Ch. 22: The Respiratory System

Explain the microscopic and gross anatomy of the respiratory system.

Identify the pleural cavities, its membranes and the muscles of ventilation.
Respiratory system tasks

1° Functions:
- Gas Transport
- Gas Exchange
  - O₂ and CO₂ via diffusion
- Acid-Base Balance
  \[ \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^- \]

2° Functions:
- Moistening and warming/cooling
- Particulate/pathogen removal

Understand this formula!
Respiratory Epithelium (review ch. 4)

- Histology? Pseudo...
- Mucus produced by numerous goblet cells

Defense by means of
- filtering hairs
- turbinates
- ciliary escalator (mucociliary blanket)
- sticky mucus
Respiratory System starts at the nares

Major Functions

Upper respiratory system:
1. Air conditioning (warming)
2. Defense against pathogens
3. Gas Transport

Lower respiratory system:
1. Speech & other respiratory sounds
2. Gas exchange (ventilation)
3. Maintenance of homeostasis, e.g. pH
Upper Respiratory System

1. Nose
2. Nasal Cavity
3. Paranasal sinuses
4. Pharynx
Upper Respiratory System

1) Nose
   - external and internal **nares** = **Nostrils**
   - Nose Hairs = vibrissae
   - Alar cartilages on the nose
   - Paranasal Sinuses
     - Fig 7.11 p 165
Upper Respiratory System

2. Nasal Cavity

Nasal Conchae:
- Superior, middle and inferior
- Other name: “Turbinate bones” because they create ______
- Advantage ?

• nasal septum
• hard palate, soft palate
Upper Respiratory System

3. Paranasal Sinuses

- Named after their bones
  - Frontal
  - Ethmoid
  - Sphenoid
  - Maxillary

Fig. 7.11, p 165
Upper Respiratory System

4) Pharynx

Shared passageway for respiratory and digestive systems

- **nasopharynx** - part above uvula and posterior to internal nares
- **oropharynx** – portion visible in mirror when mouth is wide open
  - fauces = the opening
  - uvula - posterior edge of soft palate
- **laryngopharynx** – between the hyoid bone & the esophagus
Fig. 22.3
Laryngopharynx

Nasopharynx

Oropharynx

Esophagus

Trachea

(c) Head and Neck, sagittal section
Lower Respiratory System = Anything inferior to the Pharynx

Larynx: Cartilaginous
C₄ - C₇

Made up of 9 cartilages
- 3 large unpaired (know these!) Thyroid, Cricoid, and Epiglottis
- 3 small paired (involved in construction of voice box)
Larynx (AKA voice box)

- Hyoid Bone
- Epiglottis
- Thyroid Cartilage
  - Adam’s Apple
- Cricoid Cartilage
- Vocal Folds

Vocal cord stroboscopy
Larynx, cont’d

- The pitch of sound is from tension of the elastic fibers of the vocal folds
  - Resonance from shape of pharynx and mouth
- The **glottis** is the opening between the vocal folds
- Innervation via laryngeal nerves
  - Branches of CN X
  - Left recurrent laryngeal nerve loops around aorta

[Image: Vocal Folds video]
Trachea (AKA windpipe)

Passageway to lungs

Epithelial Lining?

16-20 incomplete hyaline cartilage rings (C-shaped) - completed by trachealis muscle.

Carina is the site of branching to left and right primary bronchi (AKA tracheal bifurcation)
Tracheal Blockage

Heimlich Maneuver or abdominal thrust

or

Tracheostomy
From Bronchi to Lungs: The Bronchial Tree p 645

- 1° (main) bronchi (enter lungs at hilus, complete cartilage rings)
- 2° bronchi (from now on cartilage plates)
- 3° bronchi
- Bronchioles
- Terminal bronchioles
- Respiratory bronchioles
- Alveolar ducts
- Alveolar sacs

Note: Sympathetic stimulation (epinephrine) causes bronchodilation
Alveoli are site of gas exchange
Close association with capillaries
Lots of elastic fibers in alveolar wall
**Alveoli** *(singular: alveolus)*

**Alveolar cells**
1. Type I cells – respiratory epitheliocytes
2. Type II cells – septal cells – produce surfactant, which prevents collapse of alveoli
3. Alveolar Macrophages – dust cells – phagocytic
SEM of alveoli
Respiratory Membrane

Different from respiratory epithelium

Super thin. Made up of 4 layers:
1. endothelium of capillary
2. basement membrane of capillary endothelium
3. basement membrane of epithelium of alveolus
4. epithelium of alveolus
Chronic progressive enlargement of alveoli accompanied by destruction of their wall and decrease in surface area for exchange due to prolonged exposure to respiratory irritants (??)
Lungs

Situated in Pleural (thoracic, chest) Cavity

Subdivided into lobes (each supplied by 2° bronchus)

Right lung: 3 lobes (rel. broad and short)
Left lung: 2 lobes (long and narrow)

Right and left lung separated by the mediastinum

Lung hilus
(a) Thoracic cavity, anterior view

Right lung (costal surface)

- Superior lobe, right lung
- Horizontal fissure
- Middle lobe, right lung
- Oblique fissure
- Inferior lobe, right lung
- Falciform ligament
- Liver, right lobe

Left lung (costal surface)

- Contact of right and left pleural membranes
- Superior lobe, left lung
- Oblique fissure
- Inferior lobe, left lung
- Fibrous layer of pericardium
- Cut edge of diaphragm
- Liver, left lobe
Pleural Cavities and Membranes

- Two cavities separated by mediastinum
- Lining of cavities
  - Parietal Pleura
  - Visceral Pleura
  - Pleural Cavity
- Pleurisy
- Pneumothorax, (hemothorax, pyothorax, pleural effusion)
Pleural Cavities and Membranes, cont’d

Fig 21.13
Pneumothorax
Ventilation

Inspiration = Inhalation
Expiration = Exhalation
Respiratory Muscles

Neural Control:
- Medulla
- Chemoreceptors (fig. 22.17)
  - Carotid bodies
  - Aortic bodies
Respiratory Muscles

Diaphragm: depresses on contraction ⇒ inhalation

External intercostals: elevate ribs ⇒ inhalation

Internal intercostals: depress ribs ⇒ active exhalation

(Accessory muscles - serratus anterior, scalenes, pectoralis minor, sternocleidomastoid, internal and external obliques, transverse abdominus, rectus abdominus)
(c) Inhalation

(d) Exhalation
Pulmonary Embolism

Causes for development of emboli in veins of legs:

- Immobilization
- Trauma
- Long surgeries
- Oral contraceptives
- Obesity
- Cigarette smoking
- Hypertension