The Respiratory System:

Part A

2 Respiration

• Involves both the respiratory and the circulatory systems
• Four processes that supply the body with O₂ and dispose of CO₂

3 Respiration

• Pulmonary ventilation (breathing): movement of air into and out of the lungs
• External respiration: O₂ and CO₂ exchange between the lungs and the blood
• Transport: O₂ and CO₂ in the blood
• Internal respiration: O₂ and CO₂ exchange between systemic blood vessels and tissues

4 Respiratory System: Functional Anatomy

• Major organs
  • Nose, nasal cavity, and paranasal sinuses
  • Pharynx
  • Larynx
  • Trachea
  • Bronchi and their branches
  • Lungs and alveoli

5. Fig. 22.1 pg. 805

6 Functional Anatomy

• Respiratory zone: site of gas exchange
  • Microscopic structures: respiratory bronchioles, alveolar ducts, and alveoli
• Conducting zone: conduits to gas exchange sites
  • Includes all other respiratory structures
• Respiratory muscles: diaphragm and other muscles that promote ventilation

7 The Nose

• Functions
  • Provides an airway for respiration
  • Moistens and warms the entering air
  • Filters and cleans inspired air
  • Serves as a resonating chamber for speech
  • Houses olfactory receptors
8 The Nose
• Two regions: external nose and nasal cavity
  1. External nose: root, bridge, dorsum nasi, and apex
     • Nostrils (nares): bounded laterally by the alae

9 Fig. 22a  pg. 806

10 Fig. 22b  pg. 806

11 The Nose
  2. Nasal cavity: in and posterior to the external nose
     • Divided by a midline nasal septum
     • Posterior nasal apertures (choanae) open into the nasal pharynx
     • Roof: ethmoid and sphenoid bones
     • Floor: hard and soft palates

12 Nasal Cavity
• Vestibule: nasal cavity superior to the nostrils
  • Hairs filter coarse particles from inspired air
• Olfactory mucosa
  • Lines the superior nasal cavity
  • Contains smell receptors

13 Nasal Cavity
• Respiratory mucosa
  • Pseudostratified ciliated columnar epithelium
  • Mucous and serous secretions contain lysozyme and defensins
  • Cilia move contaminated mucus posteriorly to throat
  • Inspired air is warmed by plexuses of capillaries and veins
  • Sensory nerve endings triggers sneezing

14. Fig. 22.3c  pg 808

15 Nasal Cavity
• Superior, middle, and inferior nasal conchae
  • Protrude from the lateral walls
  • Increase mucosal area
  • Enhance air turbulence

16 Functions of the Nasal Mucosa and Conchae
• During inhalation, the conchae and nasal mucosa
  • Filter, heat, and moisten air
• During exhalation these structures
  • Reclaim heat and moisture
17 Paranasal Sinuses
- In frontal, sphenoid, ethmoid, and maxillary bones
- Lighten the skull and help to warm and moisten the air

18 Pharynx
- Muscular tube that connects to the
  - Nasal cavity and mouth superiorly
  - Larynx and esophagus inferiorly
- From the base of the skull to the level of the sixth cervical vertebra

19 Fig. 22.3 b pg. 808
20 Nasopharynx
- Air passageway posterior to the nasal cavity
- Lining: pseudostratified columnar epithelium
- Soft palate and uvula close nasopharynx during swallowing
- Pharyngeal tonsil (adenoids) on posterior wall
- Pharyngotympanic (auditory) tubes open into the lateral walls

21 Oropharynx
- Passageway for food and air from the level of the soft palate to the epiglottis
- Lining of stratified squamous epithelium
- Palatine tonsils in the lateral walls of fauces
- Lingual tonsil on the posterior surface of the tongue

22 Laryngopharynx
- Passageway for food and air
- Posterior to the upright epiglottis
- Extends to the larynx, where it is also continuous with the esophagus

23. Fig. 22.3 c pg. 808
24 Larynx
- Attaches to the hyoid bone and opens into the laryngopharynx
- Continuous with the trachea
- Functions
  1. Provides a patent airway
  2. Routes air and food into proper channels
  3. Voice production

25 Larynx
- Cartilages of the larynx
  - Hyaline cartilage except for the epiglottis
  - Thyroid cartilage with laryngeal prominence (Adam’s apple)
- Epiglottis: elastic cartilage; covers the laryngeal inlet during swallowing
26  Larynx
• Vocal ligaments
  • Contain elastic fibers
  • Form core of vocal folds (true vocal cords)
    • Opening between them is the glottis
    • Folds vibrate to produce sound as air rushes up from the lungs
27  Larynx
• Vestibular folds (false vocal cords)
  • Superior to the vocal folds
  • No part in sound production
  • Help to close the glottis during swallowing

28. Fig. 22.5 a&b  pg. 811

29  Voice Production
• Speech: intermittent release of expired air while opening and closing the glottis
• Pitch is determined by the length and tension of the vocal cords
• Loudness depends upon the force of air
• Chambers of pharynx, oral, nasal, and sinus cavities amplify and enhance sound quality
• Sound is “shaped” into language by muscles of the pharynx, tongue, soft palate, and lips

30  Larynx
• Vocal folds may act as a sphincter to prevent air passage
• Example: Valsalva’s maneuver
  • Glottis closes to prevent exhalation
  • Abdominal muscles contract
  • Intra-abdominal pressure rises
  • Helps to empty the rectum or stabilizes the trunk during heavy lifting

31  Trachea
• Windpipe: from the larynx into the mediastinum
• Wall composed of three layers
  1. Mucosa: ciliated pseudostratified epithelium with goblet cells
  2. Submucosa: connective tissue with seromucous glands
  3. Adventitia: outermost layer made of connective tissue that encases the C-shaped rings of hyaline cartilage

32  Trachea
• Trachealis muscle
  • Connects posterior parts of cartilage rings
  • Contracts during coughing to expel mucus
• Carina
  • Last tracheal cartilage
  • Point where trachea branches into two bronchi
35 Bronchi and Subdivisions
• Air passages undergo 23 orders of branching
• Branching pattern called the bronchial (respiratory) tree

36 Conducting Zone Structures
• Trachea → right and left main (primary) bronchi
• Each main bronchus enters the hilum of one lung
• Each main bronchus branches into lobar (secondary) bronchi (three right, two left)
  • Each lobar bronchus supplies one lobe

37 Conducting Zone Structures
• Each lobar bronchus branches into segmental (tertiary) bronchi
  • Segmental bronchi divide repeatedly
  • Bronchioles are less than 1 mm in diameter
  • Terminal bronchioles are the smallest, less than 0.5 mm diameter

38. Fig. 22.7  pg. 813

39 Conducting Zone Structures
• From bronchi through bronchioles, structural changes occur
  • Cartilage rings give way to plates; cartilage is absent from bronchioles
  • Epithelium changes from pseudostratified columnar to cuboidal; cilia and goblet cells become sparse
  • Relative amount of smooth muscle increases

40 Respiratory Zone
• Respiratory bronchioles, alveolar ducts, alveolar sacs (clusters of alveoli)
• ~300 million alveoli account for most of the lungs’ volume and are the main site for gas exchange

41 Fig. 22.8 a  pg. 814

42 Fig. 22.8  pg. 814

43 Respiratory Membrane
• ~0.5-µm-thick air-blood barrier
• Alveolar and capillary walls and their fused basement membranes
• Alveolar walls
  • Single layer of squamous epithelium (type I cells)
  • Scattered type II cuboidal cells secrete surfactant and antimicrobial proteins

44. fig.  22.9   pg. a   pg. 816
46. Alveoli
   • Surrounded by fine elastic fibers
   • Contain open pores that
     • Connect adjacent alveoli
     • Allow air pressure throughout the lung to be equalized
   • House alveolar macrophages that keep alveolar surfaces sterile

47. Fig. 22.9 c pg. 816

48. Lungs
   • Occupy all of the thoracic cavity except the mediastinum
   • Root: site of vascular and bronchial attachments
   • Costal surface: anterior, lateral, and posterior surfaces

49. Fig. 22.10 c pg. 817

50. Lungs
   • Apex: superior tip
   • Base: inferior surface that rests on the diaphragm
   • Hilum: on mediastinal surface; site for attachment of blood vessels, bronchi, lymphatic vessels, and nerves
   • Cardiac notch of left lung: concavity that accommodates the heart

51. Lungs
   • Left lung is smaller, separated into two lobes by an oblique fissure
   • Right lung has three lobes separated by oblique and horizontal fissures
   • Bronchopulmonary segments (10 right, 8–9 left)
   • Lobules are the smallest subdivisions; served by bronchioles and their branches

52. Fig. 22.10 a pg. 817

53. Fig. 22.11 pg. 818

54. Blood Supply
   • Pulmonary circulation (low pressure, high volume)
     • Pulmonary arteries deliver systemic venous blood
       • Branch profusely, along with bronchi
       • Feed into the pulmonary capillary networks
     • Pulmonary veins carry oxygenated blood from respiratory zones to the heart
55  Blood Supply
• **Systemic circulation** (high pressure, low volume)
  • **Bronchial arteries** provide oxygenated blood to lung tissue
    • Arise from aorta and enter the lungs at the hilum
    • Supply all lung tissue except the alveoli
  • **Pulmonary veins** carry most venous blood back to the heart

56  Pleurae
• **Thin, double-layered serosa**
• **Parietal pleura** on thoracic wall and superior face of diaphragm
• **Visceral pleura** on external lung surface
• **Pleural fluid fills the slitlike pleural cavity**
  • Provides lubrication and surface tension

57. Fig. 22.10  c  pg. 817

58  Mechanics of Breathing
• **Pulmonary ventilation consists of two phases**
  1. **Inspiration**: gases flow into the lungs
  2. **Expiration**: gases exit the lungs
• **Paralysis of intercostal muscles**
1. CHAPTER 23 (8th edition) THE DIGESTIVE SYSTEM  part 1

2. Digestive System
   • Two groups of organs
     1. Alimentary canal (gastrointestinal or GI tract)
        • Digests and absorbs food
        • Mouth, pharynx, esophagus, stomach, small intestine, and large intestine

3. Digestive System
   1. Accessory digestive organs
      • Teeth, tongue, gallbladder
      • Digestive glands
         • Salivary glands
         • Liver
         • Gall bladder
         • Pancreas

4. Figure 23.1 pg. 852

5. Digestive Processes
   • Six essential activities
     1. Ingestion
     2. Propulsion
     3. Mechanical digestion
     4. Chemical digestion
     5. Absorption
     6. Defecation

6. Figure 23.2a page 852

7. Figure 23.2b page 852

8. GI tract regulatory mechanisms
   2. Intrinsic and extrinsic controls
      • Enteric nerve plexuses (gut brain) initiate short reflexes in response to stimuli in the GI tract
      • Long reflexes in response to stimuli inside or outside the GI tract involve CNS centers and autonomic nerves
      • Hormones from cells in the stomach and small intestine stimulate target cells in the same or different organs
9. Peritoneum and Peritoneal Cavity
   • Peritoneum: serous membrane of the abdominal cavity
     • Visceral peritoneum on external surface of most digestive organs
     • Parietal peritoneum lines the body wall
   • Peritoneal cavity
     • Between the two peritoneums
     • Fluid lubricates mobile organs

10. Figure 23.5 a page 855
    • Peritoneum: serous membrane of the abdominal cavity
      • Visceral peritoneum on external surface of most digestive organs
      • Parietal peritoneum lines the body wall
    • Peritoneal cavity
      • Between the two peritoneums
      • Fluid lubricates mobile organs

11. Peritoneum and Peritoneal Cavity
    • Mesentery is a double layer of peritoneum
      • Routes for blood vessels, lymphatics, and nerves
      • Holds organs in place and stores fat
    • Retroperitoneal organs lie posterior to the peritoneum
    • Intraperitoneal (peritoneal) organs are surrounded by the peritoneum

12. Figure 23.5 b page 855

    • Arteries
      • Hepatic, splenic, and left gastric
      • Inferior and superior mesenteric
    • Hepatic portal circulation
      • Drains nutrient-rich blood from digestive organs
      • Delivers it to the liver for processing

14. Histology of the Alimentary Canal
    • Four basic layers (tunics)
      • 1. Mucosa
      • 2. Submucosa
      • 3. Muscularis externa
      • 4. Serosa

15. Fig. 23.6 pg. 857
16. Mucosa
   • Lines the lumen
   • Functions
     • Secretes mucus, digestive enzymes and hormones
     • Absorbs end products of digestion
     • Protects against infectious disease
   • Three sublayers: A. epithelium, B. lamina propria, and C. muscularis mucosae

17. Mucosa
   • A. Epithelium
     • Simple columnar epithelium and mucus-secreting cells
       • Mucus
         • Protects digestive organs from enzymes
         • Eases food passage
       • May secrete enzymes and hormones (e.g., in stomach and small intestine)

18. Mucosa
   • B. Lamina propria
     • Loose areolar connective tissue
     • Capillaries for nourishment and absorption
     • Lymphoid follicles (part of MALT)
   • C. Muscularis mucosae: smooth muscle that produces local movements of mucosa

19. Submucosa
   • Submucosa
     • Dense connective tissue
     • Blood and lymphatic vessels, lymphoid follicles, and submucosal nerve plexus

20. Muscularis Externa
   • Responsible for segmentation and peristalsis
   • Inner circular and outer longitudinal layers
   • Myenteric nerve plexus
   • Sphincters in some regions

21. Serosa
   • Visceral peritoneum
     • Replaced by the fibrous adventitia in the esophagus
     • Retroperitoneal organs have both an adventitia and serosa
23. **Enteric Nervous System**  
   - Intrinsic nerve supply of the alimentary canal  
     - Submucosal nerve plexus  
       - Regulates glands and smooth muscle in the mucosa  
     - Myenteric nerve plexus  
       - Controls GI tract motility

24. **Enteric Nervous System**  
   - Linked to the CNS via afferent visceral fibers  
   - Long ANS fibers synapse with enteric plexuses  
     - Sympathetic impulses inhibit secretion and motility  
     - Parasympathetic impulses stimulate

25. **Mouth**  
   - Oral (buccal) cavity  
     - Bounded by lips, cheeks, palate, and tongue  
     - Oral orifice is the anterior opening  
     - Lined with stratified squamous epithelium

27. **Lips and Cheeks**  
   - Contain orbicularis oris and buccinator muscles  
   - Vestibule: recess internal to lips and cheeks, external to teeth and gums  
   - Oral cavity proper lies within the teeth and gums  
   - Labial frenulum: median attachment of each lip to the gum

29. **Palate**  
   - Hard palate: palatine bones and palatine processes of the maxillae  
     - Slightly corrugated to help create friction against the tongue  
   - Soft palate: fold formed mostly of skeletal muscle  
     - Closes off the nasopharynx during swallowing  
     - Uvula projects downward from its free edge
30. Tongue
   • Functions include
     • Repositioning and mixing food during chewing
     • Formation of the bolus
     • Initiation of swallowing, speech, and taste
   • Intrinsic muscles change the shape of the tongue
   • Extrinsic muscles alter the tongue’s position
   • Lingual frenulum: attachment to the floor of the mouth

31. Tongue
   • Surface bears papillae
     • Taste buds

32. Figure 23.8 pg. 860

33. Salivary Glands
   • Extrinsic salivary glands (parotid, submandibular, and sublingual)

34. Salivary Glands
   • Intrinsic (buccal) salivary glands are scattered in the oral mucosa
   • Secretion (saliva)
     • Cleanses the mouth
     • Moistens and dissolves food chemicals
     • Aids in bolus formation
     • Contains enzymes that begin the breakdown of starch

35. Salivary Glands
   • Parotid gland
     • Anterior to the ear external to the masseter muscle
     • Parotid duct opens into the vestibule next to second upper molar
   • Submandibular gland
     • Medial to the body of the mandible
     • Duct opens at the base of the lingual frenulum

36. Salivary Glands
   • Sublingual gland
     • Anterior to the submandibular gland under the tongue
     • Opens via 10–12 ducts into the floor of the mouth

37. Figure 23.9 a&b pg. 861
38. Composition of Saliva
   - Secreted by serous and mucous cells
   - 97–99.5% water, slightly acidic solution containing
     - Electrolytes—Na+, K+, Cl–, PO4 2–, HCO3–
     - Salivary amylase and lingual lipase
     - Mucin
     - Metabolic wastes—urea and uric acid
     - Lysozyme, IgA, defensins, and a cyanide compound protect against microorganisms

39. Control of Salivation
   - Intrinsic glands continuously keep the mouth moist
   - Extrinsic salivary glands produce secretions when
     - Ingested food stimulates chemoreceptors and mechanoreceptors in the mouth
     - Salivatory nuclei in the brain stem send impulses along parasympathetic fibers in cranial nerves VII and IX
   - Strong sympathetic stimulation inhibits salivation and results in dry mouth (xerostomia)

40. Teeth
   - Primary and permanent dentitions are formed by age 21
   - 20 deciduous teeth erupt (6–24 months of age)
     - Roots are resorbed, teeth fall out (6–12 years of age) as permanent teeth develop
   - 32 permanent teeth
     - All except third molars erupt by the end of adolescence

41. Figure 23.10 b pg. 862

42. Classes of Teeth
   - Incisors
     - Chisel shaped for cutting
   - Canines
     - Fanglike teeth that tear or pierce
   - Premolars (bicuspids) and molars
     - Have broad crowns with rounded cusps for grinding or crushing

43. Figure 23.10 a pg. 862

44. Tooth Structure
   - Crown: the exposed part above the gingiva (gum)
     - Covered by enamel—the hardest substance in the body (calcium salts and hydroxyapatite crystals)
   - Root: portion embedded in the jawbone
     - Connected to crown by neck
45. Tooth Structure
   • Cementum: calcified connective tissue
     • Covers root and attaches it to the periodontal ligament
   • Periodontal ligament
     • Forms fibrous joint called a gomphosis
   • Gingival sulcus: groove where gingiva borders the tooth

46. Tooth Structure
   • Dentin: bonelike material under enamel
     • Maintained by odontoblasts of pulp cavity
   • Pulp cavity: cavity surrounded by dentin
   • Pulp: connective tissue, blood vessels, and nerves
   • Root canal: extends from pulp cavity to the apical foramen of the root

47. Fig. 23.11 pg. 863

48. Tooth and Gum Disease
   • Dental caries (cavities): gradual demineralization of enamel and dentin
     • Dental plaque (sugar, bacteria, and debris) adheres to teeth
     • Acid from bacteria dissolves calcium salts
     • Proteolytic enzymes digest organic matter
     • Prevention: daily flossing and brushing

49. Tooth and Gum Disease
   • Gingivitis
     • Plaque calcifies to form calculus (tartar)
     • Calculus disrupts the seal between the gingivae and the teeth
     • Anaerobic bacteria infect gums
     • Infection reversible if calculus removed

50. Tooth and Gum Disease
   • Periodontitis
     • Immune cells attack intruders and body tissues
       • Destroy periodontal ligament
       • Activate osteoclasts
     • Consequences
       • Possible tooth loss, promotion of atherosclerosis and clot formation in coronary and cerebral arteries