

Respiratory system - General purpose and structure.

## 1. AIR CONDUCTING PORTION

- a. Nasal cavity
- b. Nasopharynx, larynx
- c. Trachea
- d. Bronchi
- e. Bronchioles
- f. Terminal bronchioles
- g. These provide a passageway to and from lungs
- h. These components also "condition" the inspired air (i.e. moistens, removes particles and some noxious gases, warms air)

## 2. RESPIRATORY PORTION

- a. respiratory bronchioles
- b. alveolar ducts
- c. alveoli used for gas exchange

3. **MUSCULOELASTIC VENTILATION APPARATUS** - muscles, e.g. intercostals and diaphragm, used for moving air in and out of the lungs. This third portion will be dealt with more in your anatomy classes.

4. Our discussions will deal with the first two of the above subdivisions, and more specifically with structures below the larynx.

C. In components of the respiratory tract including the trachea and structures below we find

1. **Epithelium** of various types depending on what part of the tree you're in

2. **Lamina propria**

3. **Elastic fibres**

a. Elastic fibres associated with tissues allows expansion followed by passive contraction.

4. **Smooth muscle**

a. Smooth muscle allows change in diameter of passageway.

5. However, the **presence or absence of the above listed components will differ depending on which specific portion of the respiratory tree we're talking about.**

6. **Hyaline cartilage** is found at the base of the lamina propria in the trachea, primary bronchi, and intrapulmonary bronchi.

a. This hyaline cartilage gives support to respiratory tree.

D. Basic components of the respiratory tree

### 1. Trachea and primary bronchi

a. Mucosal epithelium - the majority of the cells form a **pseudostratified, columnar, ciliated epithelium**

b. Interspersed among the columnar, ciliated epithelial cells are,

\* **Goblet cells** (mucus secreting) are interspersed among the more numerous columnar ciliated cells

\* **Brush cells** apical microvilli (may be immature goblet cells)

\* **Basal cells** - possibly stem cells that will divided to provide replacements for dead or lost cells of the epithelium.

b. **Lamina propria** contains many **lymphocytes** that are supported by a **meshwork of elastic and reticular fibres**.

c. A band of elastic fibres called the **membrane elastica** interna separates the mucosa from the sub mucosa.

d. The **submucosa** is composed of loose connective tissue and contains the secretory components of **serous and mucous glands** whose ducts empty into the tracheal lumen.

e. The **adventitia** is the most prominent tissue layer

\* dense connective tissue

\* **C-shaped rings of hyaline cartilage**

\* **Trachealis muscle** (smooth muscle) fills the intervals between the cartilage rings.

\* The cartilage and muscle make the trachea a very rigid structure.

### 2. Intrapulmonary bronchi (also called **secondary bronchi**)

a. **3 in right lung, 2 in left lung.**

\* These intrapulmonary bronchi each extend into a pulmonary lobe of the lung and thus are sometimes called **lobar bronchi**.

\* These and subsequent bronchi undergo repeated branching culminating in the formation of bronchioles.

b. Large intrapulmonary bronchi are histologically similar to the trachea and primary bronchi.

c. **Differences in the histology develop as the bronchi become smaller.**

\* Cartilage rings are reduced to irregular plates of cartilage.

\* A band of circular smooth muscle develops.

\* Goblet cells in the epithelium become less numerous.

\* Epithelium becomes reduced in height and simple columnar with less cilia.  
d. **Lymphatic nodules may be present in lamina propria**, particularly at branching points.

3. **Bronchioles** - diameter 1 mm or less

a. Major characteristics

\* **Bronchioles lack cartilage**

\* Smooth muscle layer is relatively thicker.

\* Many non-ciliated **Clara cells** are present in epithelium.

\* **Epithelium in simple columnar with fewer cilia.**

\* **No glands in lamina propria**

b. 4 types of bronchioles

\* **Large bronchioles** - branch repeatedly, final branches are the terminal bronchioles

\* **Terminal bronchioles** - form connection between large bronchioles and respiratory bronchioles

\*\* **Epithelium becomes simple cuboidal**

\* **Respiratory bronchioles** - form connection between terminal bronchioles and alveolar ducts

\*\* This is the transitional structure connecting the conducting zone to the respiratory zone.

\*\* Alveoli open into this structure along its length

\*\* Clara cells become abundant

\* **Alveolar ducts** - connect directly to alveoli

\*\* Walls of the ducts consist entirely of alveolar openings.

\*\* epithelium is flat (squamous) called **alveolar epithelium**

\*\* Duct terminates in a cluster of alveoli that share a common, dilated chamber - called an **alveolar sac**.

## II. Respiratory system - Cellular histology

### A. THE COLUMNAR RESPIRATORY EPITHELIUM EXHIBITS PLASTICITY.

Interesting to note that changes in air flow may result in new abrasive sites on the epithelium. The pseudostratified epithelium will respond to this by changing into stratified squamous epithelium. Other changes can also occur (see below).

1. For those of you that smoke, this means that the pseudostratified epithelium of your respiratory tract has a greater number of goblet cells than normal in order to provide additional mucous to clear your airway of particulates in the cigarette smoke.
2. Unfortunately, as a result, there are fewer ciliated cells so the mucus does not move as rapidly as it should (smoking also has a detrimental effect on the cilia).
3. Portions of your respiratory epithelium will change from pseudostratified columnar to stratified squamous. This also reduces the number of cilia, as well as the area of ciliation.
4. This causes your lungs to be more prone to congestion, i.e. the bronchioles are more likely to be clogged with mucus.
5. The increased mucus also reduces the diameter of the air passages smaller making your lungs less efficient.
6. As a result, respiratory problems like colds and hay fever cause smokers more problems than if they didn't smoke.
7. If you quit smoking, the damage is reversible because the respiratory epithelium can regenerate.

## B. SEVEN TYPES OF CELLS FOUND IN RESPIRATORY EPITHELIUM.

### 1. **Goblet cells**

- a. Mucus secretion.
- b. Plentiful in portions of respiratory tree above the smaller bronchi.
- c. Function - mucus collects particulate matter and absorbs some noxious gases.

### 2. **Ciliated columnar cells**

- a. In components above the smaller respiratory bronchioles
- b. 300 cilia/cell. move mucus back toward oral area
- c. Function - to move inhaled debris trapped in mucous out of respiratory tract.

### 3. **Columnar brush cells**

- a. Numerous microvilli on surface
- b. Some have dendritic synapses on basal surface
- c. Function - thought to be sensory.

### 4. **Basal (short) cells**

- a. Small basal cells on basal lamina that do not extend to surface of epithelium.
- b. Function - thought to be stem cells for other cell types.

### 5. **Small granule cells**

- a. Look like basal cell, but have granules in cytoplasm.

b. Function - thought to be APUD cells that secrete hormones.

## 6. Clara cells

a. Secretory cell ultrastructure

b. Function - possibly secrete surfactants that decrease surface tension of fluid that moistens the surface of lung epithelia.

7. **Alveolar cells - Type I** (see below)

8. **Alveolar cells - type II** (see below)

## III. The alveolus

A. The alveoli are lined by an **exceedingly thin, simple squamous epithelium**.

B. Between the epithelia of adjacent alveoli are

1. The endothelial lining of capillaries - continuous, non-fenestrated endothelium.

2. Basal laminae of epithelium of alveolar type I cells and capillary endothelial cells that are fused at some points.

3. Smooth muscle

4. Fibroblasts

5. Elastic and reticular fibres

6. Pores between adjacent alveoli

C. Cells of the alveolar wall

### 1. **Alveolar type I squamous epithelial cells**

a. Presumably the cells across which gaseous transfer occurs, possibly at the sites of fusion between this cell's basal lamina and that of the capillary endothelial cells.

b. Compose about 40% of the alveolar cells, but cover about 95% of the alveolar surface area.

### 2. **Alveolar type II cells (also called septal cells).**

a. These are roughly cuboidal with many microvilli on their free surface

b. Thought to synthesize a phospholipid, tripalmitin lecithin that acts as a **surfactant**, i.e. it reduces surface tension across the squamous epithelium of the alveoli and thus reduces the force needed to inflate the lungs.

3. Also find alveolar macrophages called dust cells - usually free in the alveolar lumen.

a. These cells act to clean fine inhaled debris from the alveolar free surface of cells by endocytosing particles.

b. They are critical to lung function. Deficiency in function increases the incidence and seriousness of lung disorders.

D. The **blood-air barrier**.

1. This refers to the cellular structures that lie between the air in the alveolar sacs and the blood in the capillaries.

a. Starting in the alveolar lumen this barrier consists of,

\* **Surfactant**

\* **Mostly type I alveolar cells** lining the alveolus

\* **Basal lamina** of both alveolar cells and capillary endothelial cells (fused in some areas)

\* **Non-fenestrated (continuous) endothelium** of capillary

\* In areas where basal lamina of the two endothelial layers are not fused, **reticular and elastic fibres** are present.

b. The blood-air barrier prevents air in gaseous form from mixing with the blood.

c. In certain situations, the blood air barrier may be broken

\* Called an embolism.

\* Can result in the release of gaseous oxygen into the blood circulatory system