

# **Histology**

## **THE RESPIRATORY SYSTEM**

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The respiratory system includes the **lungs** and a branching system of tubes that link the sites of gas exchange with the external environment. The respiratory system is composed of the:

**conducting portion** a series of passageways that filter, condition, and deliver the air to the gas exchange surface.

**Respiratory portion** the lung tissues in which actual gas exchange takes place.

The respiratory system also plays a role in

- Air conduction
- Air filtration
- Gas exchange (respiration)
- Speech
- Sense of smell : olfaction
- Endocrine functions : minor hormone production

## **Division of the respiratory system**

### **Conducting portion**

- Nasal cavities
- Nasopharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles
- Terminal bronchioles

### **Respiratory portion**

- Respiratory bronchioles
- Alveolar ducts
- Alveolar sacs
- Alveoli

The respiratory system consists of four main layers:

**1- Mucosa** ( epithelium , lamina propria)

**2- Submucosa**

**3- Cartilage and/or muscle layer**

**4- Adventitia / serosa**

Most of the conducting portion is lined with **ciliated pseudostratified columnar epithelium** known as **respiratory epithelium**. This epithelium has at least five cell types, all of which touch the thick basement membrane:

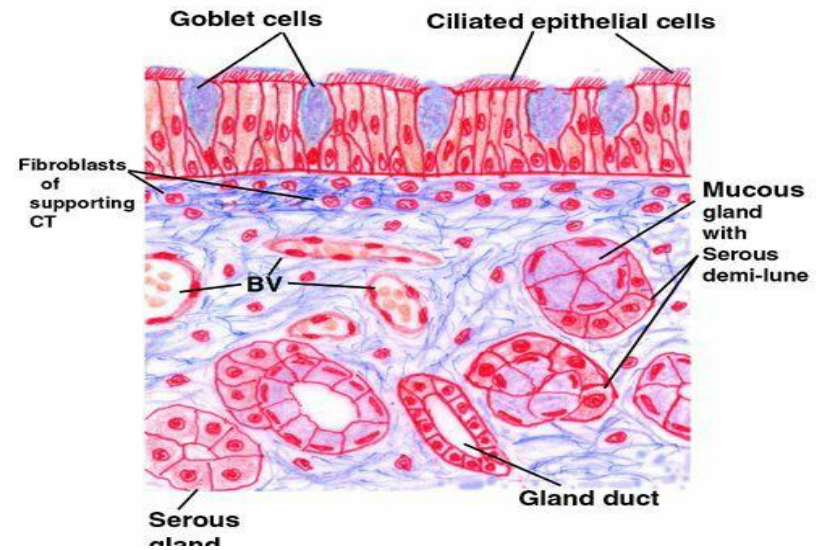
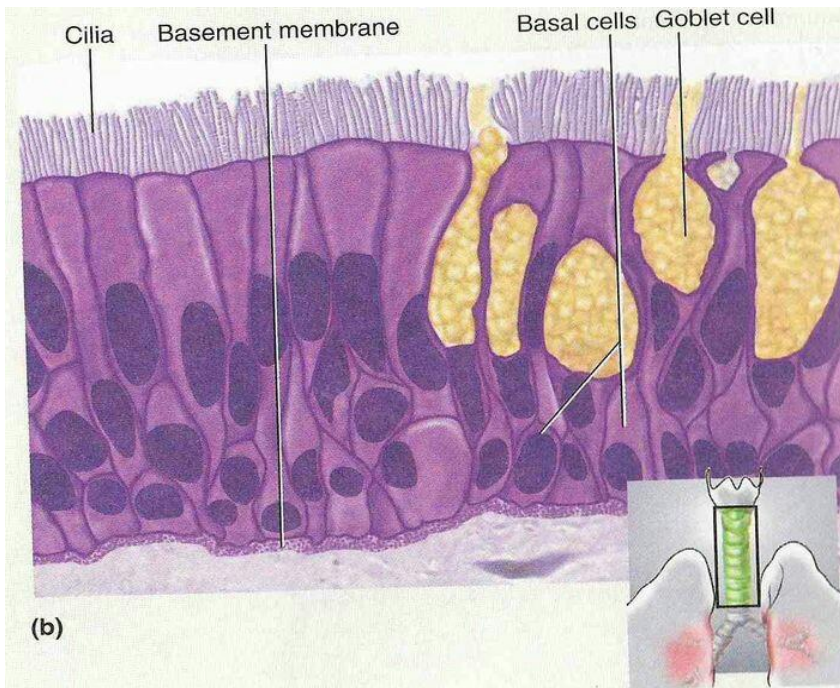
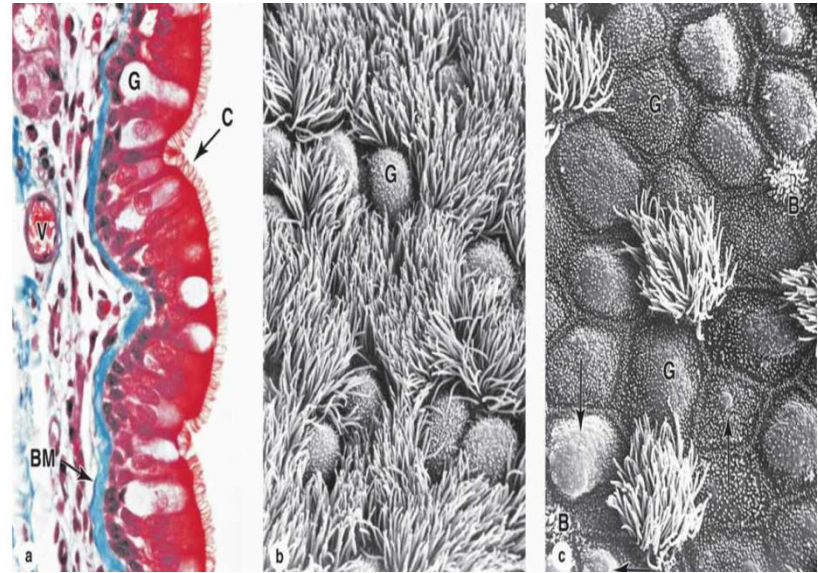
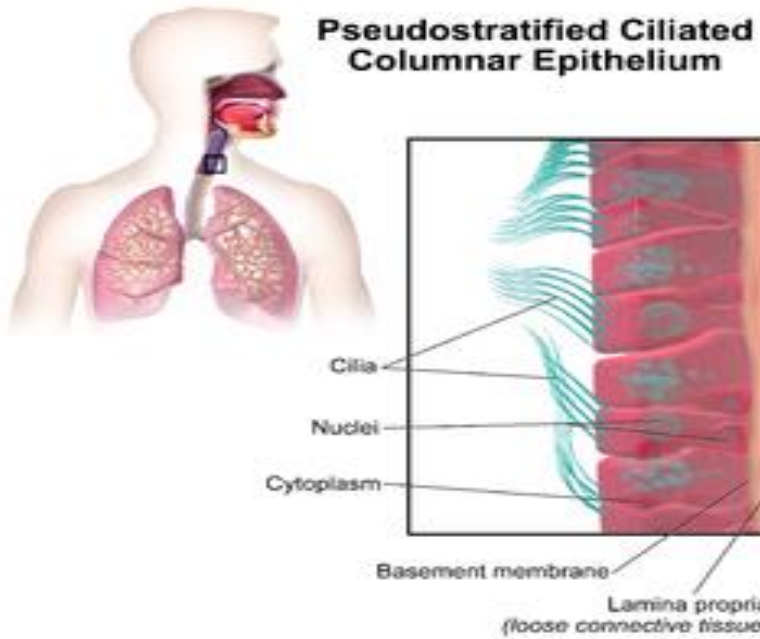
**1- Ciliated columnar cells** : are the most abundant , columnar cell have cilia on its apical surface .

**2- Goblet cells** are also abundant in some areas of the respiratory epithelium , filled in their apical portions with granules of mucin glycoproteins.

**3- Brush cells** are a much more sparsely scattered , columnar cell type, which has a small apical surface bearing a tuft of many short, blunt microvilli.

**4- Small granule cells** are possess numerous dense core granules. Like brush cells, are part of the diffuse neuroendocrine system.

**5- Basal cells**: small rounded cells on the basement membrane and not extending to the luminal surface, are stem cells that give rise to the other cell types.



- **NASAL CAVITIES**

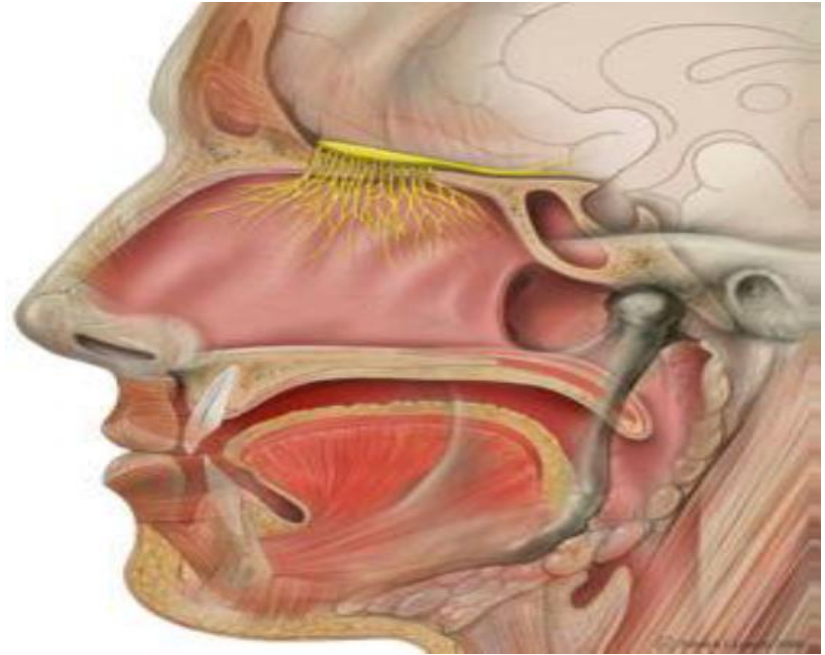
- Structure

- ■ Vestibule
- ■ Respiratory segment (RS)
- ■ Olfactory segment

- Function of RS -

- conditioning of the air

- ■ warming
- ■ moistening
- ■ removal of particulate matter





## NASAL CAVITY

The left and right nasal cavity each has two components: the external **vestibule** and the internal **nasal cavity**.

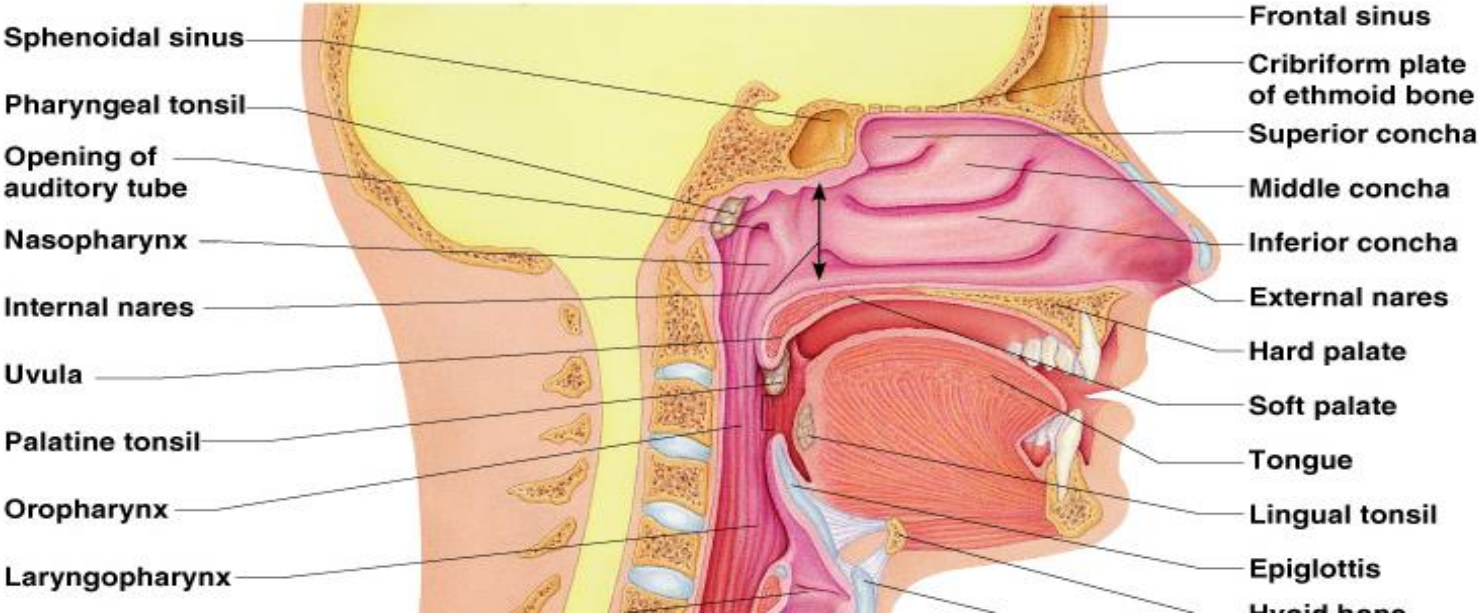
The **vestibule** is the most anterior and dilated portion of each nasal cavity, are lined with a **keratinised stratified squamous epithelium** and has sweat glands, sebaceous glands, and short coarse **vibrissae** (hairs) that filter out particulate material from the inspired air.

Within the vestibule, the epithelium loses its keratinized nature and undergoes a transition to typical pseudostratified columnar epithelium before entering the nasal cavities.

The **nasal cavities** lie within the skull as two cavernous chambers separated by the osseous nasal septum. Extending from each lateral wall are three bony shelf like projections called **conchae**.

The middle and inferior conchae are covered with **respiratory epithelium**; the superior conchae are covered with a specialized **Olfactory epithelium**.

The narrow passages between the conchae improve the conditioning of the inspired air by increasing the surface area of moist, warm respiratory epithelium and by slowing and increasing turbulence in the airflow.





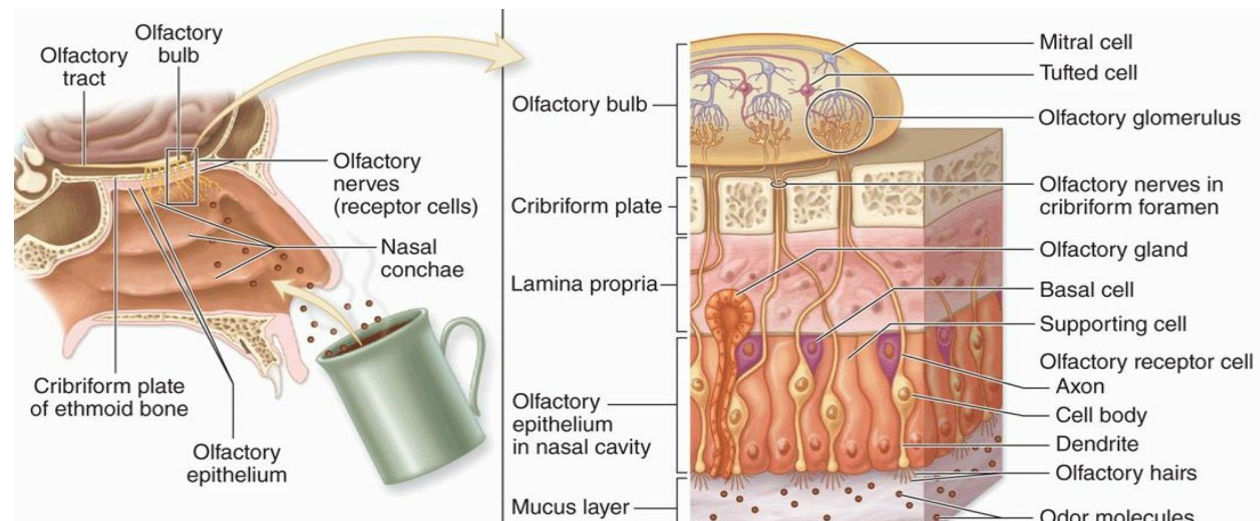
**Olfactory epithelium.** The olfactory chemoreceptors for the sense of smell are located in the olfactory epithelium, a specialized region of the mucous membrane covering the superior conchae at the roof of the nasal cavity. It is a pseudostratified columnar epithelium composed of three types of cells

**1- Basal cells** are small, spherical or cone-shaped and form a layer at the basal lamina. They are the stem cells for the other two types.

**2- Supporting cells** are columnar, with broad cylindrical apexes and narrower bases. On their free surface are microvilli submerged in a fluid layer.

**3- Olfactory neurons** are bipolar neurons present throughout this epithelium. The dendrite end of each olfactory neuron is the apical (luminal) pole of the cell.

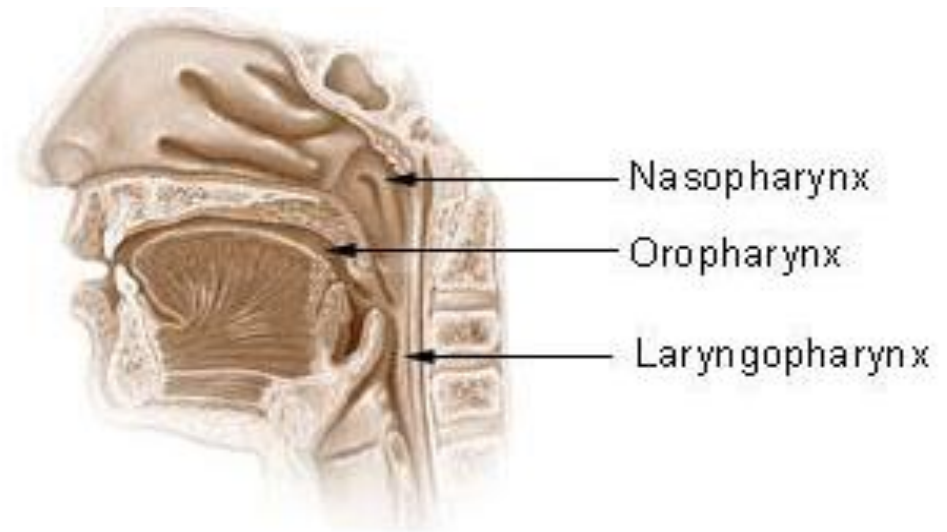
The lamina propria of the olfactory epithelium possesses large **serous glands (glands of Bowman)** which produce a flow of fluid surrounding the olfactory cilia and facilitating the access of new odoriferous substances.



## NASOPHARYNX

The nasal cavities open posteriorly into the nasopharynx, which is the first part of the pharynx and continuous caudally with the oropharynx, the posterior part of the oral cavity leading to the larynx. It is lined with stratified squamous epithelium.

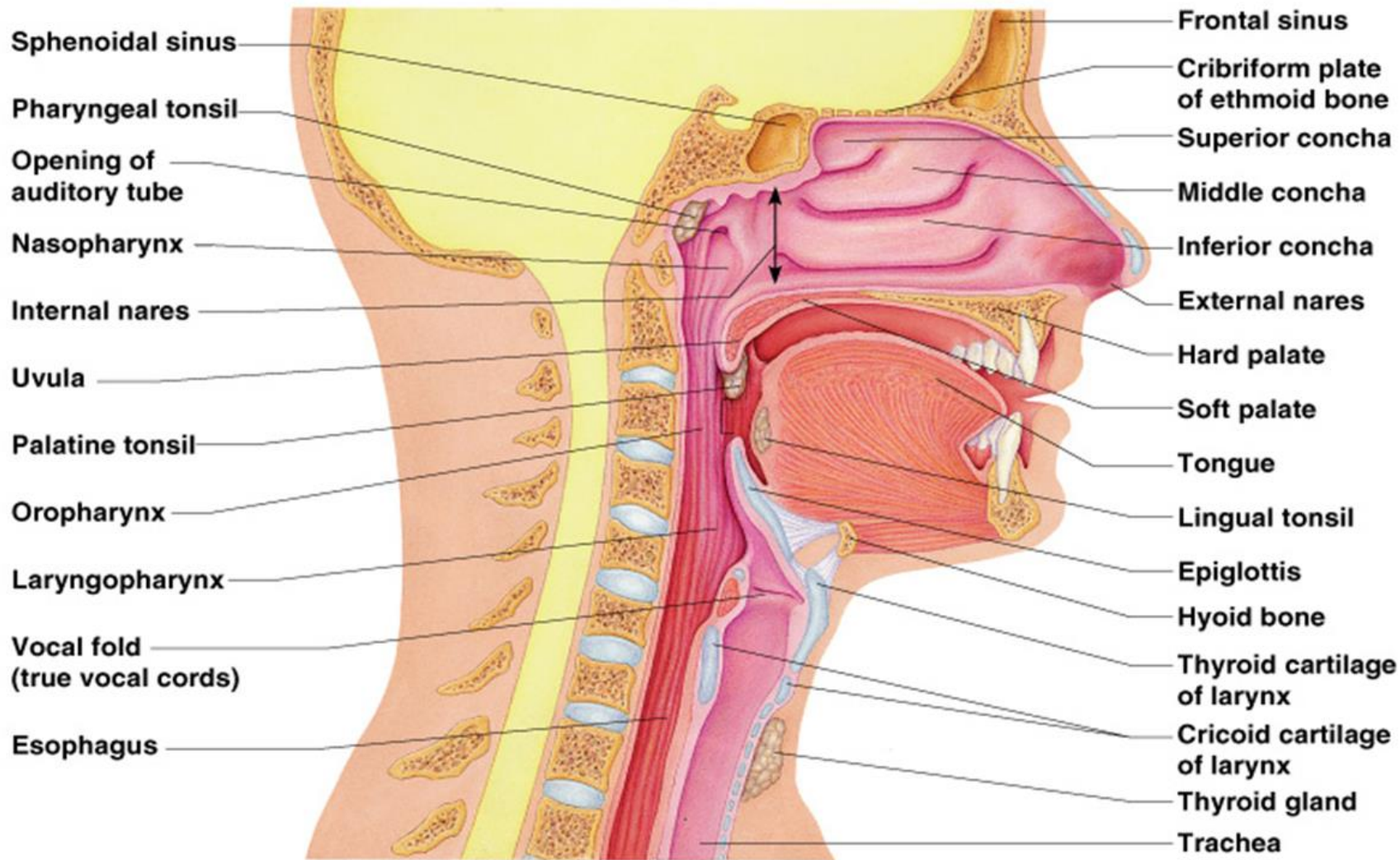
The nasopharynx is lined with respiratory epithelium, and its mucosa contains the medial pharyngeal tonsil.



# LARYNX

The larynx is a rigid, short passage for air between the pharynx and the trachea . Its wall is reinforced by **hyaline cartilage** in the (thyroid, cricoid) and smaller elastic cartilages (in the epiglottis, cuneiform, corniculate) all connected by **ligaments**.

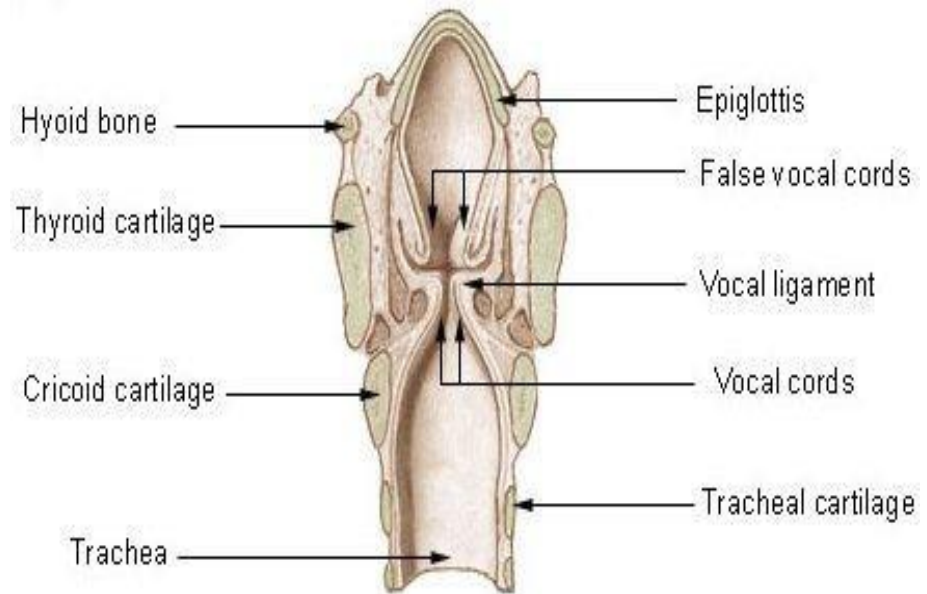
**The epiglottis**, which projects from the upper rim of the larynx, extends into the pharynx and has **lingual** and **laryngeal** surfaces. The entire lingual surface and the apical portion of the laryngeal surface are covered with **stratified squamous epithelium**. At variable points on the laryngeal surface of the epiglottis the epithelium undergoes a transition to **ciliated pseudostratified columnar epithelium**.



Below the epiglottis, the mucosa of the larynx extends two pairs of folds bilaterally into the lumen .

The upper pair, the **vestibular folds or false vocal cords**, is covered with **typical respiratory epithelium** beneath which lie numerous seromucous glands.

The lower pair of folds constitutes the **vocal cords**. These are covered with **stratified squamous epithelium** and contain bundles of parallel elastic fibers (**vocal ligament**) and large bundles of striated **vocalis muscles**.



**the vocal cords have features important for phonation or sound production:**

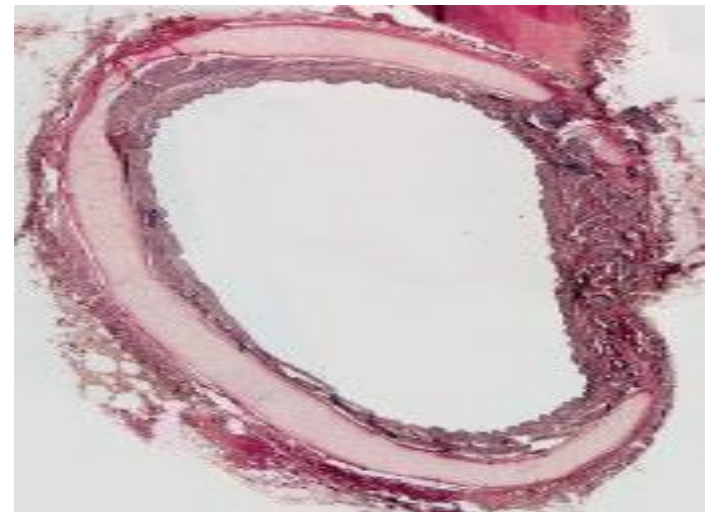
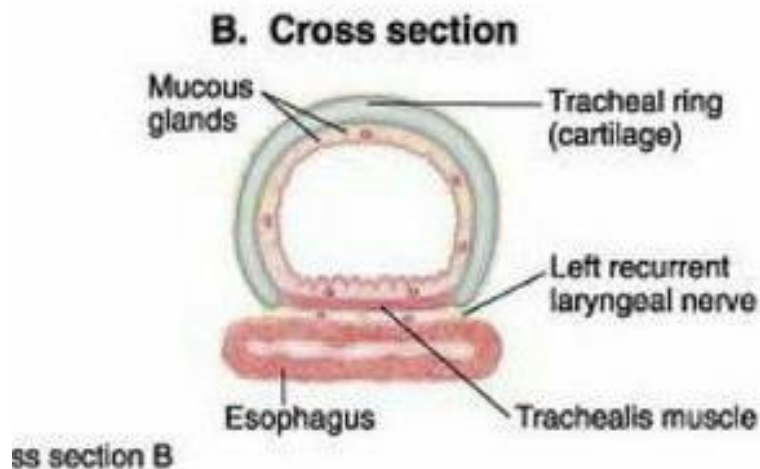
- **They are covered with stratified squamous epithelium that protects the mucosa from abrasion and desiccation from rapid air movement.**
- **A dense regular bundle of elastic connective tissue the vocal ligament supports the free edge of each vocal fold.**
- **Deep to the mucosa of each vocal fold are large bundles of striated fibers that comprise the **vocalis muscle**.**



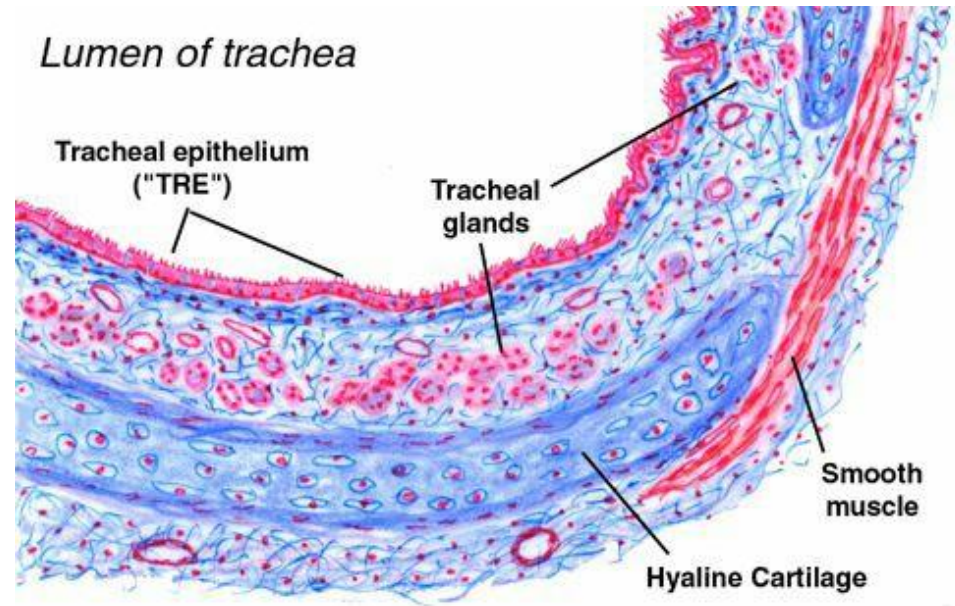
# TRACHEA

The trachea is a long flexible, tubular airway lined with a typical **respiratory epithelium** . In the **lamina propria** numerous **seromucous glands** produce watery mucus. A series with about **a dozen C-shaped rings of hyaline cartilage** in the **submucosa** reinforces the wall and keeps the tracheal lumen open.

The open ends of the cartilage rings are on the posterior surface, against the esophagus, and are bridged by a bundle of **smooth muscle (trachealis muscle)** and a sheet of **fibroelastic tissue** attached to the perichondrium.

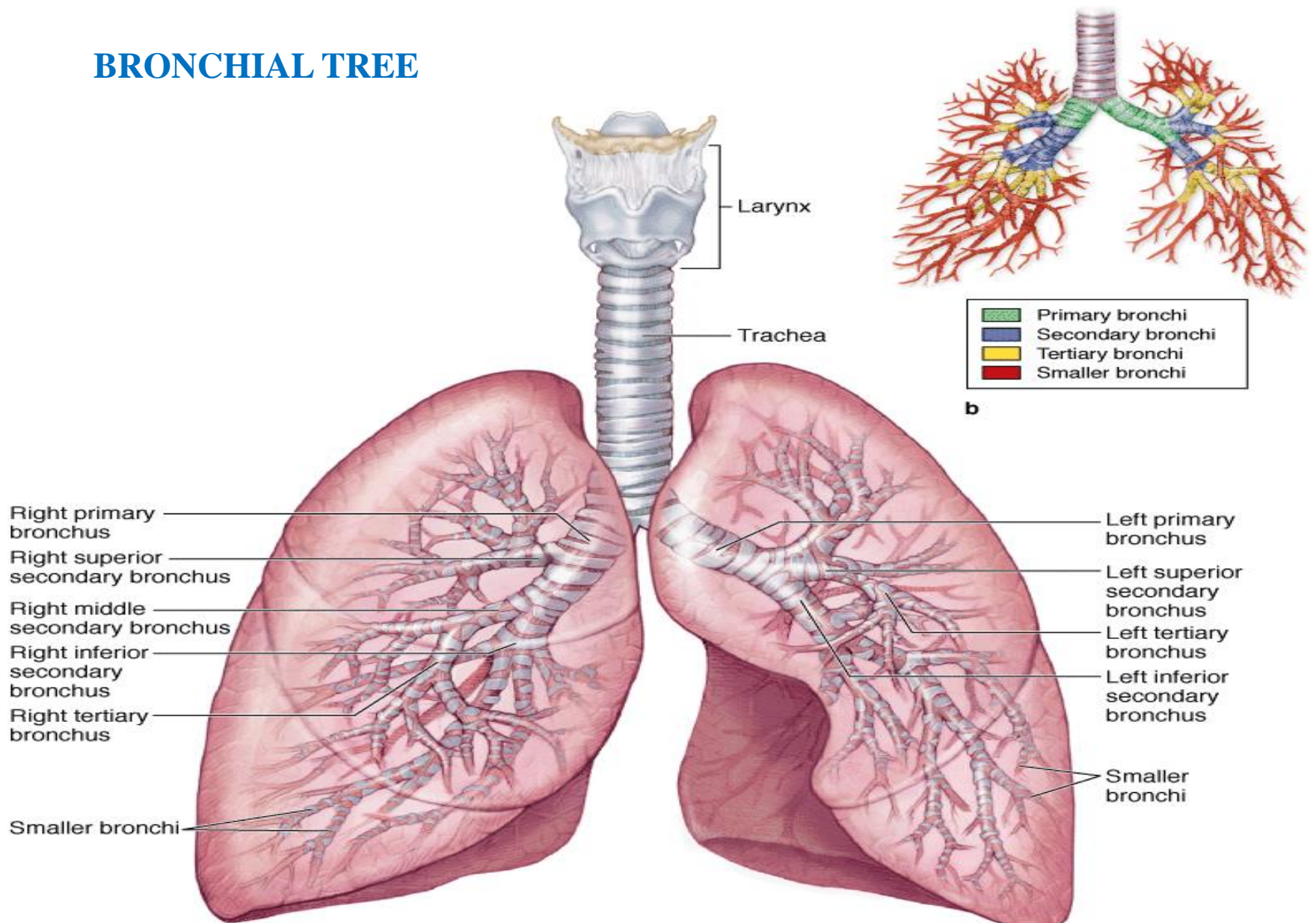


- **Mucosa** Line the tracheal lumen :
  - respiratory epithelium
  - lamina propria : connective tissue
  - **no muscular muscle** .



- **Submucosa** : Loose to dense connective tissue
  - glands
  - hyaline cartilage – C-shape
- **Adventitia** Connective tissue Secure trachea to surrounding structures, carry bigger vessels and nerves.

# BRONCHIAL TREE





## Bronchi

The mucosa of the larger bronchi is structurally similar to the tracheal mucosa except for the organization of **cartilage** and **smooth muscle**. In the **bronchial lamina propria** is a layer of crisscrossing bundles of spirally arranged smooth muscle, which become more prominent in the smaller bronchial branches.

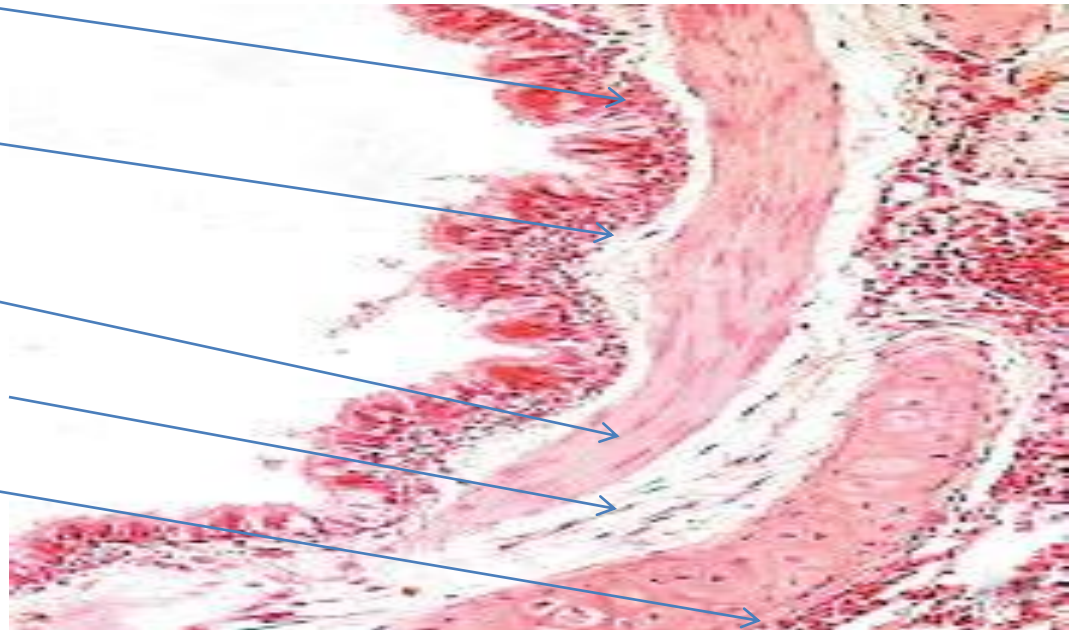
respiratory epithelium

lamina propria

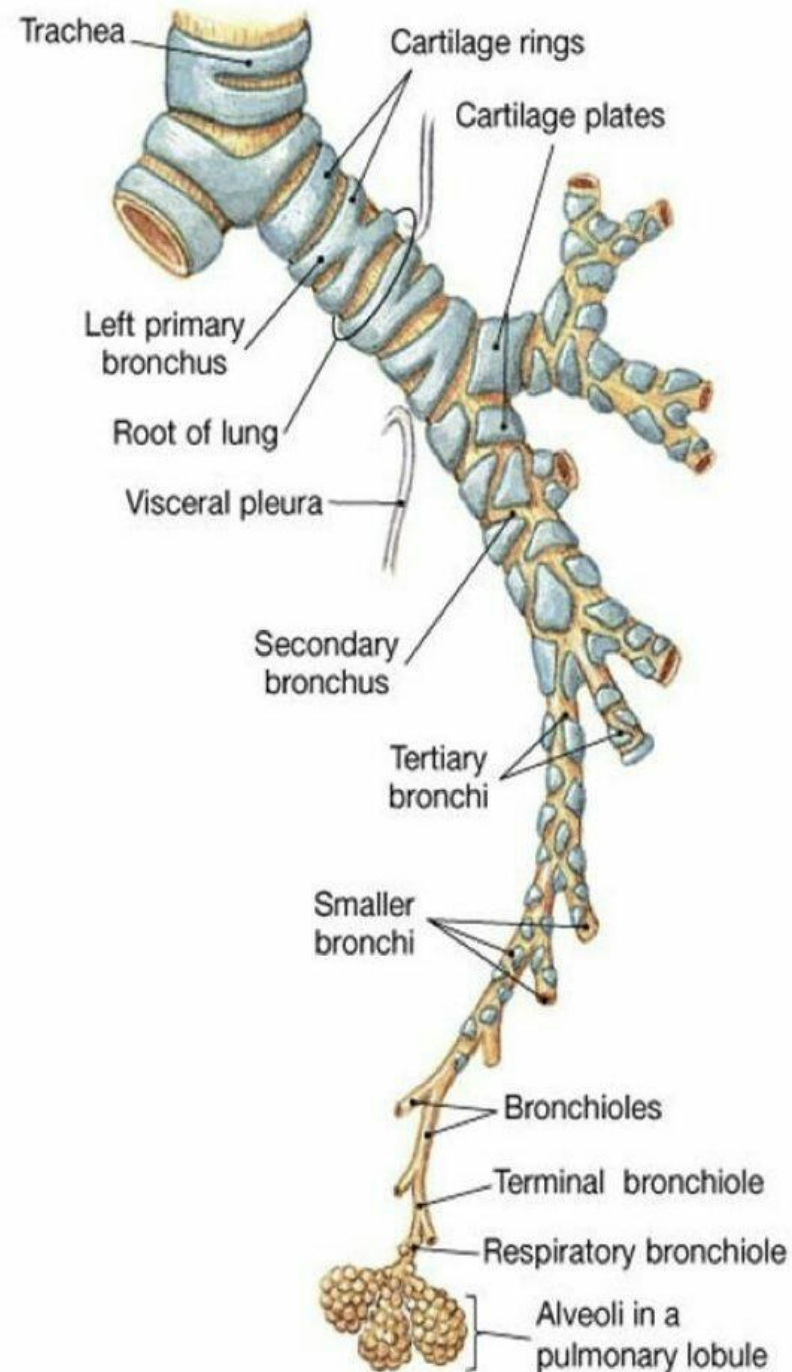
smooth muscle

submucosa

cartilage layer



In the **primary bronchi** most **cartilage rings** completely encircle the lumen, but as the bronchial diameter decreases, **cartilage rings** are gradually replaced with **isolated plates of hyaline cartilage**.



# Bronchi

**1. Mucosa :** Respiratory epithelium.

**Lamina propria :**

is a layer of crisscrossing bundles of spirally arranged smooth muscle which become more prominent in the smaller bronchial branches. Goblet cell present .

**Smooth muscle layer :** Regulate diameter of the airway

**2. Submucosa :** Loose connective tissue.

**3. Cartilage layer:** Hyaline cartilage ranging from complete rings in primary bronchi to small plates or bars in terminal bronchi.

**4. Adventitia:** Loose to dense connective tissue .



# Bronchioles

The tertiary bronchi branch into the **bronchioles**. These are histologically distinct from the tertiary bronchi in that their walls, they lack both **mucosal glands and cartilage**. In the larger bronchioles, the epithelium is still **ciliated pseudostratified columnar**, but this decreases in height and complexity to become **ciliated simple columnar** or **simple cuboidal epithelium**

## 1. Luminal epithelium

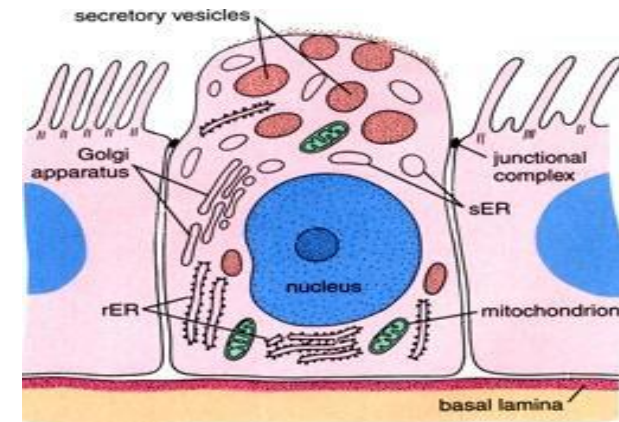
a. Respiratory epithelium

b. Ciliated simple columnar epithelium

c. Clara cells non ciliated cuboidal cells with dome-like apical ends with secretory Granules.

2. Smooth muscle layer , no gland and cartilage

3. Adventitia .



**Clara cells have various functions, including the following:**

- Secretion of surfactant lipoproteins and mucins in the fluid layer on the epithelial surface.**
- Detoxification of inhaled xenobiotic compounds by enzymes of the SER.**
- Secretion of antimicrobial peptides and cytokines for local immune defense.**

## **Terminal bronchioles**

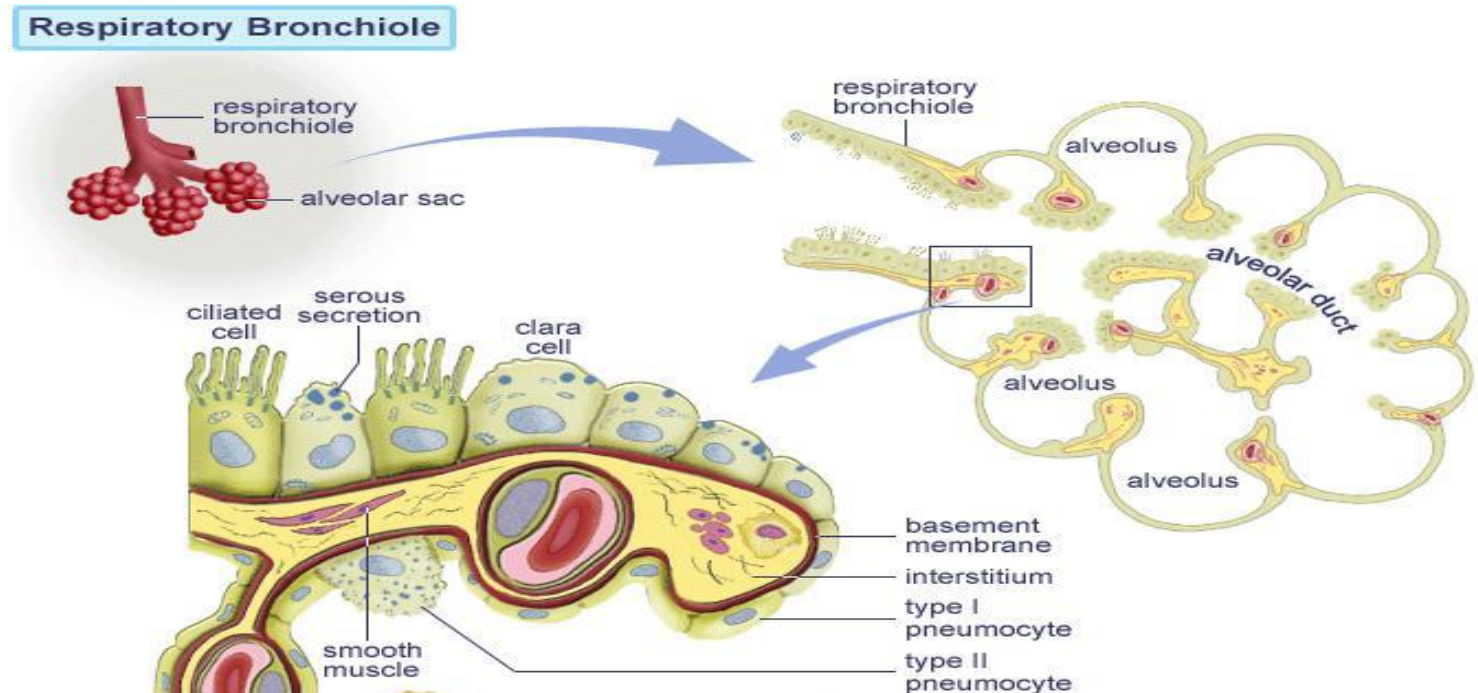
- 1. Simple cuboidal epithelium and Clara cells. no goblet cells**
- 2. Smooth muscle layer. no glands and cartilage**
- 3. Adventitia.**

## Respiratory bronchioles

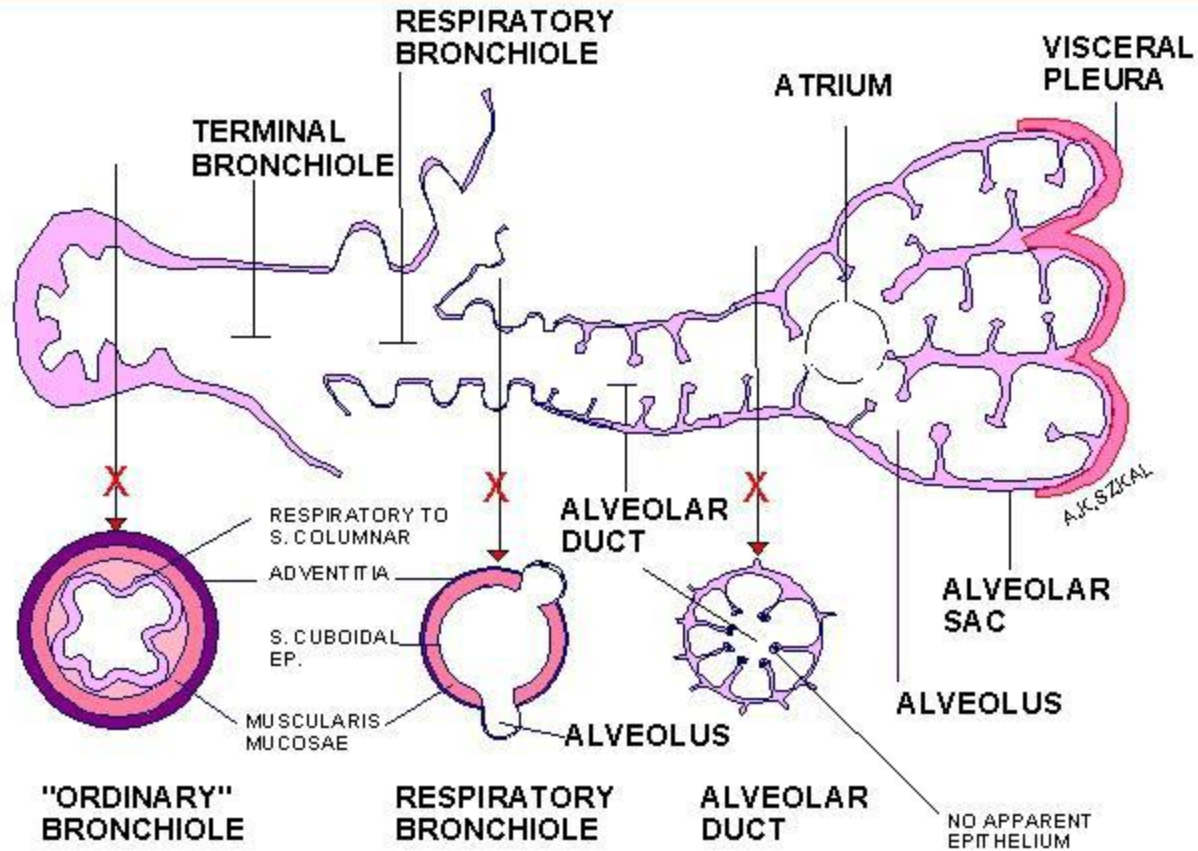
is a regions of transition between the conducting and respiratory portions of the respiratory system , which lead to alveolar ducts , alveolar sacs and alveoli.

1. **Ciliated simple cuboidal epithelium** containing **Clara cells** supported by **smooth muscle** and **elastic fibres** .

2. Several alveoli: directly arise from the bronchiole.



# HISTOLOGY OF BRONCHIOLES



## **Alveolar Ducts**

**Distal ends of respiratory bronchioles branch into tubes called alveolar ducts that are completely lined by the openings of alveoli. Both the alveolar ducts and the alveoli themselves are lined with squamous cells.**

**In the thin lamina propria, a strand of smooth muscle cells surrounds each alveolar opening and a matrix of elastic and collagen fibers supports both the duct and its alveoli.**

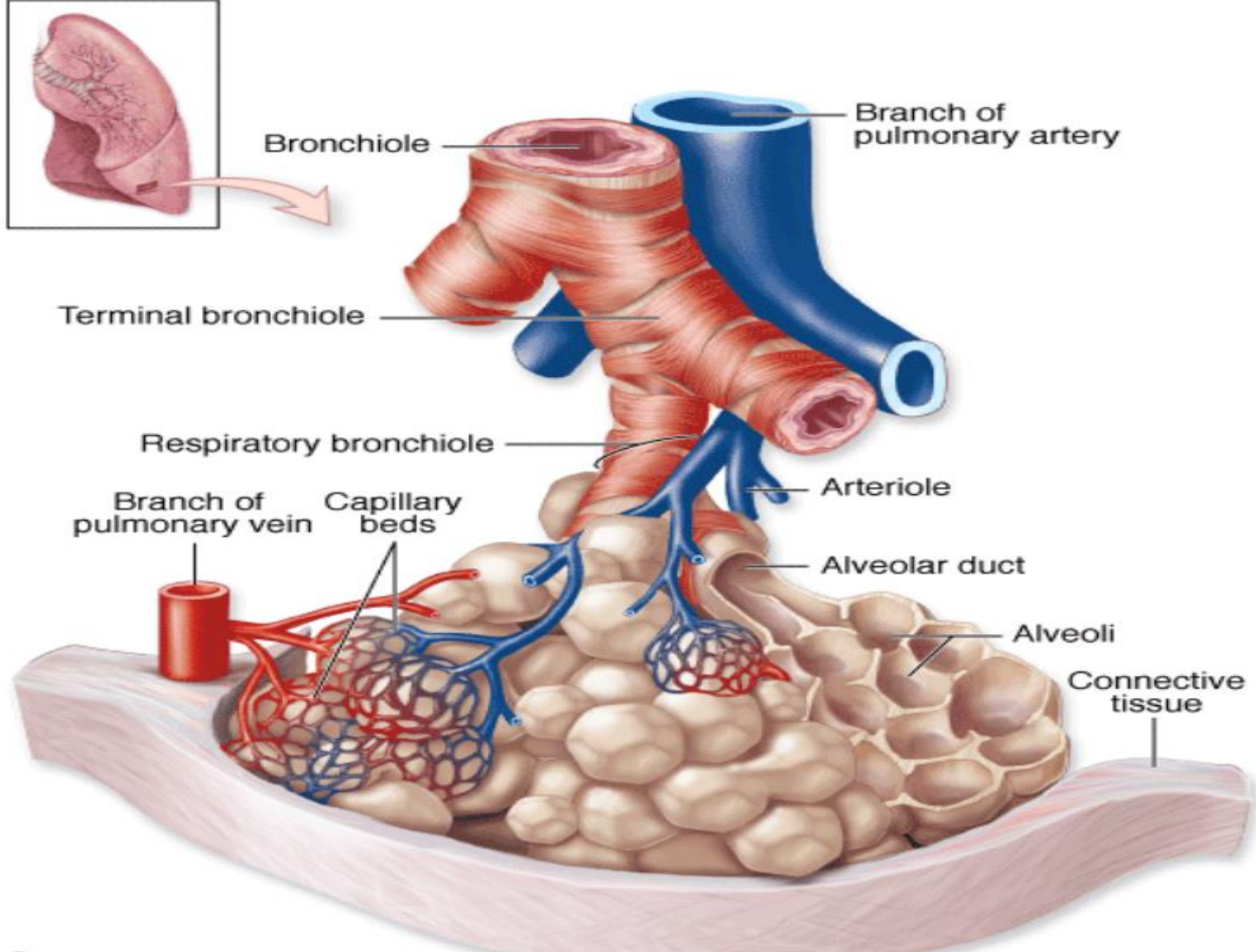
**Larger clusters of alveoli called alveolar sacs. The lamina propria is thin consisting essentially of a network of elastic and reticular fibers that encircles the alveolar openings and closely surrounds each alveolus. Network of capillaries also surrounds each alveolus.**

## **Alveoli**

**Alveoli are responsible for the spongy structure of the lungs. The structure of alveolar walls is specialized to enhance diffusion between the external and internal environments. Between neighboring alveoli lie thin inter alveolar septa consisting of elastic and reticular fibers of connective tissue.**

**The arrangement of elastic fibers enables alveoli to expand with inspiration and contract passively with expiration; reticular fibers prevent both collapse and excessive distention of alveoli.**

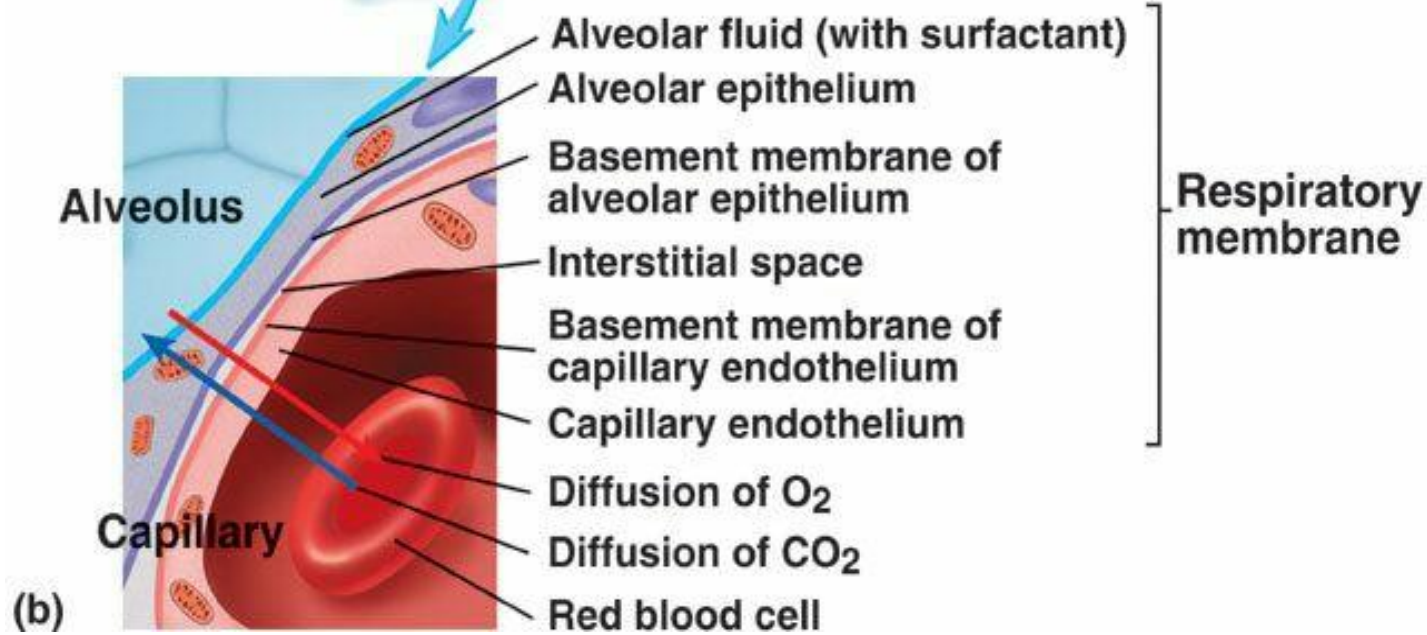
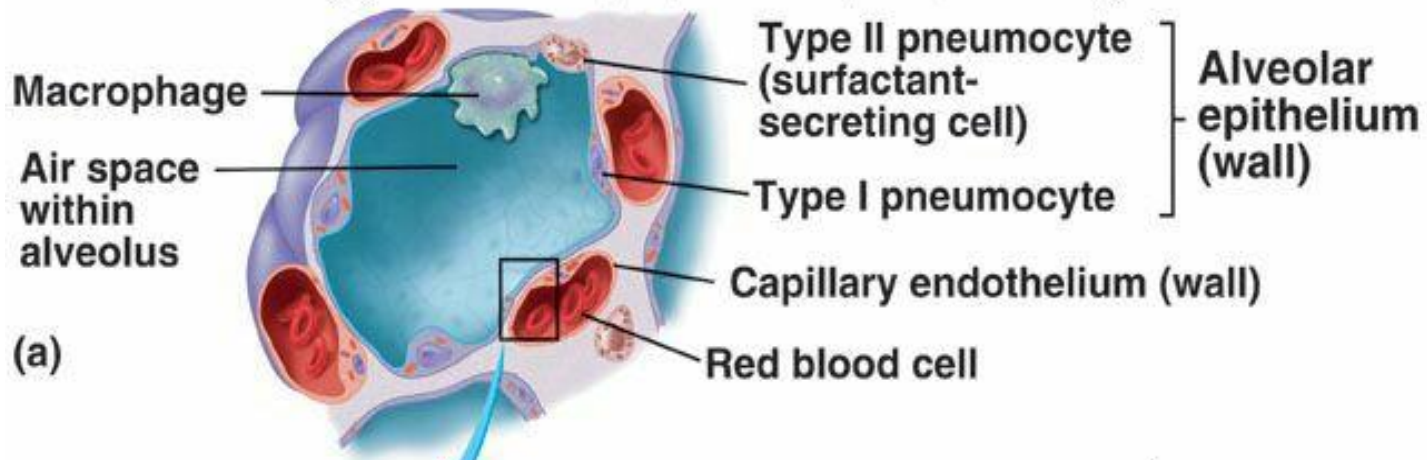




## INTER-ALVEOLAR SEPTUM (Septal wall)

**1- Type I alveolar cells** (also called type I pneumocytes or squamous alveolar cells) are line the alveolar, large flattened cells (95% of the total alveolar) which present a very thin diffusion barrier for gases. They are connected to each other by tight junctions.

**2- Type II alveolar cells:** type II pneumocytes are interspersed among the type I alveolar cells , (making up 5% of the total alveolar area) These cells secrete 'surfactant' which decreases the surface tension between the thin alveolar walls, and stops alveoli collapsing when you breathe out.

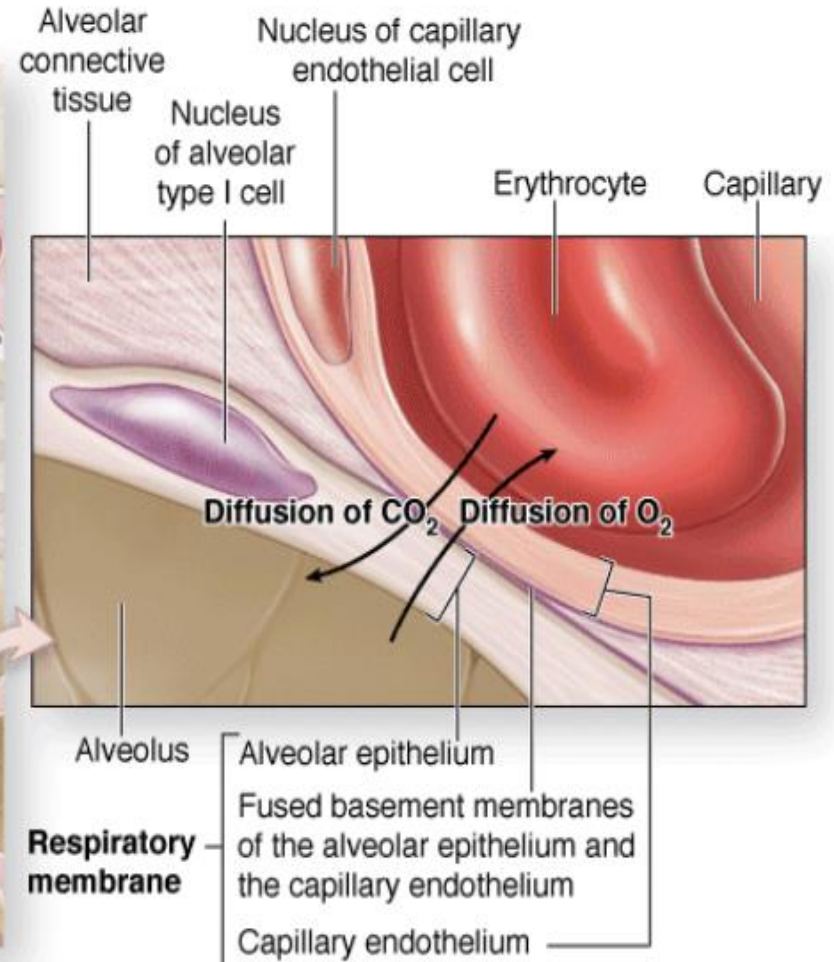
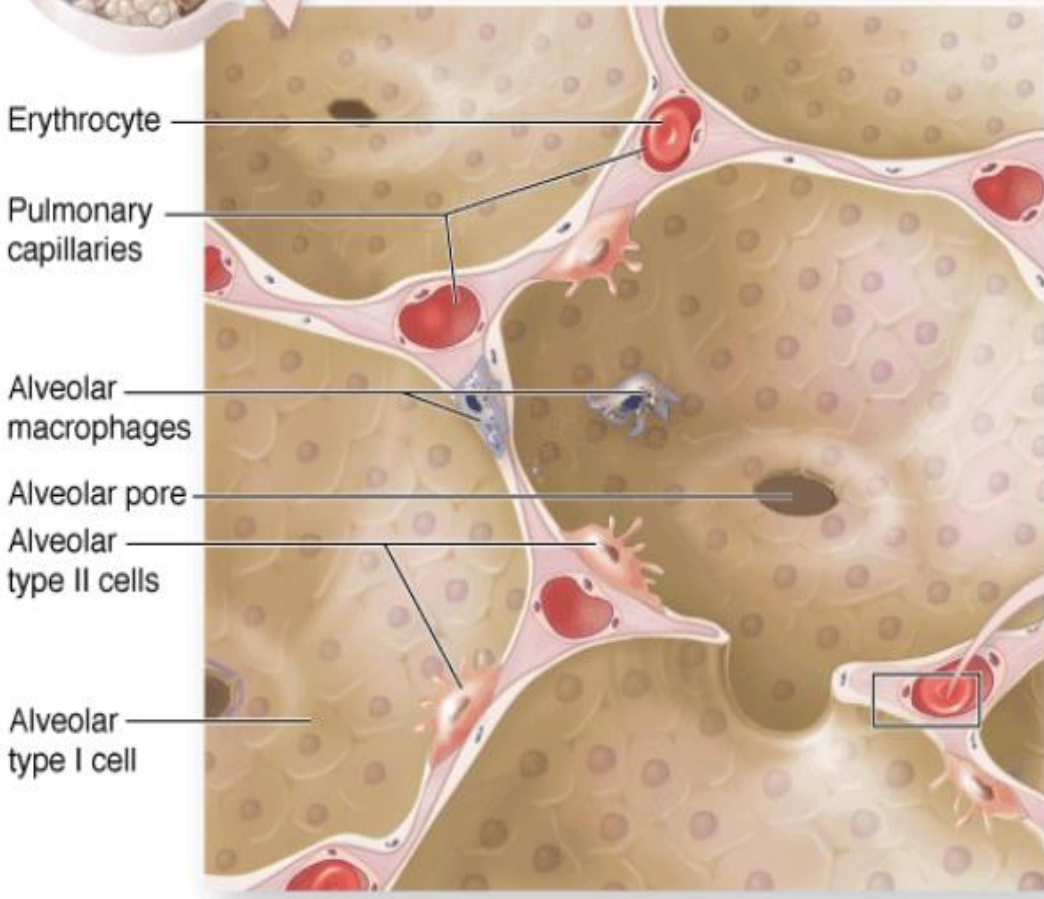


**Air in the alveoli is separated from capillary blood by three components referred to collectively as the **respiratory membrane or blood-air barrier:****

- Surface lining and cytoplasm of the alveolar cells (type I pneumocytes and type II pneumocytes ).**
- The fused basal laminae of these cells and capillary endothelial cells.**
- Cytoplasm of the endothelial cells.**



The structure of alveolar walls is specialized to enhance diffusion between the external and internal environments.



## PLEURAL MEMBRANES

The lung's outer surface and the internal wall of the thoracic cavity are covered by a serous membrane called the pleura. **The membrane attached to lung tissue is called the visceral pleura and the membrane lining the thoracic walls is the parietal pleura.** The two layers are continuous at the hilum and are both composed of **simple squamous mesothelial cells** on a thin connective tissue layer containing collagen and elastic fibers. The elastic fibers of the visceral pleura are continuous with those of the pulmonary parenchyma.

