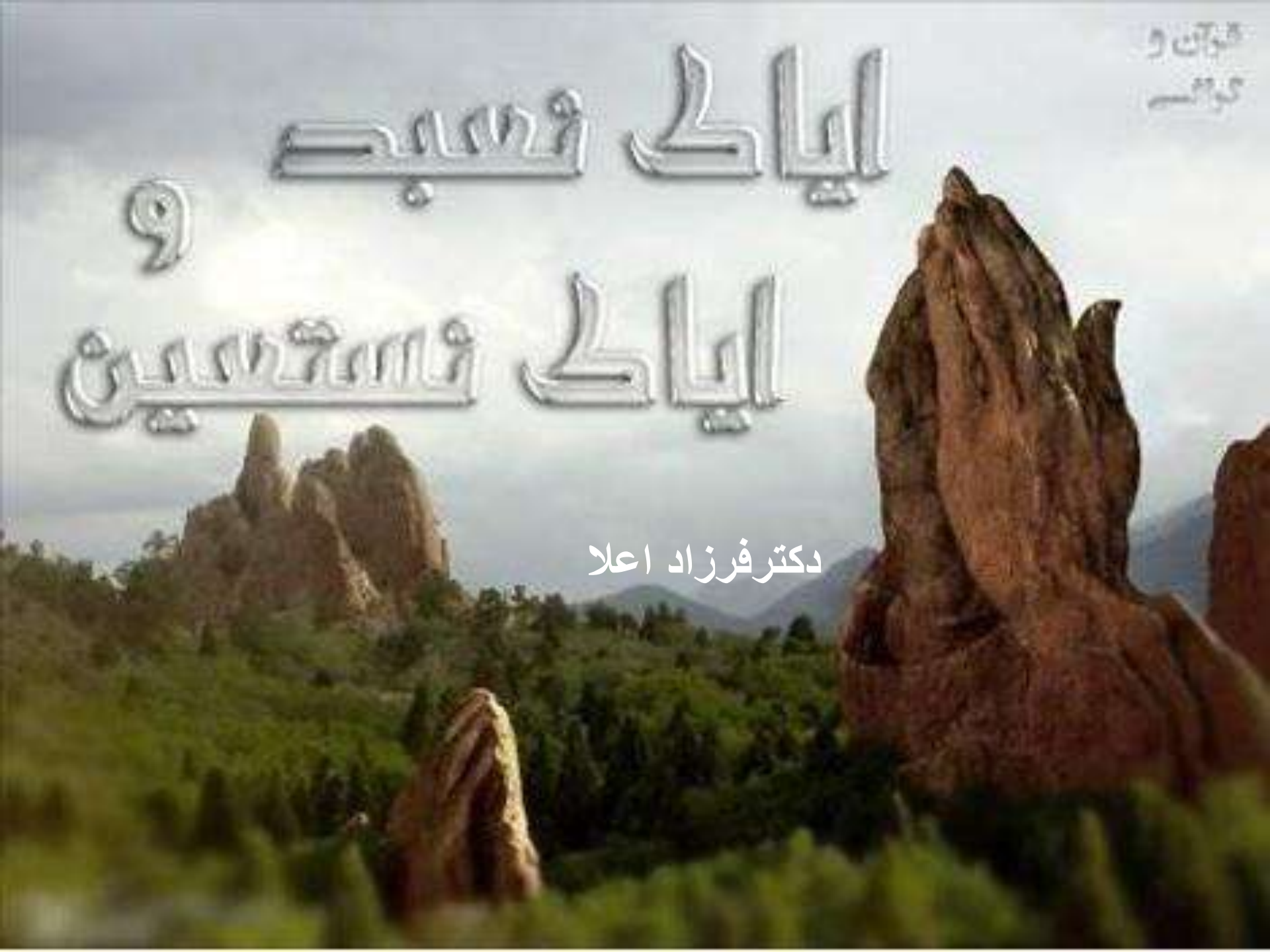
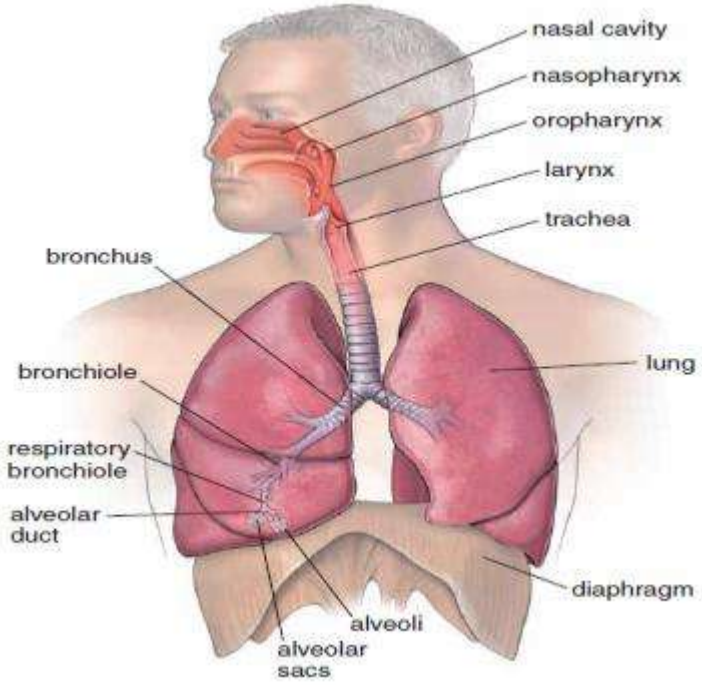
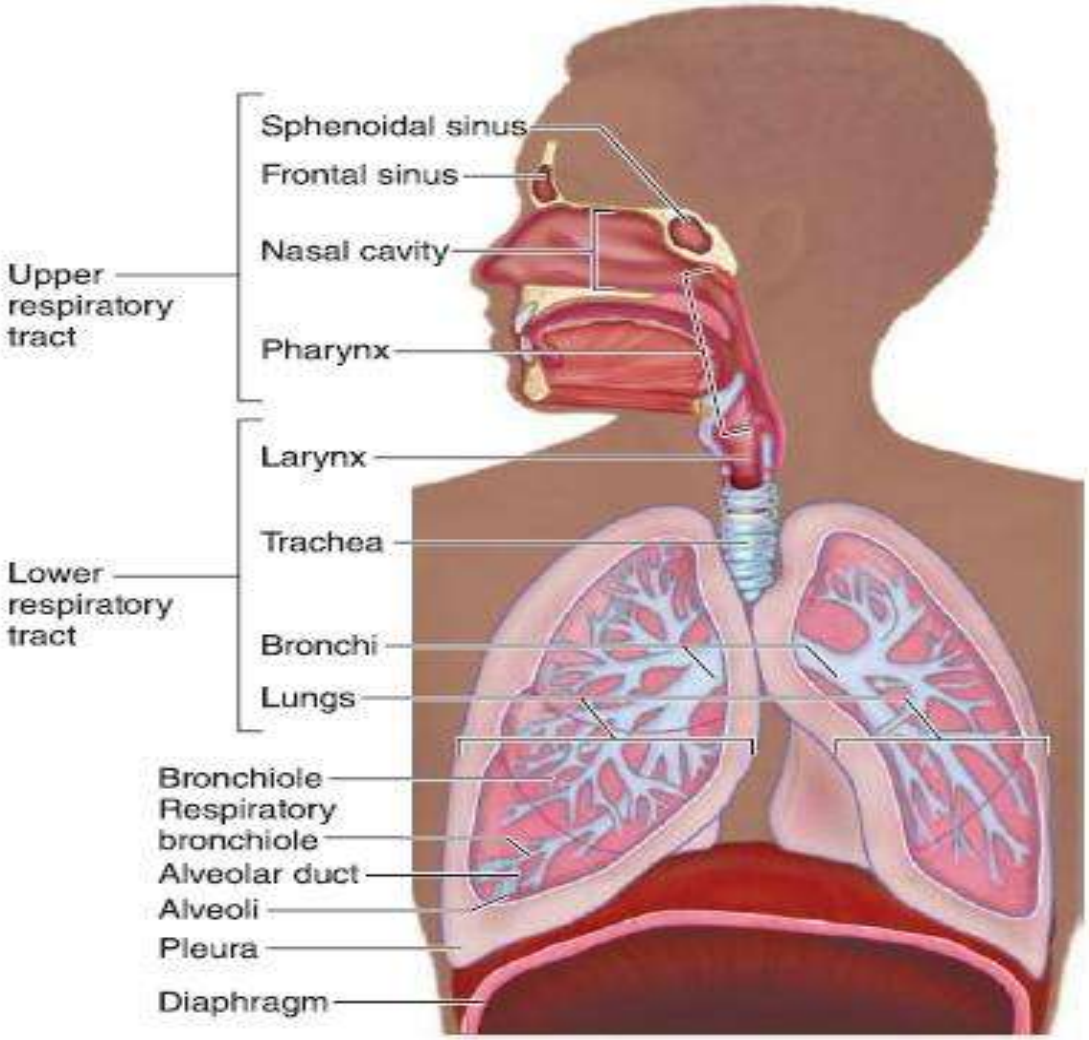

قرآن و
گوشه
ایاک نعبد
و
ایاک نستعین
دکترفرزاد اعلا

دكتر اعلا

Respiratory System





Anatomically, the respiratory tract has upper and lower parts. Histologically and functionally, the respiratory system has a **conducting portion**, which consists of all the components that condition air and bring it into the lungs, and a **respiratory portion**, where gas exchange actually occurs, consisting of respiratory bronchioles, alveolar ducts, and alveoli in the lungs. Portions of two sets of paranasal sinuses are also shown here.

NASAL CAVITIES

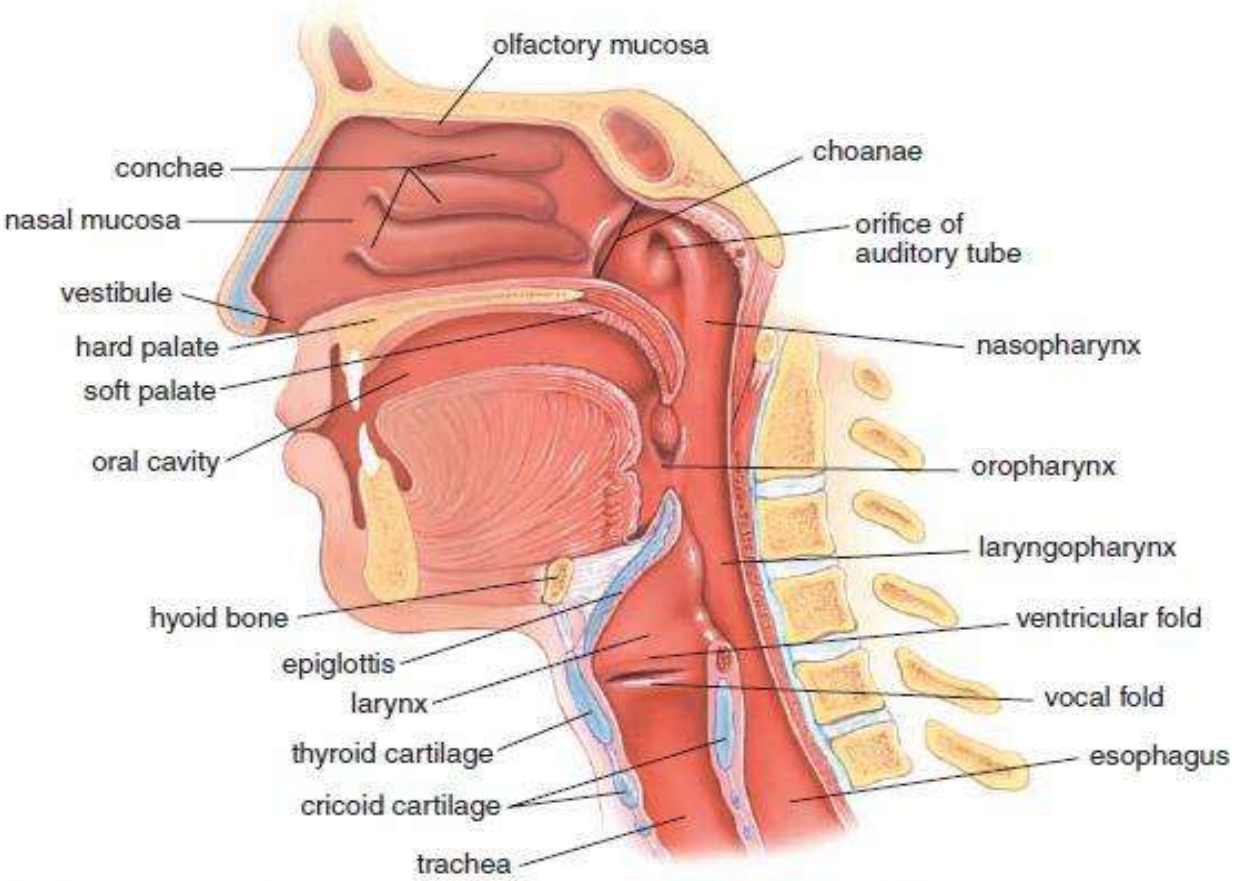


FIGURE 19.2 ▲ Diagram of the relationship of the pharynx to the respiratory and digestive systems. The pharynx is divided into three parts: nasopharynx, oropharynx, and laryngopharynx. It is located posterior to the nasal and oral cavities and extends inferiorly past the larynx. The pharynx serves both respiratory and digestive systems. This midsagittal section also transects the cartilages forming the skeleton of the larynx (i.e., epiglottis, thyroid cartilage, and cricoid cartilage). Note the ventricular and vocal folds in the middle of the larynx, approximately at the level of the thyroid cartilage. This part of the larynx represents the narrowest portion of the respiratory system and is responsible for producing sound by audible vibration of the vocal folds.

1. Vestibule of the Nasal Cavity

- It is lined with stratified squamous epithelium.
- Has Sebaceous glands

Epithelium on the middle and inferior conchae is respiratory epithelium; the roof of the nasal cavities and the superior conchae are covered with specialized olfactory epithelium.

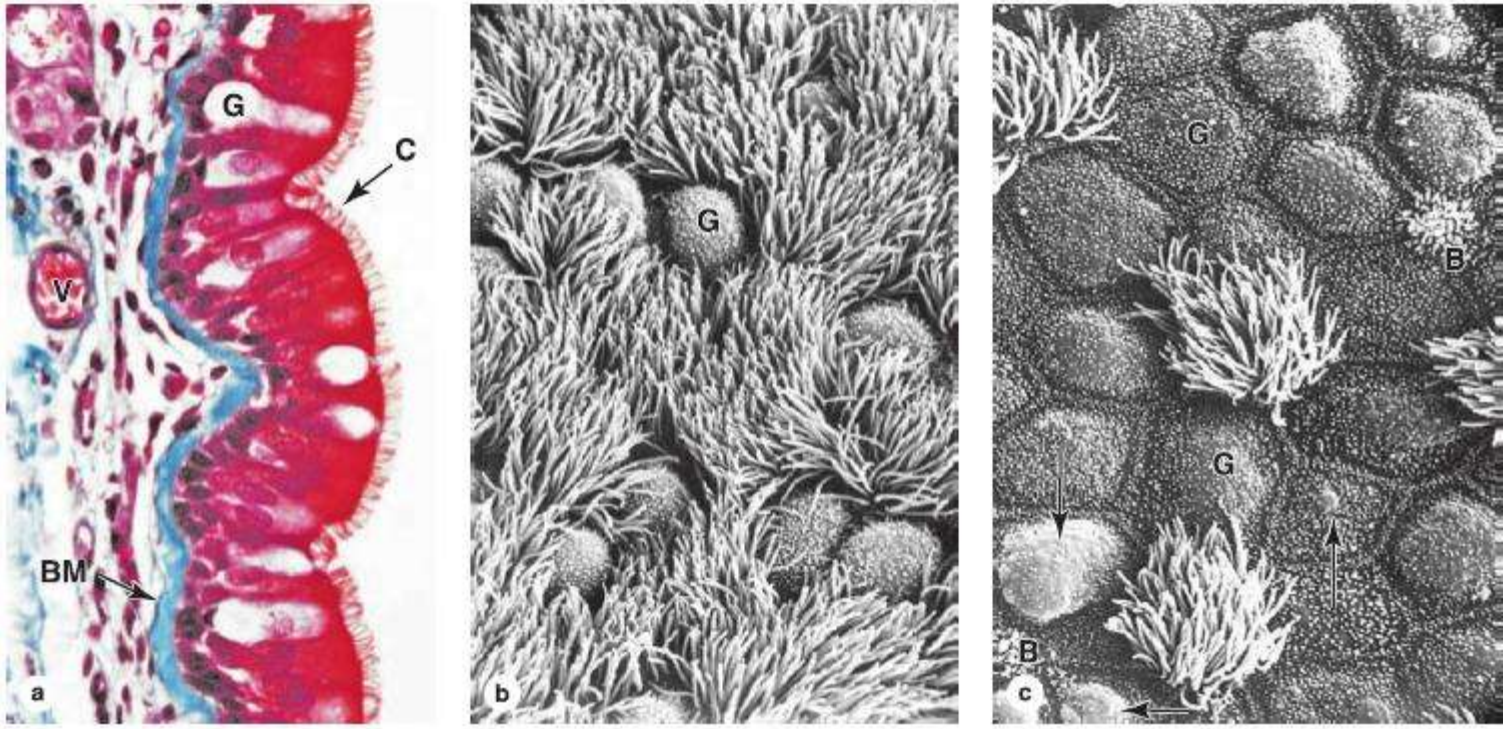
2. Respiratory Region of the Nasal Cavity:

- constitutes most of the volume of the nasal cavities. It is lined by the respiratory mucosa that contains a ciliated, pseudostratified columnar epithelium.

↓

Ciliated cells, Goblet cells, Brush cells, Small granule cells (Kulchitsky cells), Basal cells

- The underlying lamina propria is firmly attached to the periosteum and perichondrium.
- The lamina propria of the respiratory mucosa has a rich, vascular network that includes a complex set of capillary loops
- contains mucous glands, many exhibiting serous demilunes.

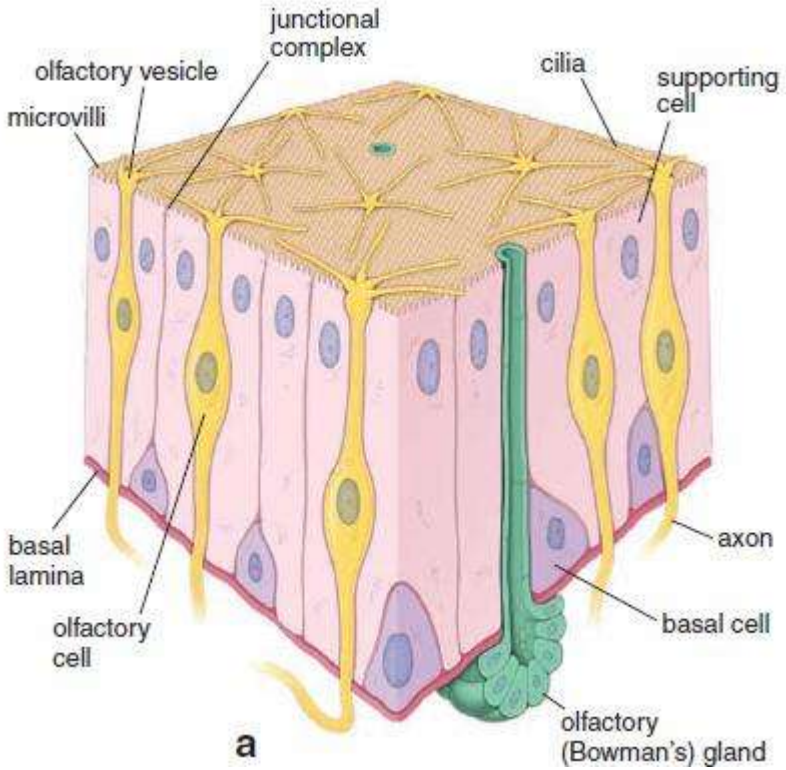

G
C
V
BM
a
G
b
G
B
G
B
c

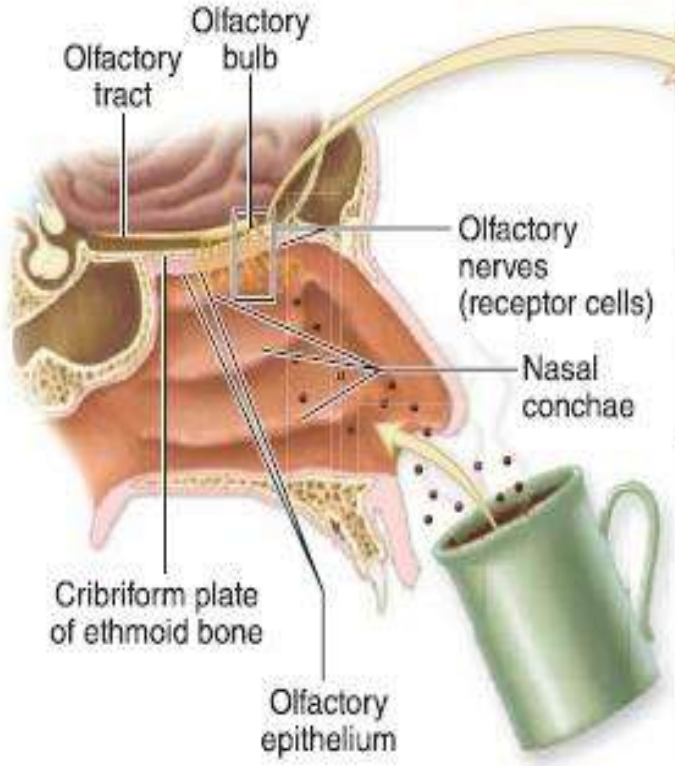
3. Olfactory Region of the Nasal Cavity:

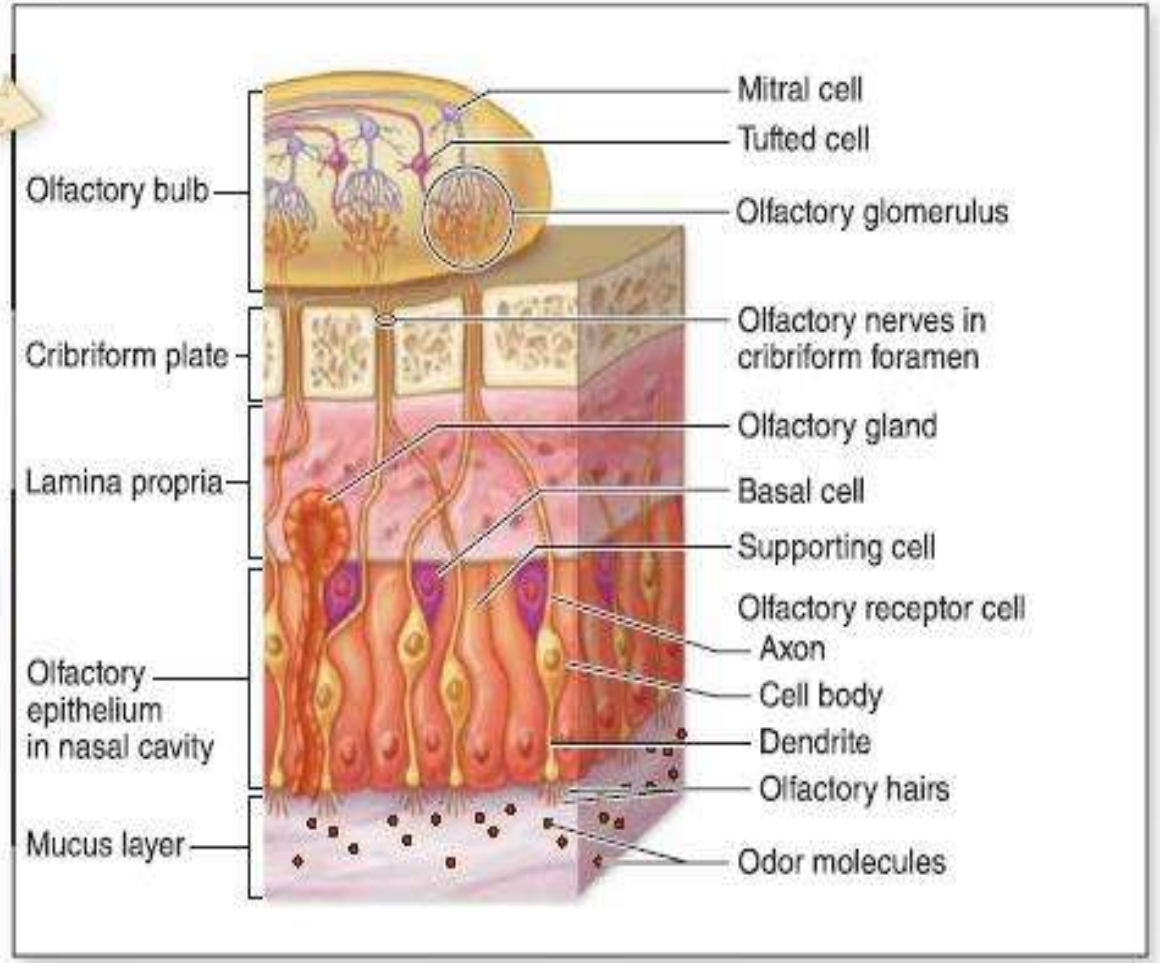
- It is lined with a specialized olfactory mucosa
- The lamina propria contains olfactory glands.
- The olfactory epithelium is composed of the following cell types

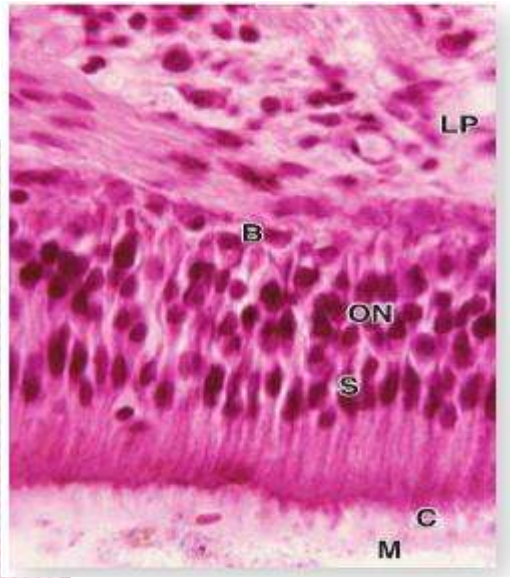
1. Olfactory receptor cells (bipolar olfactory neurons)
2. Supporting or sustentacular cells are columnar cells (They synthesize and secrete odorant-binding proteins).
3. Basal cells (are columnar cells specialized for transduction of general sensation).

Replacing the olfactory neurons every 2-3 months and support cells less frequently.




Olfactory tract
Olfactory bulb
Olfactory nerves (receptor cells)
Nasal conchae
Cribriform plate of ethmoid bone
Olfactory epithelium


Olfactory bulb
Cribriform plate
Lamina propria
Olfactory epithelium in nasal cavity
Mucus layer
Mitral cell
Tufted cell
Olfactory glomerulus
Olfactory nerves in cribriform foramen
Olfactory gland
Basal cell
Supporting cell
Olfactory receptor cell
Axon
Cell body
Dendrite
Olfactory hairs
Odor molecules


LP
B
ON
S
C
M

Olfactory glands (Bowman's glands)

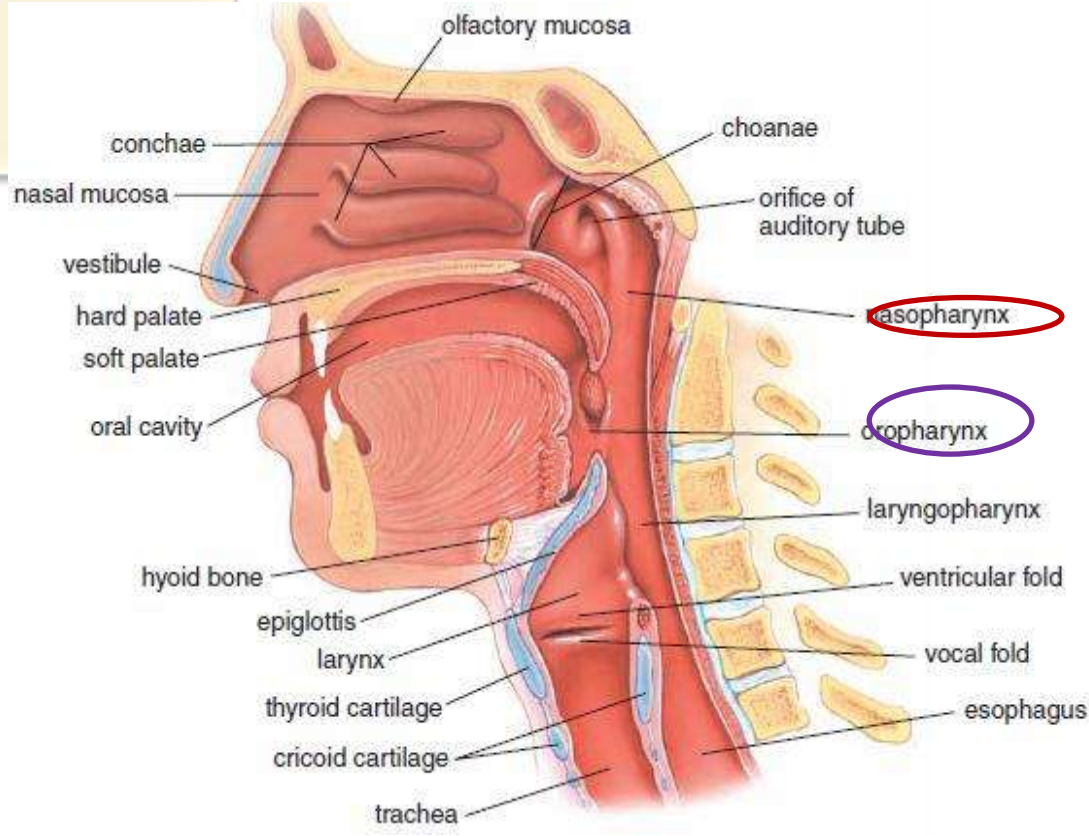
- a characteristic feature of the mucosa, are ***branched tubuloalveolar serous glands*** that deliver their proteinaceous secretions via ducts onto the olfactory surface.
- The serous secretion of the olfactory glands serves as a trap and solvent for odoriferous substances

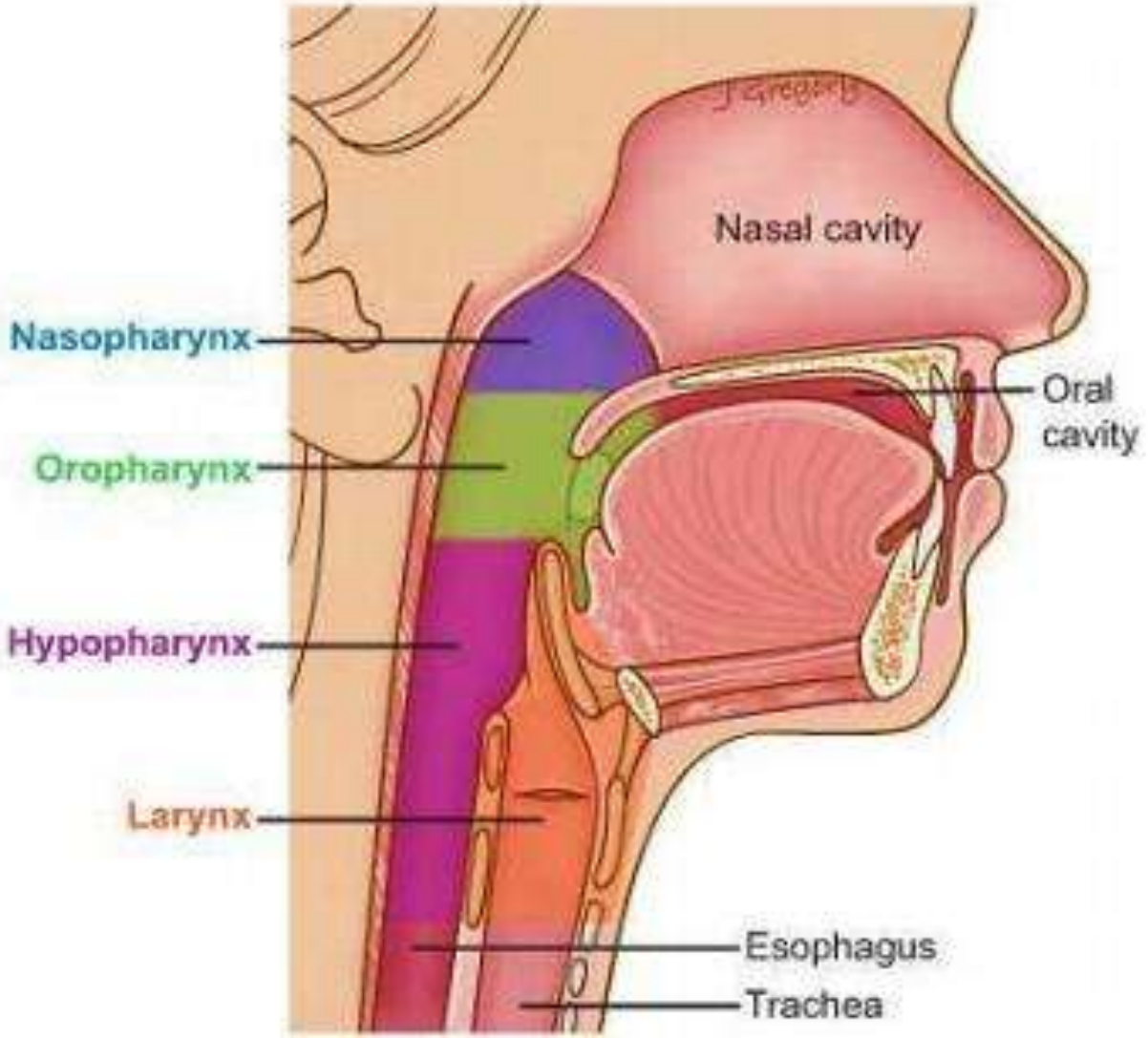
Paranasal Sinuses

- Paranasal sinuses are air-filled spaces in the bones of the walls of the nasal cavity
- They are extensions of the respiratory region of the nasal cavity and are lined by respiratory epithelium with numerous goblet cells .

▪ *PHARYNX:*

- The pharynx is located posterior to the nasal and oral cavities and is divided regionally into the nasopharynx and ***oropharynx***, respectively.
- The auditory (Eustachian) tubes connect the ***nasopharynx*** to each middle ear.
- Diffuse lymphatic tissue and lymphatic nodules are present in the wall of the nasopharynx (pharyngeal tonsil)




Nasal cavity
Nasopharynx
Oropharynx
Hypopharynx
Larynx
Oral cavity
Esophagus
Trachea

Larynx

larynx is a short passage for air between pharynx and the trachea.

Hyaline cartilages:
Thyroid, cricoid, inferior arytenoid cartilages

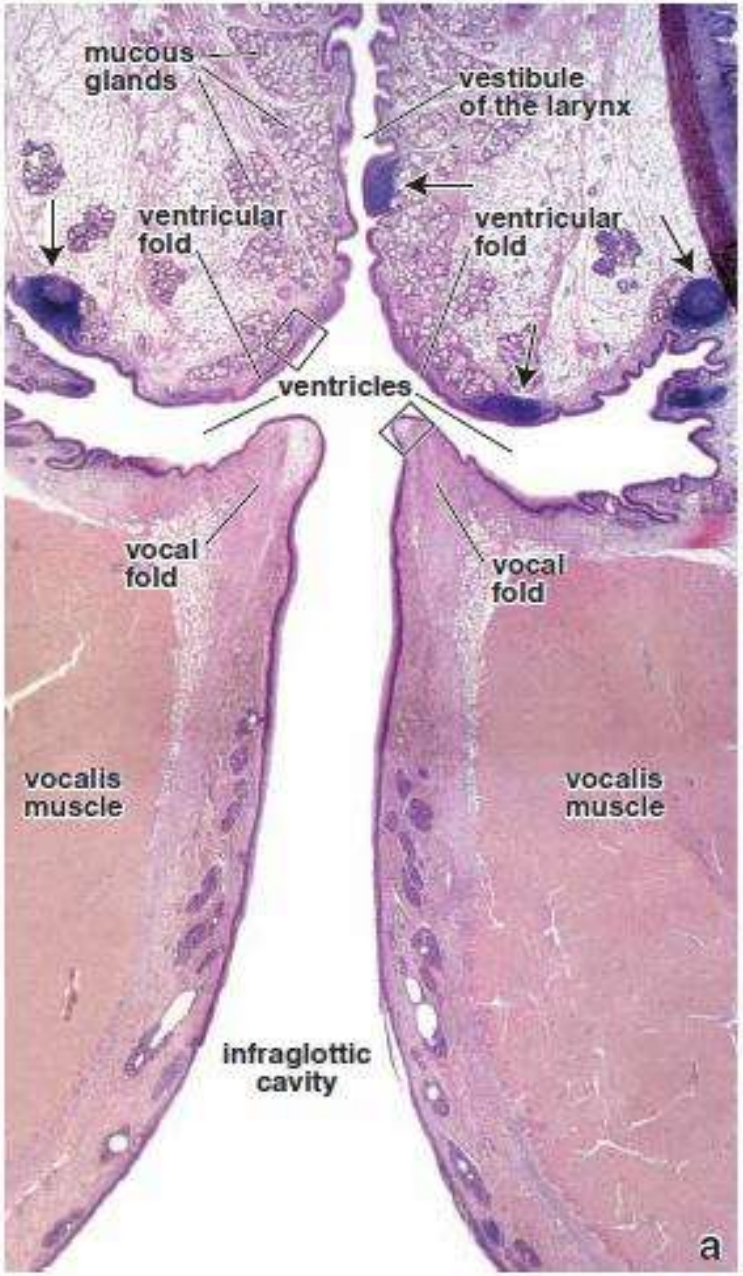
Elastic cartilages:
Epiglottis, cuneiform, corniculate, superior arytenoid cartilages

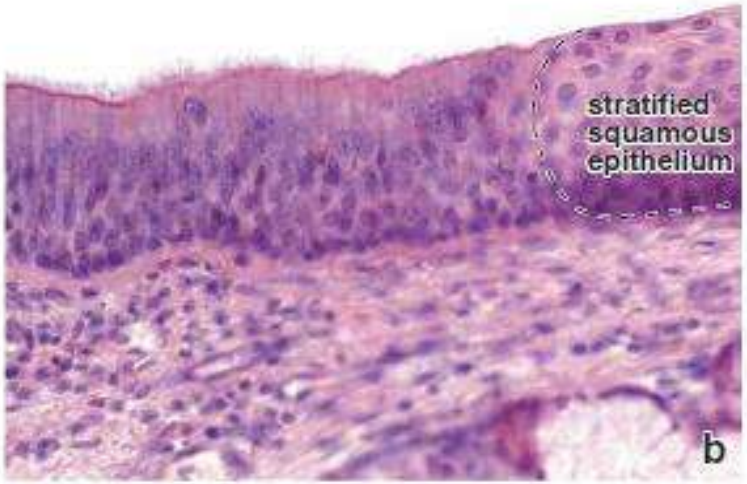
Epiglottis:
Lingual surface has stratified squamous epithelium.
Laryngeal surface has ciliated pseudostratified columnar epithelium.

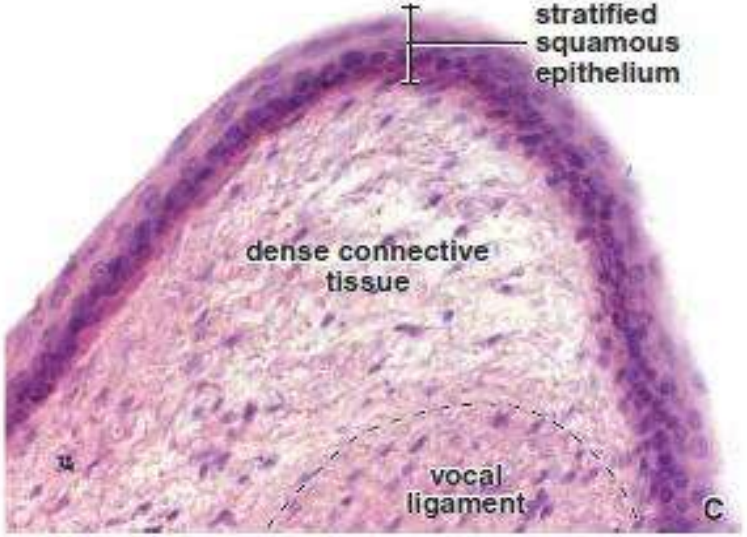
The larynx is a short air passage between the pharynx and trachea. Its wall contains skeletal muscles and pieces of cartilage, all of which make the larynx specialized for sound production, or phonation. This low-power micrograph shows the laryngeal vestibule (**LV**), which is surrounded by seromucous glands (**G**). The lateral walls of this region bulge as a pair of vestibular folds (**VF**). These also contain seromucous glands and areolar tissue with MALT, often with lymphoid nodules (**L**) and are largely covered by respiratory epithelium, with regions near the epiglottis having stratified squamous epithelium.

Below each large vestibular fold is a narrow space or ventricle (**V**), below which is another pair of lateral folds, the vocal folds or cords (**VC**). These are covered by stratified squamous epithelium and project more sharply into the lumen. Each contains a large striated vocalis muscle (**VM**) and nearer the surface a small ligament, which is cut transversely and therefore difficult to see here. Variable tension of these ligaments caused by the muscles produces different sounds as air is expelled across the vocal cords. All the structures and spaces above these folds add resonance to the sounds, assisting phonation. (X15; H&E)

Ventricular folds or fals vocal cords.
These folds do not have the intrinsic muscular investment of the true vocal cords and therefore do not modulate in phonation. They and the ventricle, however, are important in creating sound resonance


mucous glands
vestibule of the larynx
ventricular fold
ventricular fold
ventricles
vocal fold
vocal fold
vocalis muscle
vocalis muscle
infraglottic cavity
a


stratified squamous epithelium
b


stratified squamous epithelium
dense connective tissue
vocal ligament
c

TRACHEA

➢ It has 2.5 cm in diameter and about 10 cm long

➢ **The wall of the trachea consists of four definable layers**:

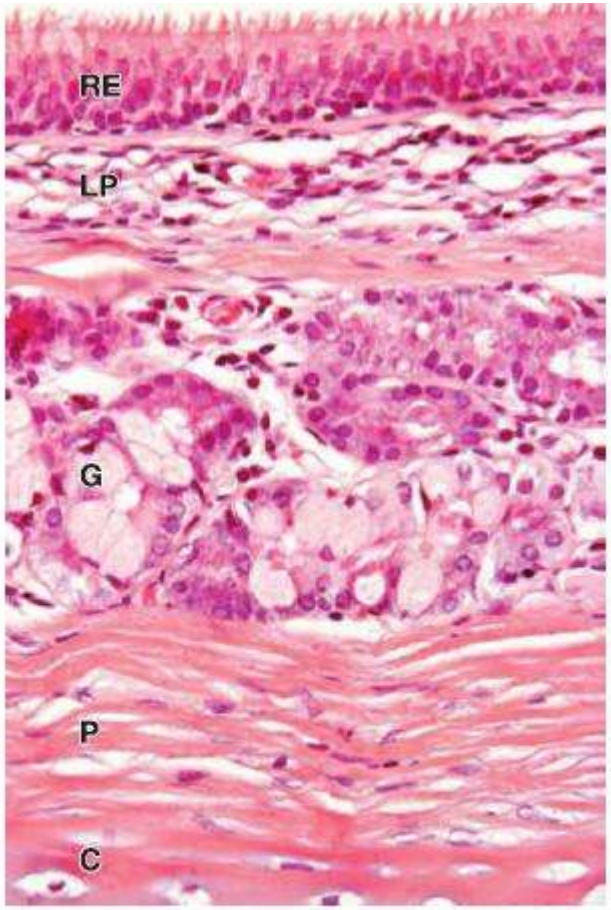
• ***Mucosa***, composed of a ciliated, pseudostratifi ed epithelium and an elastic, fiber-rich lamina propria

• ***Submucosa,*** composed of a slightly denser connective tissue than the lamina propria

• ***Cartilaginous layer***, composed of C-shaped hyaline cartilages

• ***Adventitia***, composed of connective tissue that binds the trachea to adjacent structures.

➢ Fibroelastic tissue and smooth muscle, the **trachealis muscle**, bridge the gap between the free ends of the C-shaped cartilages



The trachea is lined by typical respiratory epithelium (**RE**) underlain by connective tissue of the lamina propria (**LP**) and seromucous glands (**G**) in the lamina propria and submucosa. Adjacent to the submucosa are the C-shaped rings of hyaline cartilage (**C**) covered by perichondrium (**P**). (X50; H&E)

TABLE 17–1 Histologic features of the upper respiratory tract, larynx, and trachea.

Region	Epithelium	Glands	Musculoskeletal Support	Other Features and Major Functions
Vestibules of nasal cavities	Stratified squamous, keratinized to nonkeratinized	Sebaceous and sweat glands	Hyaline cartilage	Vibrissae (stiff hairs) and moisture both filter and humidify air
Most areas of nasal cavities	Respiratory	Seromucous glands	Bone and hyaline cartilage	Rich vasculature and glands warm, humidify, and clean air
Superior areas of nasal cavities	Olfactory, with bipolar neurons	Serous (Bowman) glands	Bone (ethmoid)	Solubilize and detect odorant molecules in air
Nasopharynx and posterior oropharynx	Respiratory and stratified squamous	Seromucous glands	Bone and skeletal muscle	Conduct air to larynx; pharyngeal and palatine tonsils
Larynx	Respiratory and stratified squamous	Mucous glands, smaller seromucous glands	Elastic and hyaline cartilage, ligaments, skeletal muscle	Site for phonation; epiglottis closes while swallowing
Trachea	Respiratory	Mainly mucous glands, some serous or mixed glands	C-shaped rings of hyaline cartilage, with smooth (trachealis) muscle in posterior opening of each	Conduct air to primary bronchi entering lungs; some MALT

Tracheal Epithelium

Tracheal epithelium is similar to respiratory epithelium in other parts of the conducting airway.

1.Ciliated cells: Each cell has approximately 250 cilia .

2.Mucous cells

3.Brush cells: The basal surface of the cells is in synaptic contact with an afferent nerve ending (epitheliodendritic synapse). Thus, the brush cell is regarded as a receptor cell.

4.Small granule cells (Kulchitsky cells) are respiratory representatives of the general class of enteroendocrine cells of the gut and gut derivatives. Their presence is explained by the development of the respiratory tract and lungs from an evagination of the primitive foregut.produce : catecholamine, serotonin, calcitonin, and gastrin-releasing peptide (bombesin)

5.Basal cells

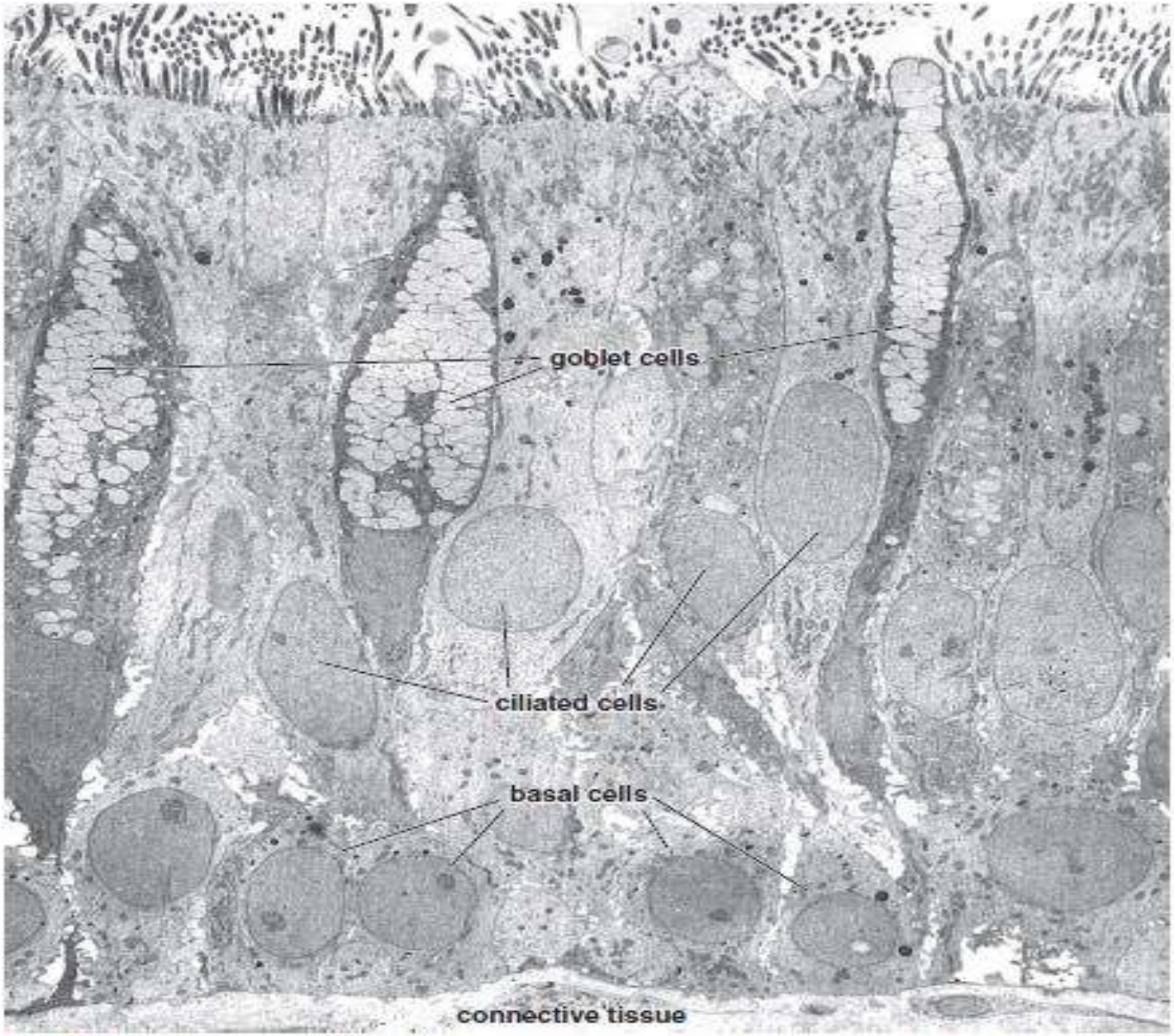


FIGURE 19.7 ▲ Electron micrograph of human trachea. This electron micrograph shows the three main cell types of this respiratory epithelium. They are represented by ciliated epithelial cells extending to the surface, where they possess cilia; goblet cells with mucinogen granules; and basal cells, which are confined to the basal portion of the epithelial layer near the connective tissue. ×1,800. (Courtesy of Dr. Johannes A. G. Rhodin.)

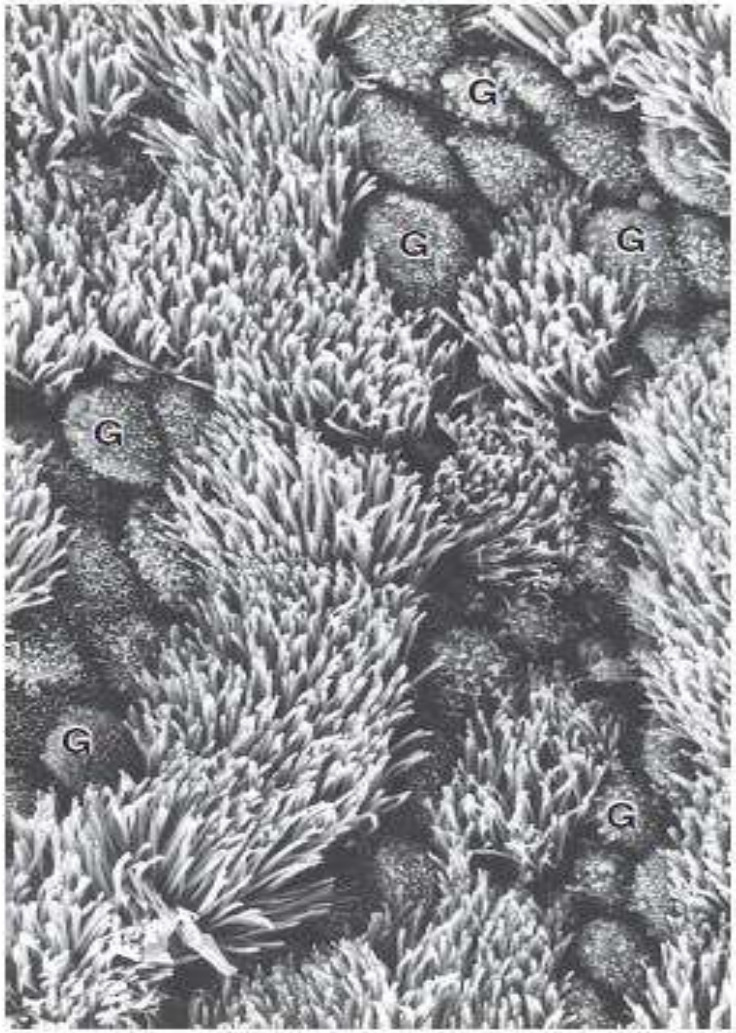


FIGURE 19.8 ▲ Scanning electron micrograph of the luminal surface of a bronchus. The nonciliated cells are the goblet cells (G). Their surface is characterized by small blunt microvilli that give a stippled appearance to the cell at this low magnification. The cilia of the many ciliated cells occupy the remainder of the micrograph. Note how all are "synchronously" arrayed (i.e., uniformly leaning in the same direction), appearing just as they were when fixed at a specific moment during their wave-like movement. ×1,200.

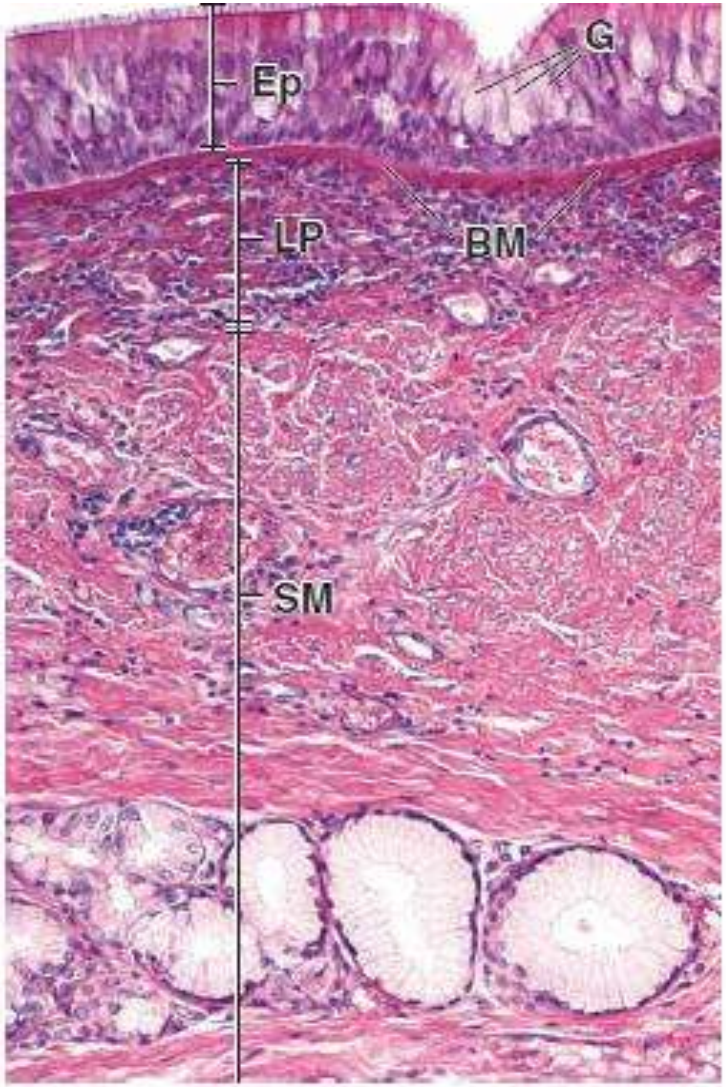


FIGURE 19.9 ▲ Photomicrograph of tracheal epithelium.

Basement Membrane, Lamina Propria, and Submucosa

- A thick “basement membrane” is characteristic of tracheal epithelium (25 to 40 m thick).
- The lamina propria, excluding that part just designated as basement membrane, appears as a typical loose connective tissue.
- This band or elastic membrane marks the boundary between the lamina propria and submucosa.
- Submucosal glands composed of mucus-secreting acini with serous demilunes are also present in the submucosa.
- The tracheal cartilages are C-shaped. With age, the hyaline cartilage may be partially replaced by bone tissue, causing it to lose much of its flexibility

The adventitia, the outer layer, lies peripheral to the cartilage rings and trachealis muscle

BRONCHI

Initially, the bronchi have the same general histologic structure as the trachea.

The cartilage rings are replaced by cartilage plates of irregular shape

The wall of the bronchus:

1. **Mucosa**, composed of a pseudostratifi ed epithelium with the same cellular composition as the trachea.
basement membrane" is conspicuous in the primary bronchi but quickly diminishes in thickness. The lamina propria is similar to that of the trachea.

2. **Muscularis**, a continuous layer of smooth muscle in the larger bronchi.

3. **Submucosa** remains as a relatively loose connective tissue. Glands are present as well as adipose tissue in the larger bronchi.

4. **Cartilage layer** consists of discontinuous cartilage plates that become smaller as the bronchial diameter diminishes.

5.**Adventitia** is moderately dense connective tissue

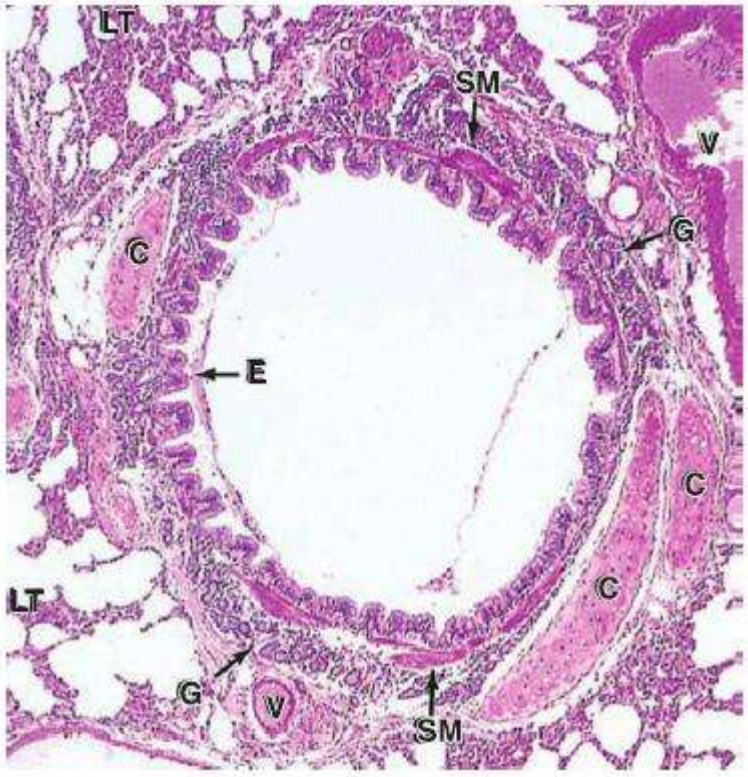
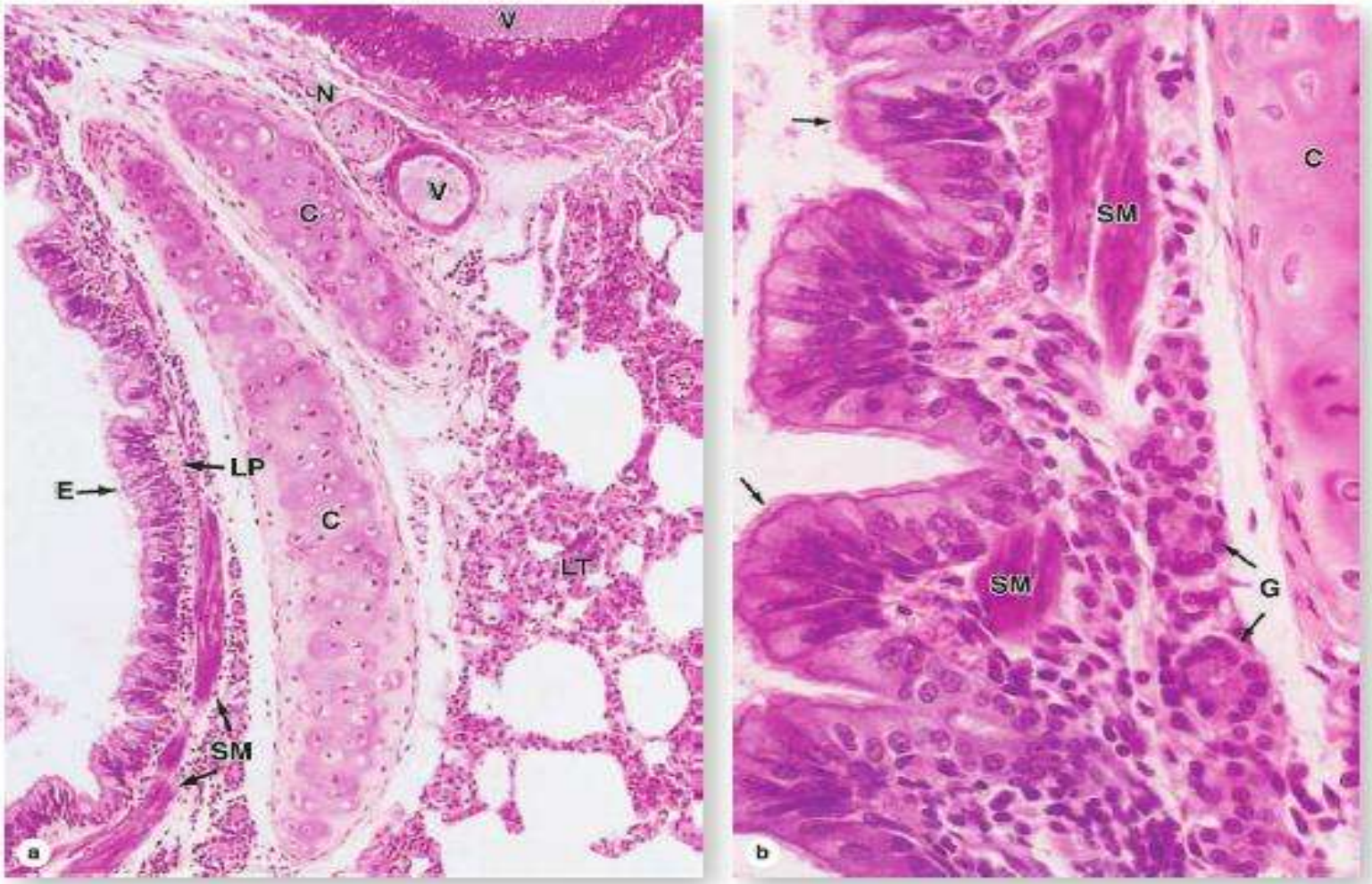
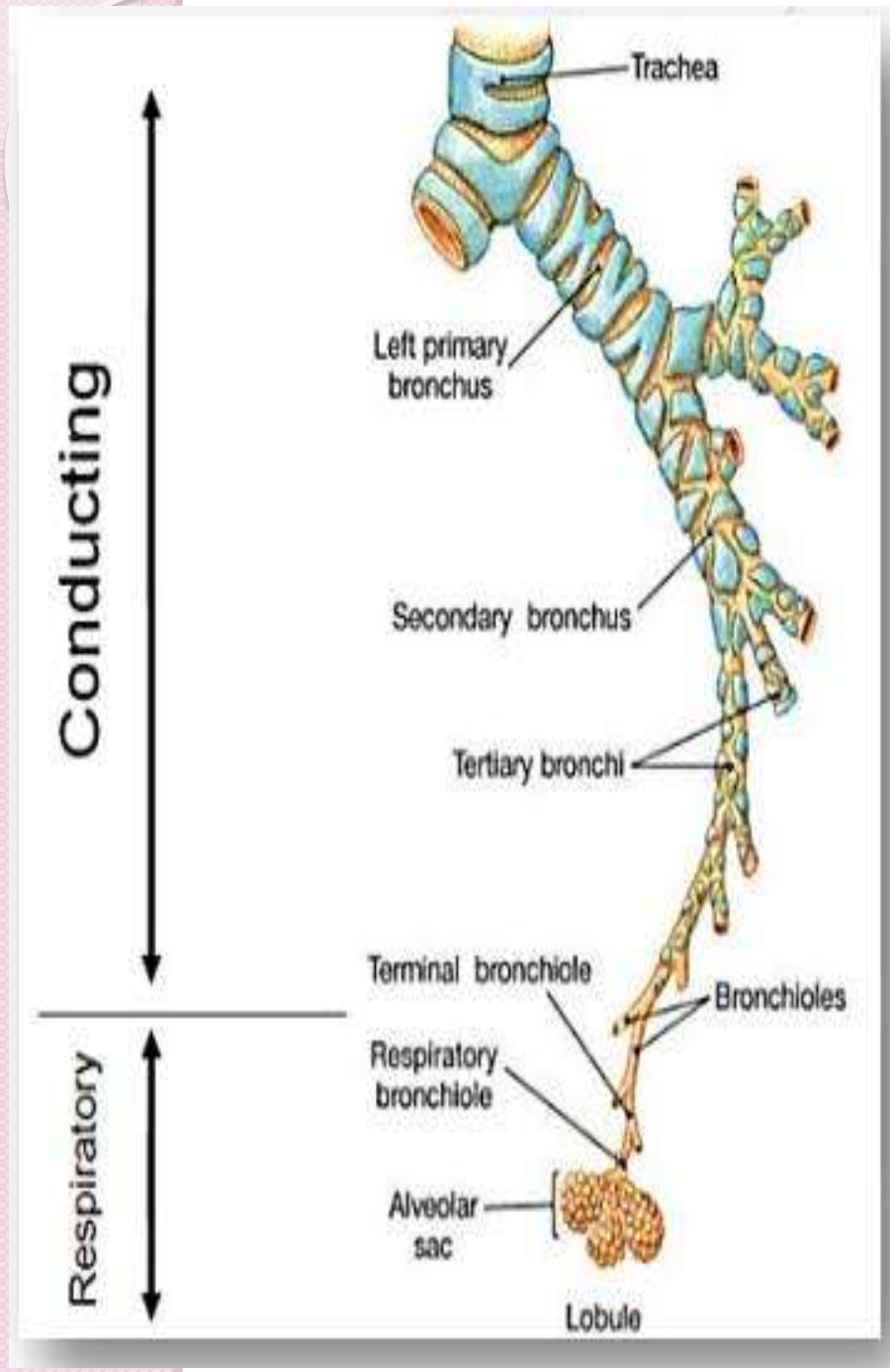


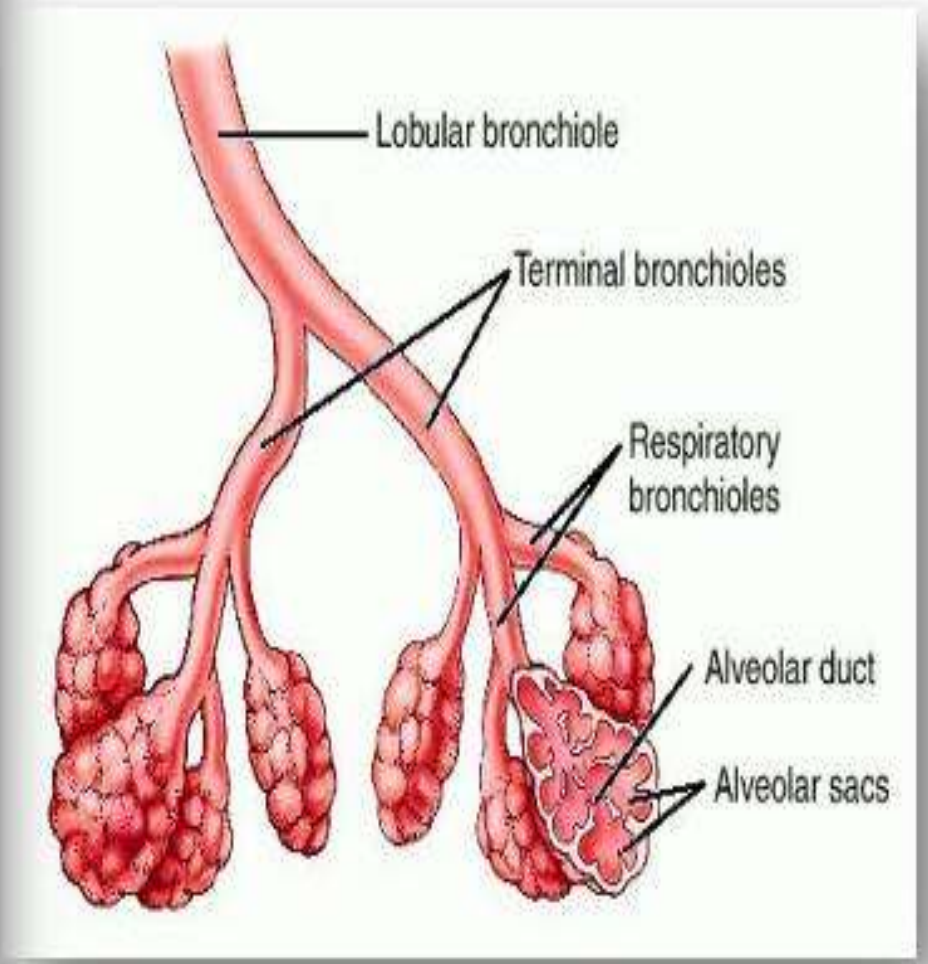
FIGURE 17–8 Bronchial wall.



(a) The epithelial lining (**E**) of bronchi is mainly pseudostratified ciliated columnar cells with a few goblet cells. The lamina propria (**LP**) contains the distinct layer of smooth muscle (**SM**) surrounding the entire bronchus. The submucosa is the site of the supporting cartilage (**C**) and the adventitia includes blood vessels (**V**) and nerves (**N**). Lung tissue (**LT**) directly surrounds the adventitia of bronchi. (X140; H&E)

(b) In the smaller bronchi the epithelium is primarily of columnar cells with cilia (arrows), with fewer goblet cells. The lamina propria has both smooth muscle (**SM**) and small serous glands (**G**) near cartilage (**C**). (X400; H&E)

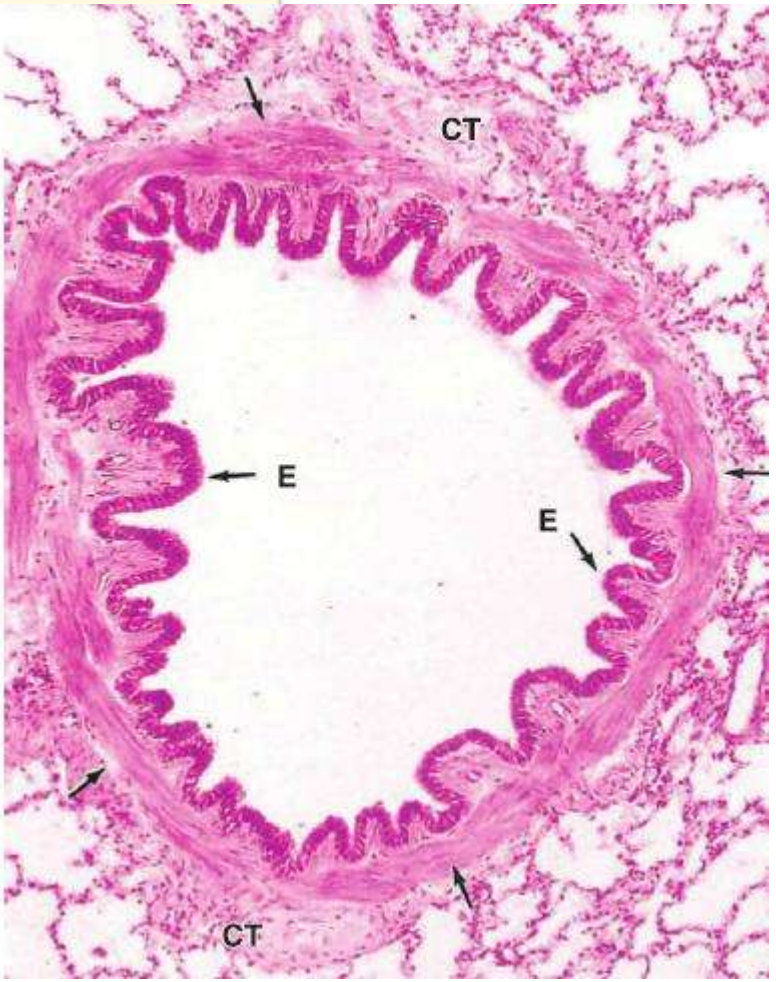

Conducting
Respiratory
Trachea
Left primary bronchus
Secondary bronchus
Tertiary bronchi
Terminal bronchiole
Bronchioles
Respiratory bronchiole
Alveolar sac
Lobule

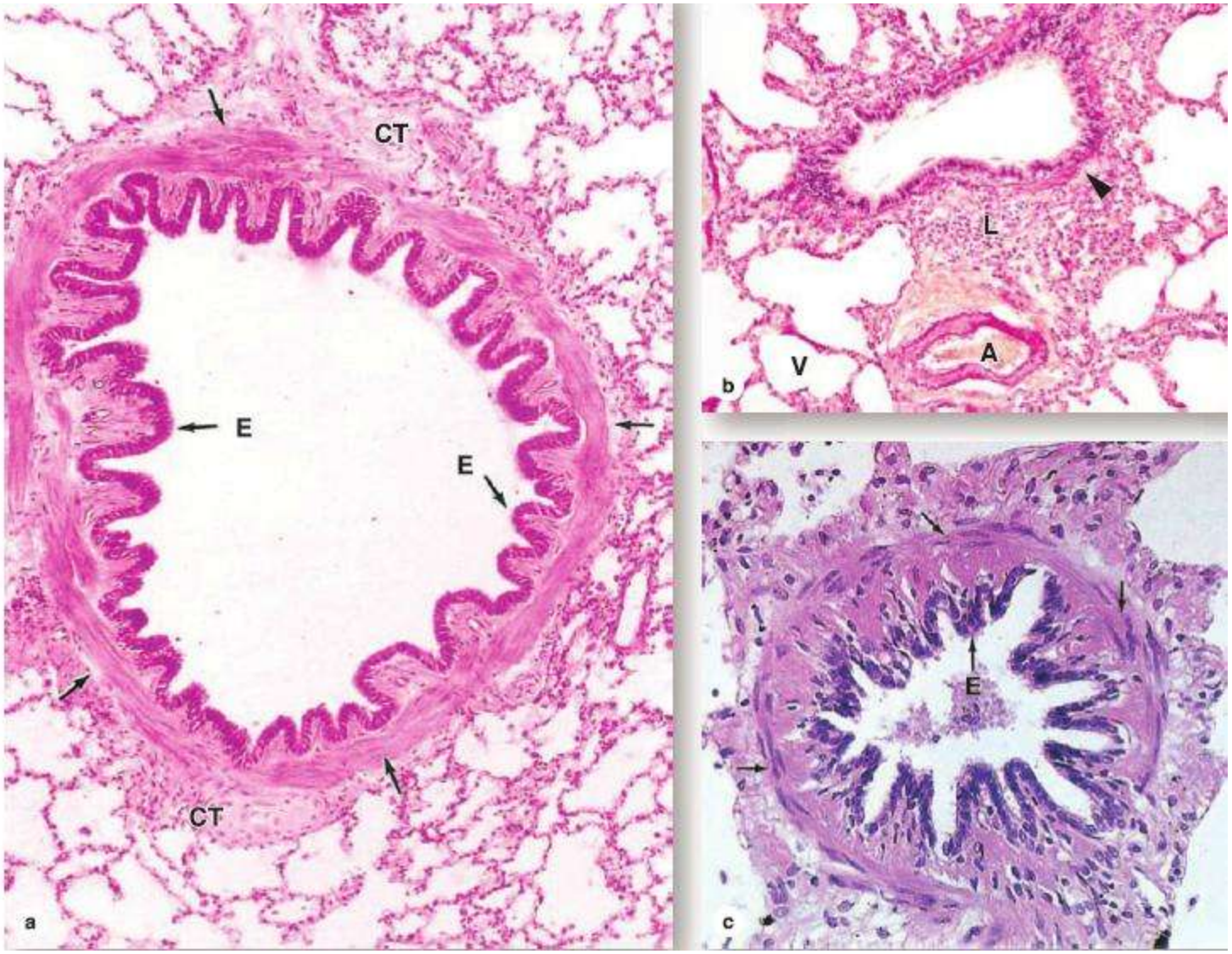

Lobular bronchiole
Terminal bronchioles
Respiratory bronchioles
Alveolar duct
Alveolar sacs

BRONCHIOLES

- Bronchioles are intralobular air-conducting ducts that measure 1 mm or less in diameter

- Cartilage plates and glands are not present in bronchioles.
- The larger-diameter bronchioles initially have a ciliated, pseudostratified columnar epithelium that gradually transforms into a simple ciliated columnar epithelium as the duct narrows.
- Goblet cells are still present in the largest bronchioles but are not present in the terminal bronchioles hat follow.




CT
E
E
CT
a
L
A
V
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c

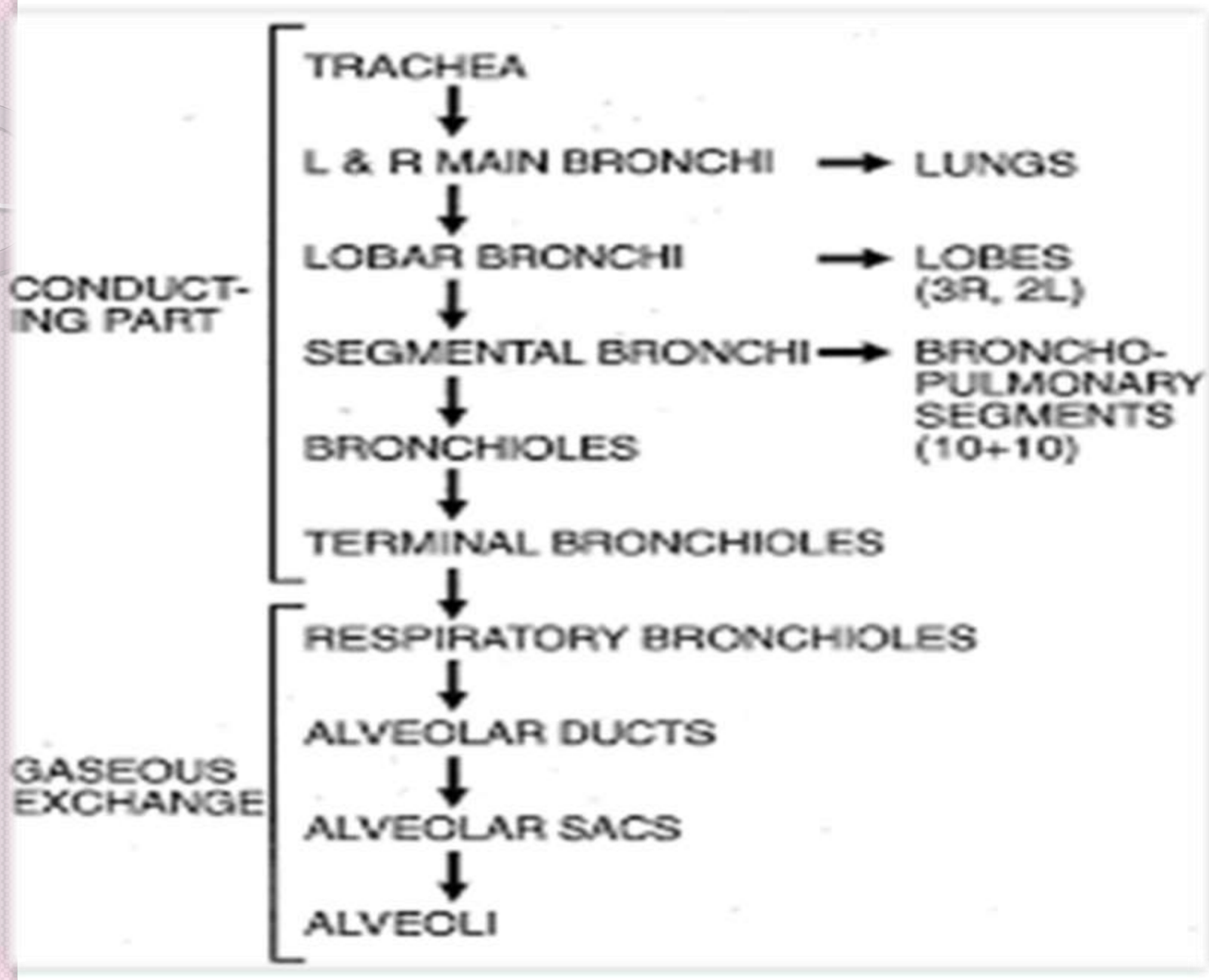
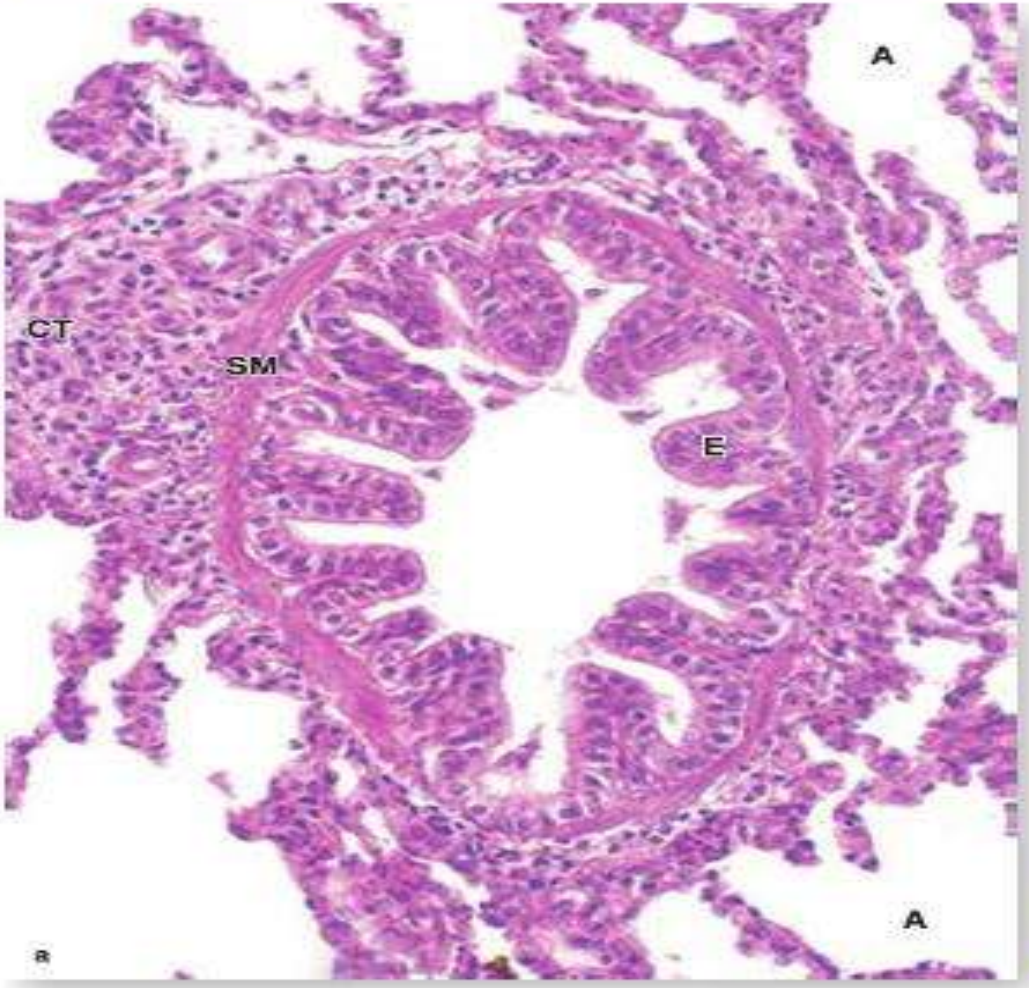

CONDUCT-
ING PART
TRACHEA
L & R MAIN BRONCHI
LUNGS
LOBAR BRONCHI
LOBES
(3R, 2L)
SEGMENTAL BRONCHI
BRONCHO-
PULMONARY
SEGMENTS
(10+10)
BRONCHIOLES
TERMINAL BRONCHIOLES
GASEOUS
EXCHANGE
RESPIRATORY BRONCHIOLES
ALVEOLAR DUCTS
ALVEOLAR SACS
ALVECLI

FIGURE 17–10 Terminal bronchiole and exocrine bronchiolar cells.



The last parts of the air conducting system before the sites of gas exchange appear are called the **terminal bronchioles**.

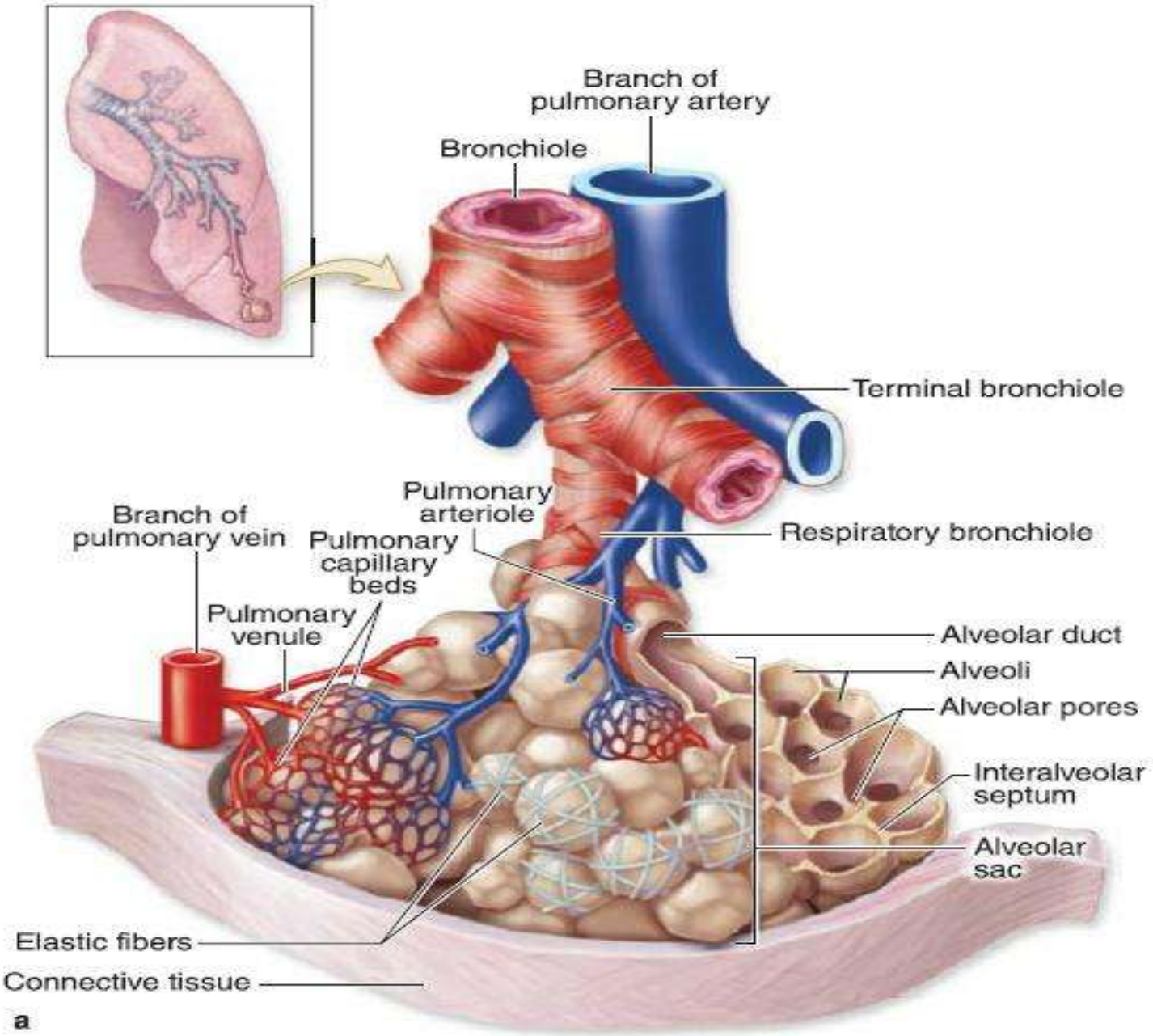
(a) A terminal bronchiole has a mucosa with nonciliated cuboidal or low columnar epithelium (**E**), surrounded by only one or two layers of smooth muscle (**SM**) embedded in connective tissue (**CT**). Alveoli (**A**) are seen in the surrounding lung tissue. (X300; PT)

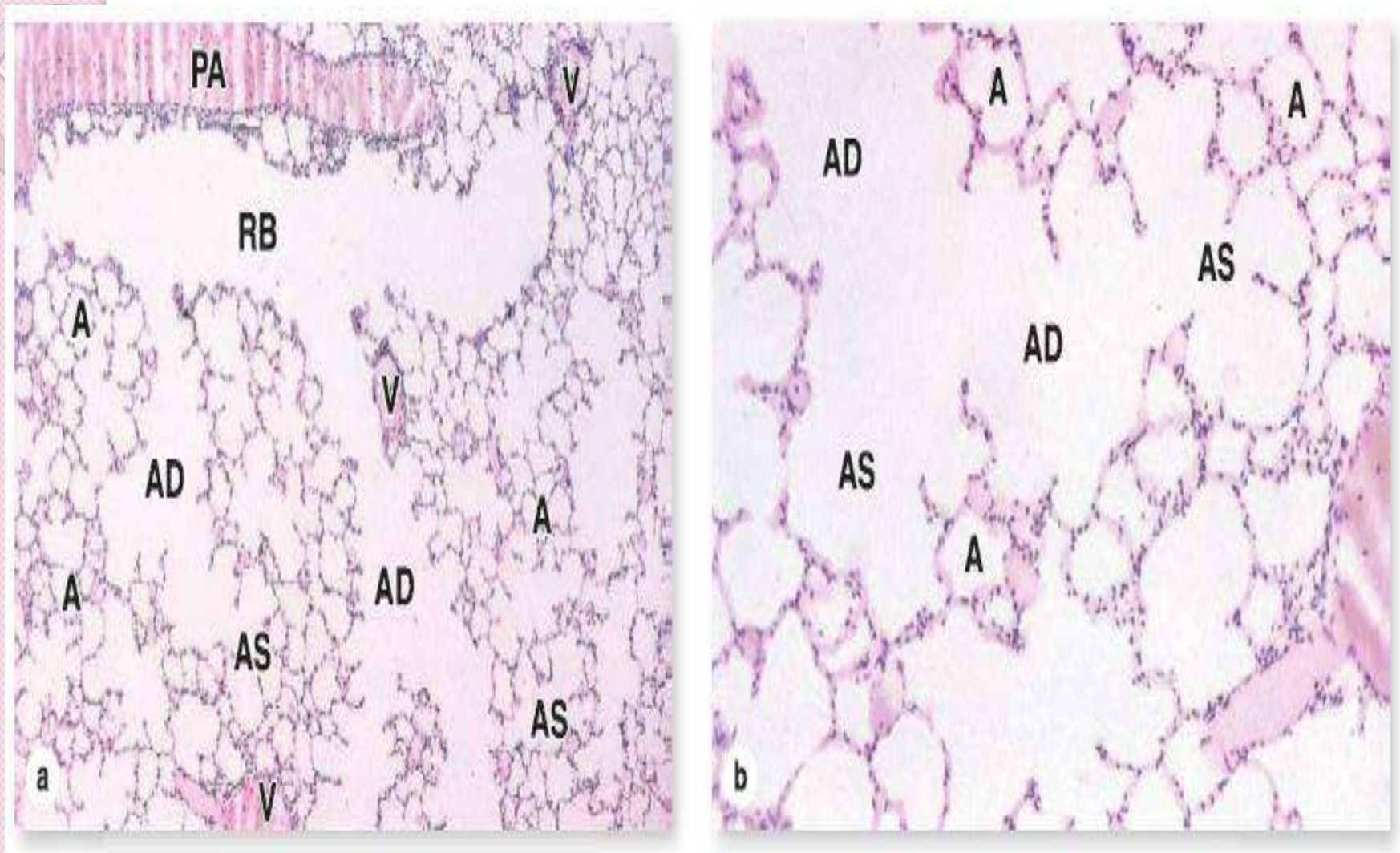
(b) Most of the epithelium consists of exocrine club cells (**C**) with bulging domes of apical cytoplasm contain granules, as shown here in a plastic section. These cells have several important functions. They secrete components of surfactant which reduces surface tension and helps prevent collapse of the bronchioles. The P450 enzyme system of their smooth ER detoxifies potentially harmful compounds in air. In other defensive functions the cells also produce the secretory component for the transfer of IgA into the bronchiolar lumen; lysozyme and other enzymes active against bacteria and viruses; and several cytokines regulating local inflammatory responses. Also included among the cuboidal cells are stem cells that give rise to all of the cells within the bronchiolar epithelium. (X500; PT)

Club cells

- **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

Also present in the terminal bronchiole epi.....um are chemosensory **brush cells** and **DNES small granule cells** like those of the epithelium higher in the respiratory system.


Branch of pulmonary artery
Bronchiole
Terminal bronchiole
Pulmonary arteriole
Branch of pulmonary vein
Pulmonary capillary beds
Respiratory bronchiole
Pulmonary venule
Alveolar duct
Alveoli
Alveolar pores
Interalveolar septum
Alveolar sac
Elastic fibers
Connective tissue
a

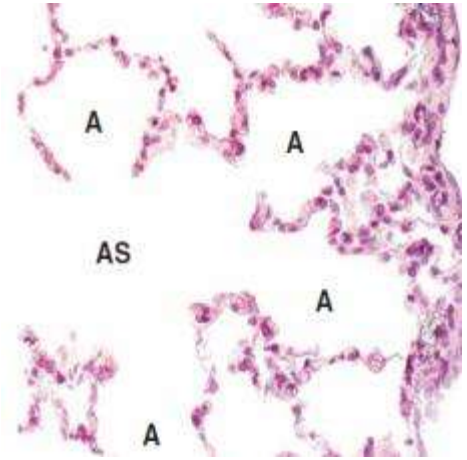

PA
V
RB
A
V
AD
A
A
AD
AS
AS
V
a
A
A
AD
AS
AD
A
AS
b

ALVEOLI

- ***Alveoli*** are the site of gas exchange.
- Each alveolus is a thin-walled polyhedral chamber approximately 0.2 mm in diameter that is confl uent with an alveolar sac

Alveolar ducts are elongated airways that have almost no walls, only alveoli, as their peripheral boundary. Rings of smooth muscle are present in the knob-like interalveolar septa

Alveolar sacs are spaces surrounded by clusters of alveoli



Alveolar epithelium:

1. ***Type I alveolar cells,*** also known as type I pneumocytes,
- comprise only 40% of the entire alveolar lining cells. Th ey are extremely thin squamous cells; they line most (95%) of the surface of the alveoli.

- joined to one another and to the other cells of the alveolar epithelium by occluding junctions.

- Type I alveolar cells are not capable of cell division
- They may play a role in the turneover of surfactant and the removal of small particulate contaminants from the alveolar surface .

2. **Type II alveolar cells,** also called type II pneumocytes or septal cells, are secretory cells

- They contain lamellar bodies (a mixture of phospholipids, neutral lipids, and proteins =surfactant).
- They are progenitor cells for type I alveolar cells.
- After lung injury, they proliferate and restore both types of alveolar cells within the alveolus.
- They have the same origin as the type I cells

3. **Brush cells** are also present in the alveolar wall, but they are few in number. They may serve as receptors that monitor air quality in the lung.

- Surfactant synthesis in the fetus occurs after the 35th week of gestation and is modulated by a variety of hormones, including cortisol , insulin, prolactin, and thyroxine

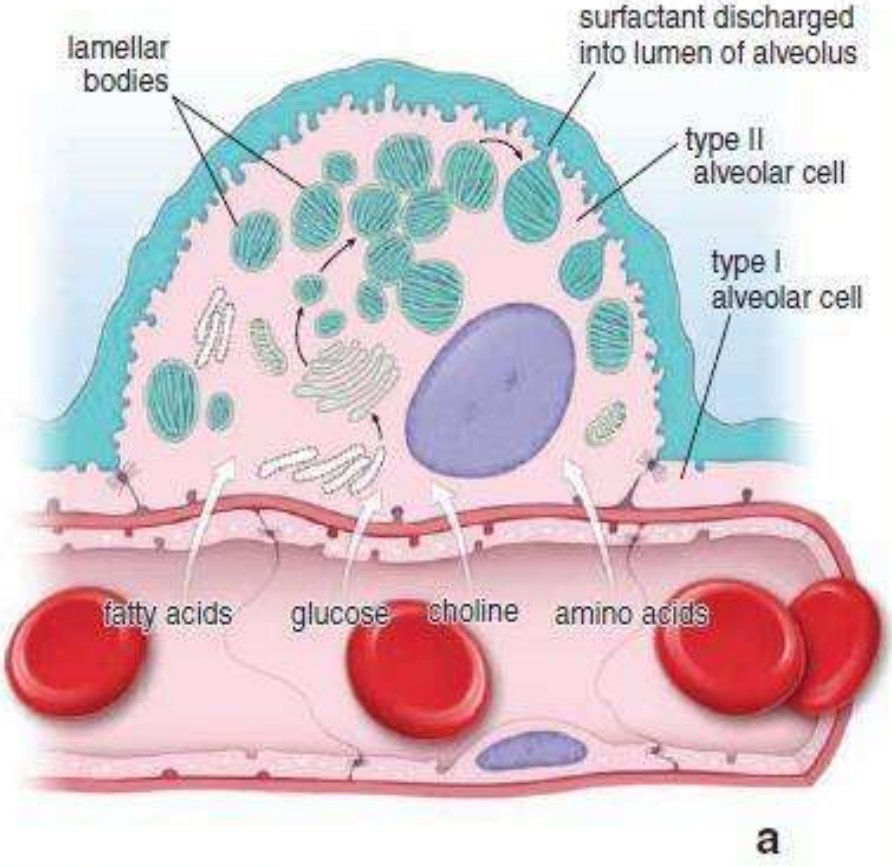
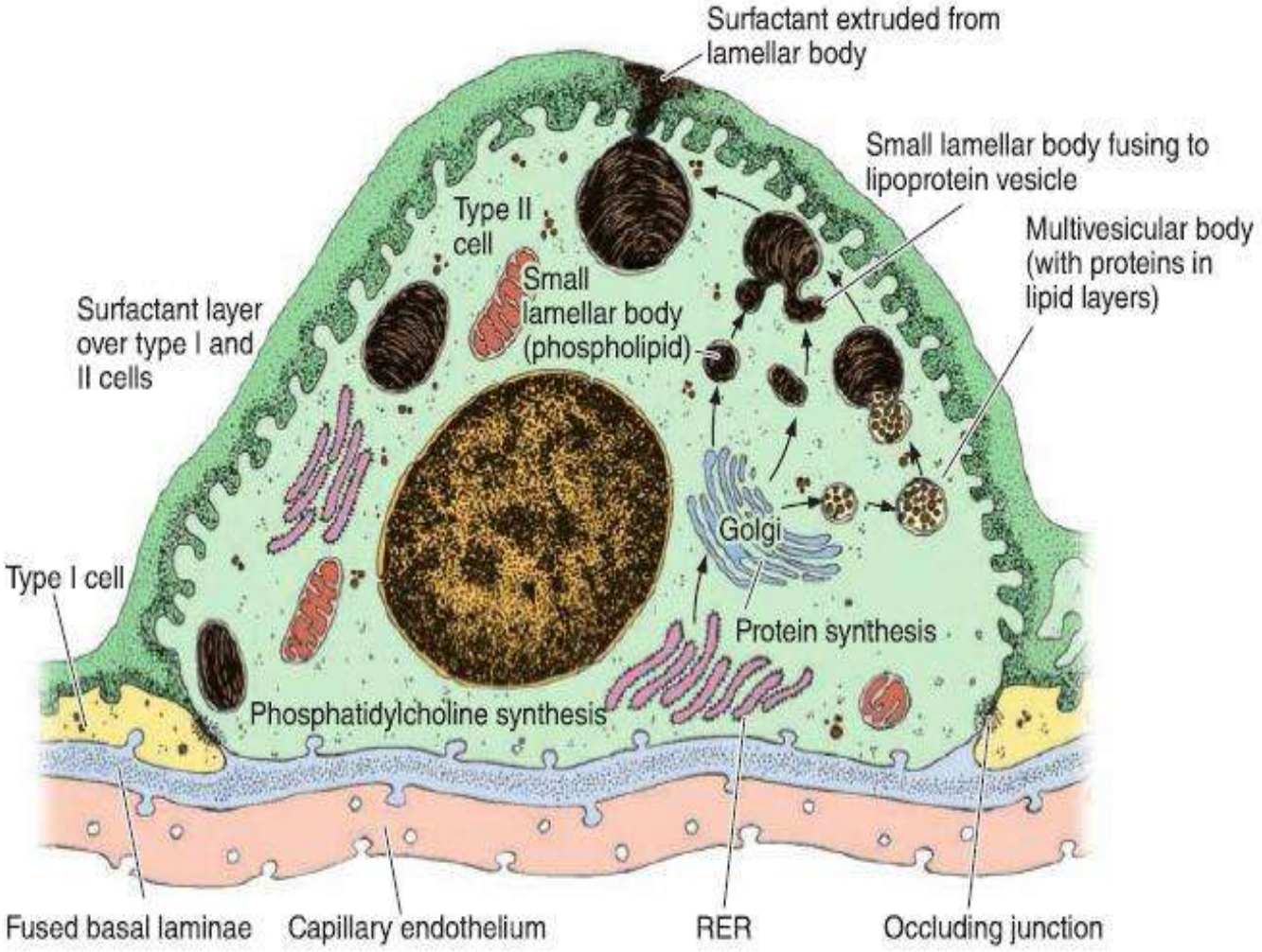


FIGURE 19.17 ▲ Diagram of a type II alveolar cell and electron micrograph of lamellar bodies. a. Surfactant is an oily mixture of proteins, phospholipids, and neutral lipids that are synthesized in the rER from precursors in the blood. These precursors are glucose, fatty acids, choline, and amino acids. The protein constituents of surfactant are produced in the rER and stored in the cytoplasm within lamellar bodies, which are discharged into the lumen of the alveolus. With the aid of surfactant protein, surfactant is distributed on the surface of epithelial cells lining the alveolus as a thin film that reduces the surface tension. **b.** Higher magnification electron micrograph showing the typical lamellar pattern of the secretory vesicles of type II alveolar cells. These vesicles contain the pulmonary surfactant precursor proteins. ×38,000. (Courtesy of Dr. A. Mercuri.)



The diagram illustrates **surfactant production** by a type II cell. Surfactant contains protein-lipid complexes synthesized initially in the ER and Golgi apparatus, with further processing and storage in large organelles called **lamellar bodies**. Also present are smaller multivesicular bodies, which form when membrane components of an early endosome are sorted, invaginate, and pinch off into smaller vesicles inside the endosome's lumen. In surfactant-producing cells the vesicles in multivesicular bodies are added to the lamellar bodies. Surfactant is secreted continuously by exocytosis and forms an oily film containing phospholipids and surfactant proteins.

Critical components of the surfactant layer are:
Phospholipid dipalmitoylphasphatidylcholine (DPPC), cholestrol and 4 surfactant proteins

Surfactant proteins help organize the surfactant layer and modulate alveolar immune responses.

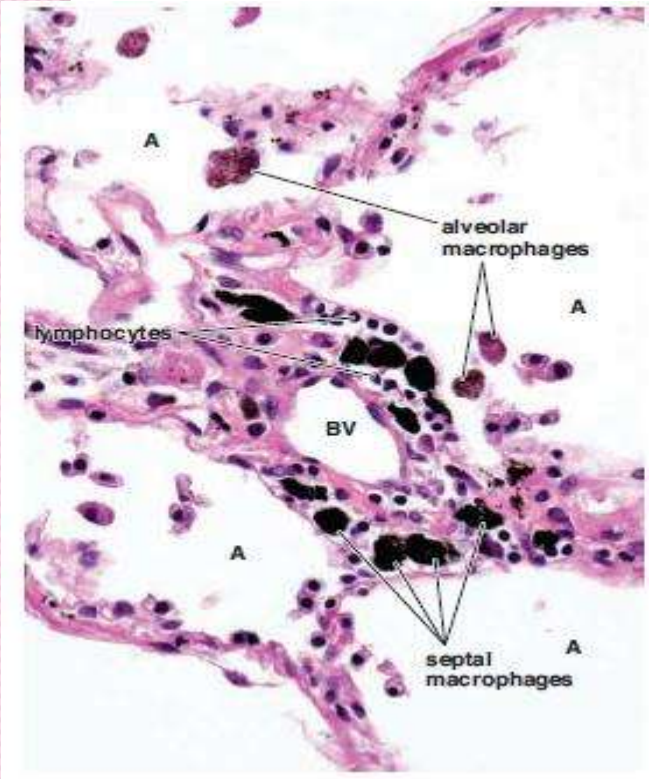
Surfactant protein A (SP-A): an abundant hydrophilic glycoprotein

Surfactant protein B (SP-B), (SP-C) : are hydrophobic membrane proteins required for the proper orientation of DPPC in the surfactant film

Surfactant protein D (SP-D): important for innate immune protection

Alveolar macrophages are unusual in that they function both in the connective tissue of the septum and in the air space of the alveolus.

Collateral air circulation through alveolar pores allows air to pass between alveoli.



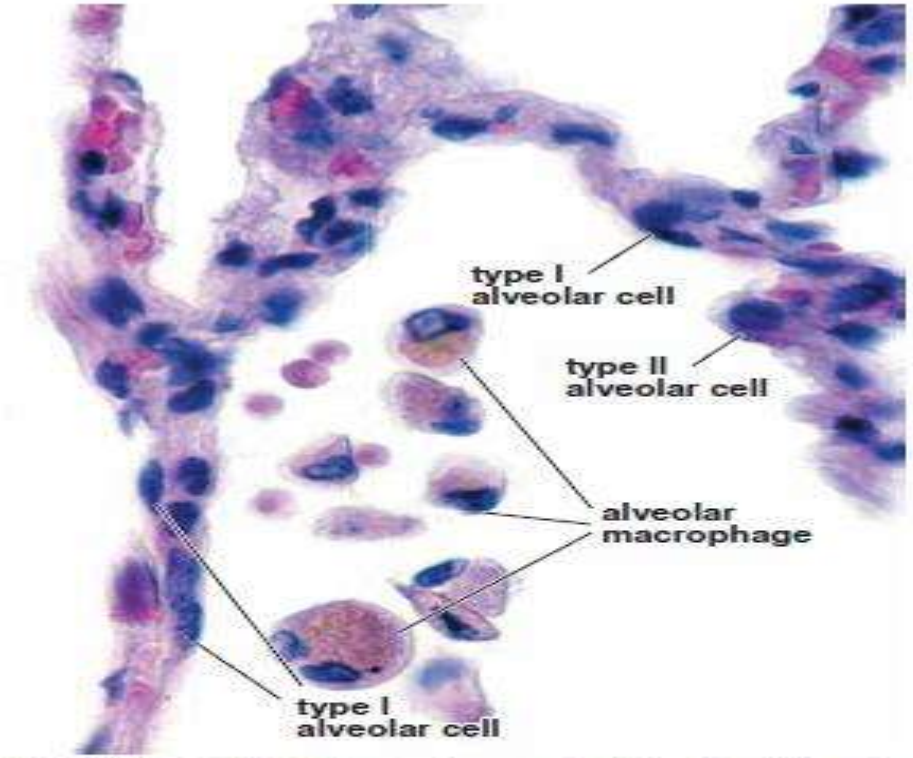
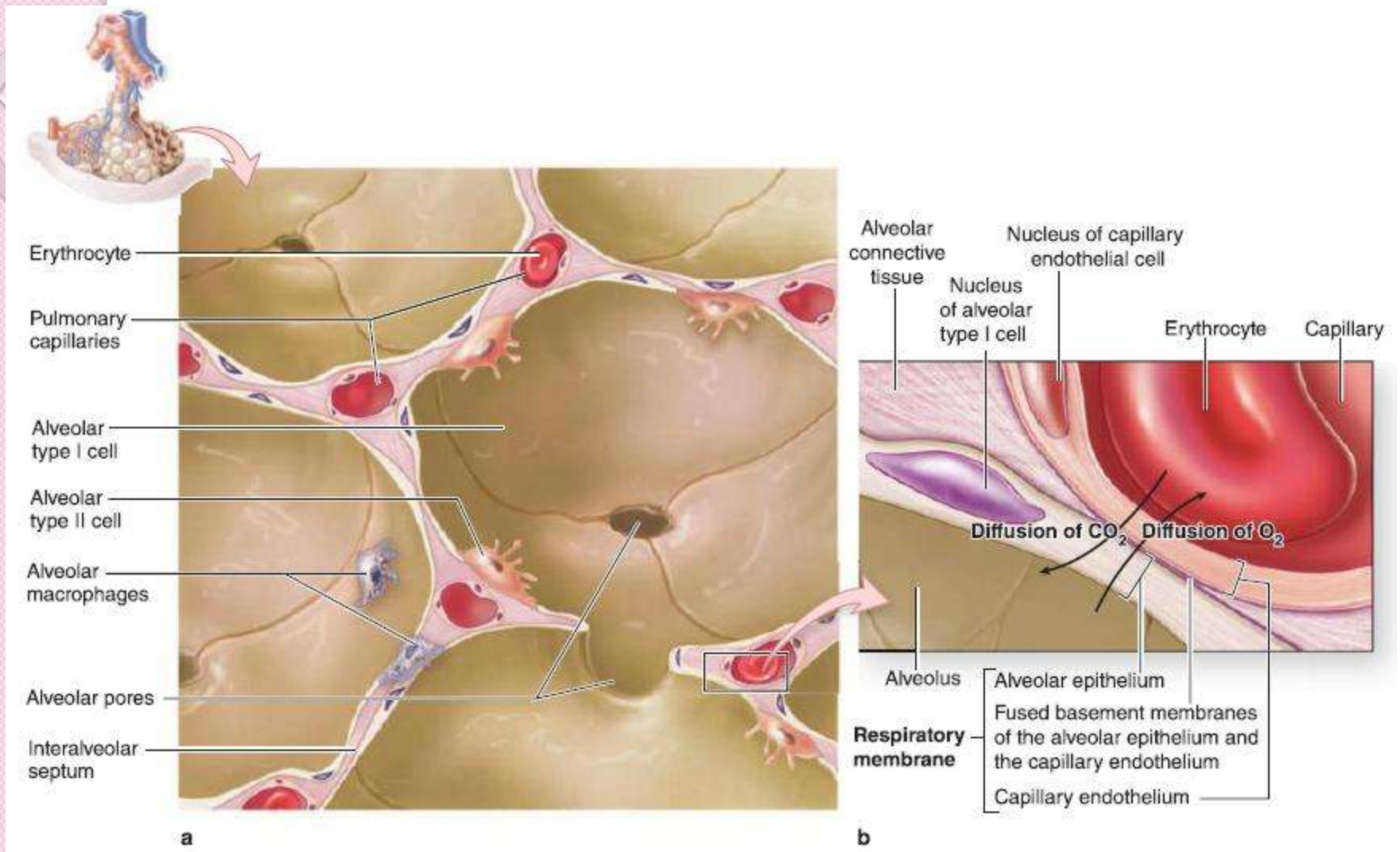


FIGURE 19.20 ▲ **Photomicrograph of alveoli and alveolar macrophages.** This high-magnification photomicrograph shows the structure of the alveolar septum and the lumen of an alveolus containing alveolar macrophages and red blood cells. The cytoplasm of the alveolar macrophages, when they are present in significant numbers, often contains the brown pigment hemosiderin from phagocytosed red blood cells. These hemosiderin-laden macrophages (often called "heart failure cells") are typically found in heart disease, mostly left ventricular failures that cause pulmonary congestion and edema. This results in enlargement of the alveolar capillaries and small hemorrhages into the alveoli. ×560.


Erythrocyte
Pulmonary capillaries
Alveolar type I cell
Alveolar type II cell
Alveolar macrophages
Alveolar pores
Interalveolar septum
a
Alveolar connective tissue
Nucleus of capillary endothelial cell
Nucleus of alveolar type I cell
Erythrocyte
Capillary
Diffusion of CO_2
Diffusion of O_2
Alveolus
Alveolar epithelium
Respiratory membrane
Fused basement membranes of the alveolar epithelium and the capillary endothelium
Capillary endothelium
b

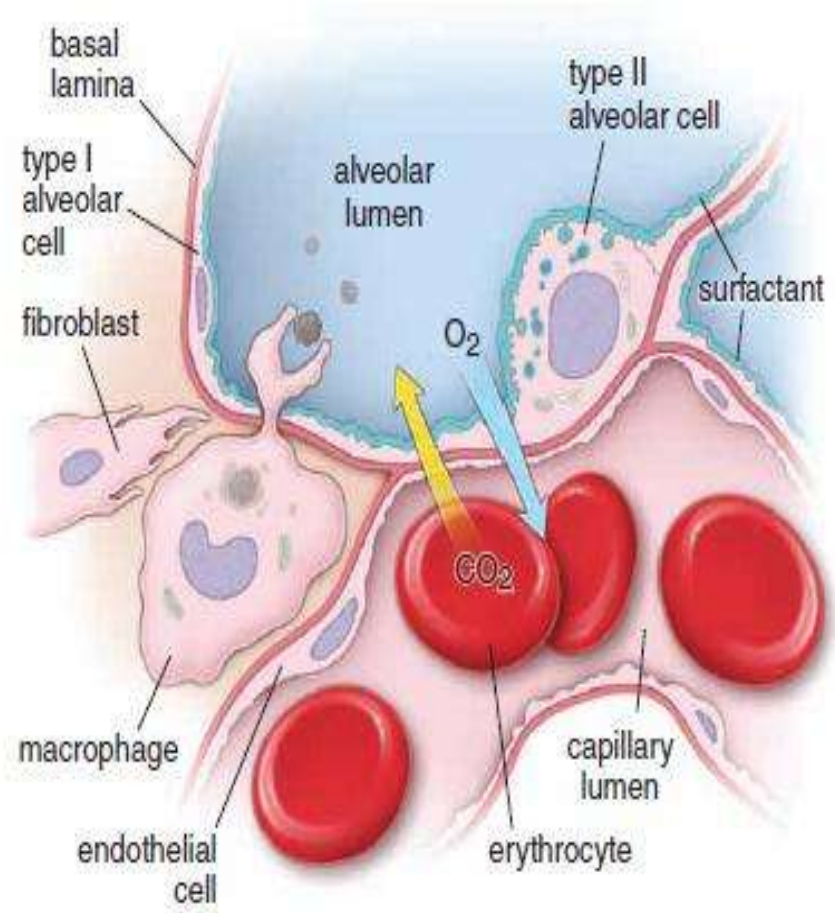
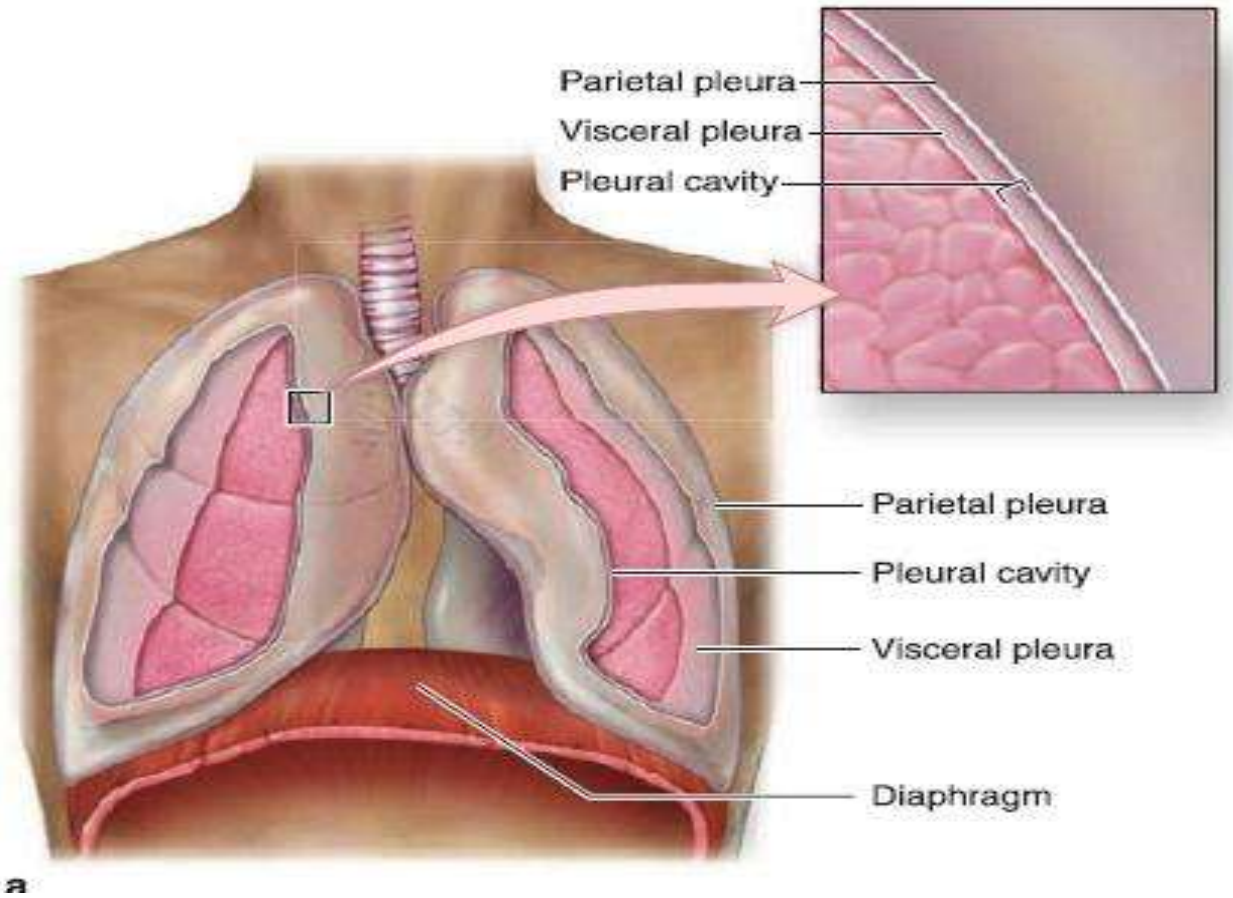


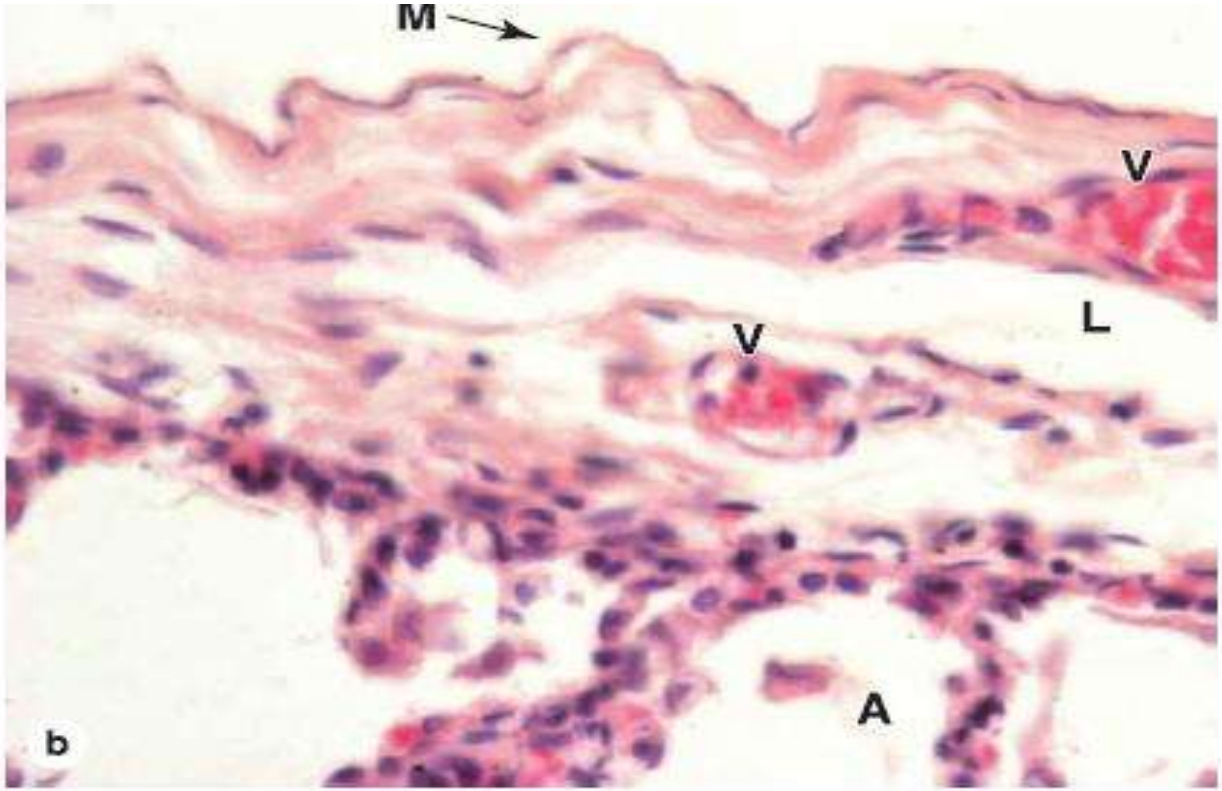
FIGURE 19.18 ▲ Diagram of the interalveolar septum. This diagram shows the thick and thin portions of the interalveolar septum. The thin portion forms the air–blood barrier and is responsible for most of the gas exchange that occurs in the lung. *Arrows* indicate the direction of CO_2 and O_2 exchange between the alveolar air space and the blood. The thick portion of the interalveolar septum plays an important role in fluid distribution and its dynamics. It contains connective tissue cells. Note the macrophage in the thick portion that extends its processes into the lumen of the alveolus.

TABLE 17–2 Features of airways within the lungs.

Region of Airway	Epithelium	Muscle and Skeletal Support	Other Features and Major Functions
Bronchi	Respiratory	Prominent spiral bands of smooth muscle; irregular hyaline cartilage plates	Repeated branching; conduct air deeper into lungs
Bronchioles	Simple ciliated cuboidal to columnar, with exocrine club cells	Prominent circular layer of smooth muscle; no cartilage	Conduct air; important in bronchoconstriction and bronchodilation
Terminal bronchioles	Simple cuboidal, ciliated cells and club cells	Thin, incomplete circular layer of smooth muscle; no cartilage	Conduct air to respiratory portions of lungs; exocrine club cells with several protective and surfactant functions
Respiratory bronchioles	Simple cuboidal, ciliated cells and club cells, with scattered alveoli	Fewer smooth muscle fibers, mostly around alveolar openings	Conduct air deeper, with some gas exchange, and protective and surfactant functions of club cells
Alveolar ducts and sacs	Simple cuboidal between many alveoli	Bands of smooth muscle around alveolar openings	Conduct air, with much gas exchange
Alveoli	Types I and II alveolar cells (pneumocytes)	None (but with network of elastic and reticular fibers)	Sites of all gas exchange; surfactant from type II pneumocytes; dust cells

FIGURE 17–18 Pleura.





The pleura are serous membranes (serosa) associated with each lung and thoracic cavity. **(a)** The diagram shows the **parietal pleura** lining the inner surface of the thoracic cavity and the **visceral pleura** covering the outer surface of the lung. Between these layers is the narrow space of the pleural cavity. **(b)** Both layers are similar histologically and consist of a simple squamous mesothelium (**M**) on a thin layer of connective tissue, as shown here for visceral pleura covering alveoli (**A**). The connective tissue is rich in both collagen and elastic fibers and contains both blood vessels (**V**) and lymphatics (**L**). (X140; H&E)

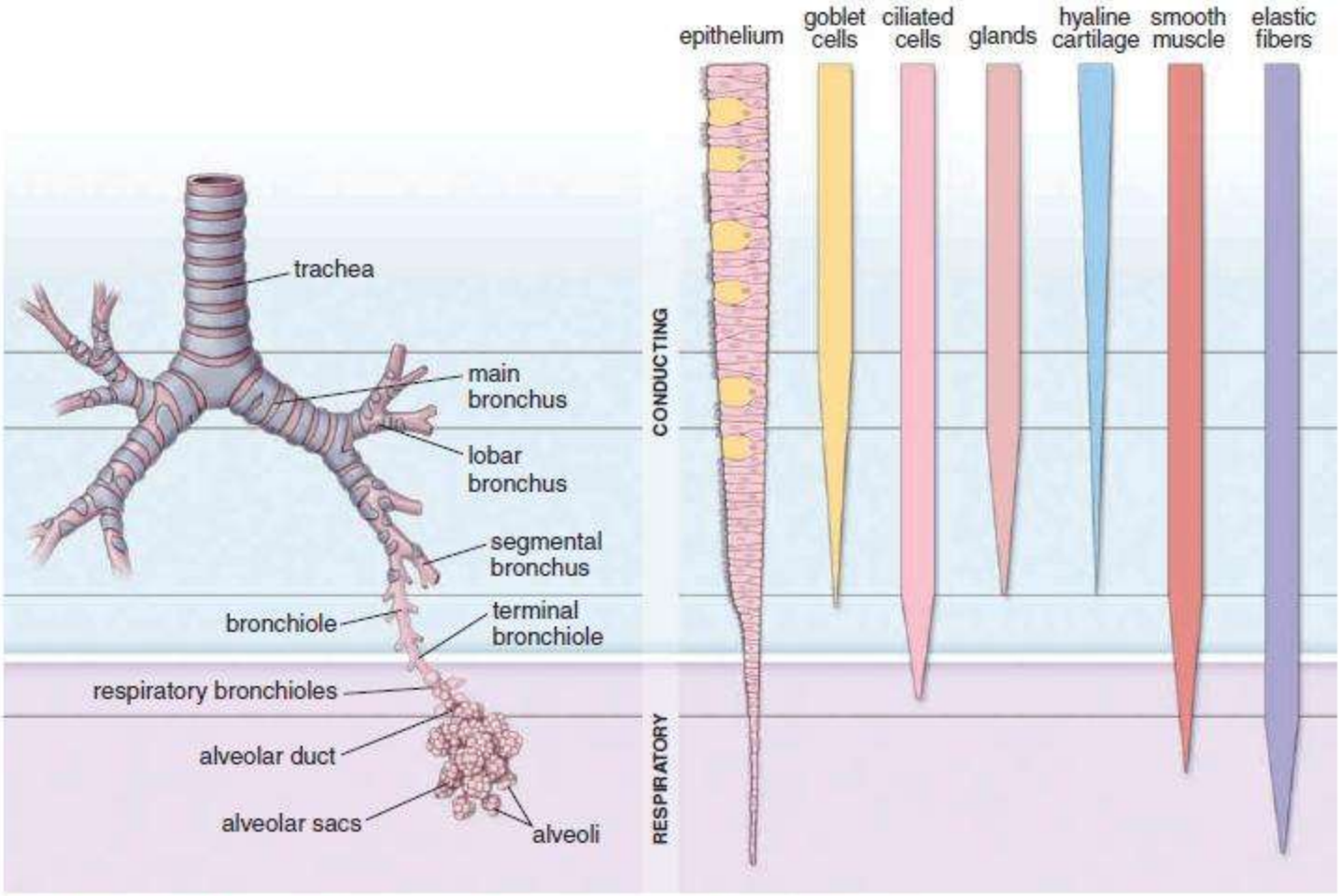


FIGURE 19.22 ▲ Divisions of the bronchial tree and summary of its histological features.


خداوندا
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هیچ کار به سامان نمیرسد
نکبت را از ما دریغ نکن