The respiratory system anatomy

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Objectives

• Describe the location, structure, and function of the different parts of the respiratory system.
• Describe the structure of the bronchial tree.
• Describe the histology and function of the respiratory membrane.
General Functions

- Exchange of gases
  - Directionality depends on gradients!
    - Atmosphere to blood
    - Blood to tissues
- Regulation of pH
  - Dependent on rate of CO$_2$ release
- Protection: Filters, warms, and humidifies air
- Vocalization
- Allows for sense of smell
Components of the Respiratory System

• Nose
• Pharynx
• Larynx
• Trachea
• Bronchi
• Lungs
Structural Divisions of the Respiratory System

- Upper respiratory tract (outside thorax)
  - Nose
  - Nasal Cavity
  - Sinuses
  - Pharynx
Structural Divisions of the Respiratory System

- Lower respiratory tract (within thorax)
  - Larynx
  - Trachea
  - Bronchial Tree
  - Lungs
Functional Divisions of the Respiratory System

(1) The conducting zone: a series of cavities and tubes both outside and within the lungs (nose, pharynx, larynx, trachea, bronchi, bronchioles, and terminal bronchioles) their function is to filter, warm, and moisten air and conduct it into the lungs.

(2) The respiratory zone consists of tissues within the lungs where gas exchange occurs. These include the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli; they are the main sites of gas exchange between air and blood.
Components of the Respiratory System

• Nose- the nose serves to warm, moisturize, and filter the particulate matter contained in the air. The nose also provides the body with the sense of smell. It modifies speech vibrations as they pass through the large, hollow resonating chambers.

• Pharynx (throat)- a tubular structure about 13 cm long which serves as a passage way for both air and food. It houses the tonsils, which participate in immunological reactions against foreign invaders.
Components of the Respiratory System

• Larynx (voice box) – a short passageway that connects the pharynx with the trachea

• larynx is composed of nine pieces of cartilage. Three occur singly (thyroid cartilage, epiglottis, and cricoid cartilage), and three occur in pairs (arytenoid, cuneiform, and corniculate cartilages).

• The arytenoid cartilages are the most important because they influence changes in position and tension of the vocal cords for speech.
Components of the Respiratory System

• Larynx (voice box)-
  – The Epiglottis is situated in the larynx and covers the trachea and esophagus (depending upon whether the individual is breathing or swallowing) to keep foreign matter out of the lungs.
  – The Glottis is made of vocal cords and this is where sound originates.
Components of the Respiratory System

• Trachea (wind pipe) – a tubular passageway for air about 12 cm in length and 2.5 cm in diameter. The trachea sits anterior to the esophagus.

• Bronchi – tubes that branch off the trachea (at about the 5th thoracic vertebrae) and extend into the lungs.
• Point where trachea branches.
• The right primary bronchus is more vertical, shorter, and wider than the left. As a result, an aspirated object is more likely to enter and lodge in the right primary bronchus than the left.
• Mucosa highly sensitive to irritants: cough reflex
• Main=primary bronchi divide into secondary=lobar bronchi, each supplies one lobe
  – 3 on the right
  – 2 on the left
• Lobar bronchi branch into tertiary = segmental bronchi
• Continues dividing: about 23 times
• Tubes smaller than 1 mm called bronchioles
• Smallest, terminal bronchioles, are less the 0.5 mm diameter
• Tissue changes as becomes smaller
  – Cartilage plates, not rings, then disappears
  – Pseudostratified columnar to simple columnar to simple cuboidal without mucus or cilia
  – Smooth muscle important: sympathetic relaxation (“bronchodilation”), parasympathetic constriction (“bronchoconstriction”)
Respiratory Zone

- End-point of respiratory tree
- Structures that contain air-exchange chambers are called alveoli
- Respiratory bronchioles lead into alveolar ducts: walls consist of alveoli
- Ducts lead into terminal clusters called alveolar sacs – are microscopic chambers
- There are 3 million alveoli!
Gas Exchange

• Air filled alveoli account for most of the lung volume. The lungs contain 30 million alveoli providing a surface area of about the size of a tennis court.

• Through a process known as diffusion, oxygen moves from the alveoli into the blood, and carbon dioxide move from the blood into the alveoli.

• Alveolar wall
  – Single layer of squamous epithelial cells surrounded by basal lamina
  – External wall covered by web of capillaries

• Respiratory membra
  – Alveolar wall
  – Capillary wall

(air on one side; blood on the other)
Figure 23.11 Structural components of an alveolus. The respiratory membrane consists of a layer of type I and type II alveolar cells, an epithelial basement membrane, a capillary basement membrane, and the capillary endothelium.

The exchange of respiratory gases occurs by diffusion across the respiratory membrane.
Alveoli

- An **alveolus**: a cupshaped outpouching lined by simple squamous epithelium.
- An **alveolar sac**: two or more alveoli that share a common opening

The walls of alveoli consist of two types of cells:

1. **Type I alveolar cells**: lining of the alveolar wall, main sites of gas exchange
   
2. **Type II alveolar cells (septal cell)**: secrete alveolar fluid with the **surfactant**, a complex mixture of phospholipids and lipoproteins. Surfactant lowers the surface tension of fluid, which reduces the tendency of alveoli to collapse.

- Associated with the alveolar wall are **alveolar macrophages (dust cells)**.
Summary

• The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi, and lungs.

• The bronchial tree consists of the trachea, primary bronchi, secondary bronchi, tertiary bronchi, bronchioles, and terminal bronchioles.

• Walls of bronchi contain rings of cartilage; walls of bronchioles contain increasingly smaller plates of cartilage and increasing amounts of smooth muscle.

• The right lung has three lobes separated by two fissures; the left lung has two lobes separated by one fissure.

• Secondary bronchi give rise to branches called segmental bronchi, which supply segments of lung tissue.

• Each bronchopulmonary segment consists of lobules, which contain terminal bronchioles, respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli.

• Alveolar walls consist of type I alveolar cells, type II alveolar cells, and associated alveolar macrophages.

• Gas exchange occurs across the respiratory membranes.