Describe the cortex of a lymph node: ________________________________
h. Describe the medulla of a lymph node: ________________________________
i. Afferent lymphatic vessels carry ________________________________
j. Efferent lymphatic vessels carry ________________________________
k. What do macrophages do to lymph? ________________________________
l. What happens at a germinal center? ________________________________

8. Spleen
a. Roughly the size of ________________________________
b. The outer capsule is composed of ________________________________
c. Trabeculae are composed of ________________________________
d. Trabeculae subdivide the spleen into ________________________________
e. White pulp is associated with ________________________________
f. Red pulp is associated with ________________________________
g. What is the periarterial lymphatic sheath? ________________________________
h. What are the splenic cords? ________________________________
i. What are the venous sinuses? ________________________________
j. Blood flows through the spleen at ________________________________
k. Functionally the spleen:
1. Destroys defective ________________________________
   a. Old red blood cells can rupture ________________________________
b. Splenic macrophages ____________________________________

2. Detects and responds to ____________________________________
   a. Stimulate an ____________________ because of specialized
      lymphocytes in the ______________________________
   b. High concentrations of T cells in ___________________________
   c. High concentrations of B cells in ___________________________

3. Acts as a blood _________________________________________
   a. During exercise splenic volume ____________________________
   b. Increase in circulating red blood cells can promote ____________
      to _______________ during __________ or _______________

9. Thymus
   a. Where is the thymus located ____________________________________
   b. The thymus is a ____________________ gland
   c. The thymus is surrounded by a thin __________________________
   d. Lobules are formed by _________ that extend ____________________
   e. The framework of the thymus consists of ______________________
      1. The cells are joined by ______________________________
      2. Form small, _________________________ filled with _____________
   f. Describe the cortex: __________________________________________
   g. Describe the medulla: _________________________________________
   h. What are thymic corpuscles? ___________________________________
   i. The thymus is the site of maturation for _________________________
   j. Large numbers ____________________ but most __________________
   k. The lymphocytes that survive maturation are capable of:
      1. Reacting ______________________________
      2. Normally they do not _______________________________________

II. Immunity
A. What is immunity? ____________________________________________
   1. Innate immunity is also called ________________________________
   2. Adaptive immunity is also called ______________________________
   3. Specificity and memory are characteristics of ______________________
4. What is specificity? ________________________________

5. What is memory? ________________________________

6. In innate immunity:
   a. Each time ________________________________
   b. The response is ______________________
   c. Because ________________________________

7. In adaptive immunity:
   a. Response during the second exposure is ______________________ than ________________________________,
   b. Because the immune system ________________________________

III. Innate Immunity

A. Mechanical Mechanisms
   1. Form barriers that prevent ________________________________
      a. Such as the _____________________ & __________________
   2. Remove __________________ & __________________ from the surface
      a. Washed from the eyes by __________________________
      b. Washed from the mouth by __________________________
      c. Washed from the urinary tract by ______________________
      d. Ciliated mucous membranes __________________________ to the ________________________ where they __________________
      e. Microbes are also removed from the respiratory tract by ______________ & ______________________________

B. Chemical Mediators
   1. Some found on the surface of cells kill ________________________________
   2. Other chemical mediators promote inflammation by
      a. Causing ______________________________
      b. Increasing ______________________________
      c. Attracting ______________________________
      d. Stimulating ______________________________
3. Complement
   a. Complement is a group of ____________________________________
   b. What is the complement cascade? ____________________________
   c. The alternative pathway is part of ____________________________
      1. Initiated when __________________________________________
      2. If activated C3 combines with ___________________________ it
         becomes ____________________ and activates __________________
   d. What is a membrane attack complex (MAC)? _____________________
      1. What happens because of the hole? _________________________
      2. What does lysozyme do in conjunction with MAC? ______________
   e. Complement proteins can attach to bacteria and stimulate ____________
   f. Complement proteins also:
      1. Attract ______________________________
      2. Promote ______________________________

4. Interferons
   a. Interferons are proteins that _________________________________
   b. Viruses stimulate an infected cell to _____________________________
   c. Interferons bind to the _________________________________
      1. This stimulates the neighboring cells to produce _________________
      2. This stops viral reproduction by ______________________________
   d. Interferons act against _____________________________________
   e. Interferons also play a role in ________________________________

C. Cells
   1. White blood cells are the most important _________________________
   2. What are chemotactic factors? _________________________________
      a. Important examples include:
         1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

3. How are chemotactic factors spread? ______________________________
4. White blood cells follow chemotactic factors by moving from areas of ______________ concentration to areas of ______________ concentration
   a. This ability is called ______________________________

5. Describe the ameboid movement of white blood cells: __________________
   ________________________________________________________________

6. What happens in phagocytosis? ______________________________
   ________________________________________________________________

7. Neutrophils
   a. Neutrophils are ______________________________
   b. Neutrophils are usually the______________________________ and they often ______________________________
   c. Neutrophils also release ______________________________ that
      1. Kill ______________
      2. Cause ______________ damage
      3. Cause ______________________________
   d. Pus is an accumulation of ______________________________
      _____________________________________________________________

8. Macrophages
   a. Macrophages are ______________ that leave blood, enter ______________
      enlarge ______________, & increase ____________________________
   b. Macrophages are ____________________ phagocytic cells that
      1. Outlive ______________________________
      2. Ingest _________ & _______________________________
   c. Usually accumulate in tissue ______________________________
   d. Responsible for ______________________________
   e. Macrophages enhance the immune response by producing a variety of chemicals such as: ______________, ______________, & ______________
f. Macrophages are located just beneath the free surfaces of the body to provide ____________________________

g. Macrophages are also located within ____________ called ___________

1. These macrophages are now called the: ____________________________

9. Basophils, Mast Cells, and Eosinophils

a. Basophils are motile white blood cells that ____________________________

b. Mast cells are non-motile cells in ________________________________

1. Located at potential __________________________________________________________________

c. When activated basophils and mast cells:

1. Release ________________ such as _________ & ____________

a. Produce __________________________________________________________________________

b. Activate __________________________________________________________________________

d. Eosinophils

1. Eosinophils release enzymes that ____________________________

2. Mechanism to contain and ________________________________

3. Eosinophil numbers greatly increase in patients with ____________

____________________________________________________________________________________

4. Eosinophils also secrete enzymes that ____________________________

10. Natural Killer (NK) Cells

a. Natural killer cells are a type of ________________________________

b. The attack classes of cells such as _____________ & _____________

c. NK cells kill their target cells by using _____________________________________________

D. Inflammatory Response

1. What is the inflammatory response? ________________________________________________

____________________________________________________________________________________

2. Damage to tissues cause the release or activation of ____________ such as:

a. ______________________________________________________________________________

b. ______________________________________________________________________________

c. ______________________________________________________________________________

d. ______________________________________________________________________________
3. What effects are produced by the chemical mediators?
   a. ___________________________________________________________
   b. ___________________________________________________________
   c. ___________________________________________________________

4. How is the infected area walled off? _________________________________

5. Complement:
   a. Further ______________________________
   b. Attracts ______________________________

6. The process continues until _________________________________

7. Finally phagocytes ________________________________ and the tissue _________________________________

8. What is local inflammation? _________________________________
   a. Symptoms of local inflammation include: ____________, ____________, ____________, ____________, & ________________

9. What is systemic inflammation? _______________________________
   a. Three additional features of systemic inflammation are:
      1. Red bone marrow ________________________________
      2. Pyrogens are released by ________________________________
         a. Pyrogens stimulate ________________________________
      3. Large amounts of fluid ________________________________
         a. Decreased blood volume can cause ____________ & ____________

IV. Adaptive Immunity

A. General
   1. Adaptive immunity involves ________________________________

   2. What are antigens? ________________________________
   3. What are haptens? ________________________________

   4. Foreign Antigens
      a. Antigens not produced by the body but ________________________________
b. Examples of foreign antigens include:


c. What is an allergic reaction?

d. Foreign antigens in transplanted tissues and organs result in

5. Self-antigens
   a. Molecules produced by the body that stimulate
   b. What is an autoimmune disease?

6. Antibody-Mediated Immunity (formerly Humoral Immunity)
   a. B cells give rise to ___________ that produce _______________ found in

7. Cell-Mediated Immunity
   a. Different subpopulations of T cells are responsible for particular aspects:
      1. Effector T cells such as:
         a. ______________________________
         b. ______________________________
            1. Responsible for producing ______________________________
      2. Regulatory T cells such as:
         a. ______________________________
         b. ______________________________
            1. Can promote or inhibit ______________________________

B. Origin and Development of Lymphocytes
   1. In the red bone marrow:
      a. Some stem cells give rise to pre-T cells
         1. Pre-T cells migrate ______________________________
         2. The pre-T cells divide and ______________________________
            a. What is the function of thymosin? ______________________________
            b. Other stem cells produce ______________________________
               1. Processed in the red bone marrow into ______________________________
2. What happens in the positive selection process? ________________________
   ________________________________________________________________

3. What is a clone of lymphocytes? ________________________________
   ________________________________________________________________
   a. Each clone can respond only to a ______________________________

4. What happens in the negative selection process? ______________________
   ________________________________________________________________

5. T cells and B cells continually circulate between the ________________ &
   ________________

6. The primary lymphatic organs are the sites where ______________________
   a. These organs are the _________________________ & ______________

7. The secondary lymphatic organs and tissues are the sites where __________
   ________________________________________________________________
   a. These include the ________________, ________________,
   ________________, ________________, & _______________

C. Activation of Lymphocytes
1. The two general principles of lymphocyte activation are:
   a. ___________________________________________________________
   b. ___________________________________________________________

2. Antigenic Determinants and Antigen Receptors
   a. What must happen for an adaptive immune response to occur?
      ___________________________________________________________
   b. The portion of an antigen recognized by a lymphocyte is called:
      ___________________________________________________________
      or _______________________________________________________
   c. The portion of a lymphocyte that reacts with the antigen is called:
      ___________________________________________________________

   1. The T cell receptor consists of 2 ________________ subdivided
      into a ________________ & a ________________ region
      a. Which part binds to the antigen? _____________________________

   2. The B-cell receptor consists of 4 ______________________________
      with 2 ________________ regions
3. Major Histocompatibility Complex Molecules
   a. Most lymphocyte activation involves glycoproteins on the surfaces of cells called ____________________________
   b. MHC molecules have a variable region that can bind to _______________
   c. MHC Class I Molecules
      1. Are found on nucleated cells and function to ______________________________
      2. MHC class I/antigen complexes on the surface of cells can:
         a. Bind to ______________________________
         b. This combination ______________________________
         c. Activated T cells can ______________________________
         d. Effectively stopping ______________________________
   3. What does MHC-restricted mean? ______________________________
      __________________________________________________________
   d. MHC Class II Molecules
      1. Are found on ______________________________ which include:
         a. ______________________________
         b. ______________________________
         c. ______________________________
         d. ______________________________
      2. What are dendritic cells? ______________________________
      3. Antigen-presenting cells are specialized to:
         a. Take ______________________________
         b. Process ______________________________
         c. Use ______________________________
         d. To display ______________________________
            1. MHC class II/antigen complex can ______________________________
            e. The displaying cell ______________________________ destroyed
            f. Stimulates other immune cells ______________________________
   4. Costimulation
      a. Needed to ______________________________ in B cells and T cells
b. Costimulation is accomplished by:
   1. ______________________________
   2. ______________________________

c. What are cytokines? __________________________________________
   _____________________________________________________________

d. Certain pairs of molecules can also be involved in costimulation:
   1. When the surface molecule on one cell combines with ________________
      ______________________________
   2. The combination can act as:
      a. Signal ______________________________
      b. Can hold ______________________________

5. Lymphocyte Proliferation
   a. Proliferation of Helper T cells
      1. How is the antigen presented? _______________________________
      2. What helper T cells can respond to this presentation? _____________
      3. How do the helper T cells respond to activation? _________________
   b. Proliferation and Activation of B or Effector T cells
      1. B cells present processed antigen on surface with ________________
      2. What responds to this presentation? ___________________________
      3. These cells then stimulate the B cells to ________________________

D. Inhibition of Lymphocytes
   1. What is tolerance? _____________________________________________
   2. The most important function of tolerance is _______________________
      ______________________________
   3. List and describe three ways tolerance can be induced:
      a.  ___________________________________________________________
         ___________________________________________________________
         ___________________________________________________________
      b.  ___________________________________________________________
         ___________________________________________________________
         ___________________________________________________________
E. Antibody-Mediated Immunity

1. Effective against ________________________________________________

2. Antibodies
   a. Antibodies are _______________________________________________
   b. Antibodies are what portion of plasma proteins? ________________
   c. Antibodies are also known as ________________________________
   d. Each antibody is composed of _________________________________
      1. Two ______________________________
      2. Two ______________________________
   e. Where is the variable region? _________________________________
   f. The variable region is responsible for? _________________________
   g. What is the constant region responsible for? ___________________

3. Effects of Antibodies
   a. Antibodies can directly affect antigens in two ways:
      1. Can bind to ______________________________________________
      2. Can combine with _________________________________________
   b. Antibodies can indirectly affect antigens by:
      1. Activate the ______________________________________________
      2. Initiate an ______________________________________________
      3. Act as an opsonin by:
         a. Connecting to __________________________________________
         b. Connect to a macrophage ________________________________
         c. Then the macrophage ___________________________________

4. Antibody Production
   a. Primary Response
      1. Response to the __________ exposure to a specific antigen
      2. Antigen binds to B cell receptors on _________________________
      3. Activation causes the small lymphocyte B cell to undergo ________
4. Some of the cells become:
   a. Plasma cells that ______________________________
   b. Others revert back _______________ & become ____________

5. How long does it take to produce enough antibodies to be effective against the antigen? ________________________________

6. Disease symptoms develop because ________________________________

b. Secondary or Memory Response
   1. Occurs when _____________________________________________
   2. Results from ________________________________ which
      a. Rapidly ________________________________ and
      b. Large amounts of ________________________________

3. Provides better protection for two reasons:
   a. Time required ________________________________
   b. Amount of ________________________________

4. Antigen is quickly destroyed, ________________________________, & ________________________________

5. The memory response also forms ________________________________

F. Cell-Mediated Immunity
   1. Function of T cells and is most effective against ________________________________
   2. Activation of T cells is regulated by:
      a. ________________________________
      b. ________________________________
   3. Once activated T cells go through a series of divisions and produce:
      a. ________________________________ such as ________________________________
      b. ________________________________
   4. Functionally effector T cells are responsible for ________________________________
   5. Functionally memory T cells are responsible for ________________________________
   6. Cytotoxic T Cells
      a. Contact antigens on the surface of a cell:
         1. ________________________________ on virus-infected cells
2. ____________________ on tumor cells
3. ____________________ on transplanted tissues

b. When the cytotoxic T cell binds with its target cell:
   1. Releases chemicals that ______________________________
      a. How does perforin work? _________________________________
      ______________________________________________________
   2. Can also release cytokines that ______________________________

7. Delayed Hypersensitivity T Cells
   a. Respond to antigens by ______________________________
      1. Promote ______________________________ &
      2. ____________________ especially in ______________________

V. Immunotherapy
   A. Immunotherapy treats disease by ______________________________ or
      __________________________________________________________
      1. Some approaches attempt ______________________________
      2. Sometimes inhibiting ______________________________
   B. Monoclonal Antibodies
      1. Producing monoclonal antibodies may result in __________________
         ______________________________________________________
      2. What is the major problem with monoclonal antibodies? _________________
         ______________________________________________________
      3. What is humanization? ______________________________
         a. What is its purpose? __________________________________

VI. Acquired Immunity
   A. Terminology
      1. List the four ways of acquiring adaptive immunity:
         a. ______________________________
         b. ______________________________
         c. ______________________________
2. What does the term natural imply? _______________________________
3. What does the term artificial imply? _______________________________
4. What does active immunity mean? ________________________________
5. What does passive immunity mean? ________________________________
6. Which is longer lasting immunity, active or passive? ________________

B. Active Natural Immunity
1. Is the result of natural _________________________________
2. The first exposure usually causes _______________________________

C. Active Artificial Immunity
1. An antigen is deliberately _______________________________________
   a. The process is called _________________________________
   b. The introduced antigen is called a _______________________________
2. The vaccine usually contains:
   a. Some part _________________________________
   b. Dead ____________________ or a live, _________________________
3. The vaccine is designed to stimulate an immune response but __________
   ______________________________________________________________
4. Why is this a preferred method of acquiring adaptive immunity? __________
   ______________________________________________________________

D. Passive Natural Immunity
1. Results from the transfer of _______________________________________
   ______________________________________________________________
   2. Antibodies can also be transferred to the newborn in the ________________

E. Passive Artificial Immunity
1. Begins with vaccinating an _________________________________
2. Antibodies are then removed _______________________________________
3. Sometimes a human who has developed _______________________________
   ______________________________________________________________
4. Provides immediate ____________________ but is only ________________
5. What is antiserum? ________________________________________________
________________________________________________________________

VIII. Effects of Aging on the Lymphatic System and Immunity

A. What effect does aging have on the lymphatic system? ________________
________________________________________________________________

B. What effect does aging have on helper T cells? ________________
________________________________________________________________

C. Antibody Responses

1. Primary and secondary responses ________________________________

2. ____________________ is needed to produce a response

3. Response is ________________

4. Less ______________________________

5. Fewer ______________________________

6. So the ability to resist infections ________________________________

D. Cell-Mediated Immunity

1. The ability to resist intracellular pathogens ______________________________

2. Pathogens not eliminated from the body can be reactivated when ________

   a. A common example is chicken pox appearing later as ________________

E. Are new autoimmune diseases common in the elderly? ________________

   1. Increased incidence of cancer in the elderly is assumed ________________

   ____________________________________________