9.1 The respiratory system

Chp. 9 The Respiratory S.

The nose
- Opens at the nostrils/nares and leads into the nasal cavities
- Hairs and mucus in the nose filters the air
- The nasal cavity has lots of capillaries that warm and moisten the air
- Specialized cells act as odor receptors
- Tear glands drain into the nasal cavities that can lead to a runny nose

9.2 The upper respiratory tract

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What constitutes the upper respiratory tract?
- Nose
- Pharynx
- Larynx
The pharynx

- Funnel-shaped cavity commonly called the "throat"
- 3 portions based on location: nasopharynx, oropharynx and laryngopharynx
- Tonsils provide a lymphatic defense during breathing at the junction of the oral cavity and pharynx

The larynx

- Triangular, cartilaginous structure that passes air between the pharynx and trachea
- Called the voice box and houses vocal cords
- There are 2 mucosal folds that make up the vocal cords with an opening in the middle called the glottis

What constitutes the lower respiratory tract?

- Trachea
- Bronchial tree
- Lungs
### The trachea

- A tube, often called the windpipe, that connects the larynx with the 1st bronchi.
- Made of connective tissue, smooth muscle and cartilaginous rings.
- Lined with cilia and mucus that help to keep the lungs clean.

### The bronchial tree

- Starts with two main bronchi that lead from the trachea into the lungs.
- The bronchi continue to branch until they are small bronchioles about 1mm in diameter with thinner walls (no cartilage).
- Bronchioles eventually lead to elongated sacs called alveoli.
- **Lungs**: above 3 / enclosed by membranes (pleura) / macroscopically: lobes ~3(rt) & 2 (lt).

### The alveoli

- ~300 million in the lungs that greatly increase surface area.
- Alveoli are enveloped by blood capillaries.
- The alveoli and capillaries are one layer of epithelium to allow exchange of gases.
- Alveoli are lined with surfactant that act as a film to keep alveoli open.
9.4 Mechanism of breathing

**Inspiration—Active Process (Air IN)**

- The diaphragm and intercostal muscles contract
- The diaphragm flattens and the rib cage moves upward and outward
- Volume of the thoracic cavity and lungs **increase**
- The air pressure within the lungs **decrease**
- Air flows **into** the lungs

**Expiration—Passive Process (Air OUT)**

- The diaphragm and intercostal muscles **relax**
- The diaphragm moves upward and becomes dome-shaped
- The rib cage moves downward and inward
- Volume of the thoracic cavity and lungs **decrease**
- The air pressure within the lungs **increases**
- Air flows **OUT** of the lungs

**Visualizing the vital capacity**

[Diagram showing the breathing process]
How is breathing controlled by the nervous system?

- Nervous control:
  - Respiratory control center in the brain (medulla oblongata) sends out nerve impulses to contract muscle for inspiration
  - Sudden infant death syndrome (SIDS) is thought to occur when this center stops sending out nerve signals

How is breathing chemically controlled?

- Chemical control:
  - 2 sets of chemoreceptors sense the drop in pH: one set is in the brain and the other in the circulatory system
  - Both are sensitive to carbon dioxide levels that change blood pH due to metabolism

Exchange of gases in the body

- Oxygen and carbon dioxide are exchanged
- The exchange of gases is dependent on diffusion
- Partial pressure is the amount of pressure each gas exerts ($P_{CO_2}$ or $P_{O_2}$)
- Oxygen and carbon dioxide will diffuse from the area of higher to the area of lower partial pressure
9.6 Gas exchanges in the body

External respiration – In Lungs

- Exchange of gases between the lung alveoli and the blood capillaries
- \( P_{CO_2} \) is higher in the lung capillaries than the air thus \( CO_2 \) diffuses out of the plasma into the lungs’ alveoli
- The partial pressure pattern for \( O_2 \) is just the opposite so \( O_2 \) diffuses into the red blood cells of capillaries in lungs

Carbon dioxide transport: \[ H^+ + HCO_3^- \rightarrow H_2CO_3 \rightarrow anhydrase \rightarrow H_2O + CO_2 \]

Oxygen transport: \[ Hb + O_2 \rightarrow HbO_2 \]

9.6 Gas exchanges in the body

The movement of oxygen and carbon dioxide in the body

9.6 Gas exchanges in the body

Internal respiration – At Tissues

- The exchange of gases between the blood in the capillaries outside of the lungs and the tissue fluid
- \( P_{O_2} \) is higher in the capillaries than the tissue fluid thus \( O_2 \) diffuses out of the blood into the tissues

Oxyhemoglobin gives up oxygen: \[ HbO_2 \rightarrow Hb + O_2 \]

Most \( CO_2 \) is carried as a bicarbonate ion: \[ CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H_2 + HCO_3^- \]
9.7 Respiration and health

Upper respiratory tract infections

• Sinusitis – blockage of sinuses
• Otitis media – infection of the middle ear
• Tonsillitis – inflammation of the tonsils
• Laryngitis – infection of the larynx that leads to loss of voice

Lower respiratory tract disorders

• Pneumonia – infection of the lungs with thick, fluid build up
• Tuberculosis – bacterial infection that leads to tubercles (capsules)
• Pulmonary fibrosis – lungs lose elasticity because fibrous connective tissue builds up in the lungs usually because of inhaled particles
• Emphysema – chronic, incurable disorder in which alveoli are damaged and thus the surface area for gas exchange is reduced
• Asthma – bronchial tree becomes irritated causing breathlessness, wheezing and coughing
• Lung cancer – uncontrolled cell division in the lungs that is often caused by smoking and can lead to death

Health focus: Things you should know about tobacco and health

• All forms of tobacco can cause damage
• Smoking increases a person’s chance of lung, mouth, larynx, esophagus, bladder, kidney, pancreas, stomach and cervix
• The 5-year survival rate for people with lung cancer is only 13%
• Smoking also increases the chance of chronic bronchitis, emphysema, heart disease, stillbirths and harm to an unborn child
• Passive smoke can increase a nonsmokers chance of pneumonia, bronchitis and lung cancer