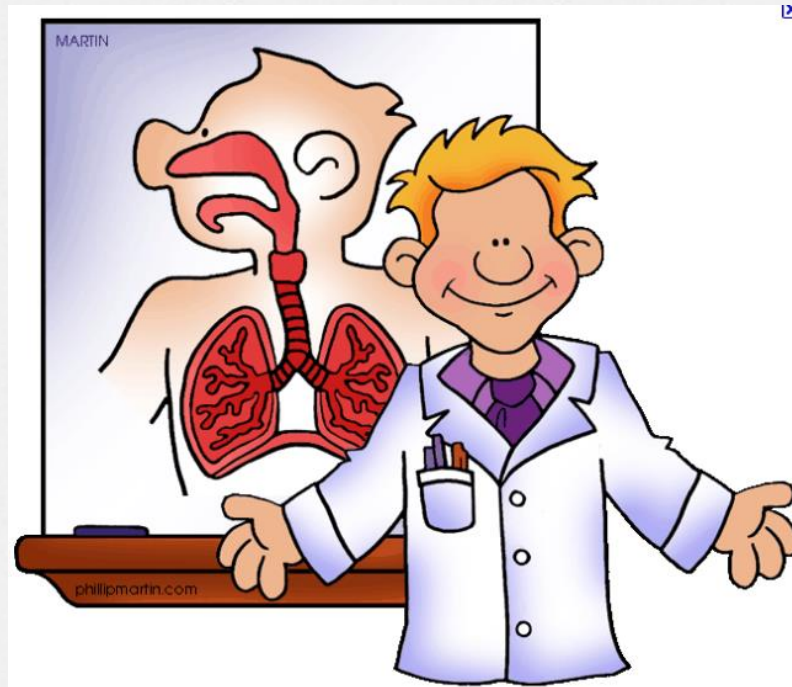


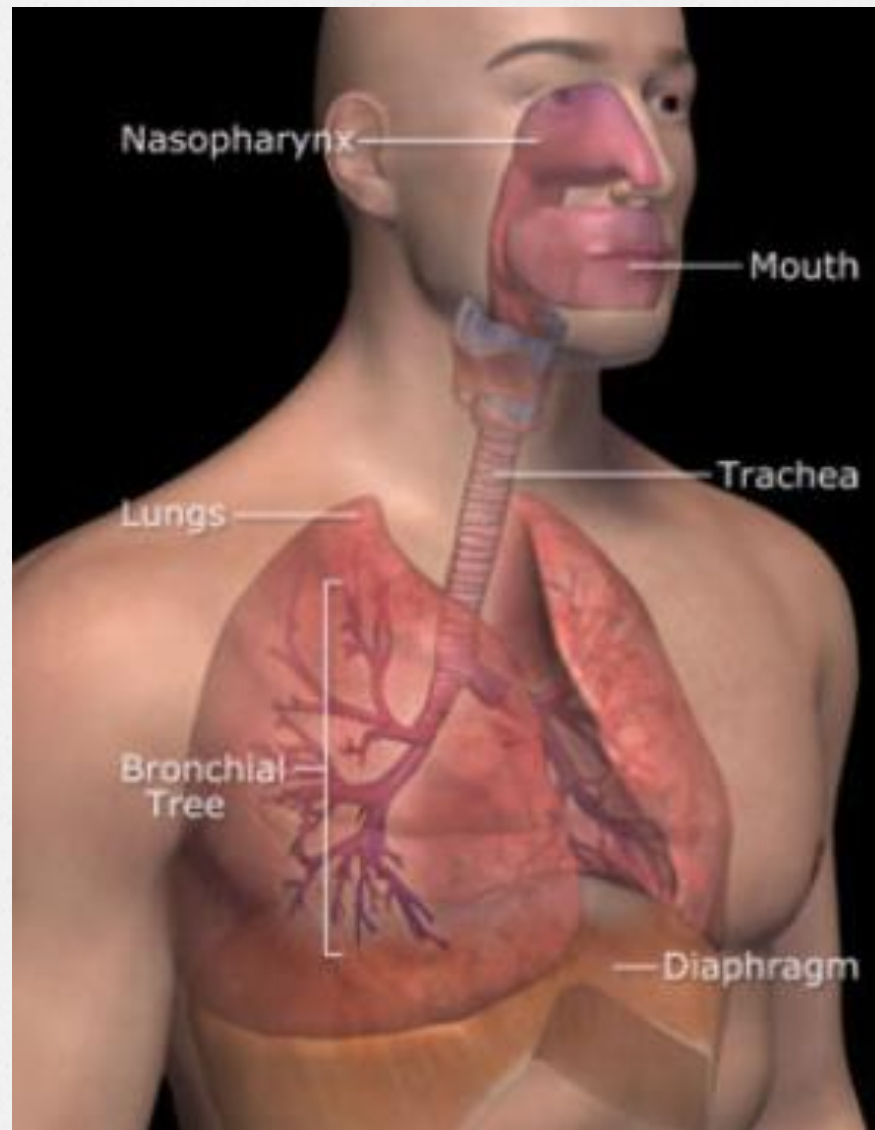
# Respiratory system



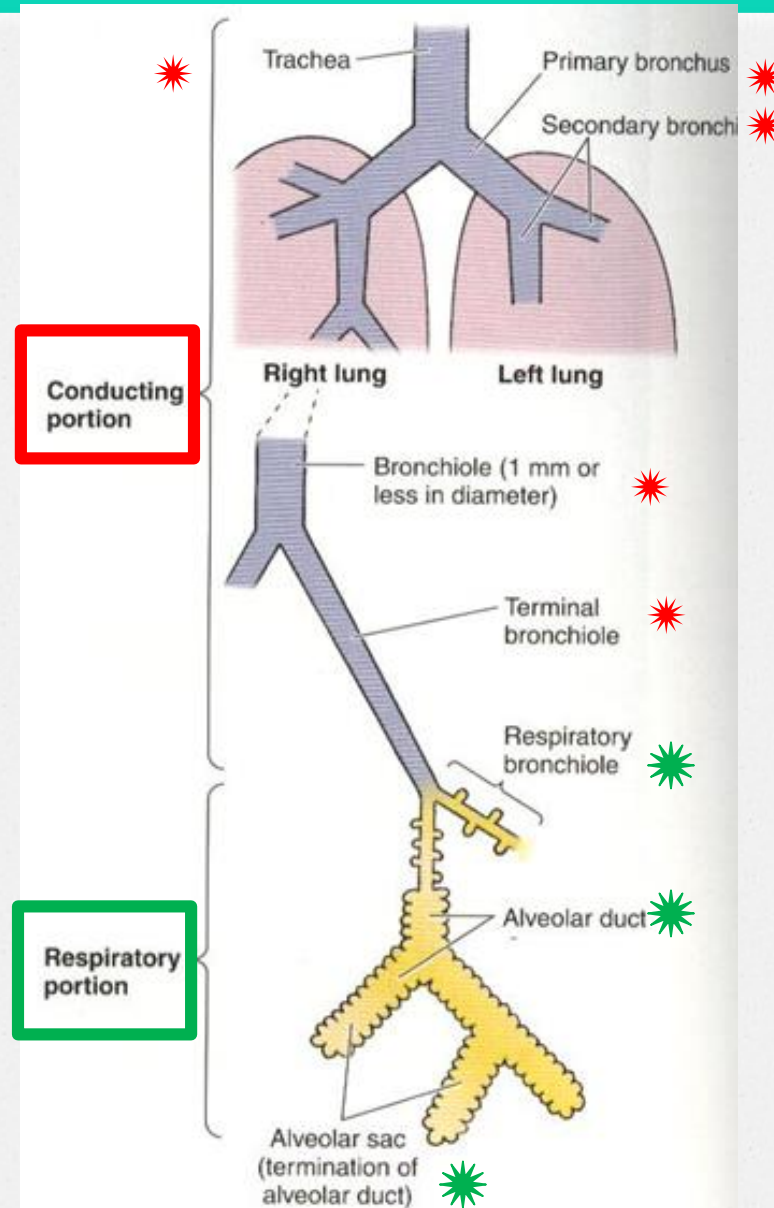
# Objectives

- List the parts of the respiratory system.
- Briefly describe the histological features of the nasal cavity, nasopharynx, larynx and trachea & bronchial tree.
- Describe the differences between follows.
  - extrapulmonary & intrapulmonary bronchi
  - bronchi & bronchioles
  - terminal bronchioles & respiratory bronchioles
- Describe the alveolar capillary membrane.
- Describe the structural adaptations of the conducting and respiratory portions of the respiratory tract.

# Respiratory system



# Respiratory system: principal component



**Conducting portion :** Nasal cavity

Nasopharynx

Larynx

Trachea

Bronchi

Bronchioles

Terminal bronchioles

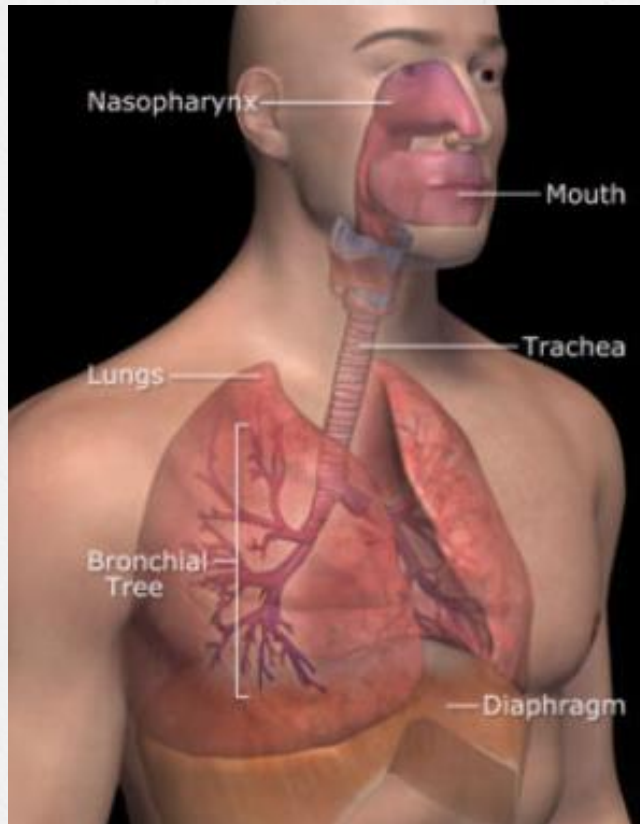
**Respiratory portion:** Sites where gas exchange occurs

Respiratory bronchioles

Alveolar ducts

Alveolar sacs and alveoli





outside air

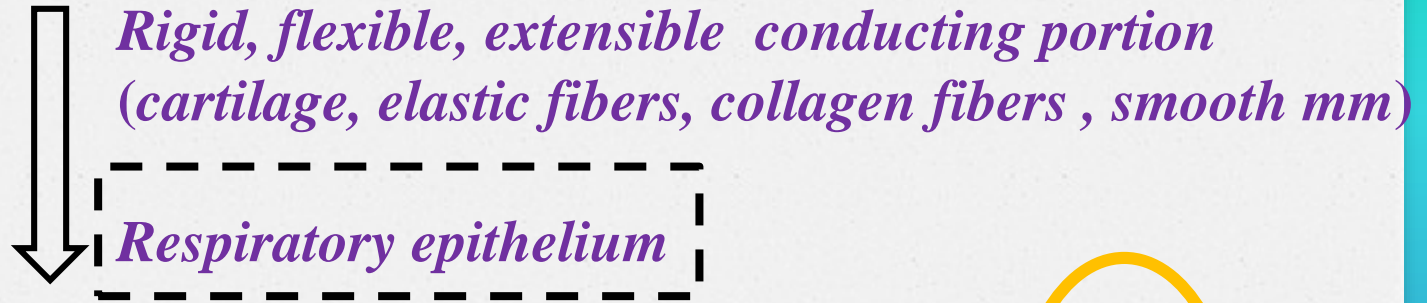
*Passageways*

Lung tissues

(one of the most delicate tissues in the body)

**Conditioning of air**

# Conditioning of air



**Cleansed  
Moistened  
Warmed**

**vibrissae  
&  
mucus**

*dust  
dirt  
smoke  
bacteria*

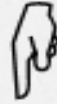


*mucous & serous secretions*

*rich superficial vascular network*

# Respiratory epithelium

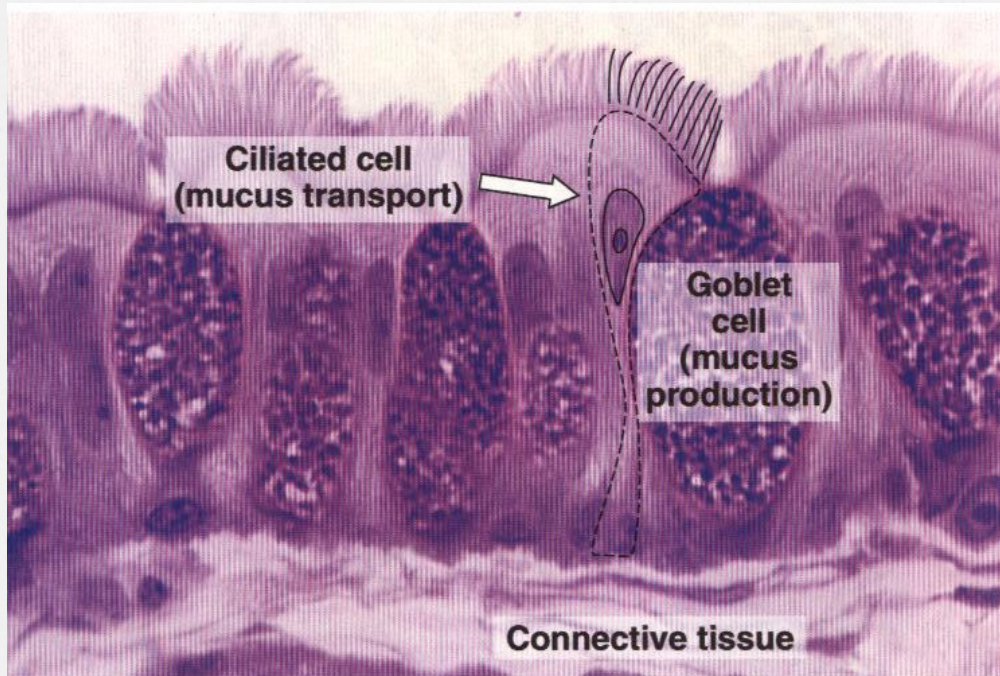
Most of the conducting portion



*pseudostratified columnar ciliated epithelium*

+

*rich population of goblet cells*





# Respiratory epithelium – 5 cell types

neuro-endocrine  
cell

small granule  
cells

Brush cell  
(with  
microvilli)

Goblet cell  
(with mucinogen  
secretory granules)

Cilia

Basal  
bodies

Columnar  
ciliated cell

Basal cell

(Stem cells)

Respiratory epithelium

Afferent  
nerve  
endings.  
Sensory  
receptors

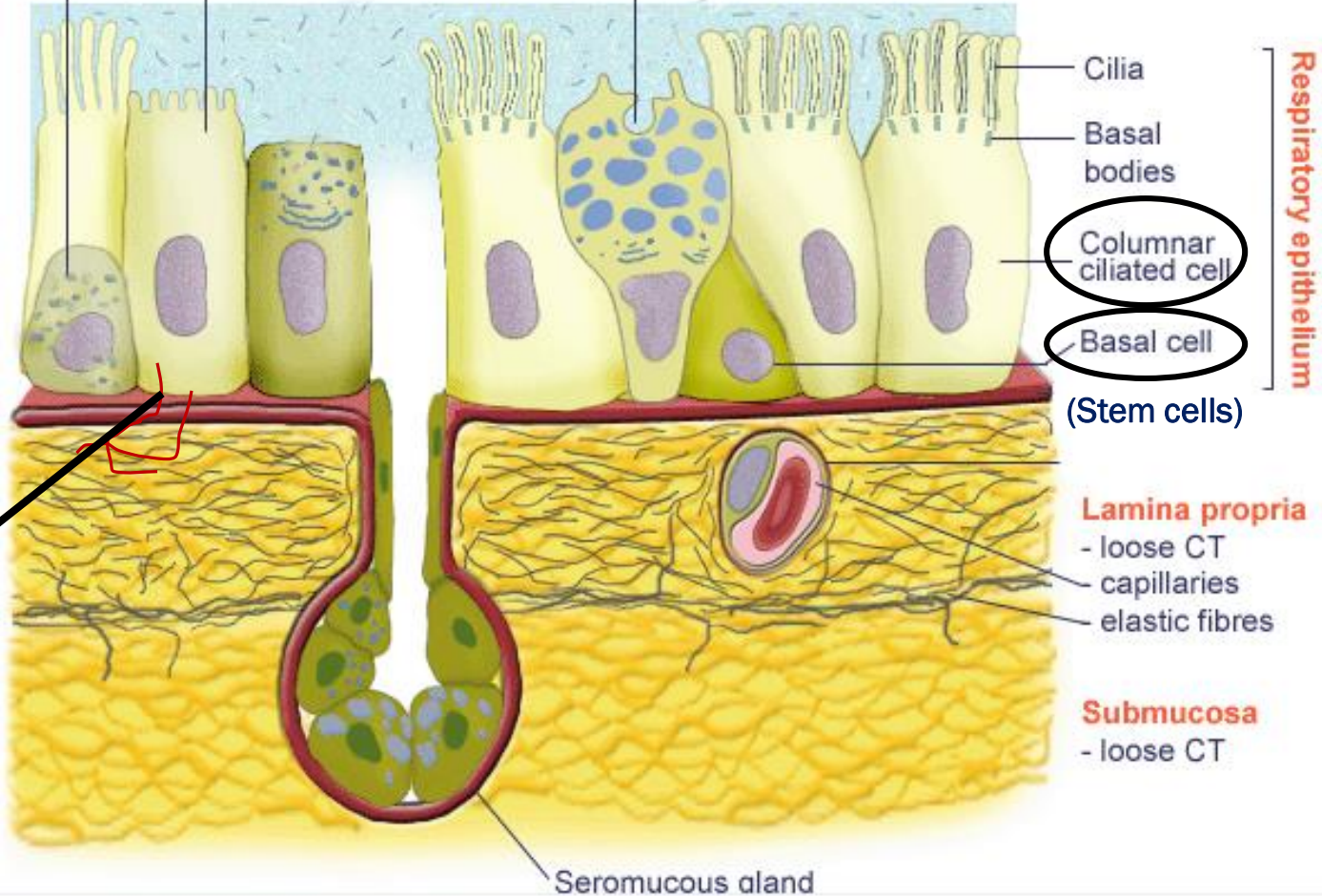
Lamina propria

- loose CT  
capillaries  
elastic fibres

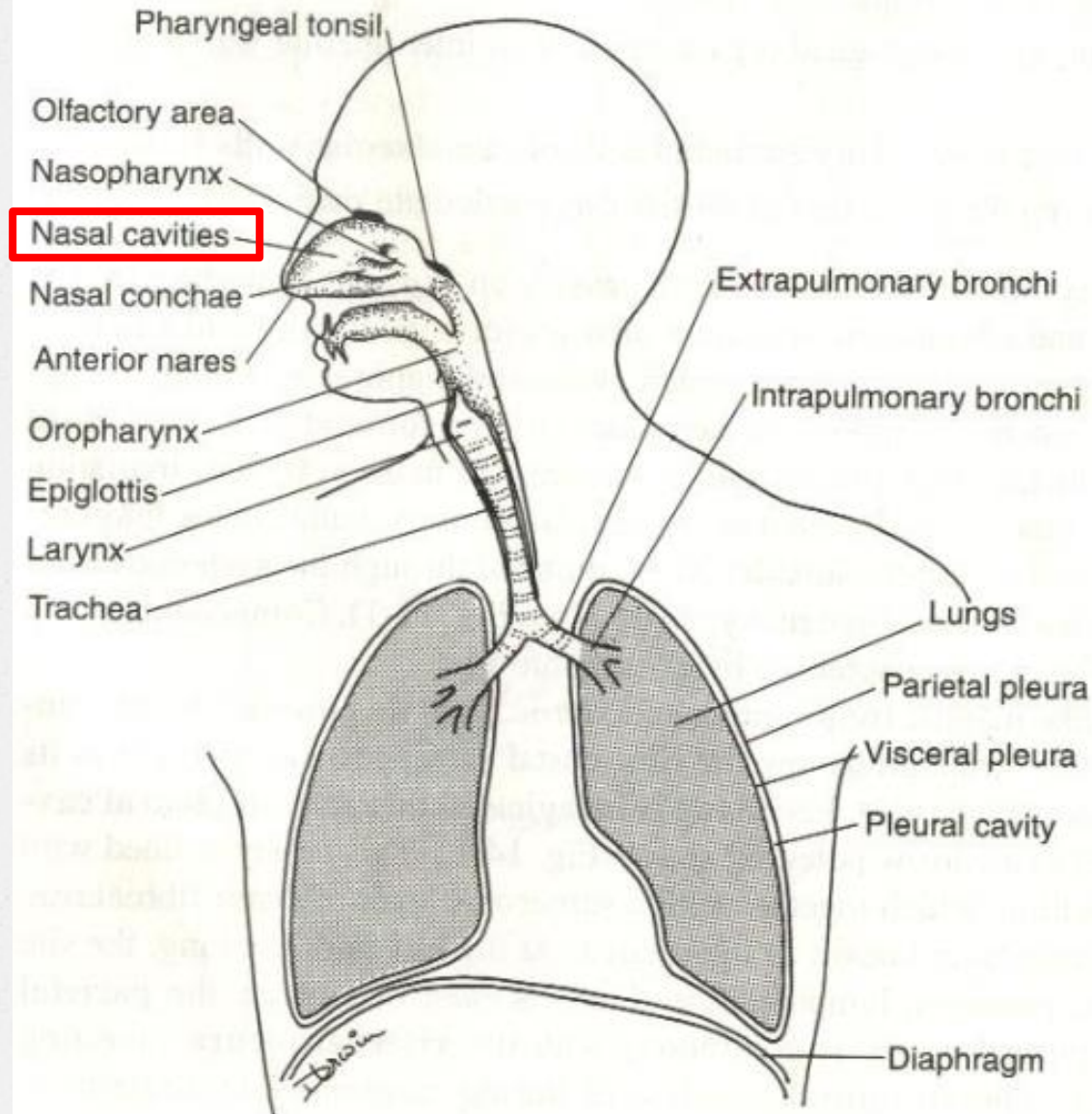
Submucosa

- loose CT

Seromucous gland



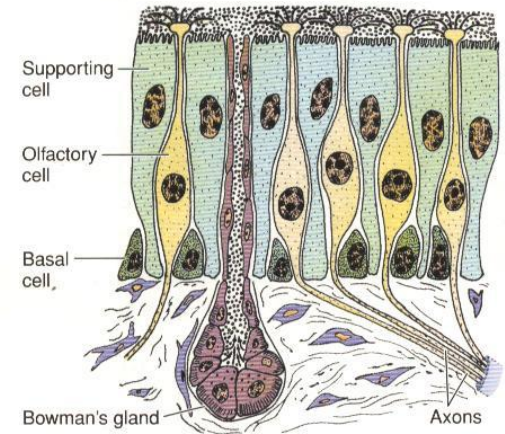
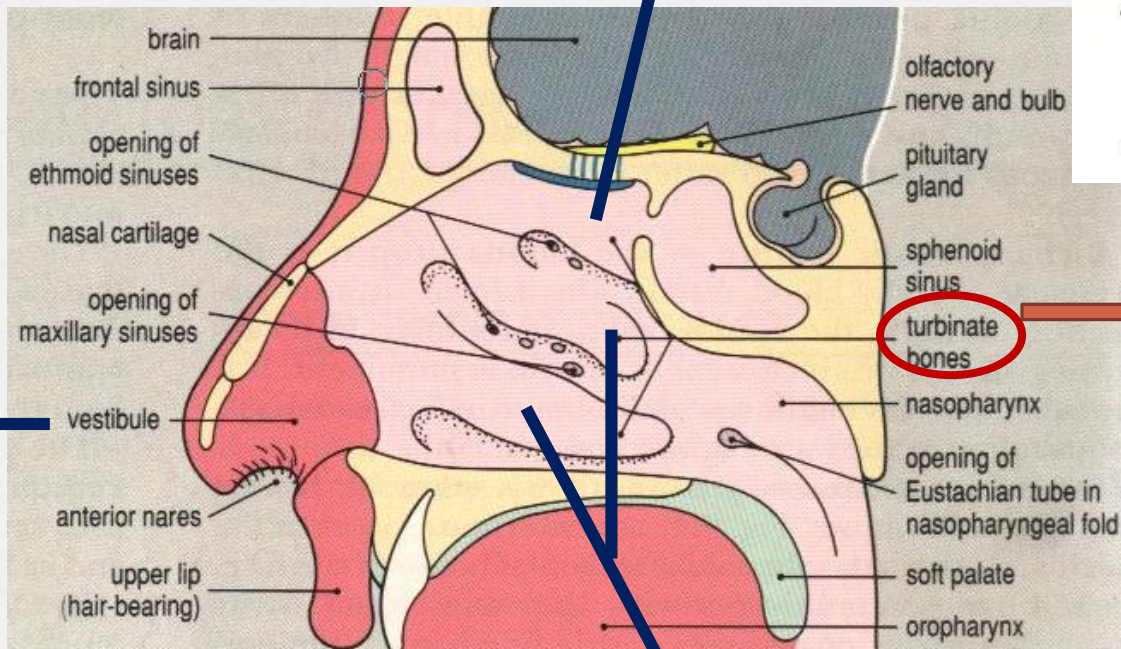
# Respiratory system: principal component





# Nasal cavity : vestibule + nasal fossae

Olfactory epithelium



Surface area ↑↑

Swell bodies  
(venous plexus)

recover from  
desiccation

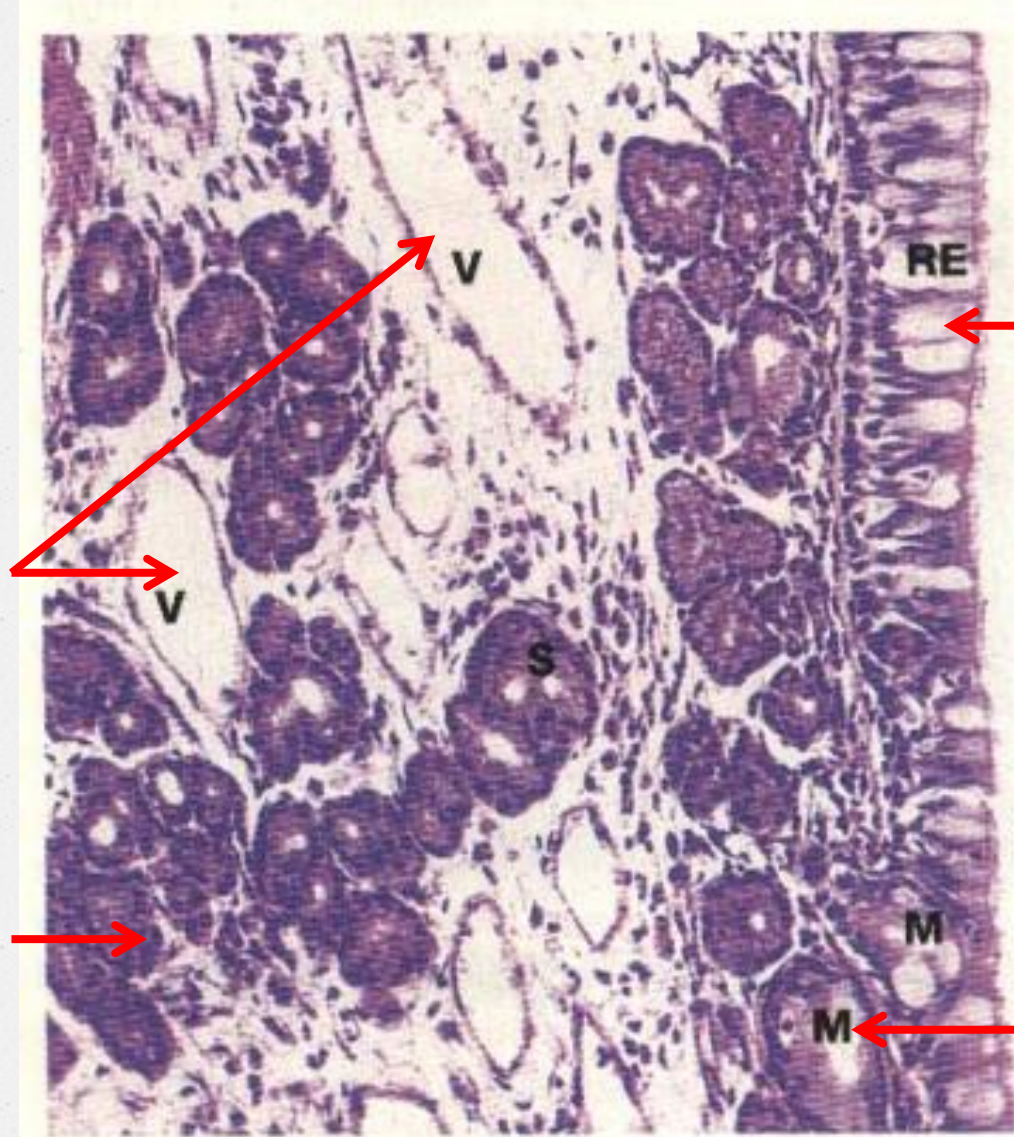
stratified squamous epithelium

pseudostratified columnar ciliated epithelium  
(respiratory epithelium)

# Nasal cavity : nasal fossae (H&E x 200 )

**Blood  
vessels**

**Serous  
glands**



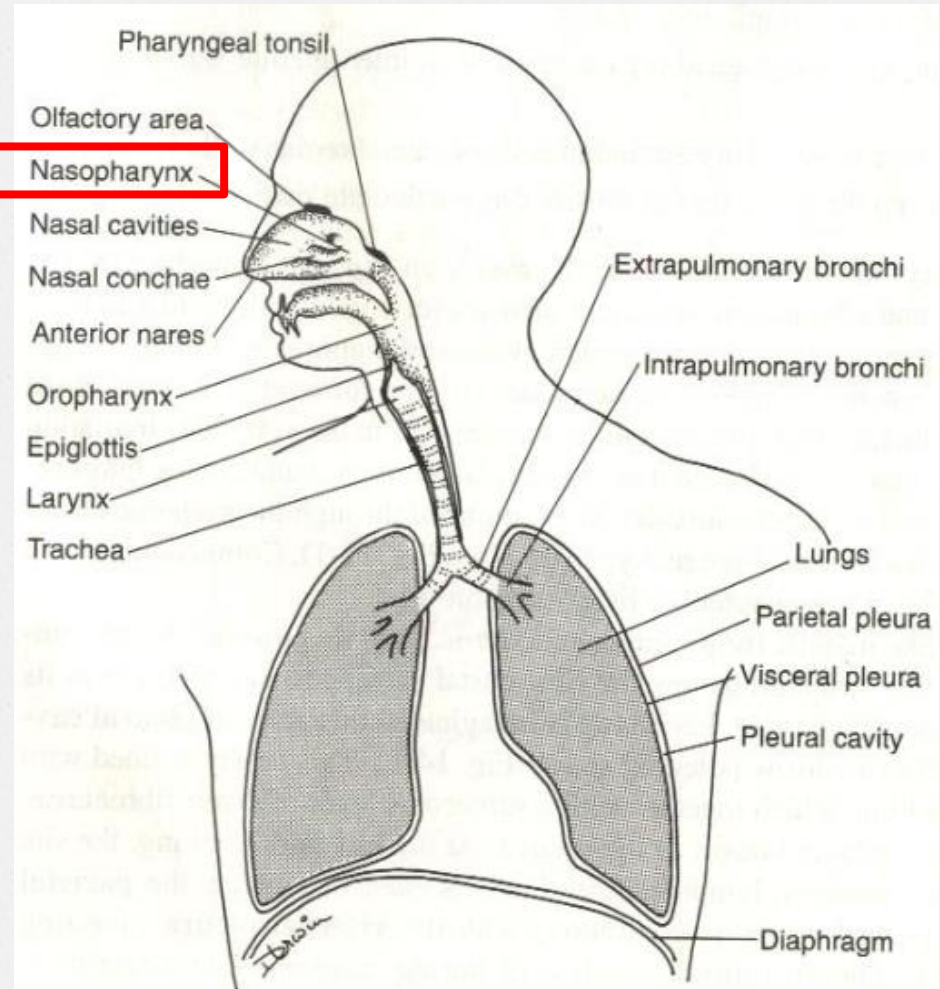
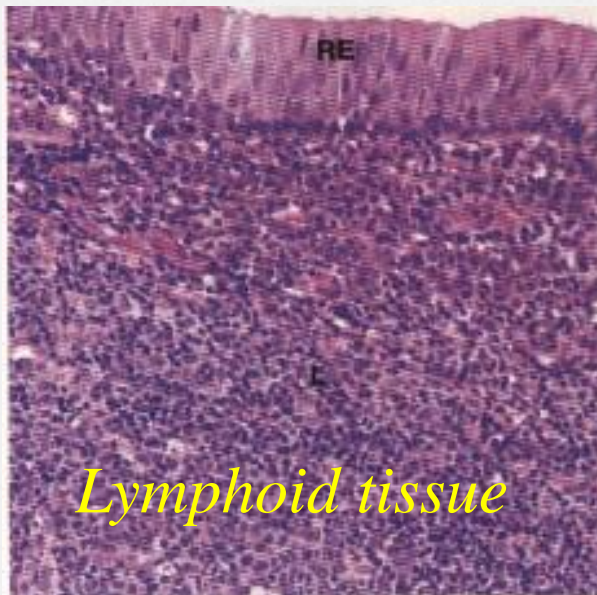
**Respiratory  
epithelium**

**Mucous  
glands**

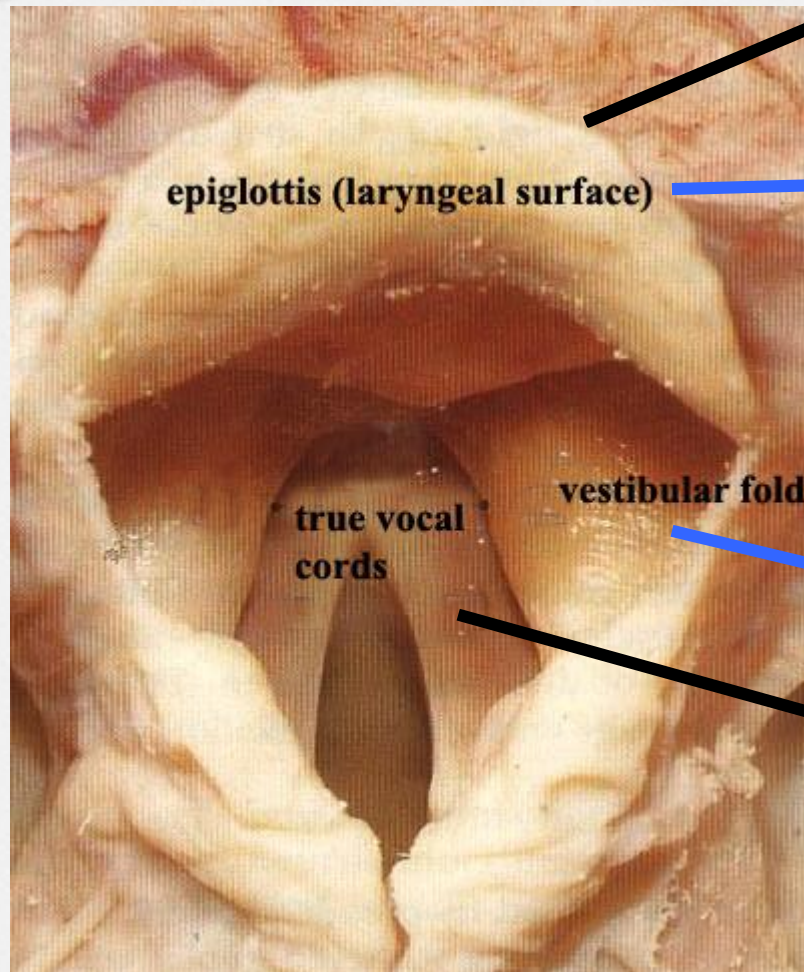


# Respiratory system: principal component

**respiratory  
epithelium**



# Larynx and Epiglottis



Lingual surface : stratified squamous epithelium

pseudostratified columnar ciliated epithelium  
(mixed mucous and serous glands – beneath the epithelium)

pseudostratified columnar ciliated epithelium

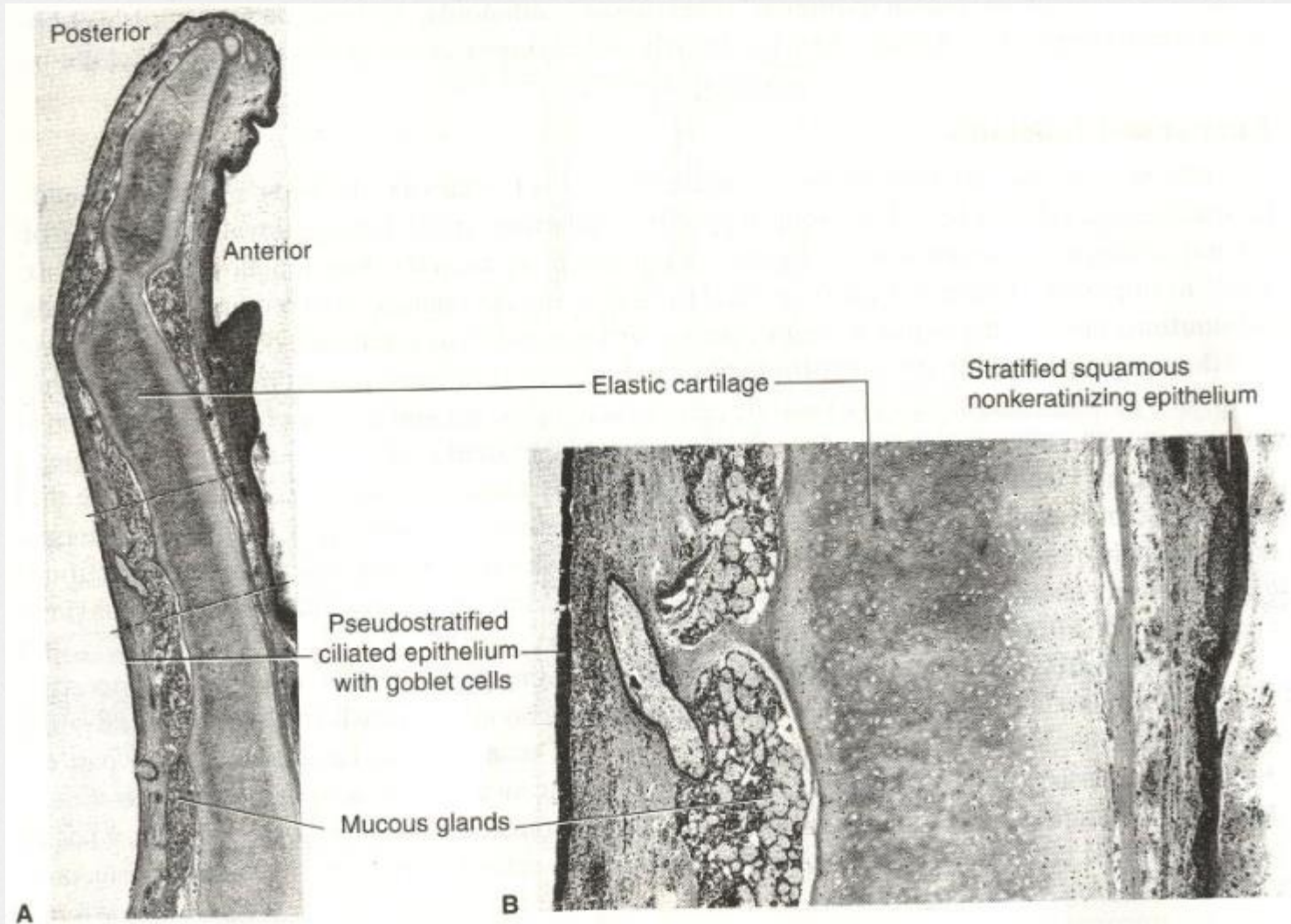
stratified squamous epithelium

true  
vocal  
cords

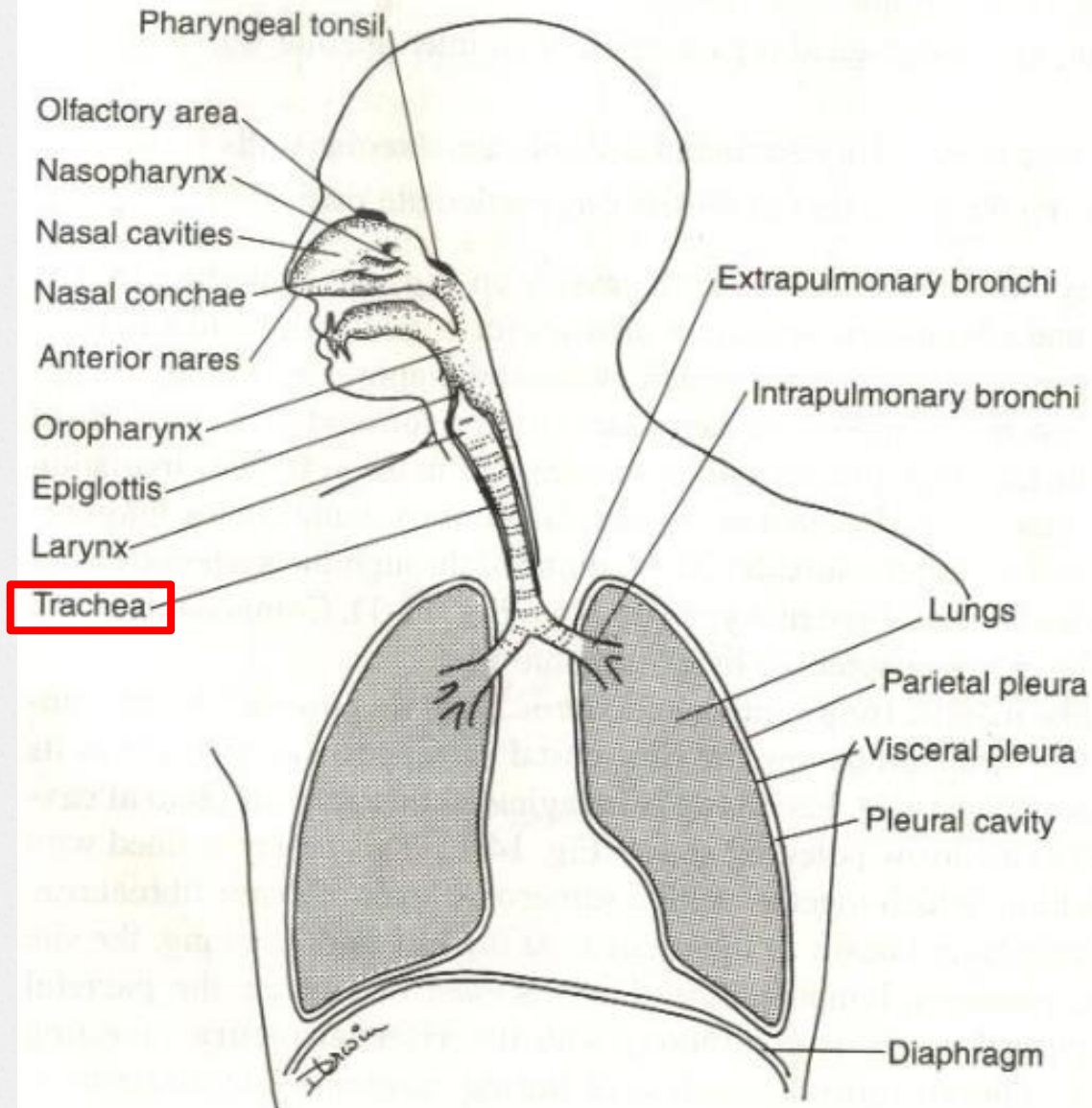
*large bundles of parallel elastic fibres - vocal ligament  
bundles of skeletal muscles parallel to ligament- Vocalis mm*



# Epiglottis



# Respiratory system: principal component





# Trachea

prevent over distention - lumen

*Fibroelastic ligament  
& smooth mm bundle*

regulation - lumen

*seromucous  
glands*

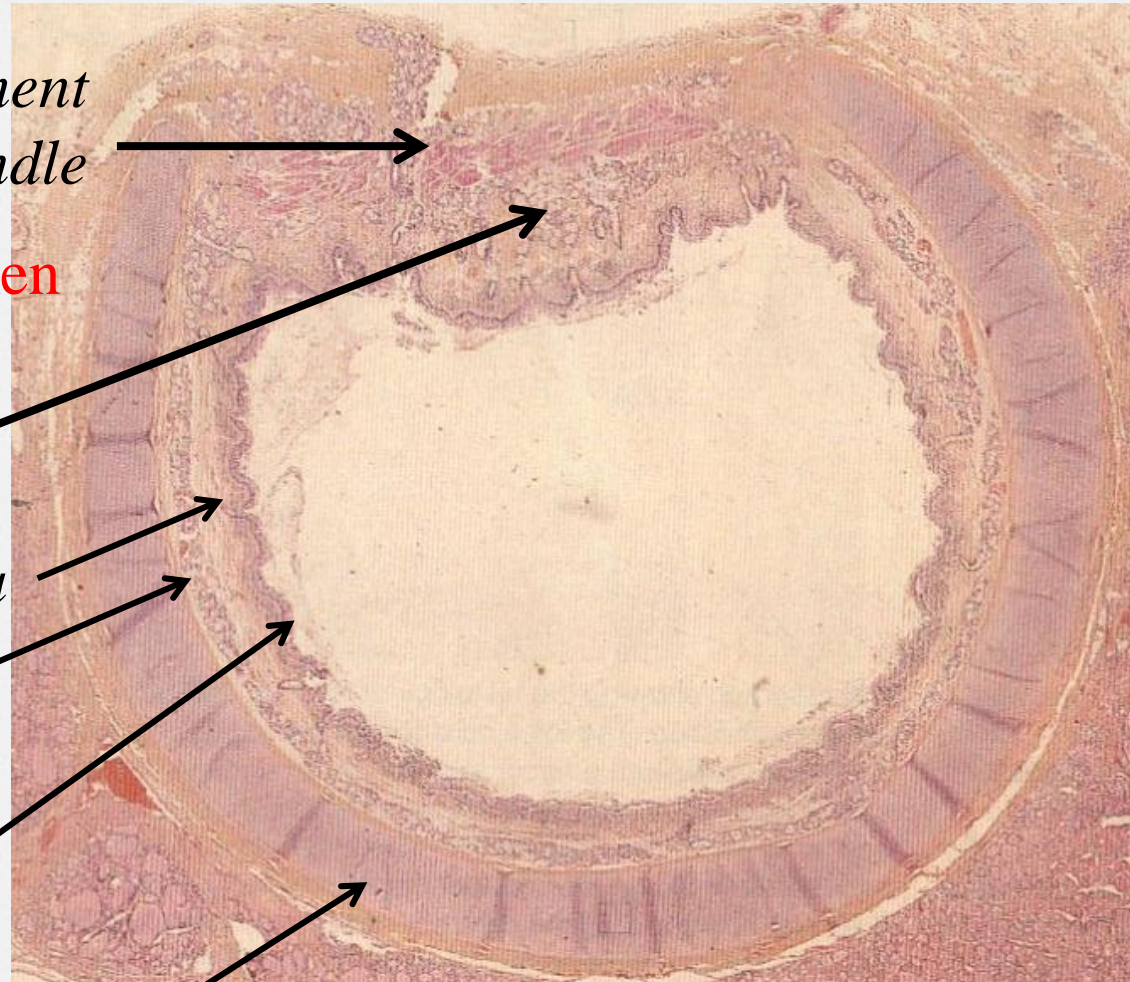
*lamina propria*

*submucosa*

*Respiratory  
epithelium*

*c-shaped cartilage*

*anterior*



# Trachea

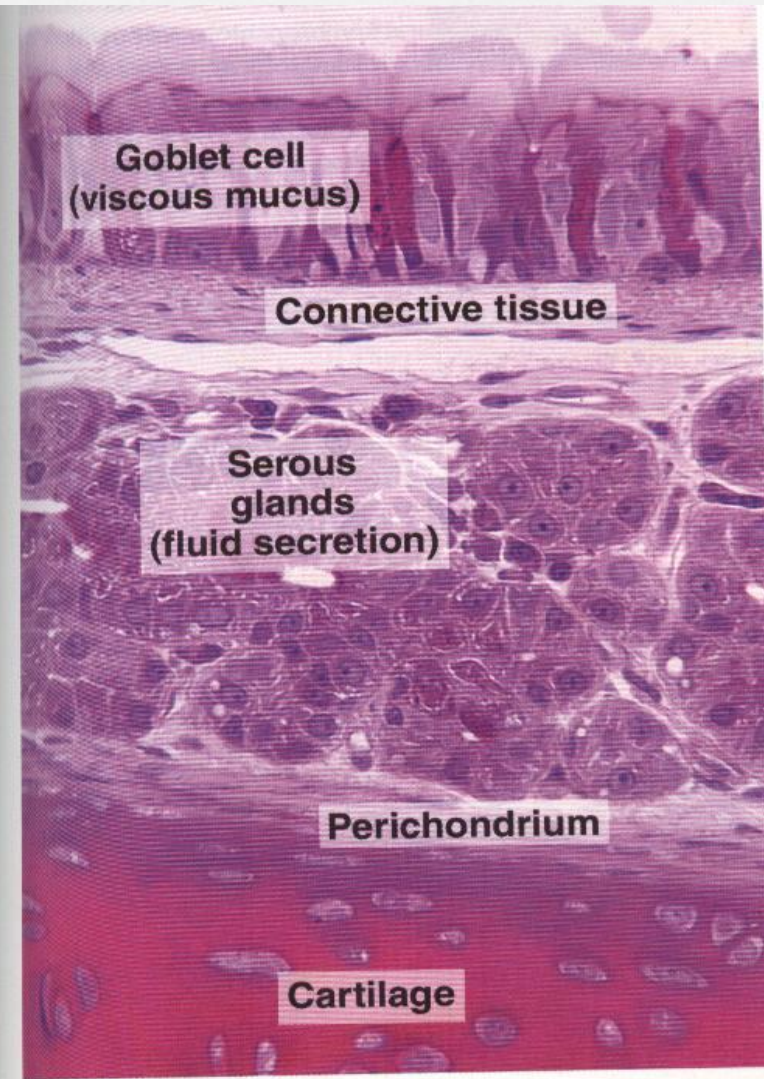
*Hyaline cartilage*



*trachealis mm*

*Longitudinal mm*

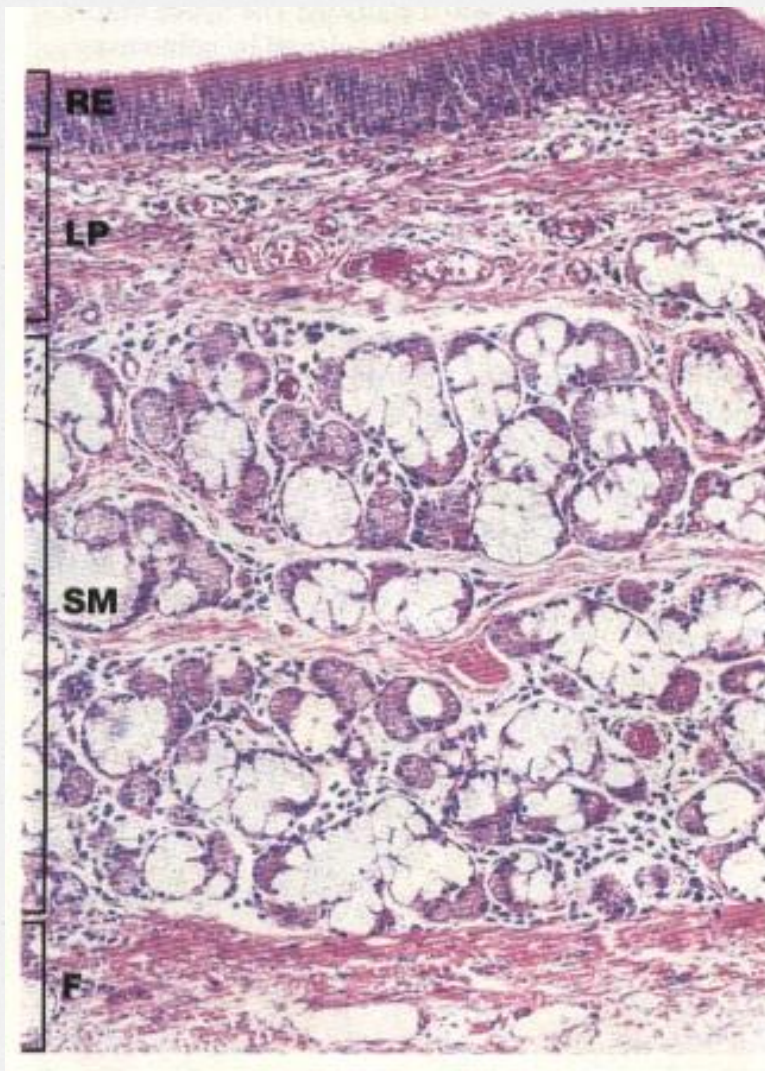
**(H&E/ Alcian x 9)**



**(PT stain )**



# Trachea



(H&E x 200)

*Hyaline Cartilage  
not in this field*

# Bronchial Tree

**Trachea**



primary bronchi

*In the larger portions of the bronchi the cartilage rings completely encircle the lumen*



**Extrapulmonary bronchi**



# Bronchial tree

**Trachea**



**primary bronchi**



**lobar bronchi + segmental bronchi**

**(Supply pulmonary lobes + broncopulmonary seg.)**



**Bronchioles** (*each enters a pulmonary lobule*)



**Terminal bronchioles**



**Respiratory bronchioles**



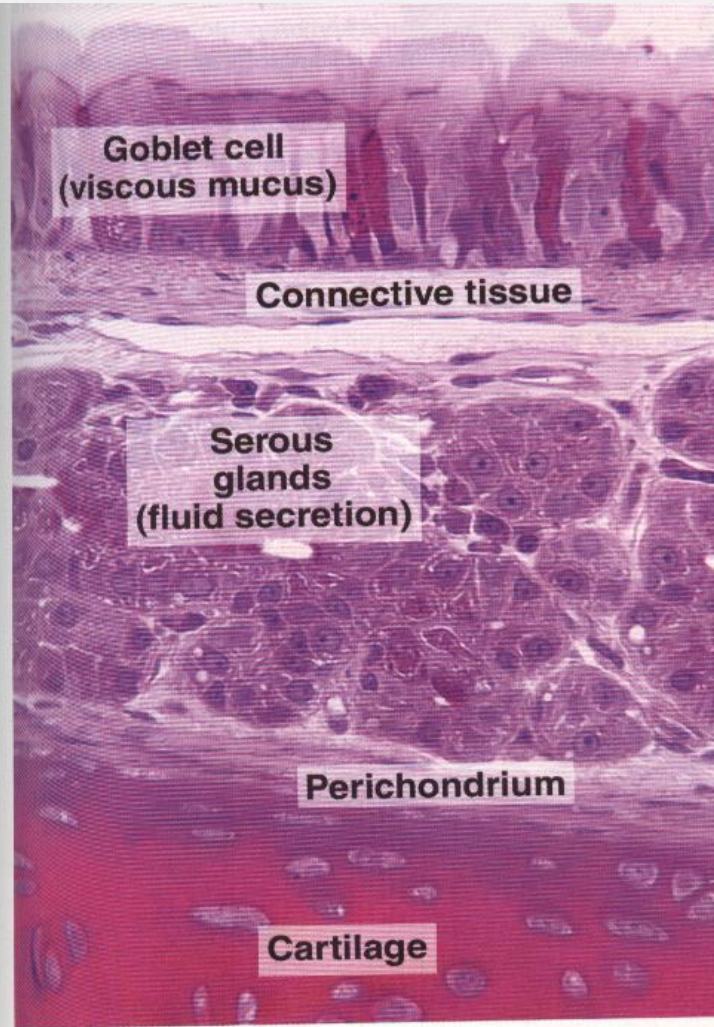
**Alveolar ducts**



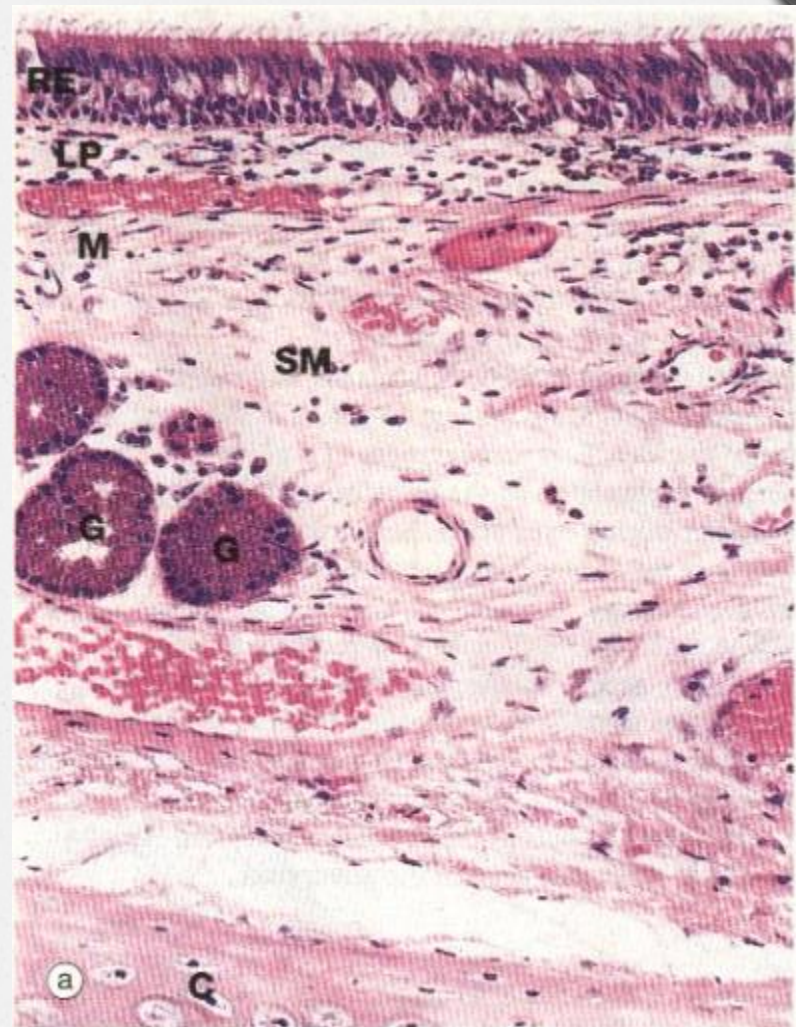
**Alveoli**

# **Histology - Bronchial tree**

- Changes occur in histological organization of both epithelium and underlying lamina propria.
- This change is gradual and no abrupt transition.



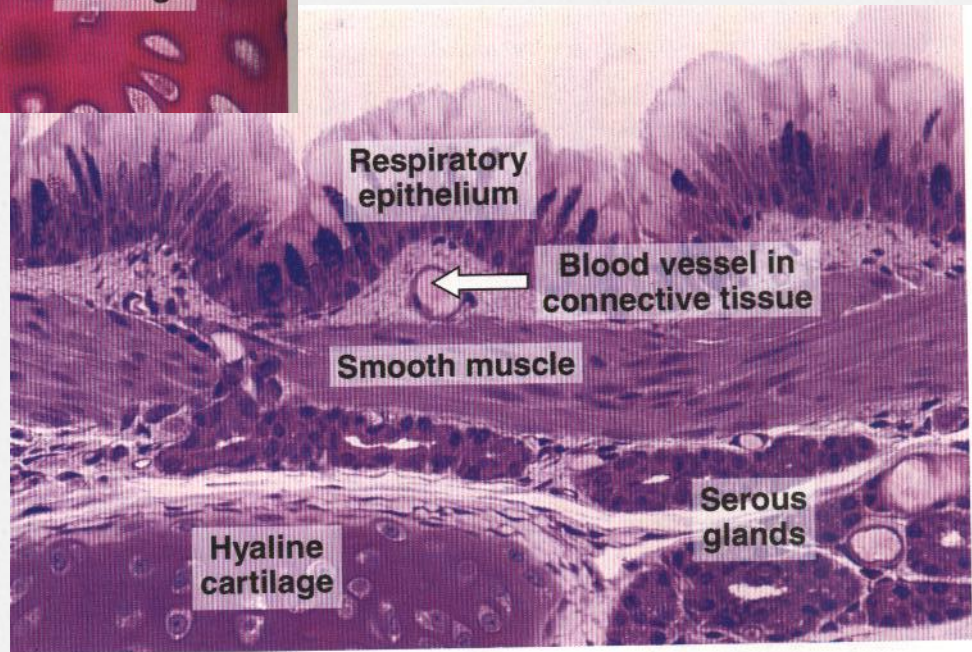
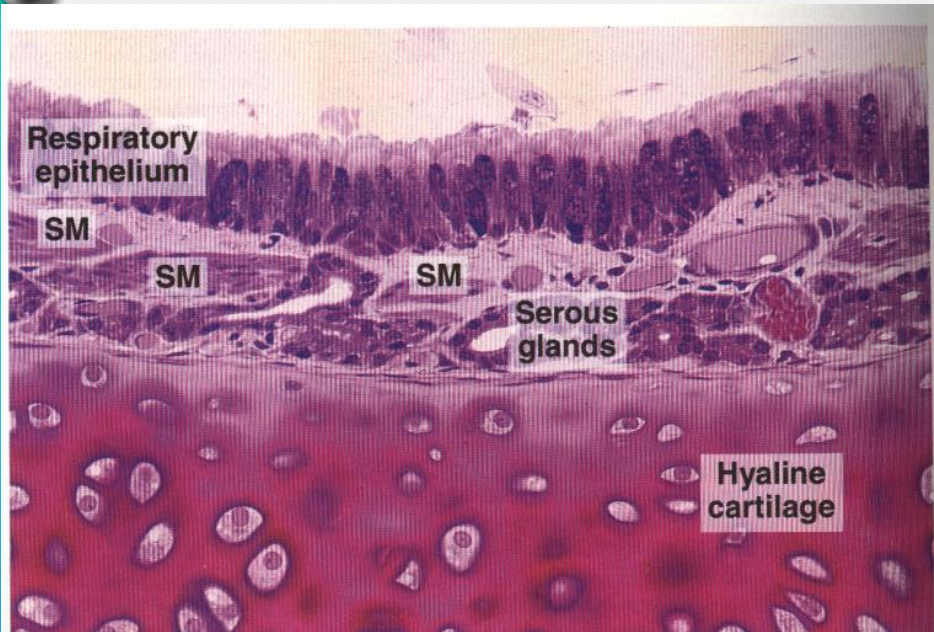
**Trachea**



**Bronchus**



# Bronchus

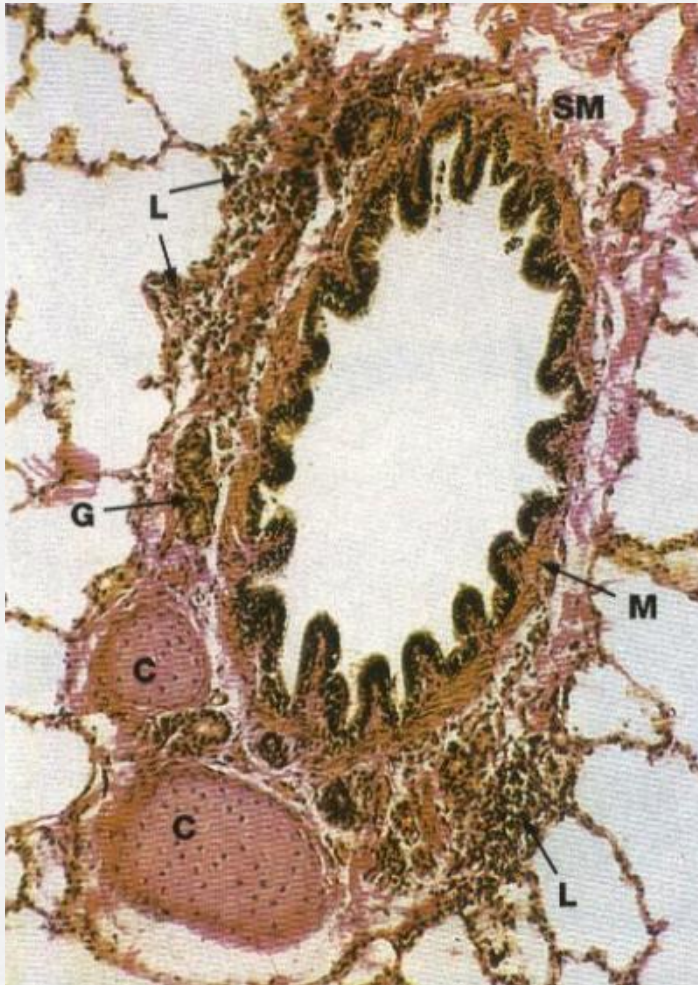




## **Bronchus is different from trachea in several ways....**

- **Less tall respiratory epithelium + fewer goblet cells**
- **Lamina propria contains more elastin**
- **Layer of smooth mm between LP & SM**
- **Fewer seromucous glands**
- **Cartilage: irregular shape/isolated plates / islands of hyaline cartilage**
- **Lymphatic nodules - at the branching points**

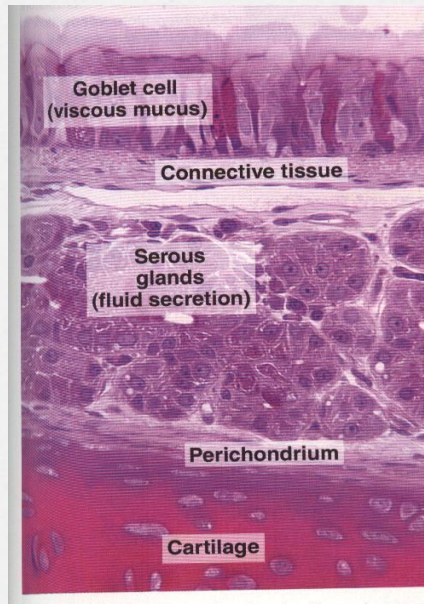
# Segmental bronchus



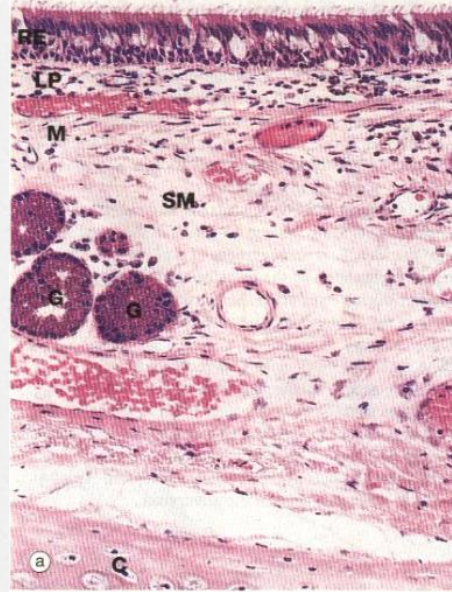
- ❖ Resembles larger bronchioles
- ❖ Tall columnar cells
- ❖ Little pseudostratification
- ❖ Goblet cells – greatly diminished
- ❖ Thin lamina propria
- ❖ Completely encircled by smooth muscle
- ❖ Seromucous glands – rare
- ❖ Cartilage: irregular plates



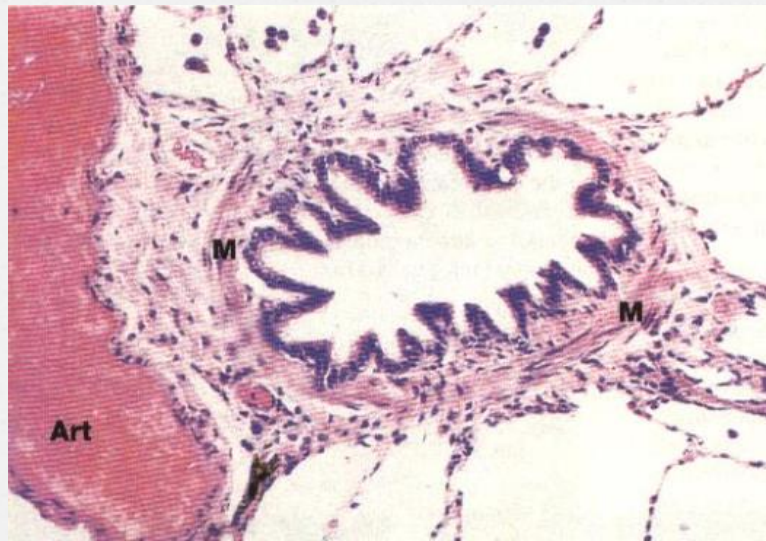
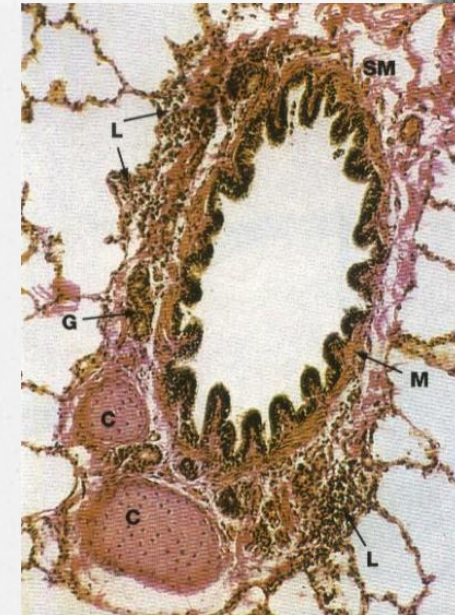
# Trachea



# Bronchus



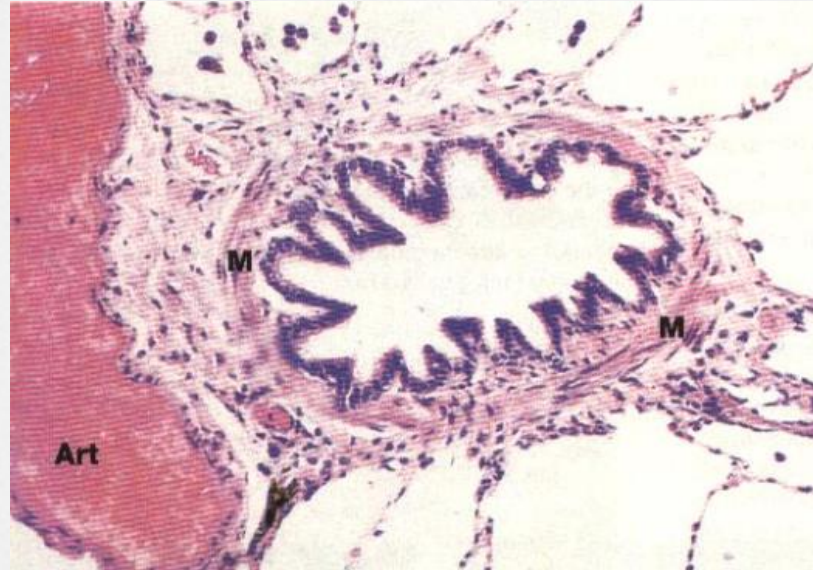
# Segmental bronchus



# Bronchioles



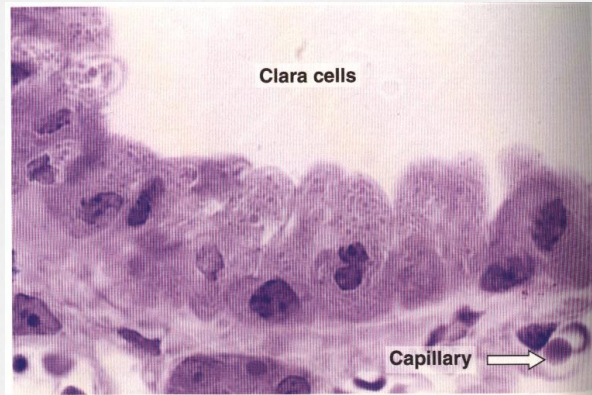
# Bronchioles



- Diameter - less than 1 mm
- No cartilages
- No glands
- Only scattered goblet cells
- Increase of smooth mm & elastic fibres
- Ciliated pseudostratified columnar epithelium → ciliated simple columnar → cuboidal

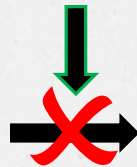
# Bronchioles

## Clara cells



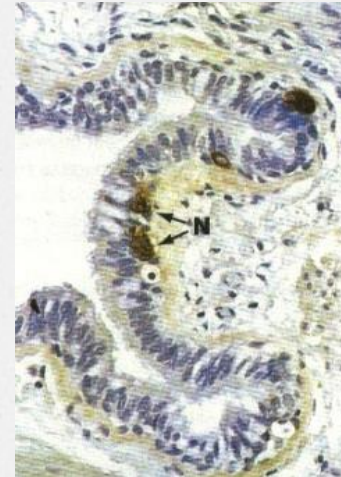
- No cilia
- secretory protein granules - apex

*Oxidative pollutants*  
*Inflammation*



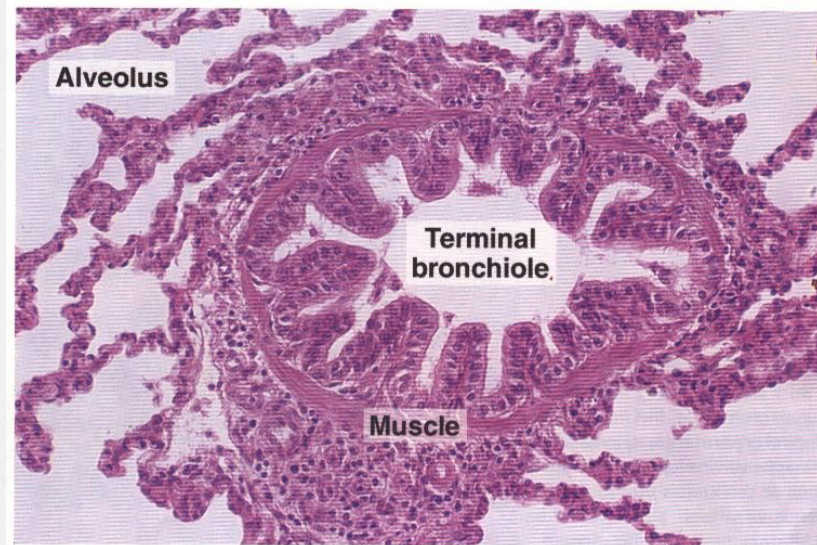
*Damage*  
*bronchiolar*  
*lining*

## Neuroepithelial bodies



- Groups of 80-100 cells  
secretory granules  
cholinergic nerve endings
- Chemoreceptors  
*react to **changes in gas composition***
- repair of epithelial cell

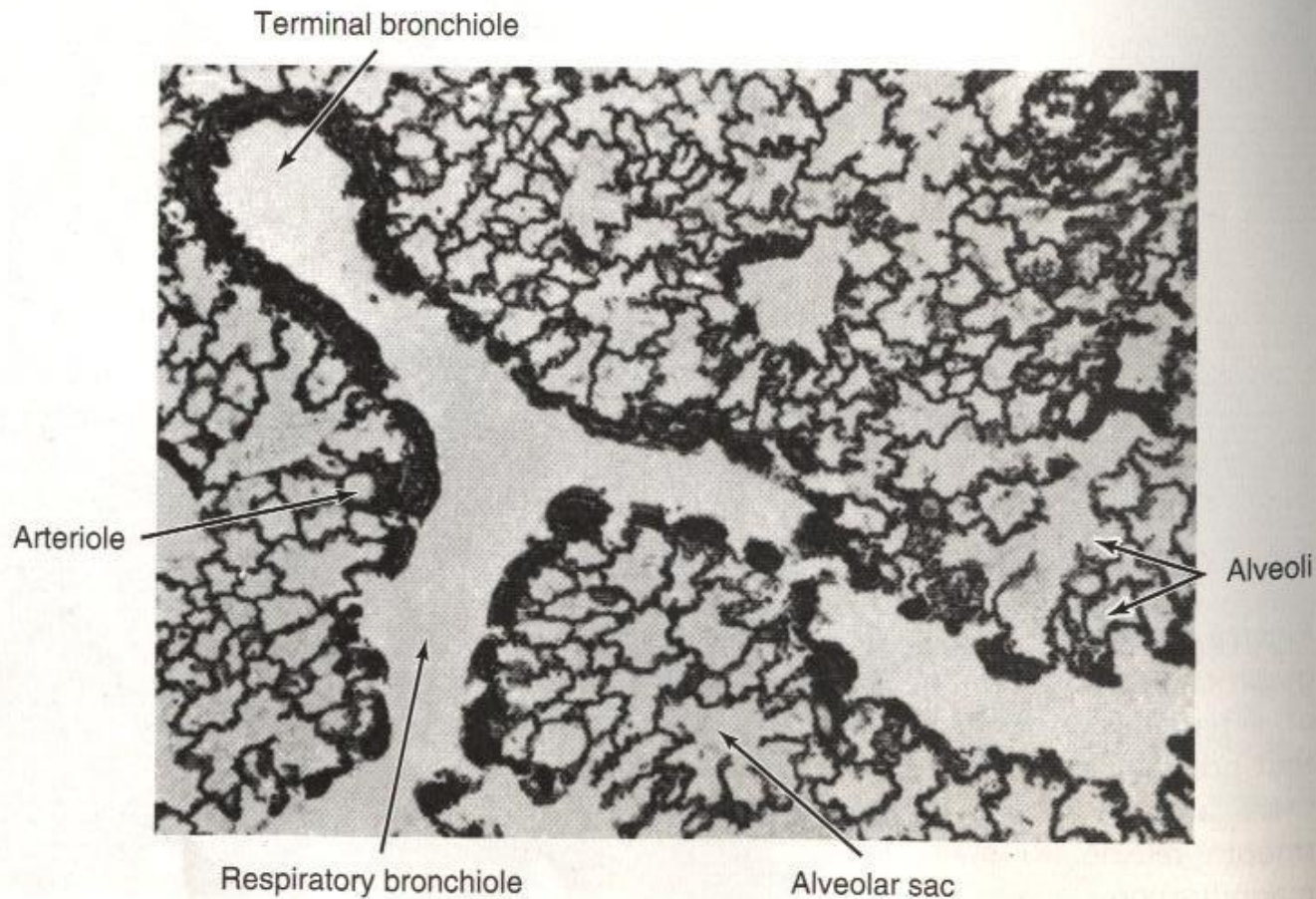
# Terminal Bronchioles



- last segment of purely conducting portion
- simple columnar or cuboidal epithelium
- no goblet cells or glands
- ciliated and non ciliated cell are present
- *cilia extend further down the tubes than mucus secreting elements*
- Elastic tissue and smooth muscles are very closely associated.

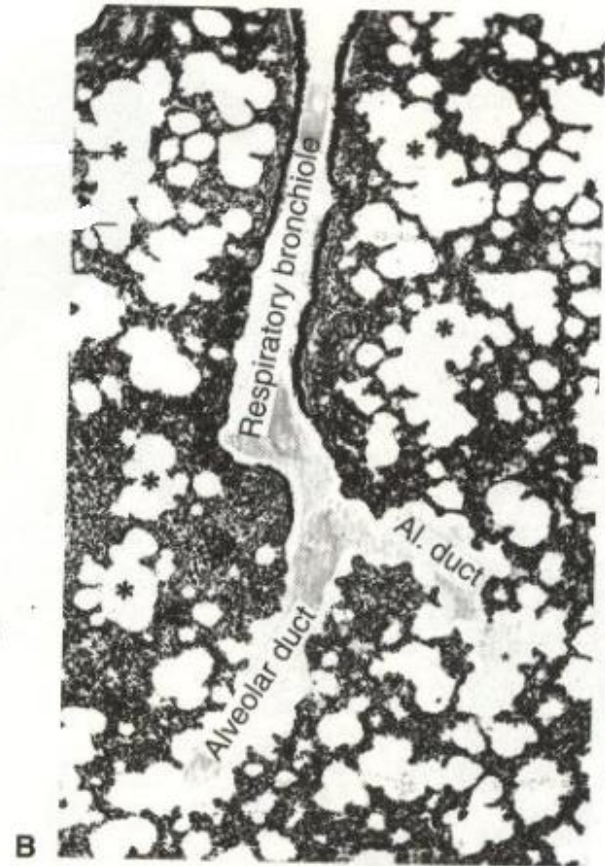
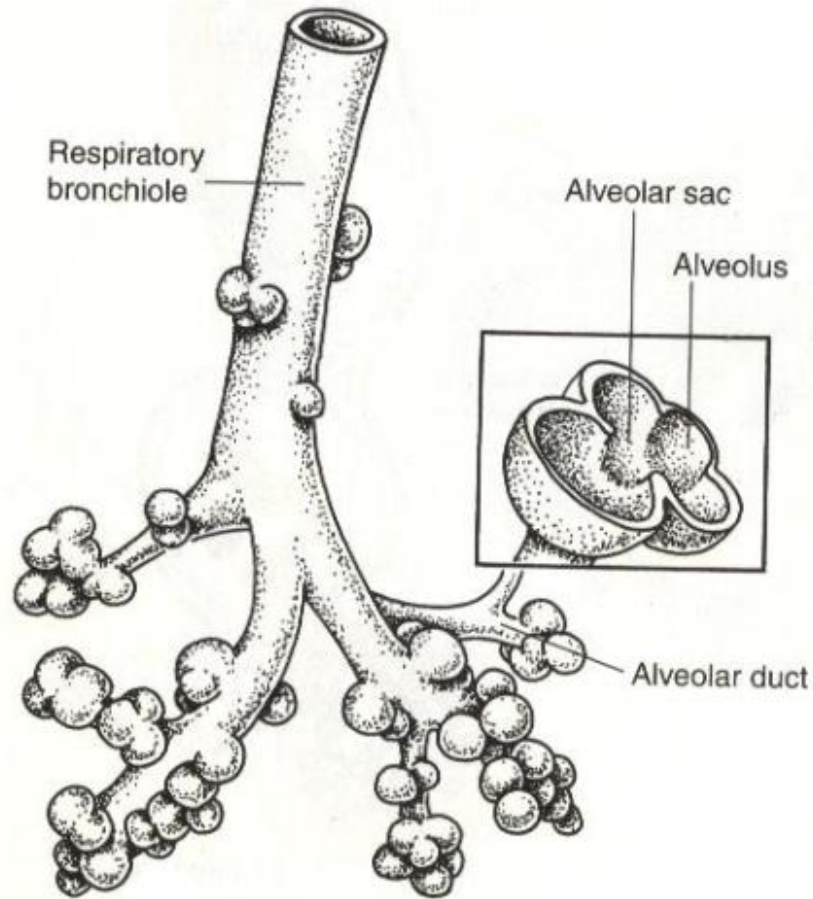


# Bronchioles



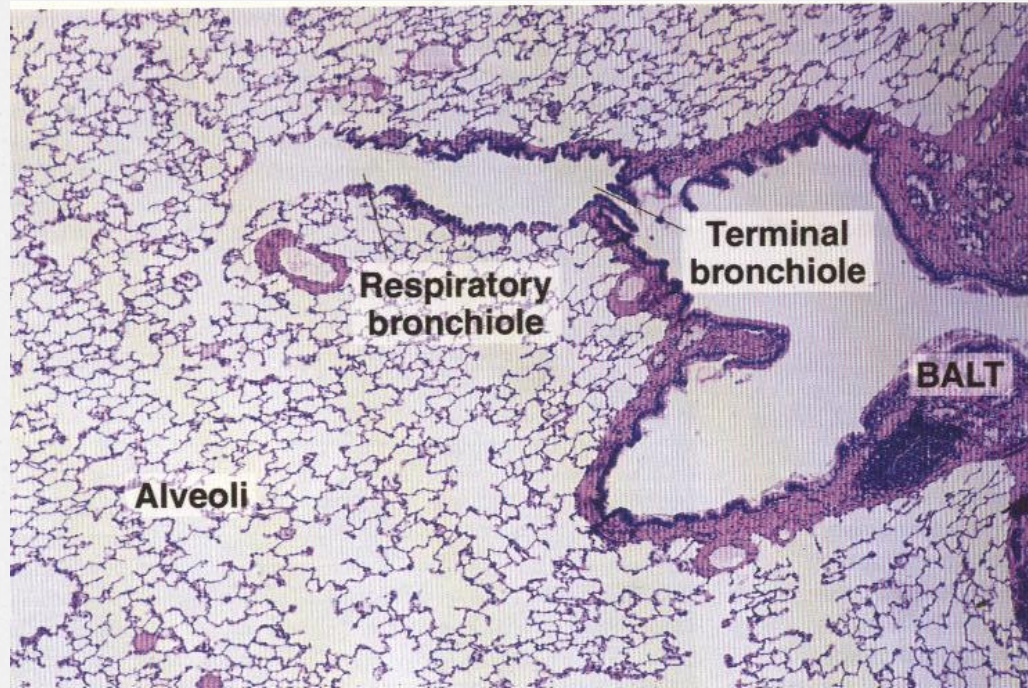
- Respiratory bronchioles:  
Transition part between the conducting & respiratory portions

# Respiratory Bronchioles





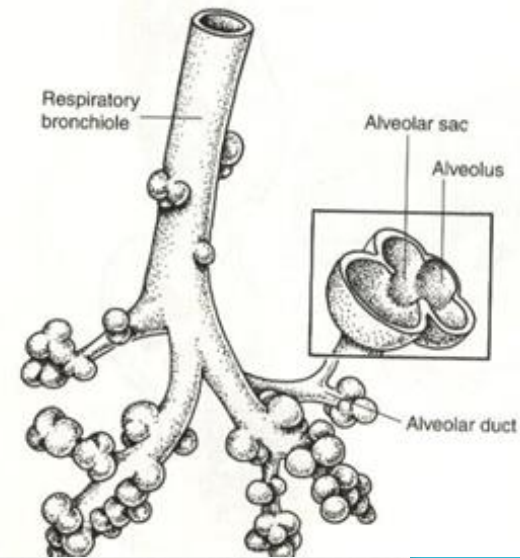
# Respiratory Bronchioles



- Mucosa : identical to that of terminal bronchioles **except** that the alveoli present in the walls.
- Ciliated cuboidal epithelial cells + clara cells
- Rim of the alveolar opening: the bronchiolar epithelium becomes continuous with squamous alveolar lining cells
- Smooth mm & elastic tissue present
- proceeding distally : no of alveoli ↑ + distance between them ↓



# Alveolar ducts



↑ Number of alveolar openings on the wall



alveolar duct

In the lamina propria surrounding the rim of alveoli is a network of smooth muscles



sphincter like –knobs

A rich matrix of elastic and reticular fibres provide the **only support** of the ducts and alveoli

# Alveolar ducts

Alveolar ducts *open into* atria *Communicate with* Alveolar sacs

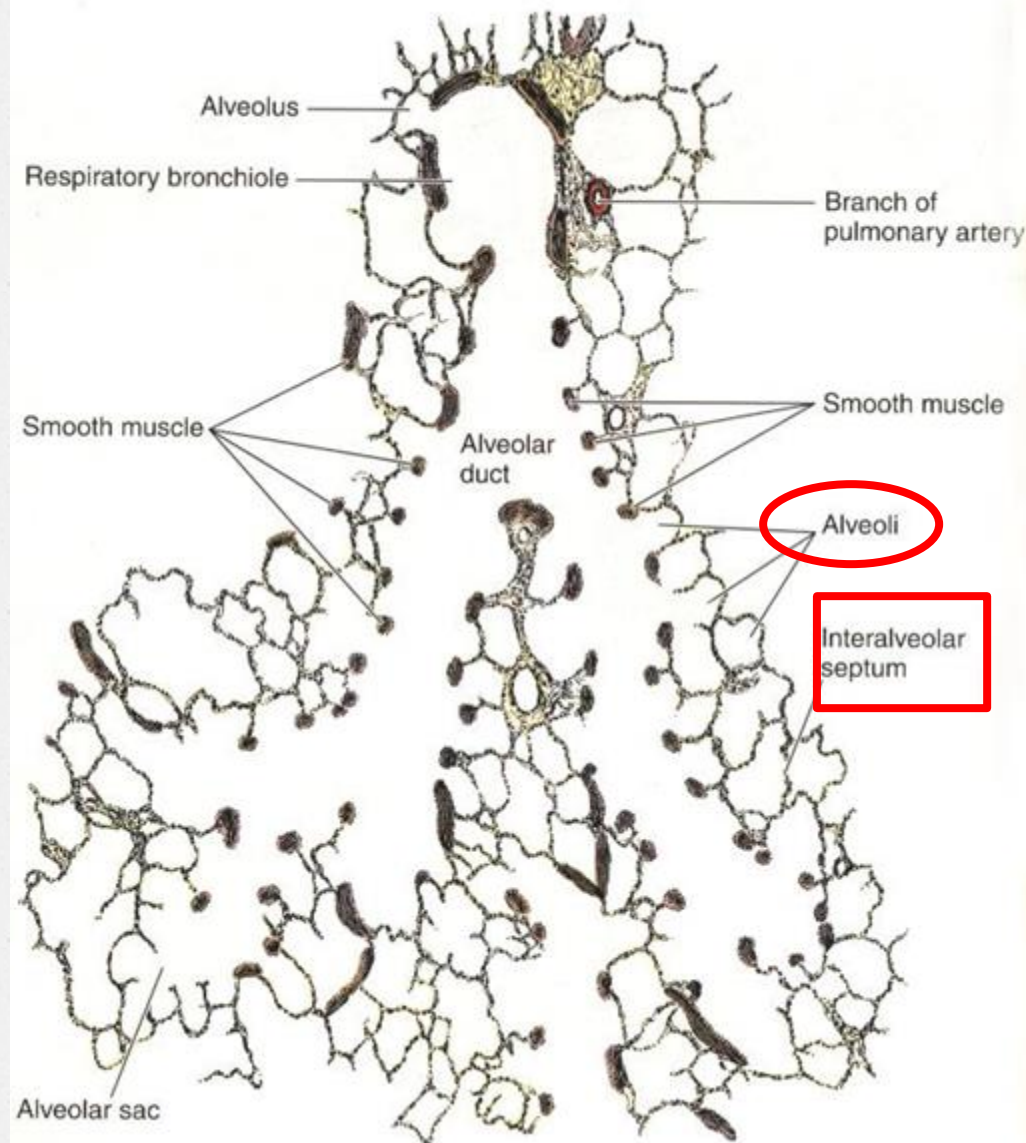
Elastic & reticular fibers *forms* Complex network *encircling* Artria  
Alveolar sacs  
alveoli

prevents overdistention  
prevent damage  
(to delicate capillaries & thin alveolar septa)

passive contraction- expiration

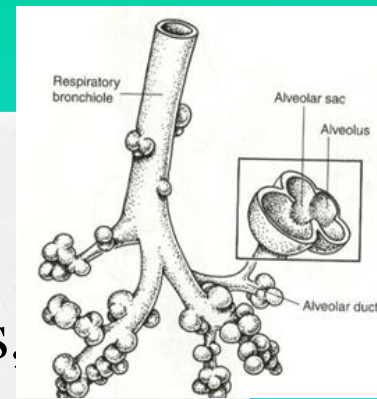
alveoli expansion - inspiration

# Alveolar ducts





# Alveoli



- sac like invaginations of respiratory bronchioles, alveolar ducts and alveolar sacs.
- responsible for spongy structure of the lung
- cuplike structure →  $O_2$  &  $CO_2$  exchange between air & blood
- between two alveoli there is a **interalveolar septum / wall**

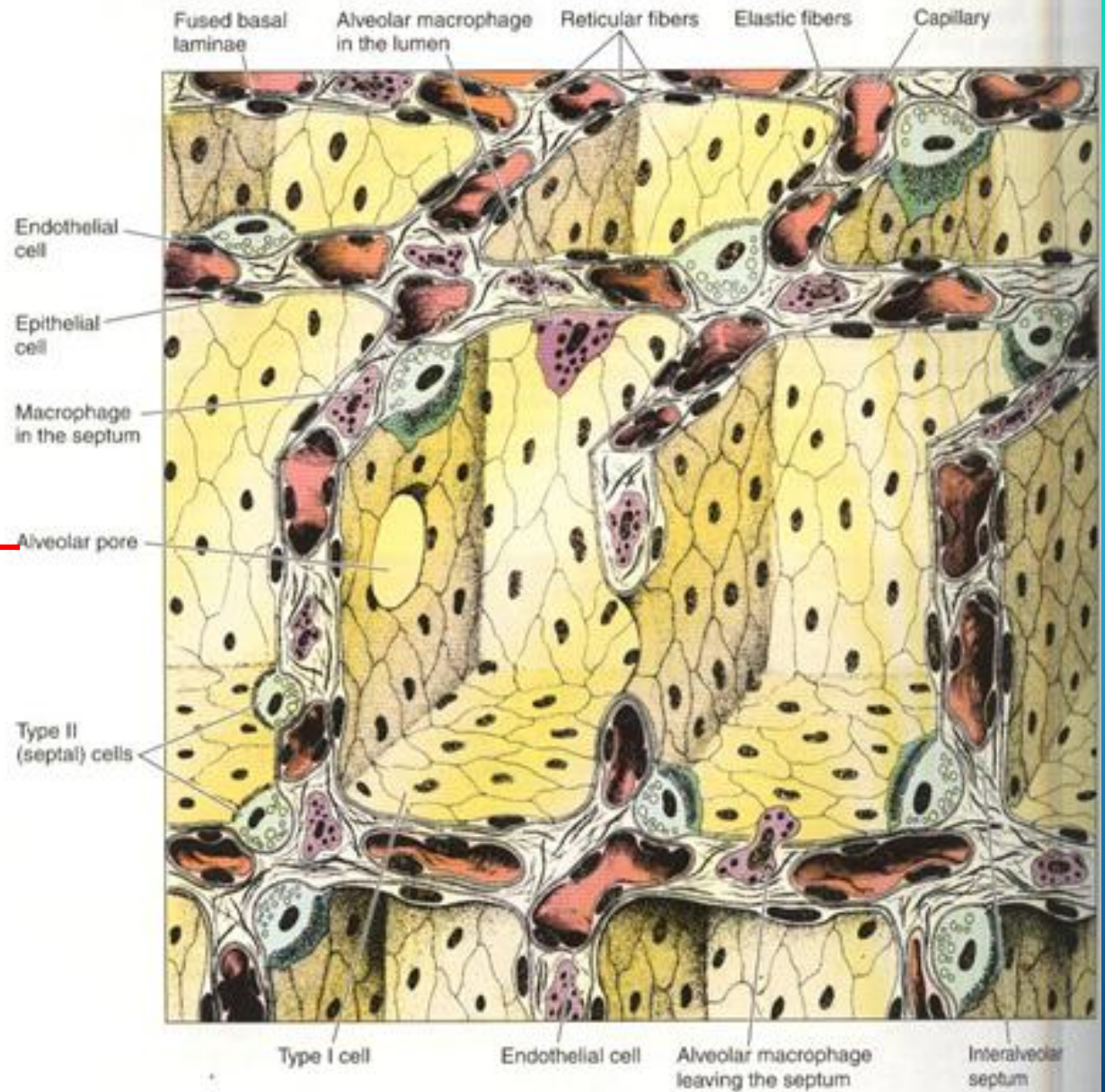


**Interstitium**

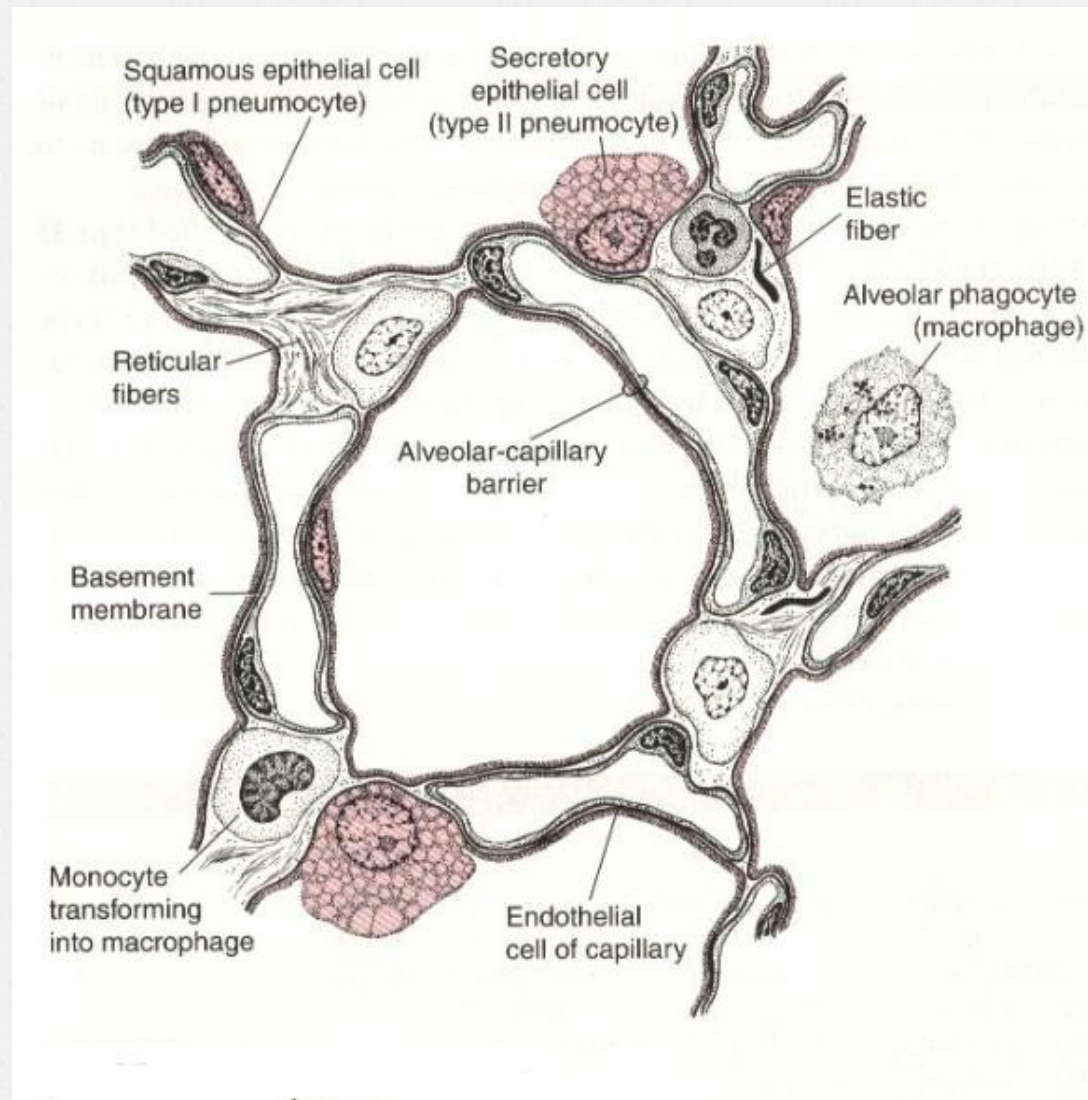
*two squamous epithelial layers*  
*{ capillaries, elastic, reticular fibres*  
*connective tissue matrix and cells*

# interalveolar septum

*Equalize air  
pressure*



# Key histological components of the interalveolar septum








# Blood- air barrier / Alveolar capillary membrane

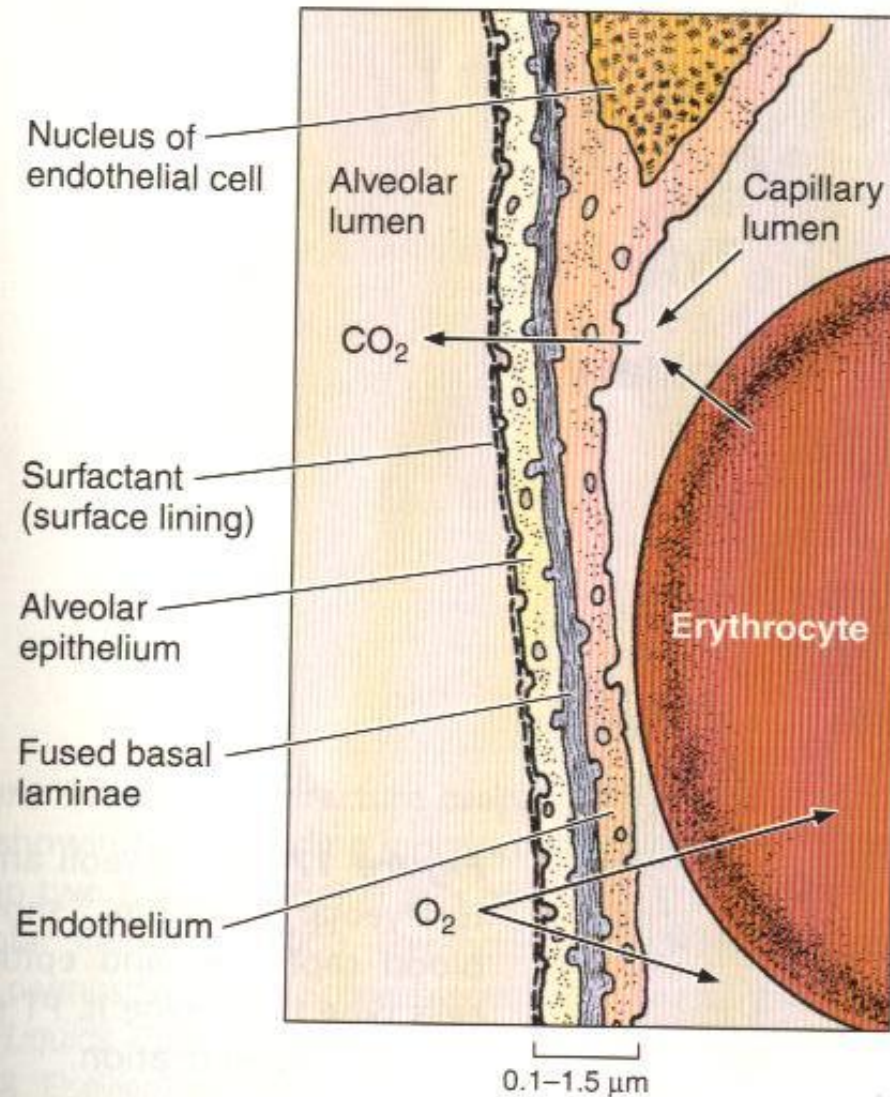
Air in the alveoli is separated from capillary blood by three components



## **blood- air barrier**

-  *Surface lining and cytoplasm of the alveolar cells*
-  *Fused basal lamina of closely apposed alveolar and endothelial cells*
-  *Cytoplasm of the endothelial cells*

# Blood- air barrier / Alveolar capillary membrane

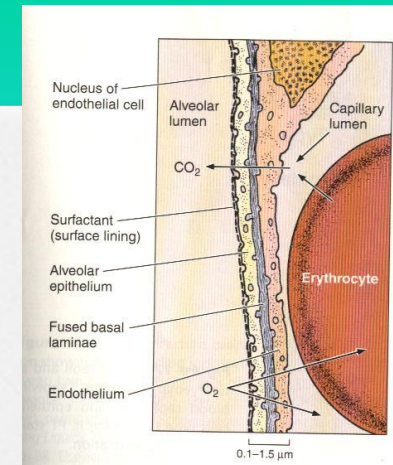


# **Blood- air barrier / Alveolar capillary membrane**

- Thickness : 0.1 to 1.5 $\mu$ m
- Interstitium
  - leucocytes
  - macrophages
  - fibroblasts
- Cell types
  - Type 1 cells/ Primary pneumocytes/ squamous alveolar cells**
  - Type II cells**
  - Alveolar macrophages or dust cells**



## Type 1 cells – Primary pneumocytes



- extremely attenuated cells - line the alveolar surfaces
- Make up about 97% of the alveolar surfaces
- Organelles: golgi, ER & mito. -grouped around the nucleus

↓  
reduce the thickness of the barrier

↓  
leave large areas of cytoplasm virtually free of organelles.

## Type 1 cells – Primary pneumocytes

pinocytotic vesicles - cytoplasm (in thin areas)



in turn over of surfactant  
removal small contaminants from outer surface

desmosomes & occluding junctions: prevent leakage of tissue  
fluid into the alveolar air spaces

*Main role : to provide a barrier of minimal thickness  
that is readily permeable to gases.*

## Type 11 cells

- o Location : among type I cells with desmosomes & occluding junctions  
located at points at which the alveolar walls unite and form angles
- o rounded cells in groups
- o rest on the basement membrane
- o Divide by mitosis to replace their own population

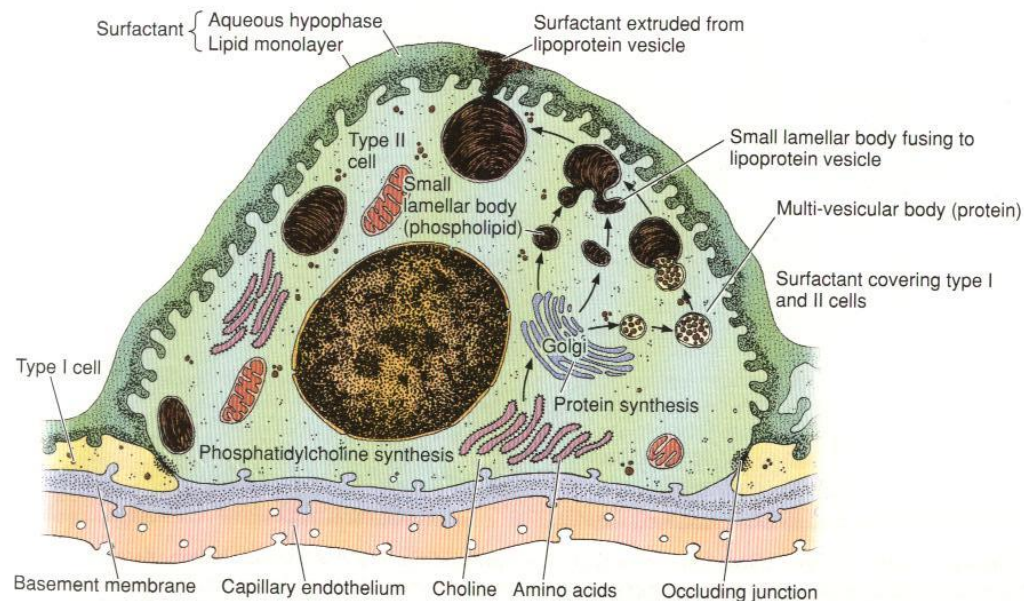


# Type 11 cells

Exhibit a characteristic vesicular or foamy appearance

**Lamellar bodies**

give rise to surfactant  
(reduce the surface tension)



# Alveolar macrophages or dust cells

- Found in the interior of the alveolar septum
- Often seen on the surface of alveoli
- Highly phagocytic
- Remove inspired particles which reach alveoli

## **Adaptations of the Alveolar-Capillary membrane for a efficient diffusion of gasses**

- Capillary endothelial cells are extremely thin and very much attenuated
- Endothelial cells linings are continuous not fenestrated
- Clustering of organelles around nuclei- remaining areas of the cell to become extremely thin
- Cytoplasm in the flattened portions of the cell contains numerous pinocytotic vesicles
- Alignment of cytoplasmic portions of endothelial and epithelial cells



# Structural adaptations of respiratory system

 Epithelial changes

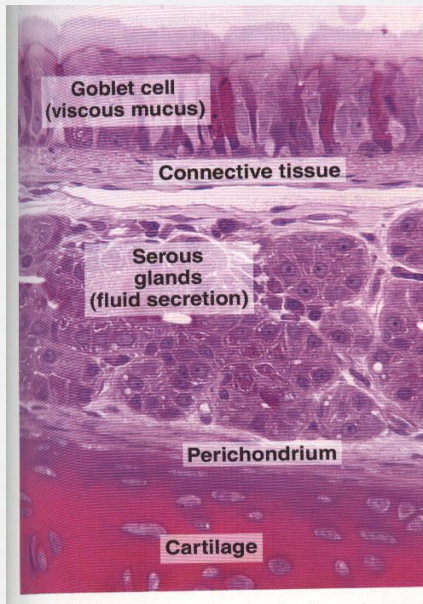
 Glands

 Smooth muscles

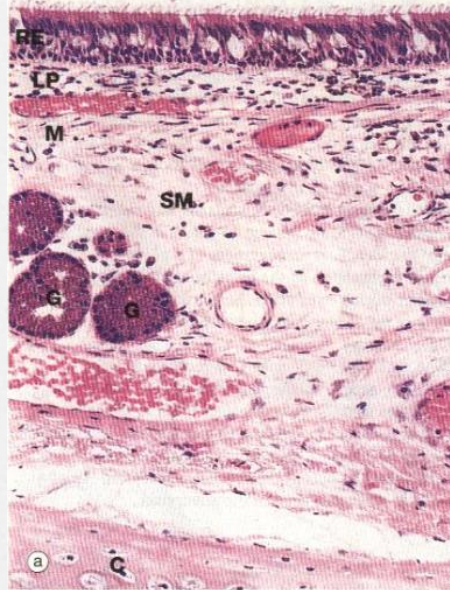
 Hyaline cartilage

 Elastic tissue

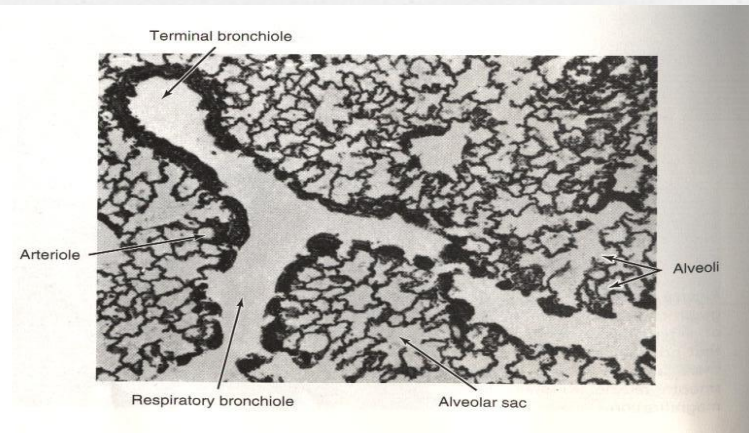
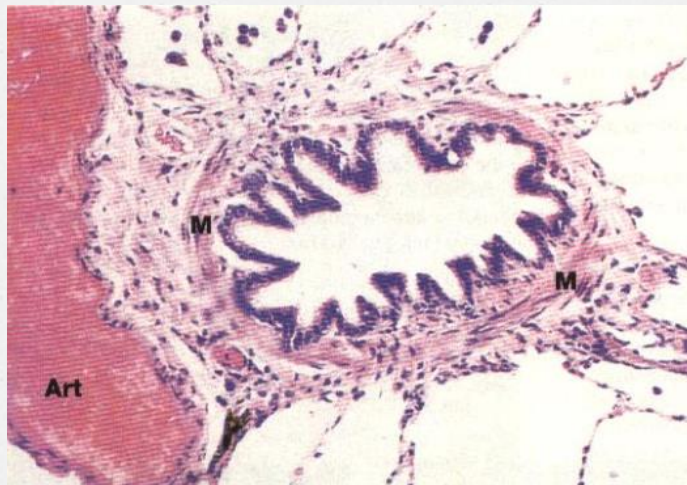
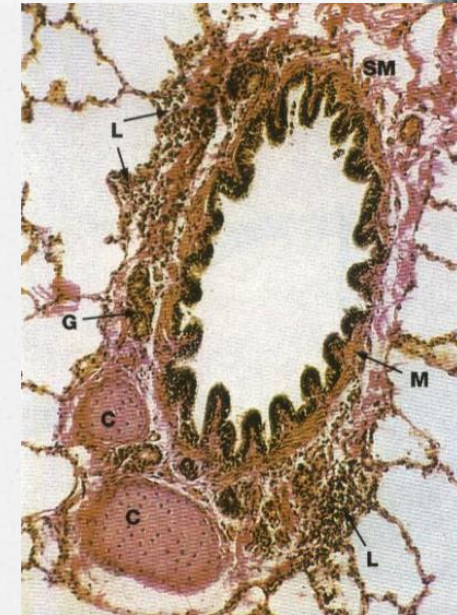
# Trachea



# Bronchus



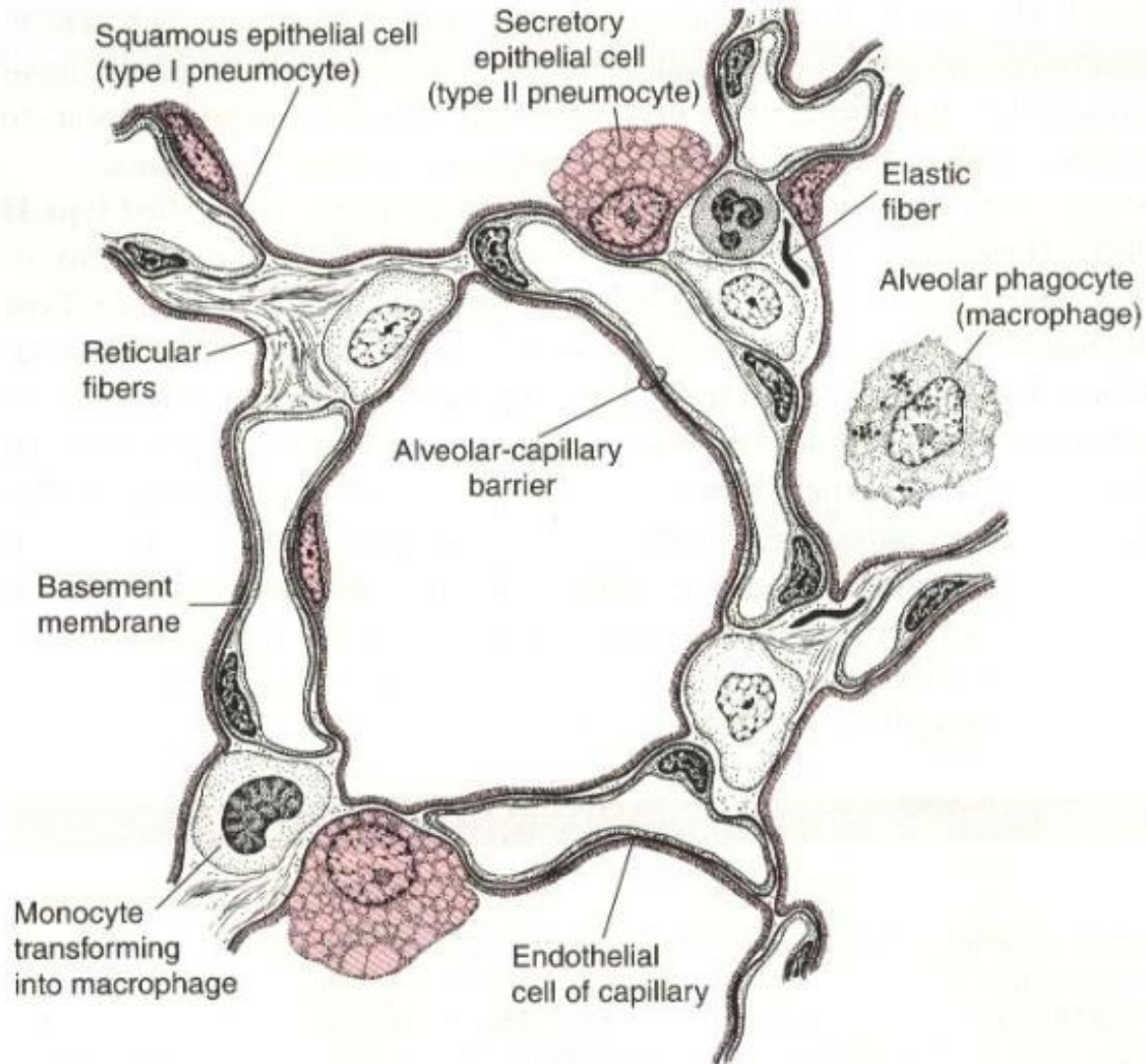
# Segmental bronchus



# Bronchioles



# Interalveolar septum





# References

**Basic Histology - L.U.Junqueira**

**Wheater's Functional Histology**

THANK YOU

