Exam 2 Review

CHAPTER 20

20.1  Lymphatic system

The lymphatic system includes lymphatic vessels, lymph, and lymph nodes

• List the functions of the lymphatic vessels. Describe the structure and distribution of lymphatic vessels.

* Lymphatic vessels offer a one-way system, ensuring lymph flows only toward heart
* Lymph vessels (lymphatics) include:
  + **Lymphatic capillaries**
  + **Larger lymphatic vessels**
* **Lymphatic** **capillaries**
  + Blind-ended vessels that weave between tissue cells and blood capillaries
    - Absent from bones, teeth, bone marrow, and CNS (CNS uses CSF for drainage)
  + Similar to blood capillaries, but more permeable
  + Can take up larger molecules and particles that blood capillaries cannot
* **Larger lymphatic vessels**
  + Lymph capillaries drain into increasingly larger vessels called **collecting** **lymphatic vessels**
  + Consist of collecting vessels, trunks, and ducts
  + Have structures and tunics similar to veins, except:
    - Have thinner walls, with more internal valves
    - Anastomose more frequently
  + Collecting vessels in skin travel with superficial veins, but deep vessels travel with arteries
* **Larger lymphatic vessels (cont.)**
  + **Lymphatic trunks**, which are formed by union of largest collecting vessels, drain large areas of body
* Lymph is delivered from trunks into one of two large **lymphatic ducts**
  + **Right lymphatic duct** drains right upper arm and right side of head and thorax
  + **Thoracic duct** drains rest of body
    - In about half of individuals, starts out as an enlarged sac, **cisterna chyli**
* Each empties lymph into venous circulation at junction of internal jugular and subclavian veins on its own side of body

• Describe the source of lymph and mechanism(s) of lymph transport.

* Lymph system is a low-pressure system like   
  venous system
* Lymph is propelled by same mechanisms:
  + Milking action of skeletal muscle
  + Pressure changes in thorax during breathing
  + Valves to prevent backflow
  + Pulsations of nearby arteries
  + Contractions of smooth muscle in walls of lymphatics

20.2  Lymphoid cells, tissues, and organs

Lymphoid cells and tissues are found in lymphoid organs and in connective   
tissue of other organs

• Describe the basic structure and cellular population of lymphoid tissue. Differentiate   
between diffuse and follicular lymphoid tissues.

* Main functions of **lymphoid** **tissue**
  + Houses and provides proliferation sites for lymphocytes
  + Offers surveillance vantage points for lymphocytes and macrophages as they filter through lymph
* Largely composed of **reticular** **connective** **tissue**, a type of loose connective tissue
  + Macrophages live on reticular fibers
  + Spaces between fibers offer a place for   
    lymphocytes to occupy when they return from patrolling body
  + **Diffuse lymphoid tissue**: loose arrangement of lymphoid cells and some reticular fibers
  + **Lymphoid** **follicles** (**nodules**): solid, spherical bodies consisting of tightly packed lymphoid cells and reticular fibers

20.3  Lymph nodes

Lymph nodes filter lymph and house lymphocytes

• Describe the general location, histological structure, and functions of lymph nodes.

* Hundreds of nodes are found throughout body
  1. Most are embedded deep in connective tissue in clusters along lymphatic vessels
  2. Some are nearer to body surface in inguinal, axillary, and cervical regions of body where collecting vessels converge into trunks
* **Cortex**
  1. Superficial area of cortex contains follicles with germinal centers that are heavy with dividing   
     B cells
  2. Deep cortex houses T cells in transit
     + T cells circulate continuously among blood,   
       lymph nodes, and lymph
  3. Abundant numbers of dendritic cells are closely associated with both T and B cells
     + Play a role in activating both lymphocytes
* **Medulla**
  1. Medullary cords extend inward from cortex and contain B cells, T cells, and plasma cells
* **Lymph sinuses** are found throughout node
  1. Consist of large lymphatic capillaries spanned by crisscrossing reticular fibers
  2. Macrophages reside on fibers, checking for and phagocytizing any foreign matter
* Two main functions of lymph nodes
  1. Cleansing the lymph: act as lymph “filters”
     + Macrophages remove and destroy microorganisms and debris that enter lymph
       - Prevent unwanted substances from being delivered to blood
  2. Immune system activation: offer a place for lymphocytes to become activated and mount an attack against antigens

20.4  Spleen

The spleen removes bloodborne pathogens and aged red blood cells

• Compare and contrast the structure and function of the spleen and lymph nodes.

* Functions
  1. Site of lymphocyte proliferation and immune surveillance and response
  2. Cleanses blood of aged blood cells and platelets; macrophages remove debris
* Three additional functions of spleen:
  1. Stores breakdown products of RBCs (e.g., iron) for later reuse
  2. Stores blood platelets and monocytes for release into blood when needed
  3. May be site of fetal erythrocyte production
* Spleen is encased by fibrous capsule and also has trabeculae
* Histologically, consists of two components
  1. **White pulp**: site where immune function occurs
     + Contains mostly lymphocytes on reticular fibers
     + White pulp clusters are found around central arteries; appear as islands of white in a sea of red pulp
  2. **Red pulp**: site where old blood cells and  
      bloodborne pathogens are destroyed
     + Rich in RBCs and macrophages that engulf them

20.5  MALT

MALT guards the body’s entryways against pathogens

• Define MALT and list its major components.

* Mucosa-associated lymphoid tissue (MALT)
  + Lymphoid tissues in mucous membranes throughout body
  + Protects from pathogens trying to enter body
  + Found in mucosa of respiratory tract, genitourinary organs, and digestive tract;  
    largest collections of MALT found in
    - **Tonsils**
    - **Peyer’s patches**
    - **Appendix**

20.6  Thymus

T lymphocytes mature in the thymus

• Describe the structure and function of the thymus.

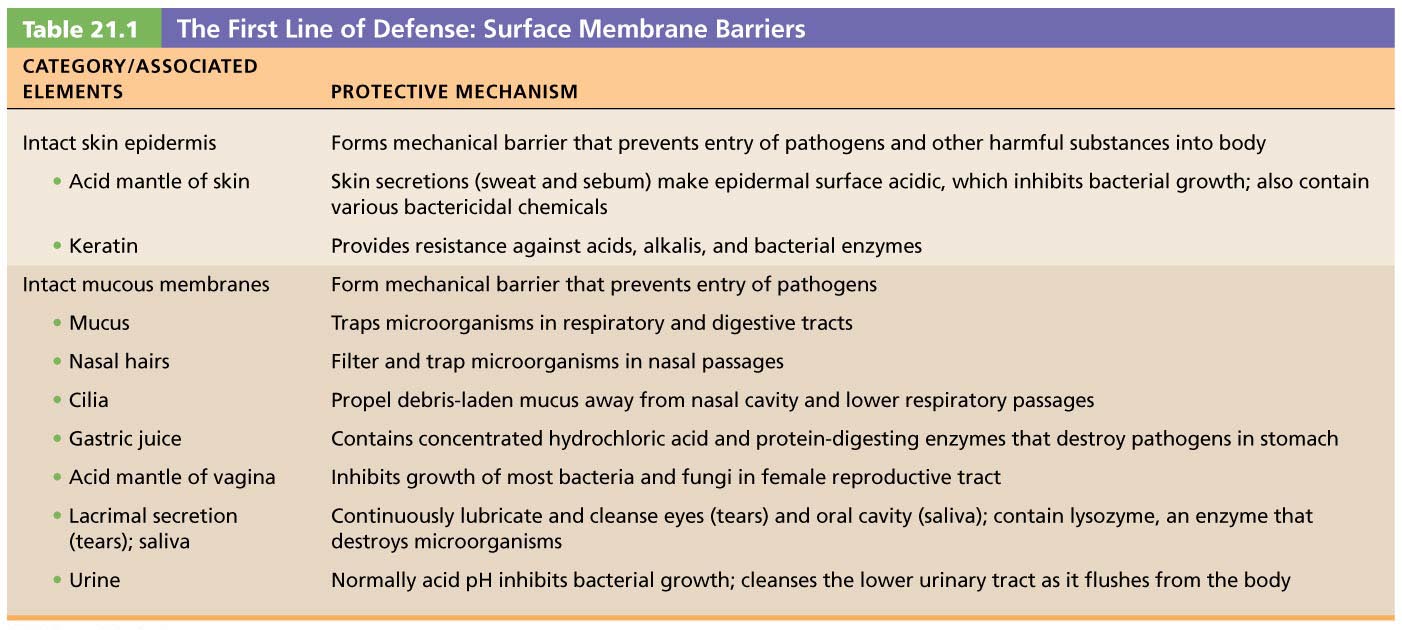
* **Thymus**: bilobed lymphoid organ found in inferior neck
* Thymus is broken into lobules that contain outer cortex and inner medulla
  + Cortex contains rapidly dividing lymphocytes (the bulk of thymic cells) and scattered macrophages
  + Medulla contains fewer lymphocytes and thymic corpuscles
    - Thymic corpuscles are where *regulatory T cells* develop
* Thymus differs from other lymphoid organs in important ways
  + Has no follicles because it lacks B cells
  + Does not directly fight antigens
    - Functions strictly in T lymphocyte maturation
      * Contains **blood thymus barrier**: keeps immature T lymphocytes isolated from any antigens to prevent premature activation
  + **Stroma** is made up of epithelial cells, not   
     reticular fibers
    - Provide environment in which T lymphocytes become immunocompetent

Chapter 21

21.1  Surface barriers: Skin and mucosae

Surface barriers act as the first line of defense to keep invaders out of the body

• Describe surface membrane barriers and their protective functions.



21.2  Innate internal defenses: Cells and chemicals

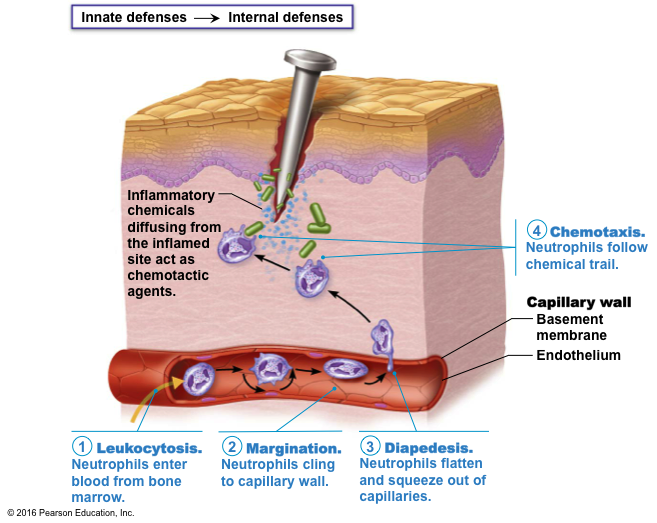
Innate internal defenses are cells and chemicals that act as the second line of   
defense

• Explain the importance of phagocytosis, natural killer cells, and fever in innate body   
defense.

* *Phagocytes*: white blood cells that ingest and digest (eat) foreign invaders
  + **Neutrophils**: most abundant phagocytes, but die fighting; become phagocytic on exposure to infectious material
  + **Macrophages**: develop from **monocytes** and are chief phagocytic cells; most robust phagocytic cell
* Natural Killer Cells
  + Nonphagocytic, large granular lymphocytes that police blood and lymph
  + Can kill cancer and virus-infected cells before adaptive immune system is activated
  + Attack cells that lack “self” cell-surface receptors
  + Kill by inducing **apoptosis** in cancer cells and virus-infected cells
  + Secrete potent chemicals that enhance inflammatory response
* **Fever**
  + Abnormally high body temperature that is systemic response to invading microorganisms
  + Leukocytes and macrophages exposed to foreign substances secrete **pyrogens**
  + Pyrogens act on body’s thermostat in hypothalamus, raising body temperature
* Benefits of moderate fever
  + Causes liver and spleen to sequester iron and zinc (needed by microorganisms)
  + Increases metabolic rate, which increases rate   
    of repair

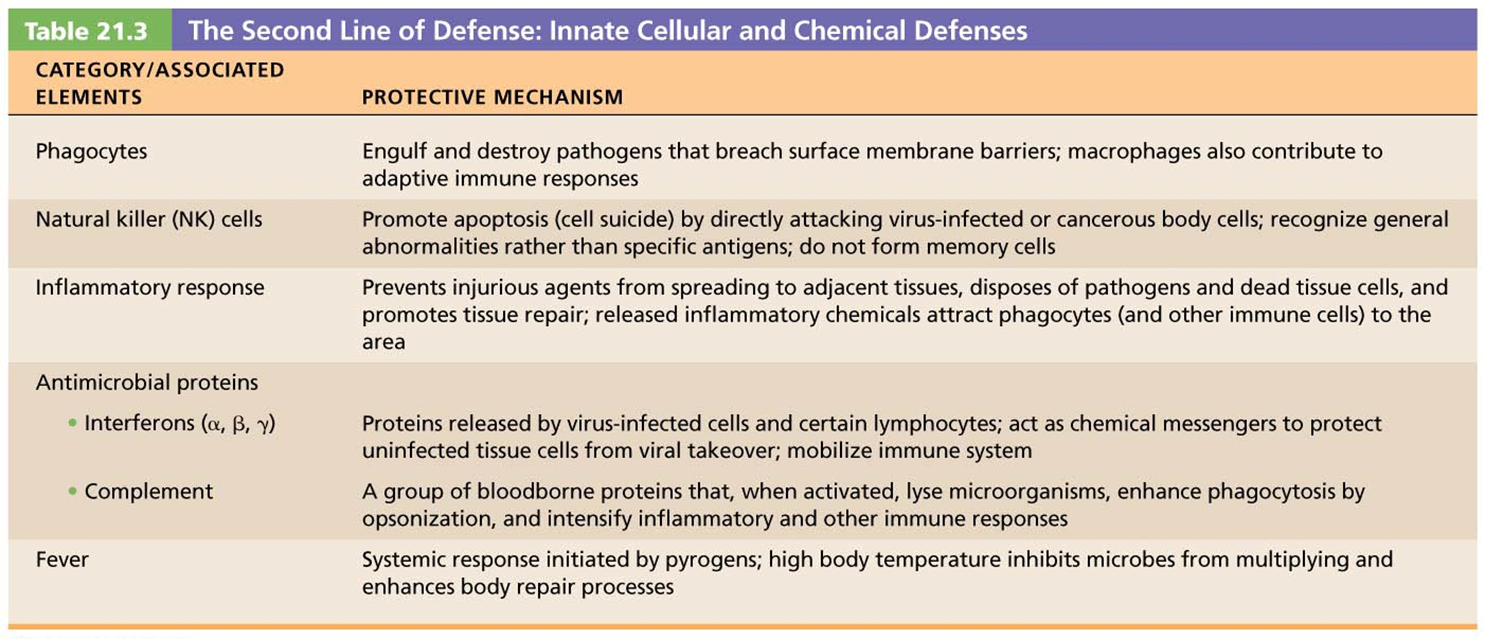
• Describe the inflammatory process. Identify several inflammatory chemicals and   
indicate their specific roles.

* Stages of inflammation



* + **Inflammatory chemical release**
    - Chemicals are released into ECF by injured tissues, immune cells, or blood proteins
    - Example: **histamine** released by **mast cells** is key inflammatory chemical
  + **Vasodilation and increased vascular permeability**
    - Vasodilation causes **hyperemia**—congestion with blood—which leads to redness and heat
    - Increased capillary permeability causes   
      **exudate**—fluid containing clotting factors and antibodies—to leak into tissue
  + **Phagocyte mobilization**
    - Neutrophils flood area first; macrophages follow
    - If inflammation is due to pathogens, complement is activated; adaptive immunity elements arrive

• Name the body’s antimicrobial substances and describe their function.



Part 2  Adaptive Defenses

21.3  Antigens

Antigens are substances that trigger the body’s adaptive defenses

• Define antigen and describe how antigens affect the adaptive defenses.

* **Antigens**: substances that can mobilize adaptive defenses and provoke an immune response

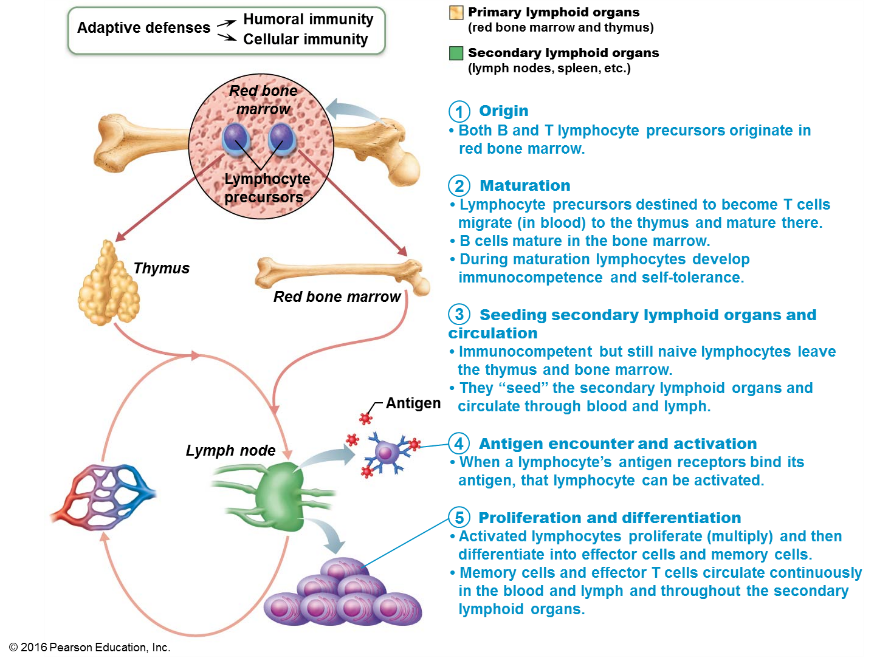
• Define complete antigen, hapten, and antigenic determinant.

* Complete antigens have two important functional properties:
  + **Immunogenicity**: ability to stimulate proliferation of specific lymphocytes
  + **Reactivity**: ability to react with activated lymphocytes and antibodies released by immunogenic reactions
* **Incomplete** **antigens**, also called **haptens**, involve molecules too small to be seen so are not immunogenic by themselves
  + Examples: small peptides, nucleotides, some hormones
  + May become immunogenic if hapten attaches to body’s own proteins
  + Causes immune system to mount attack that is harmful to person because it attacks self-proteins as well as hapten
* **Antigenic determinants**: parts of antigen that antibodies or lymphocyte receptors bind to
  + Most naturally occurring antigens have numerous antigenic determinants that:
    - Mobilize several different lymphocyte populations
    - Form different kinds of antibodies against them

21.4  Lymphocytes and antigen-presenting cells

B and T lymphocytes and antigen-presenting cells are cells of the adaptive   
immune response

• Compare and contrast the origin, maturation process, and general function of B and T lymphocytes.



• Name several antigen-presenting cells and describe their roles in adaptive defenses.

* **Dendritic cells** 
  + Found in connective tissues and epidermis
  + Act as mobile sentinels of boundary tissues
  + Phagocytize pathogens that enter tissues, then enter lymphatics to present antigens to T cells in lymph node
* **Macrophages** 
  + Widely distributed in connective tissues and lymphoid organs
  + Present antigens to T cells, which not only activates T cell, but also further activates macrophage
    - *Activated macrophage* becomes voracious phagocytic killer
* **B lymphocytes**
  + Do not activate naive T cells
  + Present antigens to helper T cell to assist their own activation

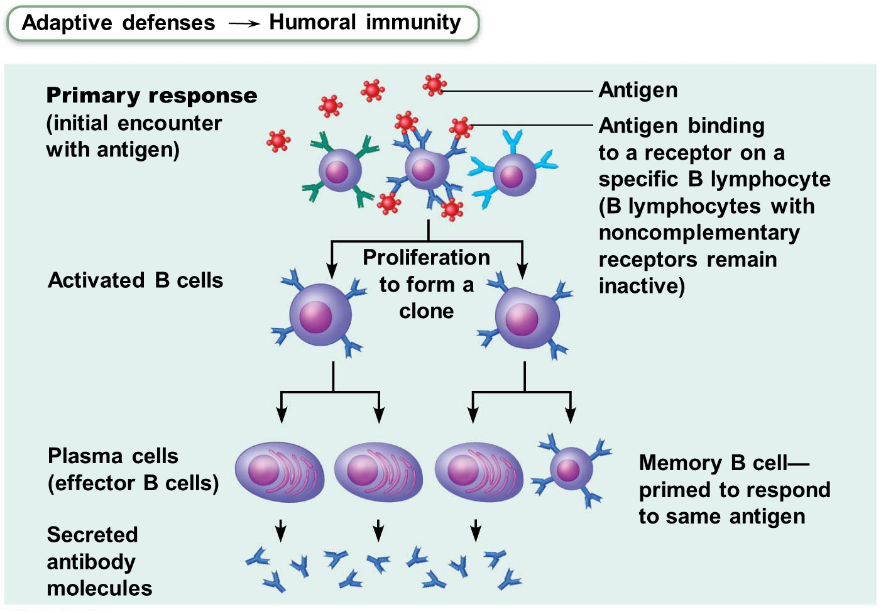
21.5  Humoral immune response

In humoral immunity, antibodies are produced that target extracellular antigens

• Define humoral immunity.

* When B cell encounters target antigen, it provokes *humoral immune response*
  + Antibodies specific for that particular antigen are then produced

• Describe the process of clonal selection of a B cell and recount the roles of plasma cells and memory cells in humoral immunity.

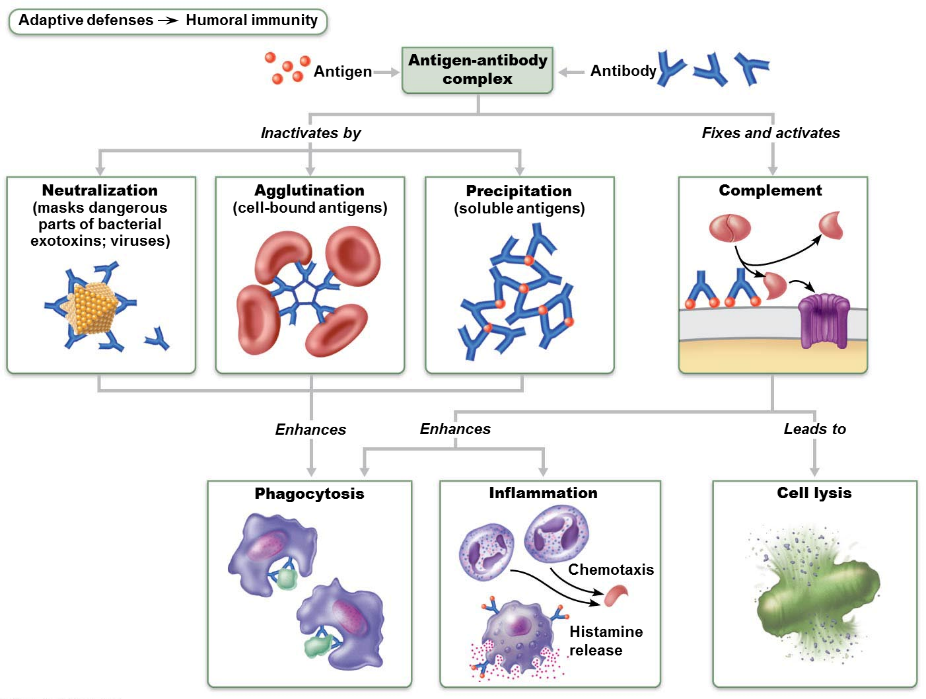


• Compare and contrast active and passive humoral immunity.

* **Active humoral immunity** occurs when B cells encounter antigens and produce specific antibodies against them
* Two types of active humoral immunity
  1. **Naturally acquired**:formed in response to   
      actual bacterial or viral infection
  2. **Artificially acquired**:formed in response to   
      **vaccine** of dead or attenuated pathogens
* **Passive humoral immunity** occurs when ready-made antibodies are introduced into body
* Two types of passive humoral immunity
  1. *Naturally acquired*: antibodies delivered to fetus   
      via placenta or to infant through milk
  2. *Artificially acquired*: injection of serum, such as   
      gamma globulin

• Describe the structure and functions of antibodies and name the five antibody classes.

* **Antibody targets and functions**
  + Antibodies do not destroy antigens; they inactivate and tag them
    - Form **antigen-antibody** (**immune**) **complexes**
  + Defensive mechanisms used by antibodies
    - **Neutralization**
    - **Agglutination**
    - **Precipitation**
    - **Complement fixation**

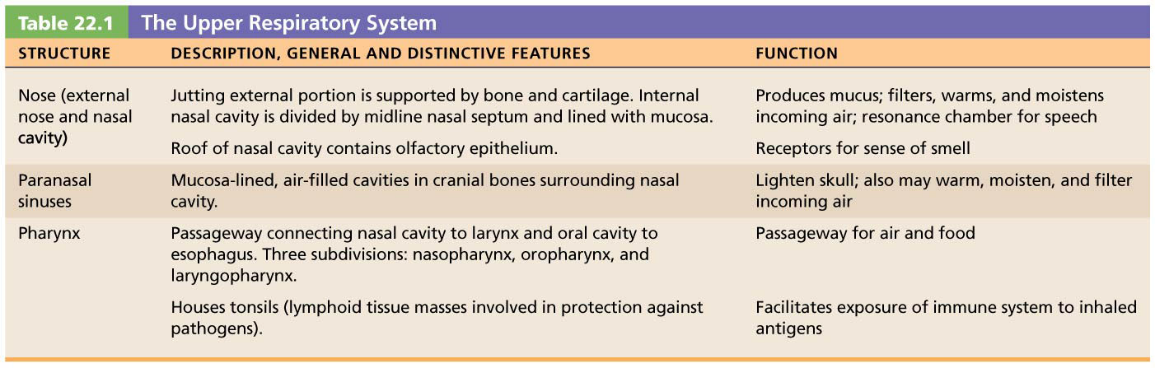


**Chapter 22**

**22.1  The upper respiratory system**

**The upper respiratory system warms, humidifies, and filters air**

• Describe the location, structure, and function of each of the following: nose, paranasal sinuses, and pharynx.



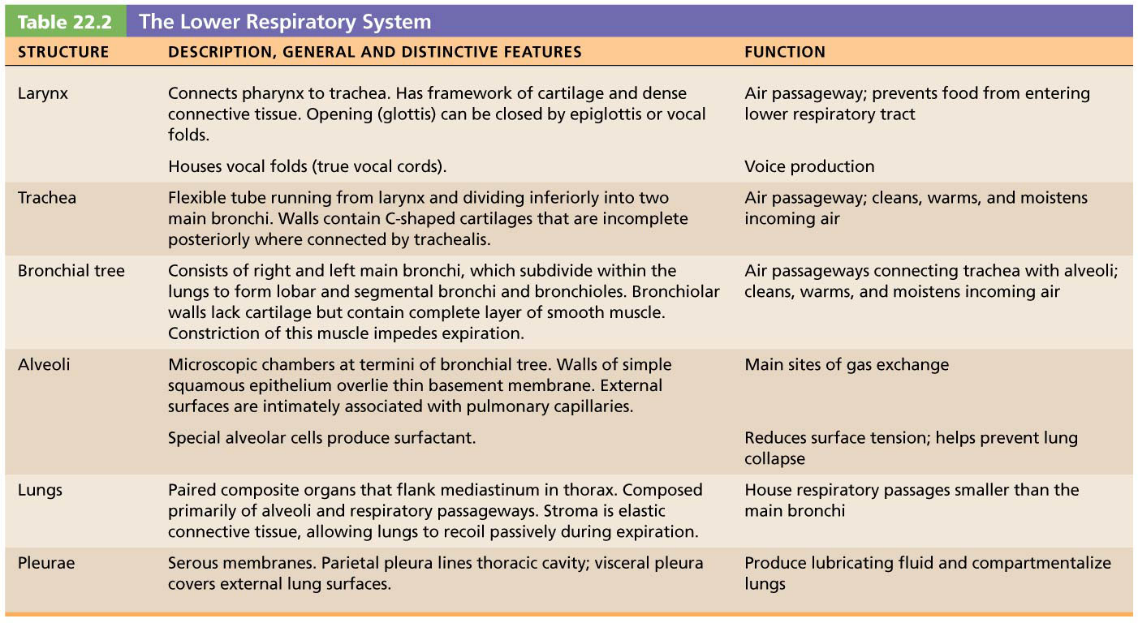
**22.2  The lower respiratory system**

**The lower respiratory system consists of conducting and respiratory zone   
structures**

• Distinguish between conducting and respiratory zone structures.

* + **Respiratory** **zone**: site of gas exchange
    - Consists of microscopic structures such as **respiratory** **bronchioles**, **alveolar** **ducts**, and **alveoli**
  + **Conducting** **zone**: conduits that tranport gas to and from gas exchange sites
    - Includes all other respiratory structures
    - Cleanses, warms, and humidifies air

• Describe the structure, function, and location of the larynx, trachea, and bronchi.



• Identify the organs forming the respiratory passageway(s) in descending order until you reach the alveoli.

* Major organs:
  + **Nose and nasal cavity**
  + **Paranasal sinuses**
  + **Pharynx**
  + **Larynx**
  + **Trachea**
  + **Bronchi and branches**
  + **Lungs and alveoli**
  1. **The lungs and pleurae**

**Each multi-lobed lung occupies its own pleural cavity**

• Describe the gross structure of the lungs and pleurae.

**Gross Anatomy of the Lungs**

* Lungs occupy all of the thoracic cavity except for mediastinum
* **Root**: site of vascular and bronchial attachment to mediastinum
* **Costal** **surface**: anterior, lateral, and posterior surfaces
* **Apex**: superior tip, deep to clavicle
* **Base**: inferior surface that rests on diaphragm
* **Hilum**: found on mediastinal surface, it is the site for entry/exit of blood vessels, bronchi, lymphatic vessels, and nerves
  1. **What causes air to move in and out of the lungs?**

**Volume changes cause pressure changes, which cause air to move**

• Explain the functional importance of the partial vacuum that exists in the intrapleural space.

* + Pressure in pleural cavity
  + Fluctuates with breathing
  + Always a negative pressure (<Patm and <Ppul)
  + Fluid level must be kept at a minimum
    - Excess fluid pumped out by lymphatic system
    - If fluid accumulates, positive Pip pressure develops
      * Lung collapses
  + One outward force tends to enlarge lungs
    - Elasticity of chest wall pulls thorax outward
  + Negative Pip is affected by these opposing forces but is maintained by strong adhesive force between parietal and visceral pleurae

• Relate Boyle’s law to events of inspiration and expiration.

Boyle’s law: relationship between pressure and volume of a gas

* + - Gases always fill the container they are in
      * If amount of gas is the same and container size is reduced, pressure will increase
    - So pressure (*P*) varies inversely with volume (*V*)
    - Mathematically: *P1V1* = *P2V2*

• Explain the relative roles of the respiratory muscles and lung elasticity in producing the volume changes that cause air to flow into and out of the lungs.

* + - Active process involving inspiratory muscles (diaphragm and external intercostals)
      * **Action of the diaphragm**: when dome-shaped diaphragm contracts, it moves inferiorly and flattens out
        + Results in increase in thoracic volume
      * **Action of intercostal muscles**: when external intercostals contract, rib cage is lifted up and out
        + Results in increase in thoracic volume

• List several physical factors that influence pulmonary ventilation.

* **Airway** **resistance**
  + Friction: major *nonelastic* source of resistance to gas flow; occurs in airways
* **Lung** **compliance**
  + Measure of change in lung volume that occurs with given change in transpulmonary pressure
* **Alveolar surface tension**
  + **Surface** **tension**: the attraction of liquid molecules to one another at a gas-liquid interface
  1. **How do we assess ventilation?**

**Measuring respiratory volumes, capacities, and flow rates helps us assess   
ventilation**

• Explain and compare the various lung volumes and capacities.

* **Tidal** **volume** (**TV**): amount of air moved into and out of lung with each breath
* **Inspiratory** **reserve** **volume** (**IRV**): amount of air that can be inspired forcibly beyond the tidal volume
* **Expiratory** **reserve** **volume** (**ERV**): amount of air that can be forcibly expelled from lungs
* **Residual** **volume** (**RV**): amount of air that always remains in lungs

• Define dead space.

* **Anatomical** **dead** **space**: does not contribute to gas exchange
  + Consists of air that remains in passageways
    - ~150 ml out of 500 ml TV
* **Alveolar** **dead** **space**: space occupied by nonfunctional alveoli
  + Can be due to collapse or obstruction
* **Total** **dead** **space**: sum of anatomical and alveolar dead space

• Indicate types of information that can be gained from pulmonary function tests.

* Pulmonary functions tests can measure *rate* of gas movement
  + **Forced** **vital** **capacity** (**FVC**): amount of gas forcibly expelled after taking deep breath
  + **Forced** **expiratory** **volume** (**FEV**): amount of gas expelled during specific time interval of FVC
* **Obstructive** **pulmonary** **disease**: increased airway resistance (example: bronchitis)
* **Restrictive** **disease**: reduced TLC due to disease (example: tuberculosis) or exposure to environmental agents (example: fibrosis)

**22.6  How do gases move between the lungs, blood, and tissues?**

**Gases exchange by diffusion among the blood, lungs, and tissues**

• Describe how atmospheric and alveolar air differ in composition, and explain these   
differences.

Alveoli contain more CO2 and water vapor than atmospheric air because of:

* + - Gas exchanges in lungs (O2 diffuses out of lung, and CO2 diffuses into lung)
    - Humidification of air by conducting passages
    - Mixing of alveolar gas with each breath
      * Newly inspired air mixes with air that was left in passageways between breaths

• Relate Dalton’s and Henry’s laws to events of external and internal respiration.

* **Dalton’s law of partial pressures**
  + Total pressure exerted by mixture of gases is equal to sum of pressures exerted by each gas
* **Henry’s** **law**
  + For gas mixtures in contact with liquids:
    - Each gas will dissolve in the liquid in proportion to its partial pressure
    - At equilibrium, partial pressures in the two phases will be equal