RESPIRATORY SYSTEM
Function of Respiratory System

• Gets air into and out of the body and allows gas exchange
• Conducting portion
  – Nasal cavity, nasopharynx, larynx, trachea, bronchi, bronchioles, terminal bronchioles
  – Warms, moistens air
• Respiratory portion
  – Respiratory bronchioles, alveolar ducts, alveoli
  – Gas exchange occurs
Main Divisions of Respiratory Tract
Layers of Wall

• Mucosa
  – Epithelium
  – Lamina propria (loose CT)
  – Smooth muscle

• Submucosa
  – Dense irregular CT
  – Glands often present

• Adventitia
Respiratory Epithelium

- In the conducting portion:
  - Ciliated columnar cells
  - Mucous goblet cells
  - Brush cells (microvilli)
    - Sensory receptor cells
  - Basal cells
    - Generative stem cells that replace other cells
  - Small granule cell (DNES)
    - Produce biogenic amines (NE, Ep, 5-HT); paracrine cells
Respiratory Epithelium

- Ciliated cell (mucus transport)
- Goblet cell (mucus production)
- Connective tissue
Ciliated Columnar Cells
Surface of Respiratory Mucosa

- Goblet cell
- Ciliated cell
- Brush cell
Small Granule Cell (DNES)

Electron micrograph of a cell of the diffuse neuroendocrine system. Note the accumulation of secretory granules (arrows) in the basal region of the cell. The Golgi complex seen in the upper part of the micrograph shows some secretory granules.
Nasal Passage

Turbinates

Frontal sinus
Nasal bone
Cartilage
Nasal cavity
Lip muscle
Teeth
Tongue
Olfactory bulb
Sphenoidal sinus
Nasopharynx
Pharyngeal tonsil
Nasal Cavity

- **Vestibule (outer nasal area)**
  - Keratinized epithelium transitions to respiratory
  - Short hairs filter

- **Nasal Fossae**
  - Chonchae
    - Respiratory epith (pseudostratified squamous)
    - Swell bodies; extensive venous system for countercurrent flow to warm air.
    - Olfactory epithelium of superior choncha
Nasal Mucosa

E – Epithelium
M – Mucous glands of lamina propria
S – Serous glands of lamina propria
V – Thin walled venules
Olfactory Mucosa

- Supporting cell
- Olfactory cell
- Basal cell
- Bowman’s gland
- Axons
Sinuses
Epithelium Lining of Sinus

Thinner respiratory epithelium that contains few goblet cells.
Respiratory Structures
LARYNX
Trachea

Pseudostratified ciliated cells and mucous (goblet) cells are the two major components of the epithelium. Cilia beat at 1,000 to 1,500 cycle per minute resulting in movement of the mucus blanket at 0.5-1 mm/min in small airways and 5-20 mm/min in the trachea and main bronchi.
Trachea  x40
Trachea

- Goblet cell (viscous mucus)
- Connective tissue
- Serous glands (fluid secretion)
- Perichondrium
- Cartilage
Mucous Glands in Upper Resp Tract
Trachea x10
Trachea  x10
Glands of Trachea  x40
BRONCHIAL TREE

Primary

Secondary

Tertiary
BRONCHIAL TREE

• 1, 2, 3 Bronchi
  – Cartilage plates, glands present, smallest is 5mm, many lymphocytes present

• Bronchioles
  – No cartilage, no glands

• Alveolar Duct

• Alveolar Sac
  – Gas exchange

• Alveolus
HISTOLOGY OF BRONCHIAL TREE

• Cartilage
  – Rings, plates, disappears

Smooth Muscle Layer

Begins in bronchi, more prominent in bronchioles, then disappears

• Epithelium
  – Pseudostratified, Simple columnar, cuboidal, squamous
Bronchus

Cartilage
Bronchus

- Lamina propria
- Respiratory epithelium
- SM
- Serous glands
- Hyaline cartilage
Bronchus

- Respiratory epithelium
- Blood vessel in connective tissue
- Smooth muscle
- Hyaline cartilage
- Serous glands
Bronchioles

- > 5mm diameter
- No cartilage or glands in mucosa
- Epithelium changes from pseudostratified to cuboidal epith., shortening along the way.
- Only scattered goblet cells initially.
- Clara cells secrete protective proteins.
- Lamina propria contains only smooth muscle and elastic fibers.
- Vagus nerve, sympathetic neurons
Bronchiole  x10
Bronchiole  x40
Alveolus, Bronchiole
Location of Gas Exchange
ALVEOLUS AND CAPILLARY

Pulmonary arteriole

Capillary network on surface of alveolus

Blood flow

Pulmonary venule
GAS EXCHANGE

• Respiratory membrane
  – Layers

• Cells present in alveolus
  – Simple squamous epithelium

• Other cells in alveolus
  – Macrophages
  – Surfactant cells
Section of a terminal bronchiole with a small portion of a respiratory bronchiole continuous with an alveolar duct and many alveoli. Low magnification.
Terminal bronchiole

Arteriole

Respiratory bronchiole

Alveolar sac

Alveoli
Diagram of a portion of the bronchial tree. Note that the smooth muscle in the alveolar duct disappears in the alveoli. (Redrawn from Baltisberger.)
Transition of a terminal bronchiole into an alveolar duct (arrow). Note the Clara cells (arrowheads). Medium magnification.
Respiratory Duct With Alveoli
Alveolus
Alveolar Sac
Blood Vessel in Lung
Alveolus with Capillary
Interface between capillary and alveolus
Interface Between Capillary, Alveolus
Alveoli and interalveolar septum showing capillaries and epith. Cells type I and II
Cells Located in Alveolus

- Type I alveolar cells
  - Simple squamous cells
- Type II cells
  - Surfactant
- Macrophages (dust cells)