# Histology of Respiratory System

# Respiratory System

- **Conducting Part:** Responsible for passage of air and conditioning of the inspired air.Includes nasal cavities, pharynx, trachea, bronchi and their intrapulmonary continuations bronchioles.
- **Respiratory Part***:* Involved with the exchange of oxygen and carbondioxide between blood and inspires air. Includes the respiratory bronchioles,alveolar ducts,alveolar sacs and alveoli.

# Respiratory Epithelium

- Respiratory system is lined by a pseudostratified columnar ciliated epithelium .
- Respiratory epithelium consist of five cell types:

➢ Ciliated columnar cells

➢ Goblet cells

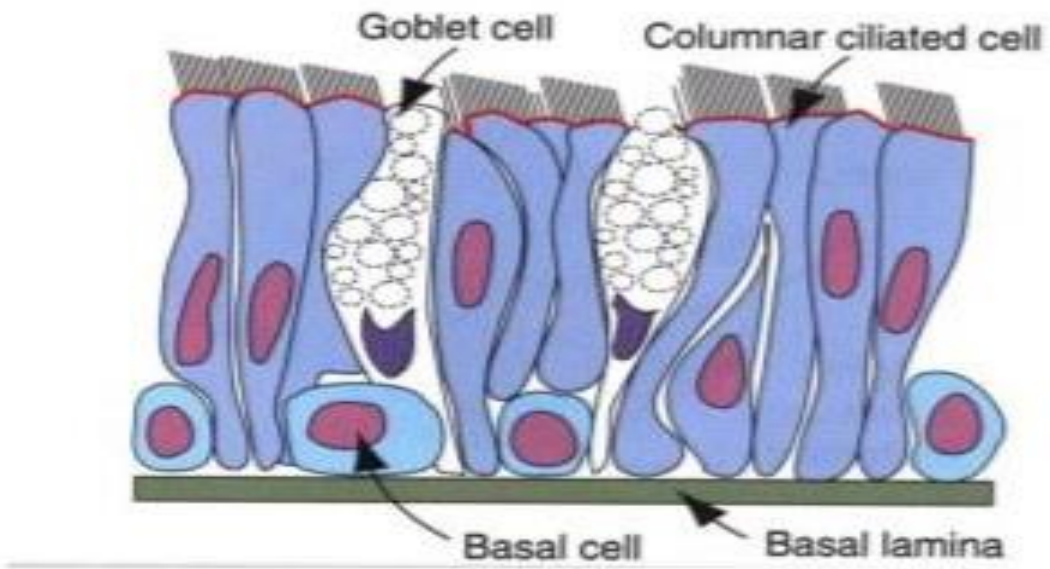
➢ Basal cells

➢ Brush cells

➢ Small granule cells.

- **Ciliated columnar cells :** About 30% of cells, are tall which have cilia and microvilli. These cells move the mucus from distal parts of respiratory passage towards the pharynx for elimination.
- **Goblet cells:** About 30% of cells, contain mucinogen. These cells secrete mucin which forms a layer over the respiratory epithelium and serves to trap debris.
- **Basal cells :** Are also about 30% of cells, they are undifferentiated stem cells which divide mitotically and produce other cell types.
- **Brush cells:** Are just 5% of cells, they are narrow columnar cells that their function is unknown, but nerve ending associated with them and serve as sensory receptor.
- **Small Granule cells** : About 5%, contains small membrane bound granules belong to neuroendocrine system.( catecolamines, serotonin,calcitonin)

# Respiratory Epithelium



# Nasal Cavities

- The nasal cavity proper (nasal fossa) is lined by nasal mucosa.

➢ Respiratory mucosa ( lines most of the nasal fossa)

➢ Olfactory mucosa ( covers the roof of nasal cavity)

➢ Respiratory mucosa is lined by typical respiratory epithelium and lamina propria. Also contain tubuloacinar glands of mixed type.

➢ The nasal mucosa contains large venous plexuses called cavernous bodies especially over the inferior concha.

# Olfactory mucosa

- The roof of nasal cavity, the superior concha and nasal septum are lined by olfactory mucosa.
- The olfactory mucosa is lined by olfactory epithelium which serves as receptor for sensation of smell.
- The lamina propria contains serous glands called olfactory glands.

# Olfactory Epithelium

- Pseudostratified columnar epithelium but lacks goblet cells.
- Epithelium is composed of 3 types of cells
- Olfactory cells: Are bipolar neurons possessing a cell body, a dendrite and an axon.
- Sustentacular cells: Are tall columnar supporting cells.They provide nourishment ,physical support and electrical insulation to olfactory cells.
- Basal cells: Are small spherical cells and can differentiate into olfactory and sustentacular cells.

# Paranasal sinuses

- The paranasal sinuses are lined by mucous membrane that resembles the mucosa of nasal cavities.
- The pseudostratified columnar ciliated epithelium of paranasal sinuses is shorter in height and contain few goblet cells.
- Lamina propria is thinner and contains fewer glands.

# Nasopharynx

Nasophraynx consists of 4 layers.

- Mucosa
- Submucosa
- Muscle layer
- Fibrosa

# Nasopharynx

- Mucosa: The mucosa consists of respiratory epithelium and lamina propria except posterior wall which is lined by stratified squamous epithelium.
- Submucosa: consists of loose connective tissue.
- Muscle layer: forming the wall of nasopharynx is of skeletal muscle.
- Fibrosa: the outer most layer consists of a thin layer of fibrous connective tissue.

# Larynx

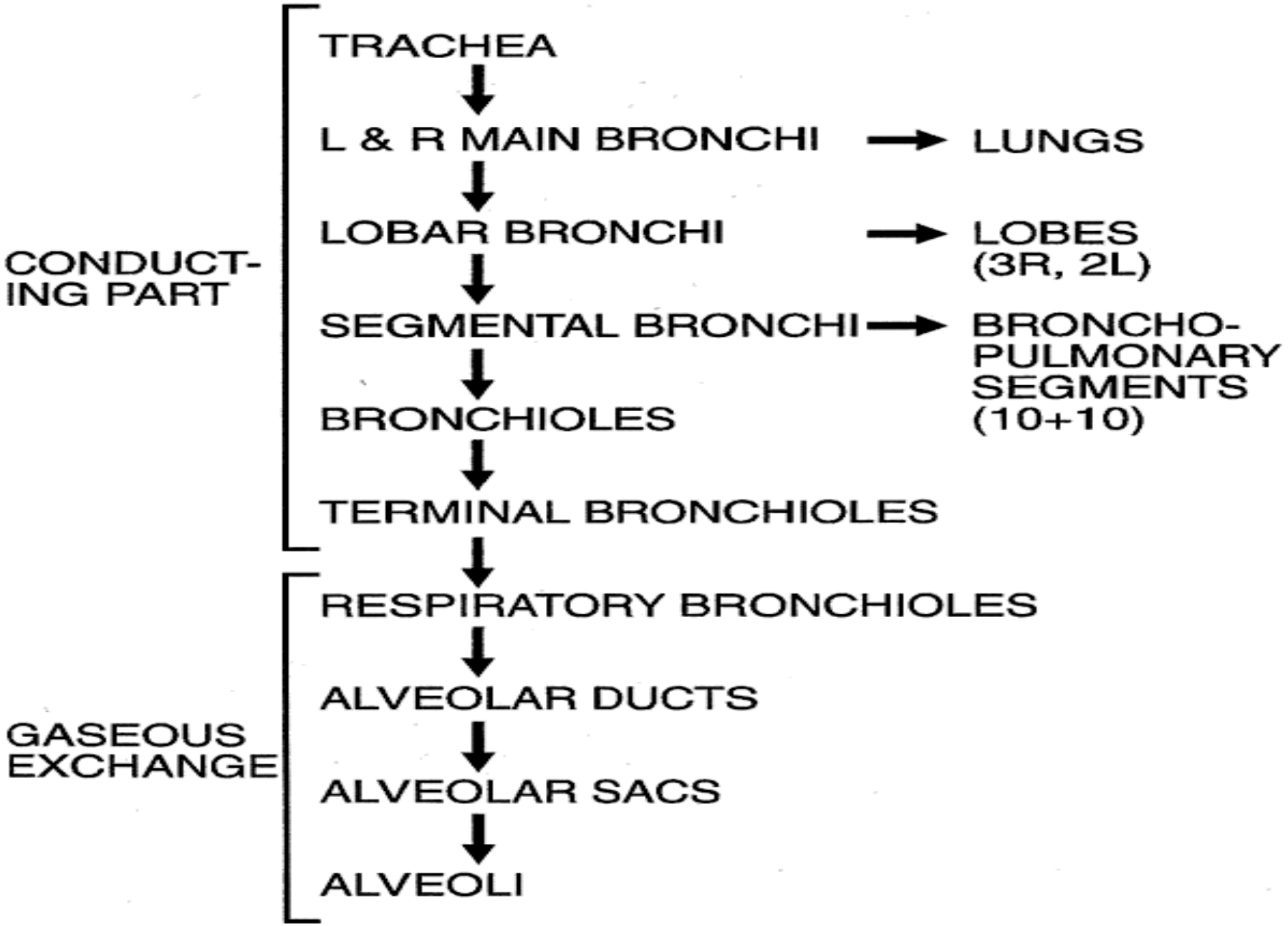
The laryngeal wall consists of

- Mucosa
- Intrinsic muscle
- Cartilage .

- Mucosa: The mucosa comprises epithelium and lamina propria. The larygeal inlet, epiglotis and true vocal cards are covered by stratified squamous non keratinized epithelium. Rest of the larynx is lined by respiratory epithelium with goblet cells.

# Larynx

- Lamina Propria: consists of connective tissue which contains simple tubuloacinar glands.
- Intrinsic muscle: The intrinsic muscle of larynx is of skeletal type.
- Cartilage: The larger laryngeal cartilage (cricoid, thyroid) are of **hyaline cartilage** while the smaller laryngeal cartilage (epiglottis) are **elastic type**.


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
ALVEOLI

# RESPIRATORY SYSTEM HISTOLOGY

- **Trachea**
- **Bronchus**

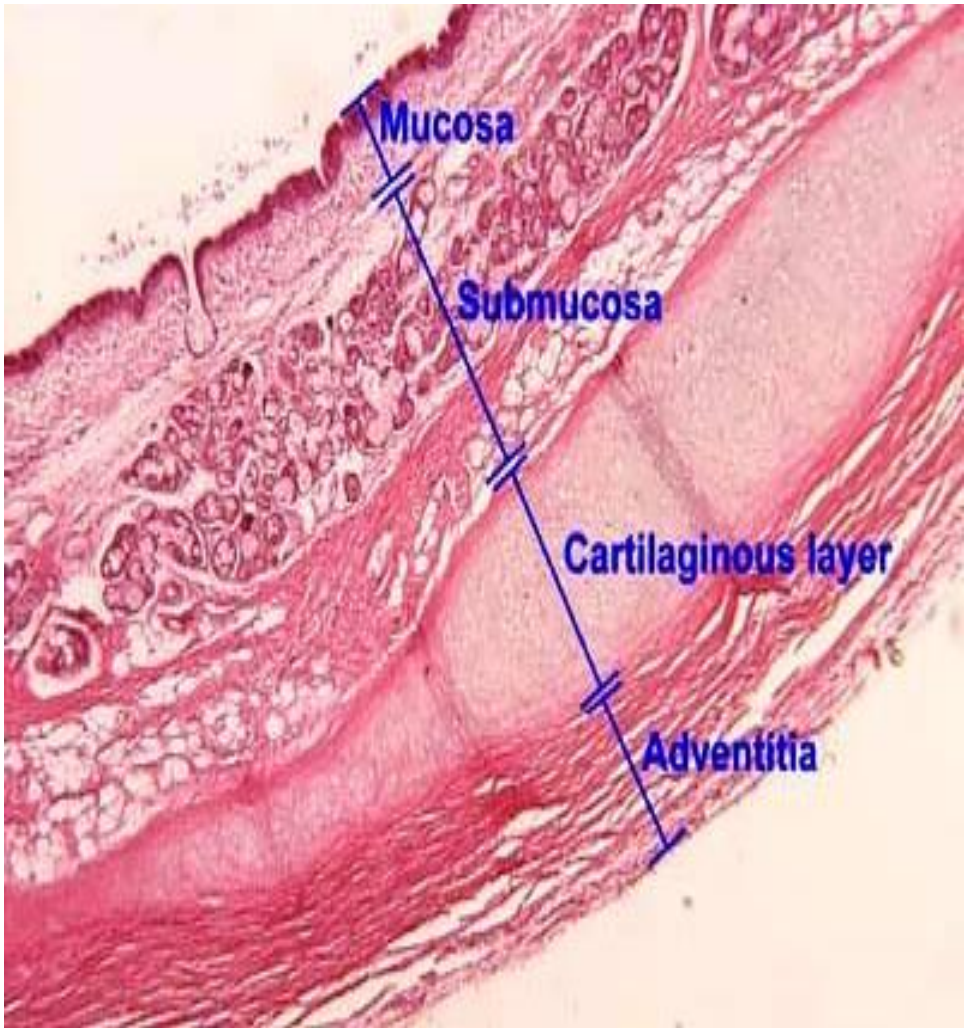
  ***-Primary bronchus***

  ***-Secondary bronchus***

  ***-Tertiary bronchus***
- **Bronchiole**
- **Lung**

# Trachea

- **Mucosa**
  - ***-Epithelium***
  - ***-Lamina propria***
- **Sub mucosa**
- **Cartilage &muscle layer**
- **Adventitia**



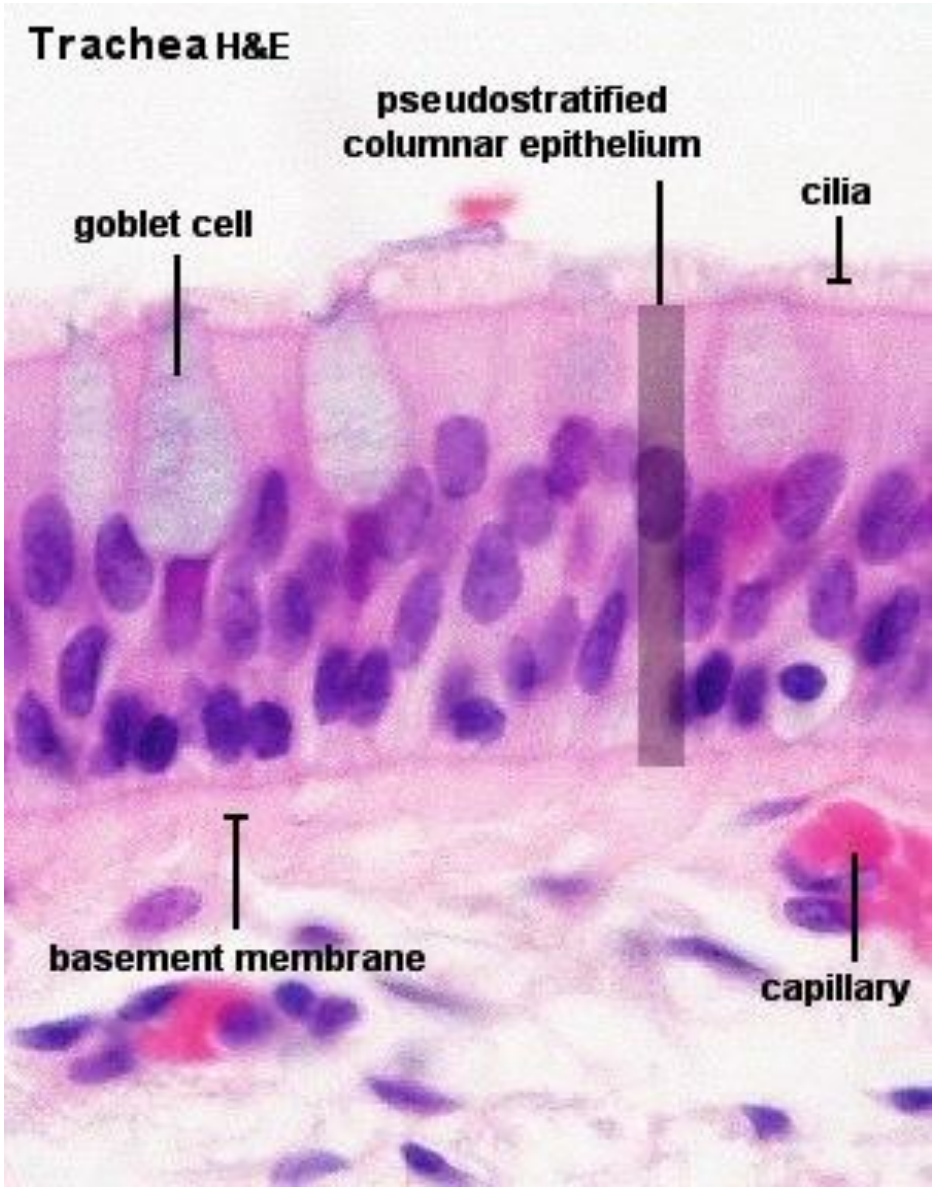
# Trachea

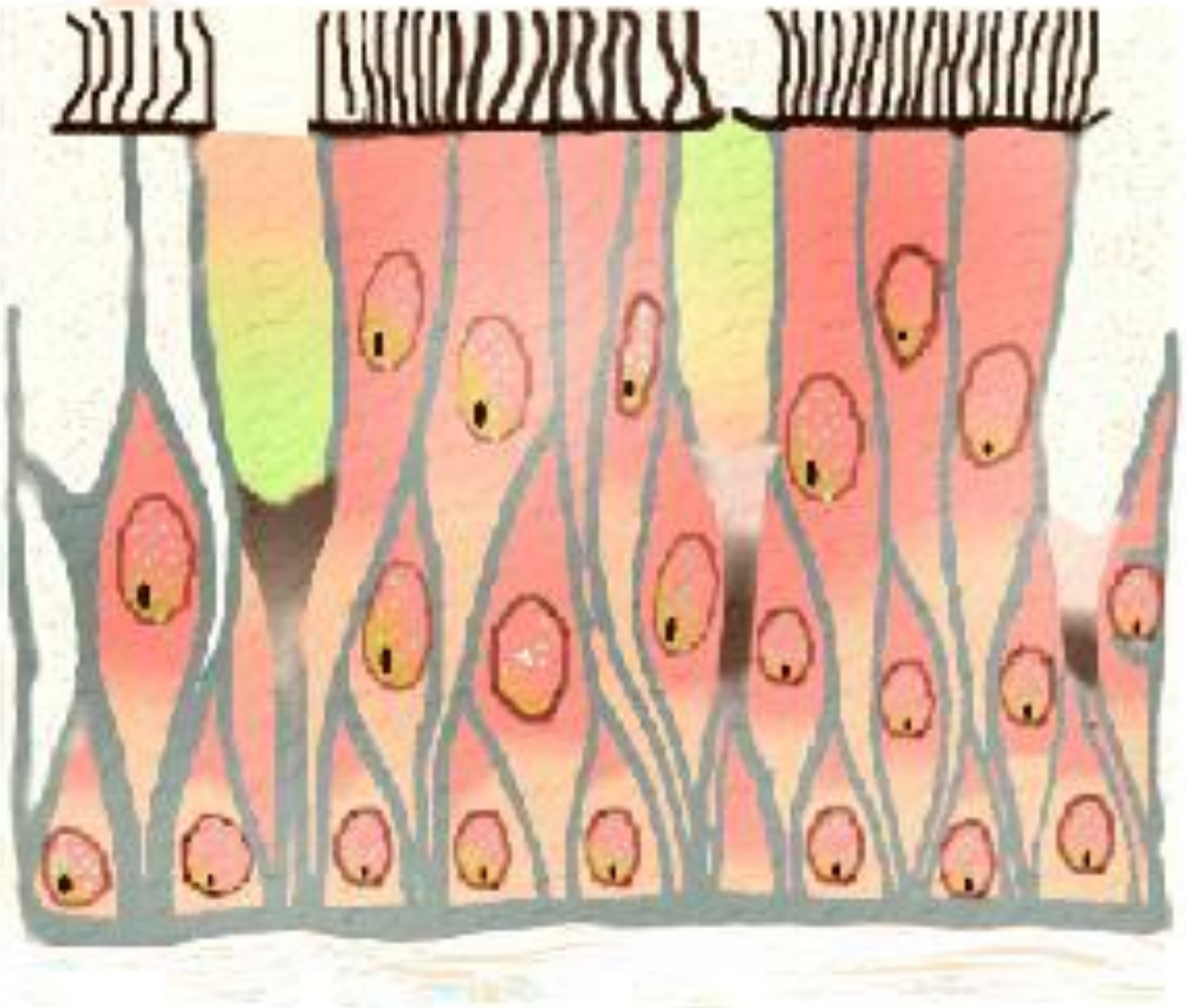
## Mucosa

- Epithelium

  Pseudo stratified ciliated columnar/ Respiratory epithelium containing Ciliated columnar cells and Goblet cells.

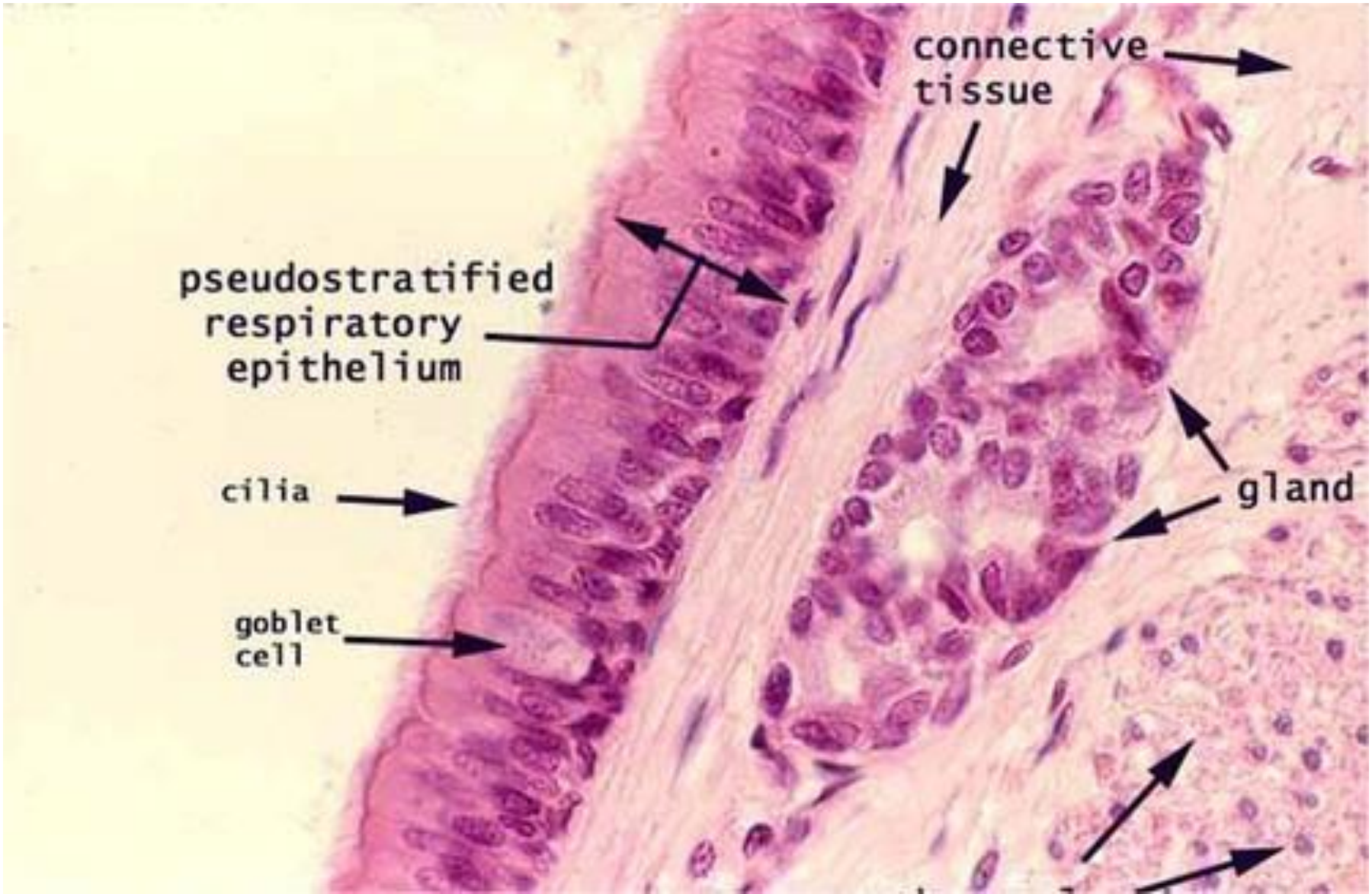
- Lamina propria - Elastic fibre, Lymphocyte, Mast cells, Blood vessels



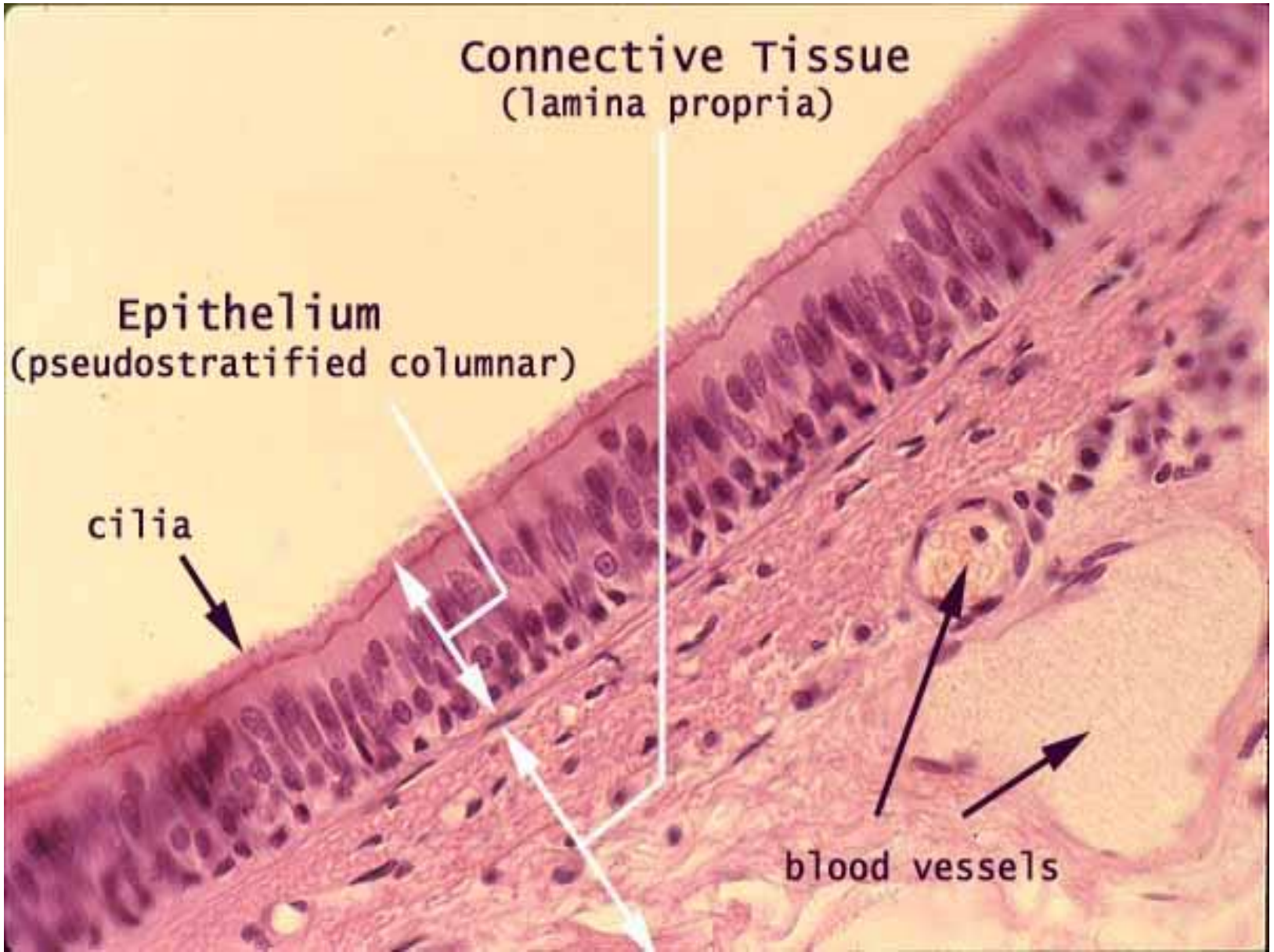



Pseudostratified Columnar Ciliated Epithelium

# Respiratory Epithelium



# Trachea( T.S. High Power)



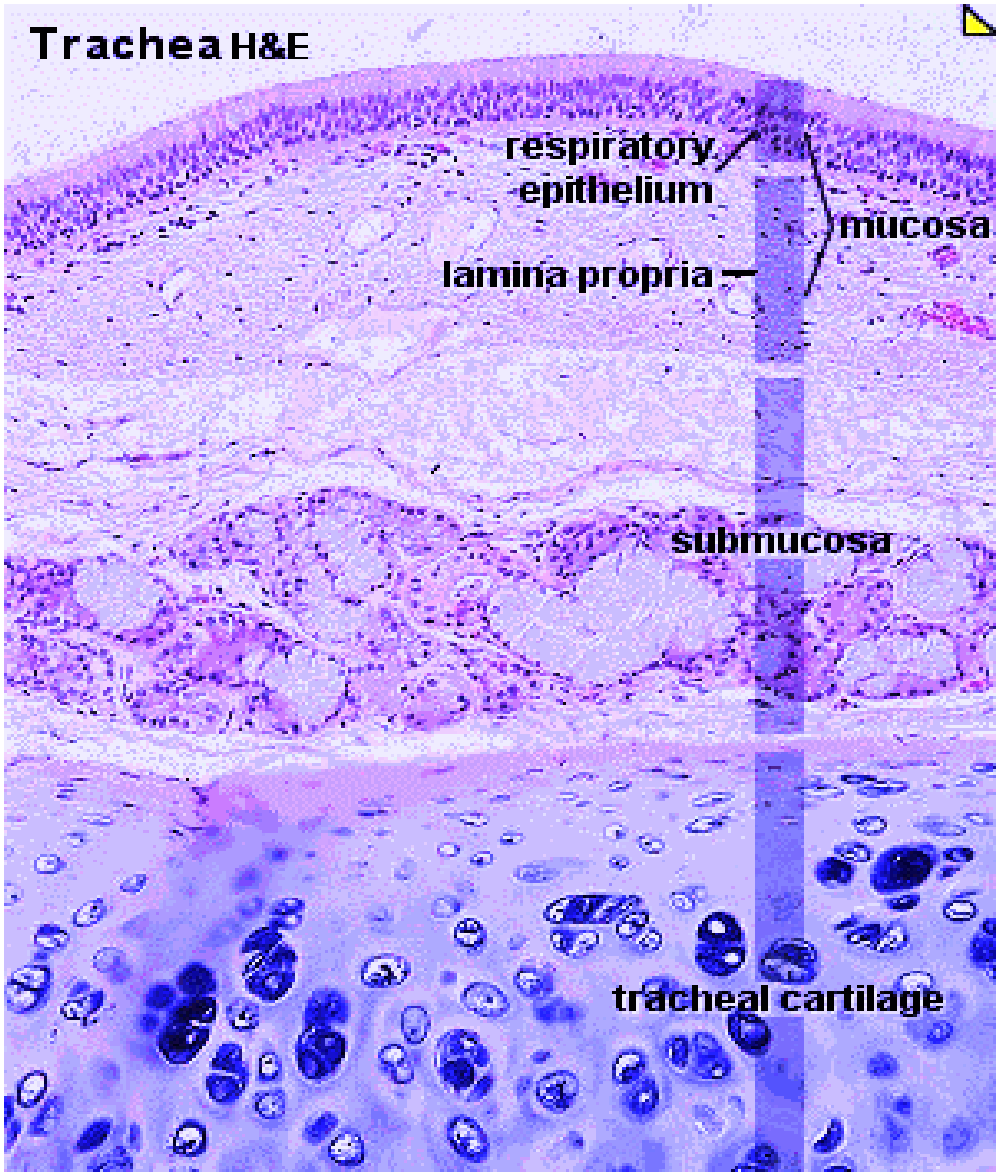
# Trachea

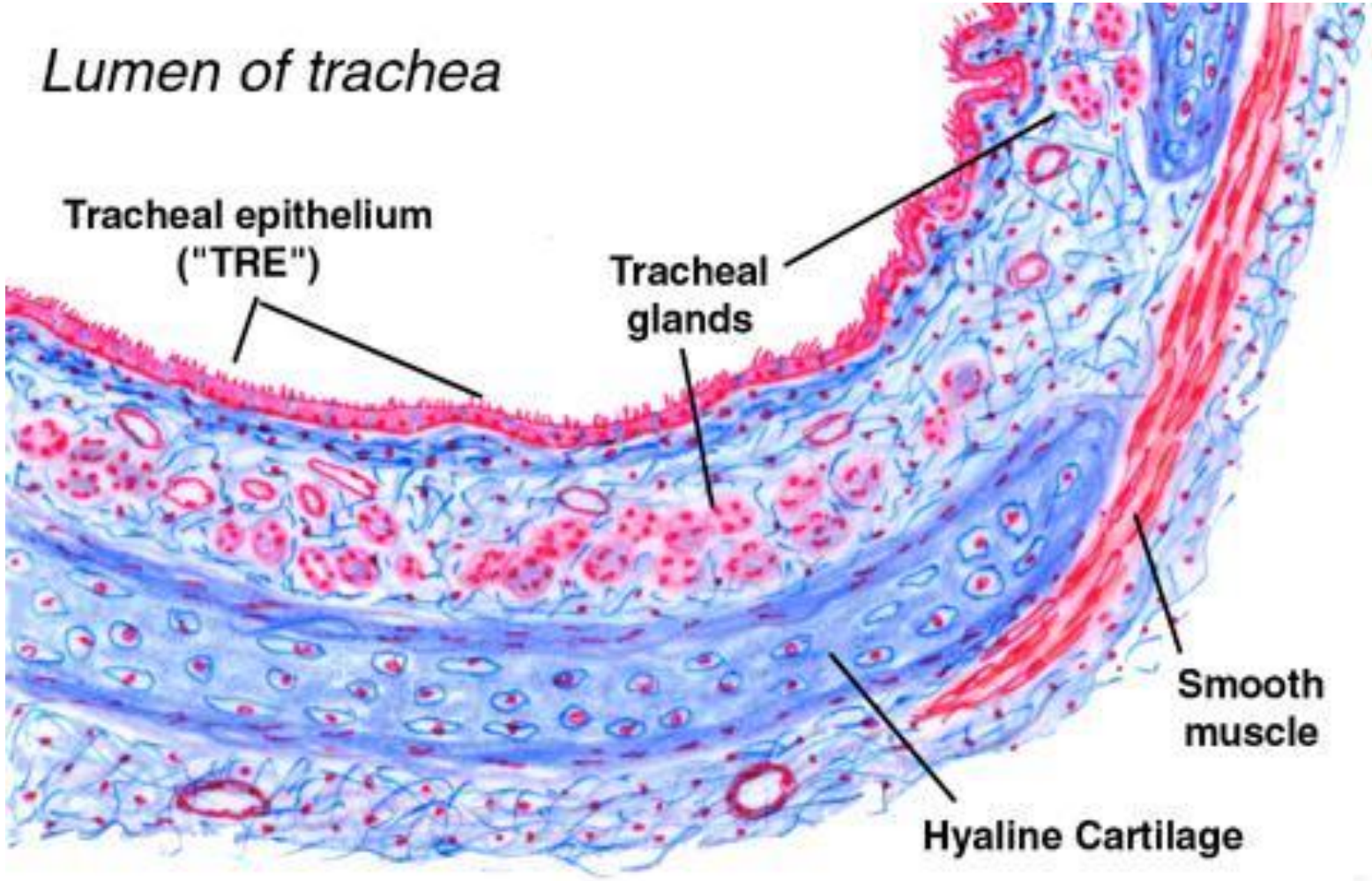
Sub mucosa

- Loose connective tissue
- Tracheal glands-Mixed (serous &mucus) glands
- Blood vessels and ducts

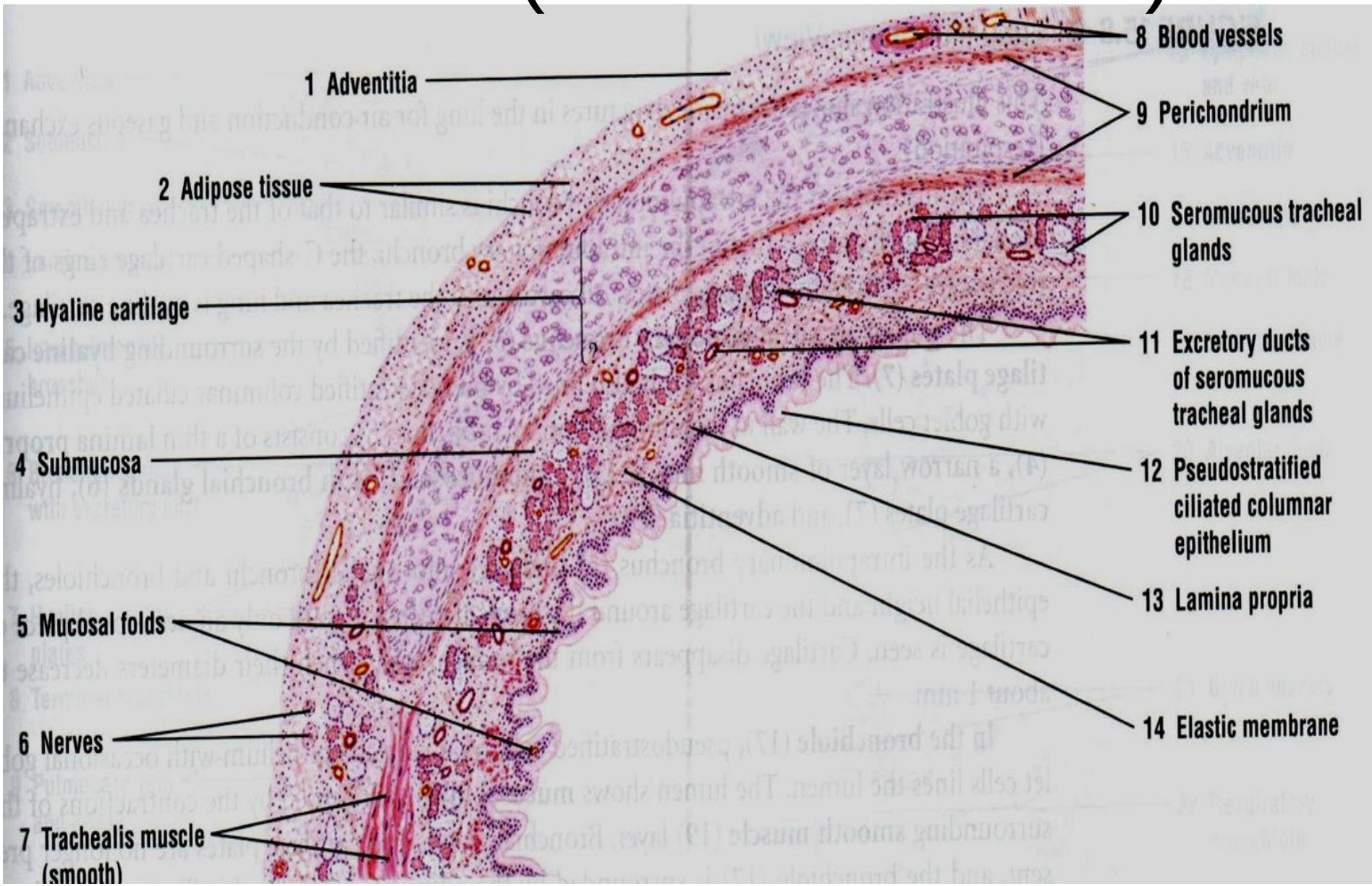
Cartilage &smooth muscle layer

- ”C” Shaped hyaline cartilage having perichondrium and chondrocytes
- Ends of cartilage connected by smooth muscles
- Adventitia: the outer most covering composed of collagen fiber and fibro elastic tissue

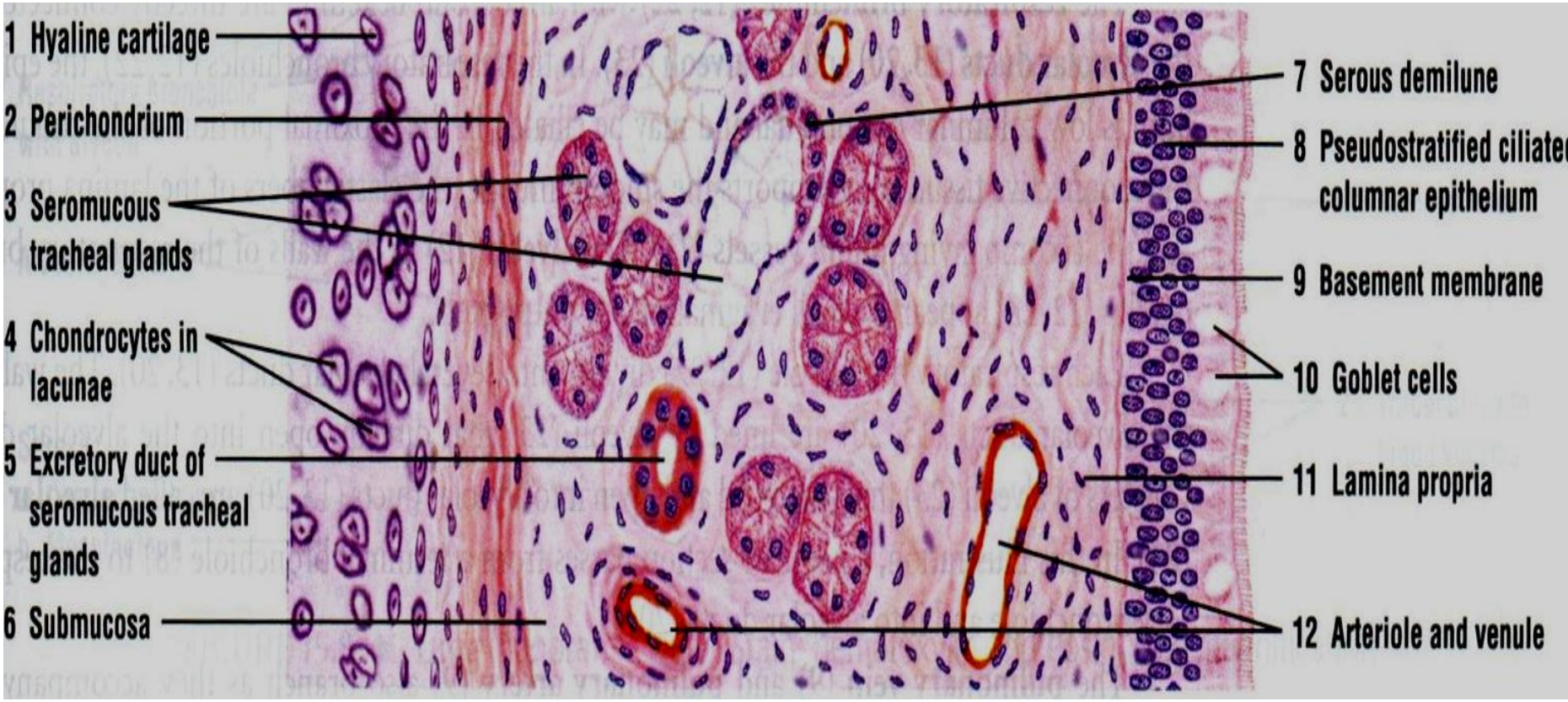



Lumen of trachea
Tracheal epithelium ("TRE")
Tracheal glands
Smooth muscle
Hyaline Cartilage

# Trachea (T.S. Low Power)



# Tracheal wall (Sectional View)



# Bronchi

- Extrapulmonary bronchi: (principal or primary)resemble trachea in structure except for their smaller diameter.
- Intrapulmonary bronchi: (lobar or secondary) have smaller diameter, smooth muscle appears in complete form and the hyaline cartilage not present in C shaped ring but occurs as irregular cartilaginous plate.
- Tertiary /Segmental bronchus: supply the bronchopulmonary segments

# Bronchus

- Principal bronchus

  -same as trachea

- Secondary /Lobar bronchus

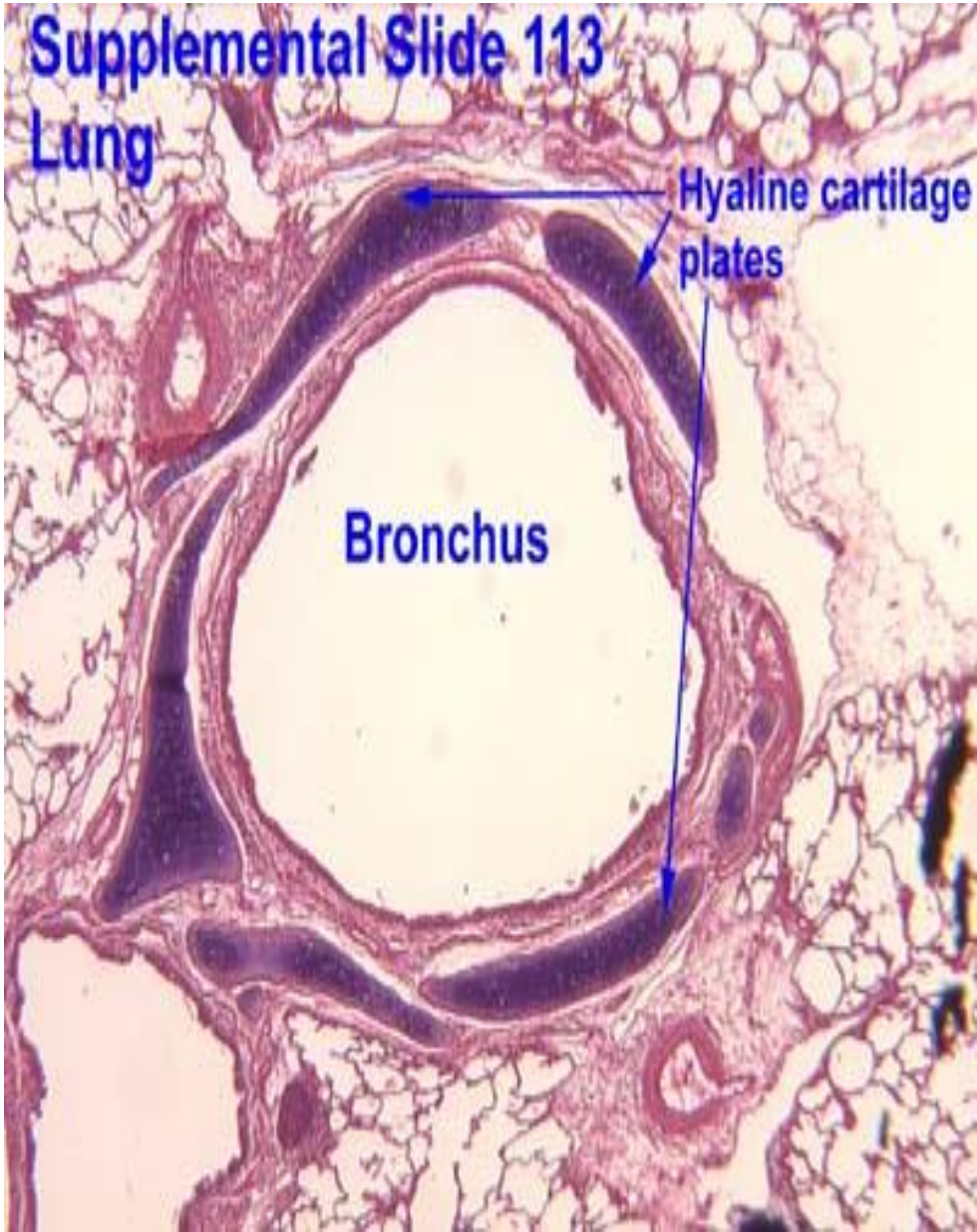
  -Irregular hyaline cartilage

  -Pseudo stratified ciliated columnar with goblet cells.

- Tertiary /Segmental bronchus

  -Columnar epithelium

  -Patches of cartilage



# Changes as bronchi become smaller

- **Cartilage**: irregular and smaller. Absent in bronchioles.
- **Muscle**:  increases as bronchi becomes smaller.(Spasm of these muscles bring difficulty in breathing in allergic conditions)
- **Epithelium**: pseudostratified ciliated columnar epithelium in principal bronchi later simple ciliated columnar,non-ciliated columnar and later cuboidal in respiratory bronchioles

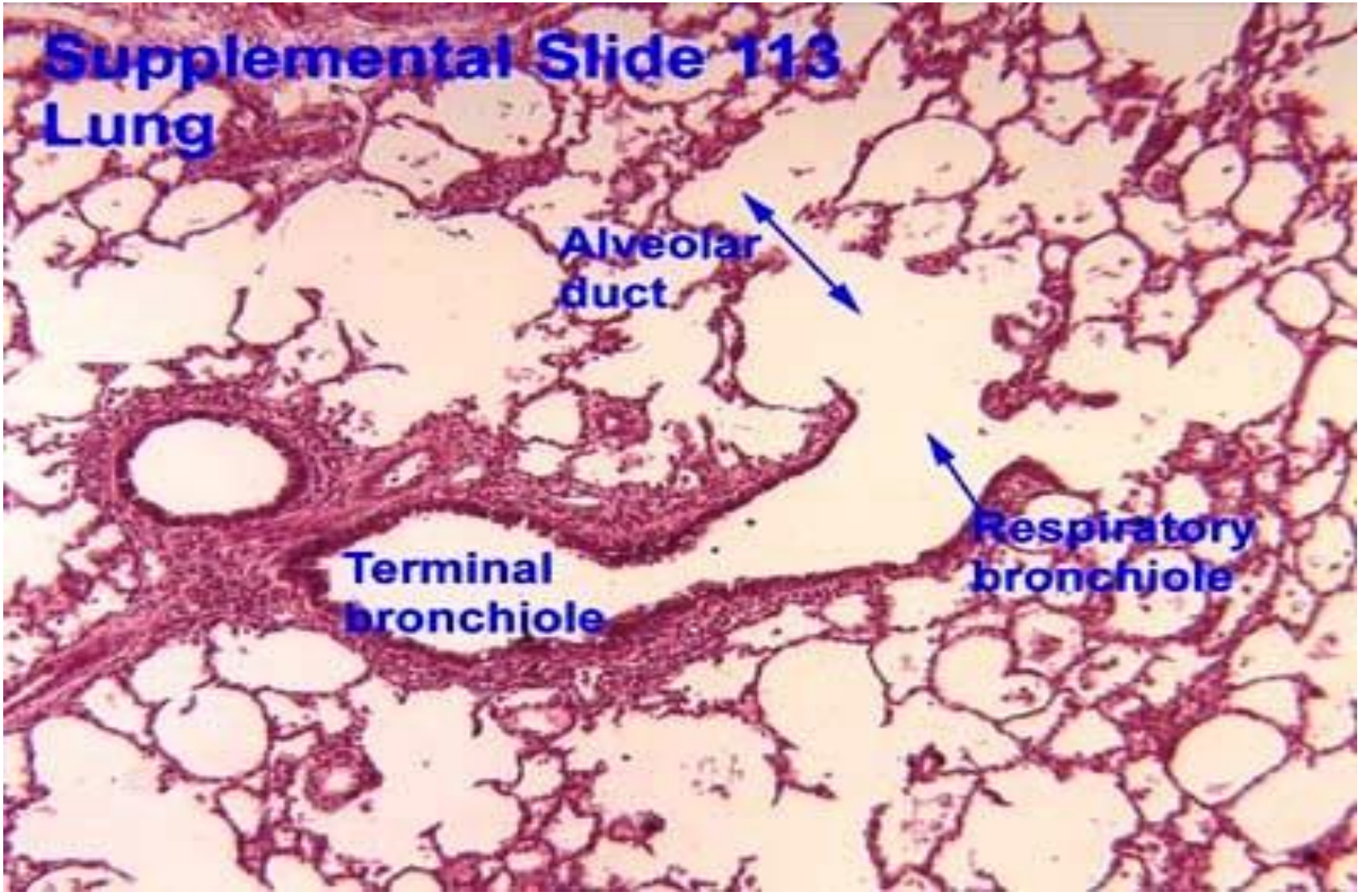
# Terminal bronchiole

- They are lined by a single layer of cuboidal ciliated cells among nonciliated cells are called Clara cells.
- No goblet cells are present.
- No cartilage in the wall of bronchiole.
- No glands in bronchiolar mucosa
- Lamina propria is composed of smooth muscle and elastic fibers.

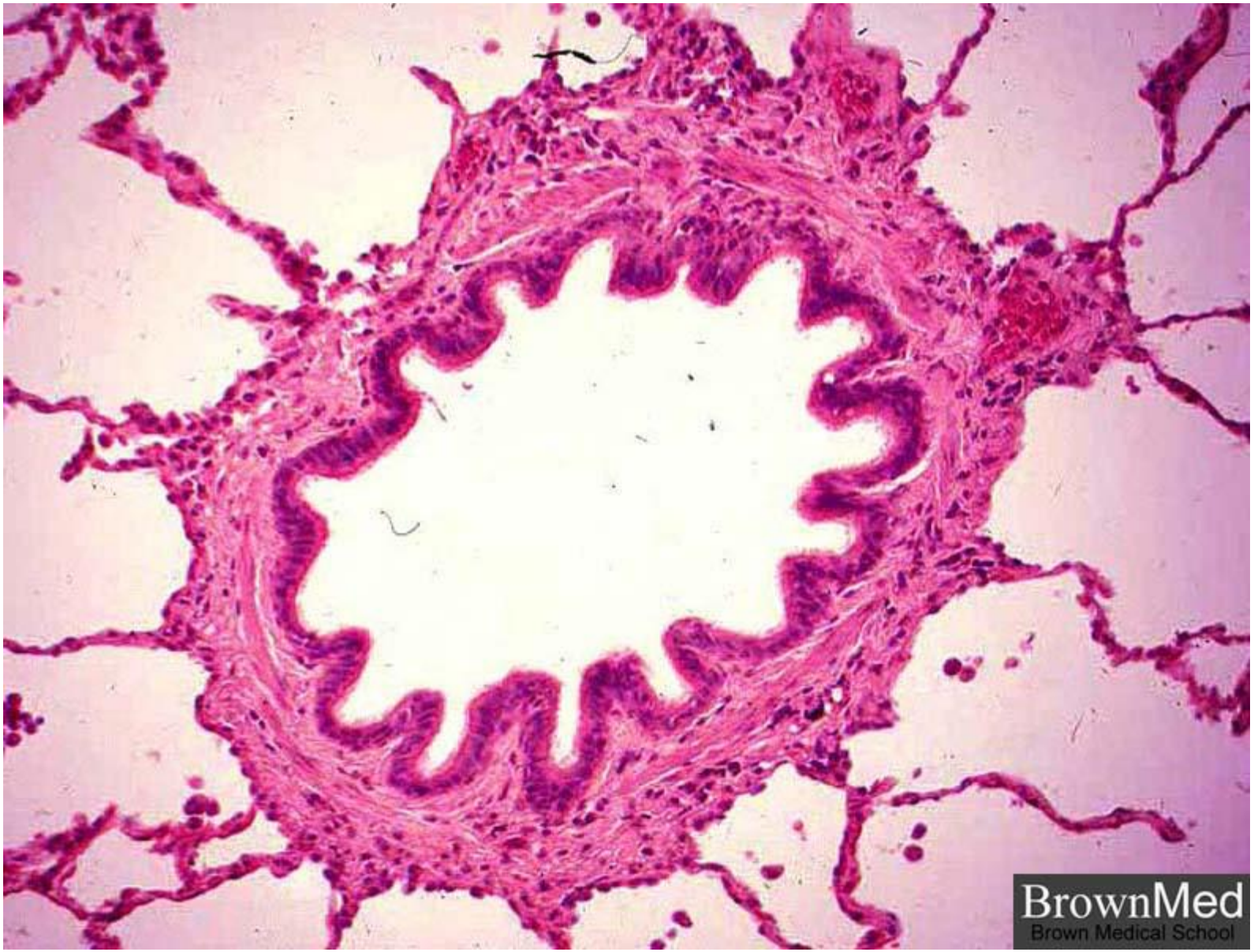
# Respiratory bronchiole

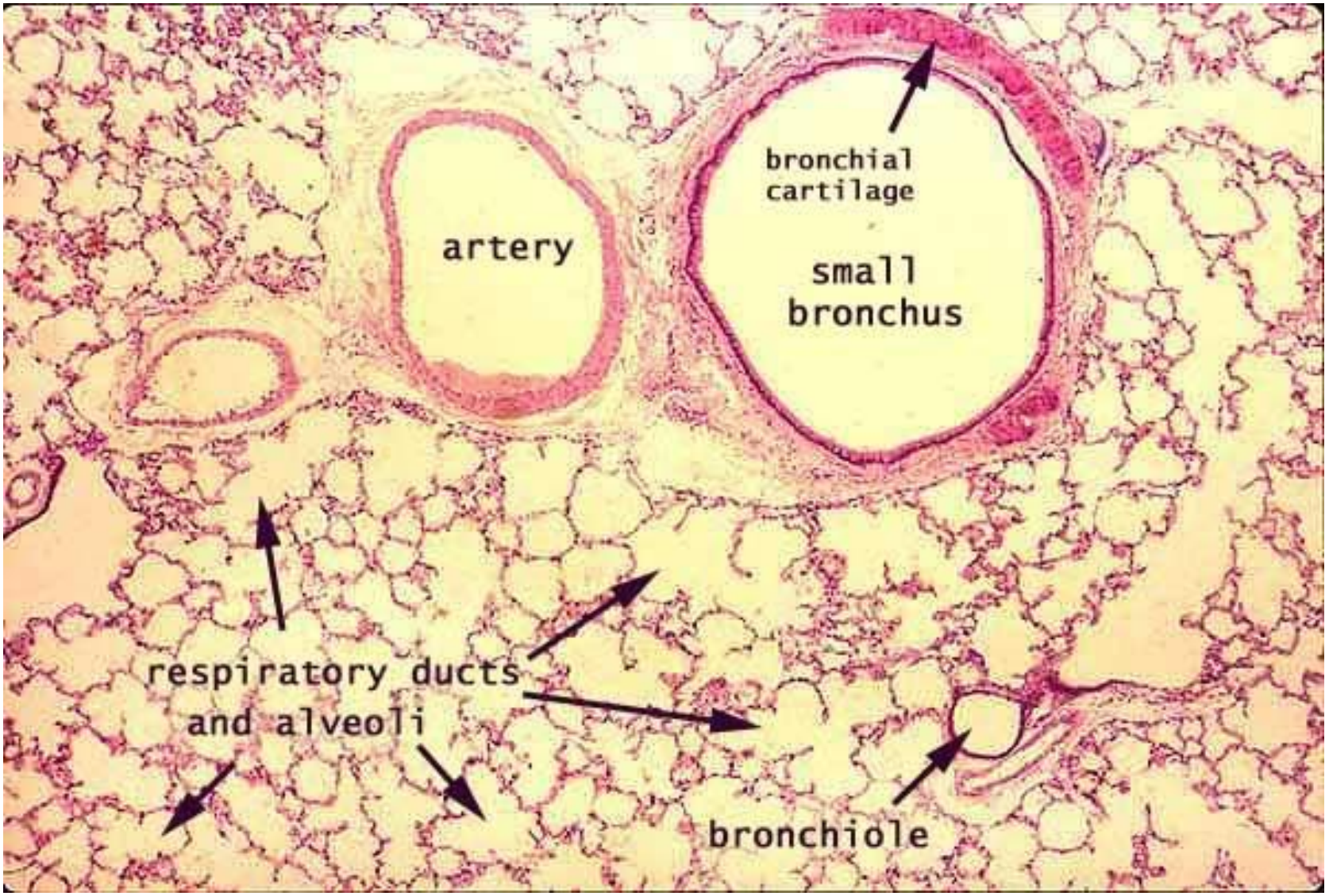
- The bronchiolar wall is lined by simple cuboidal epithelium which contain cilia but it becomes completely nonciliated in smaller ones.
- No goblet cells
- No glands are present.
- The wall of bronchiole is composed of smooth muscle and connective tissue.

# Bronchiole


Supplemental Slide 113
Lung
Alveolar duct
Respiratory bronchiole
Terminal bronchiole

# Bronchiole



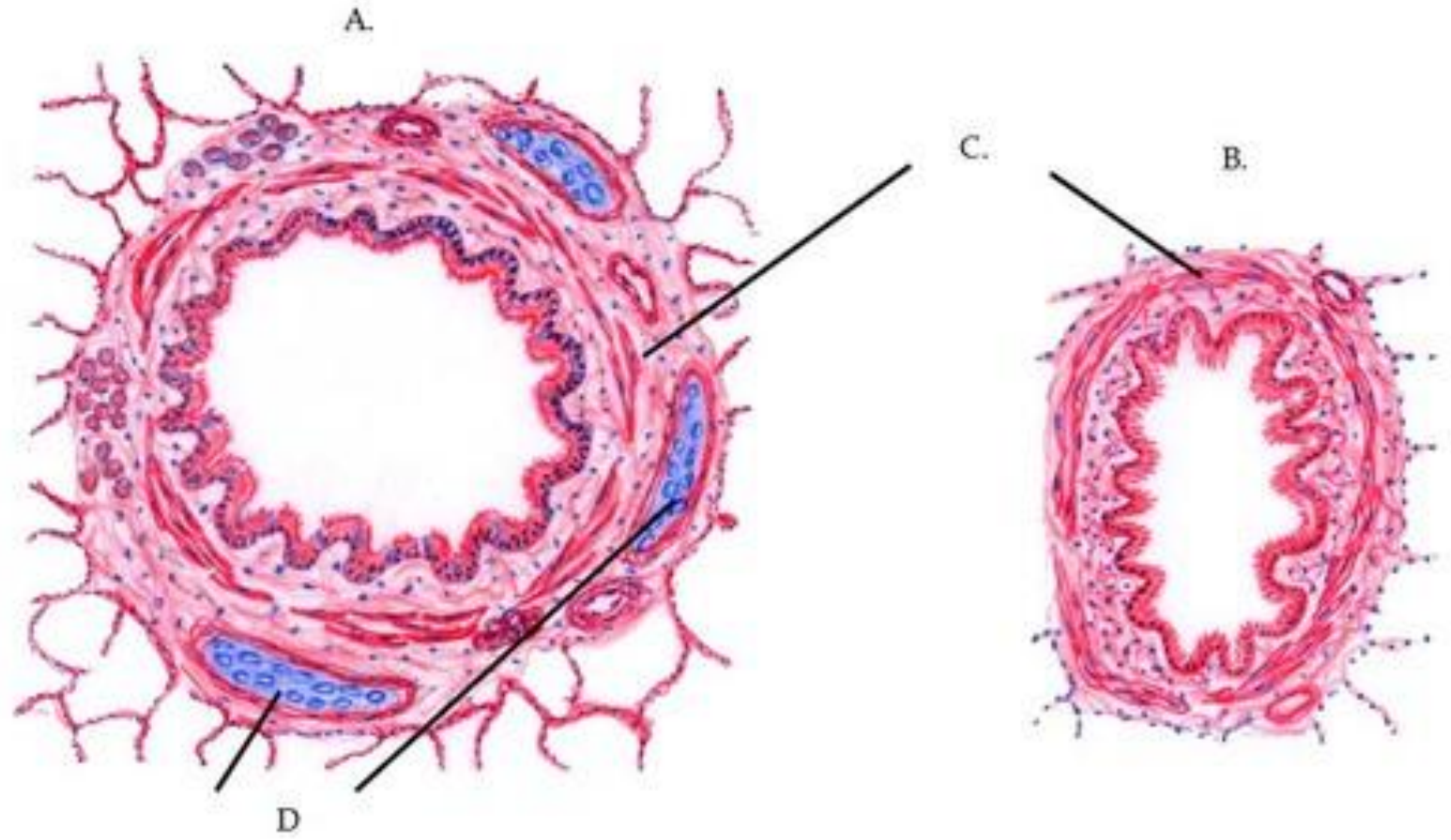

bronchial
cartilage
artery
small
bronchus
respiratory ducts
and alveoli
bronchiole

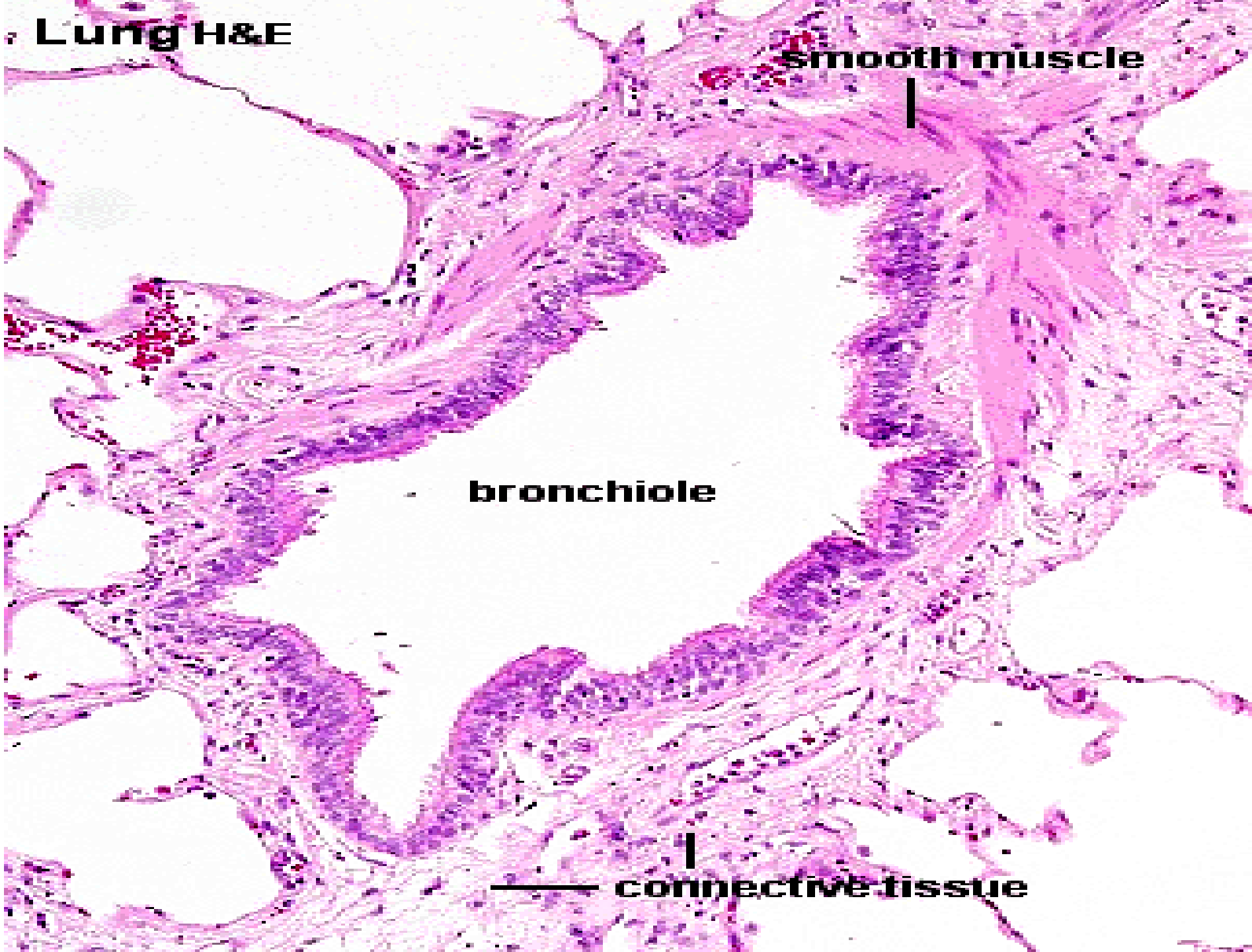
# Differences between Bronchi and Bronchioles

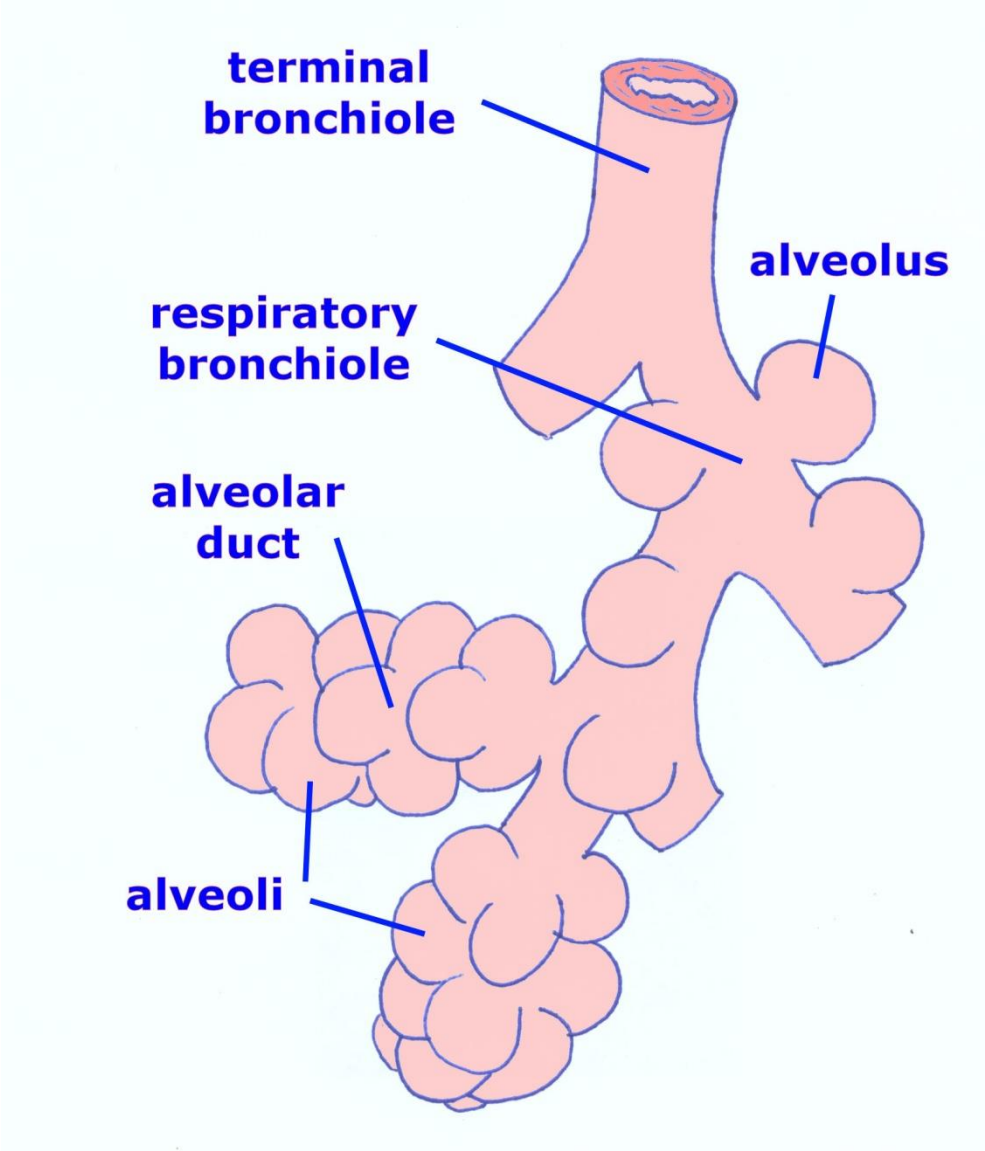
Bronchioles

- No glands
- No cartilage
- No goblet cells
- Thick smooth muscle layer
- Presence of Clara cells
- Many elastic fibres

# Bronchus and Bronchiole



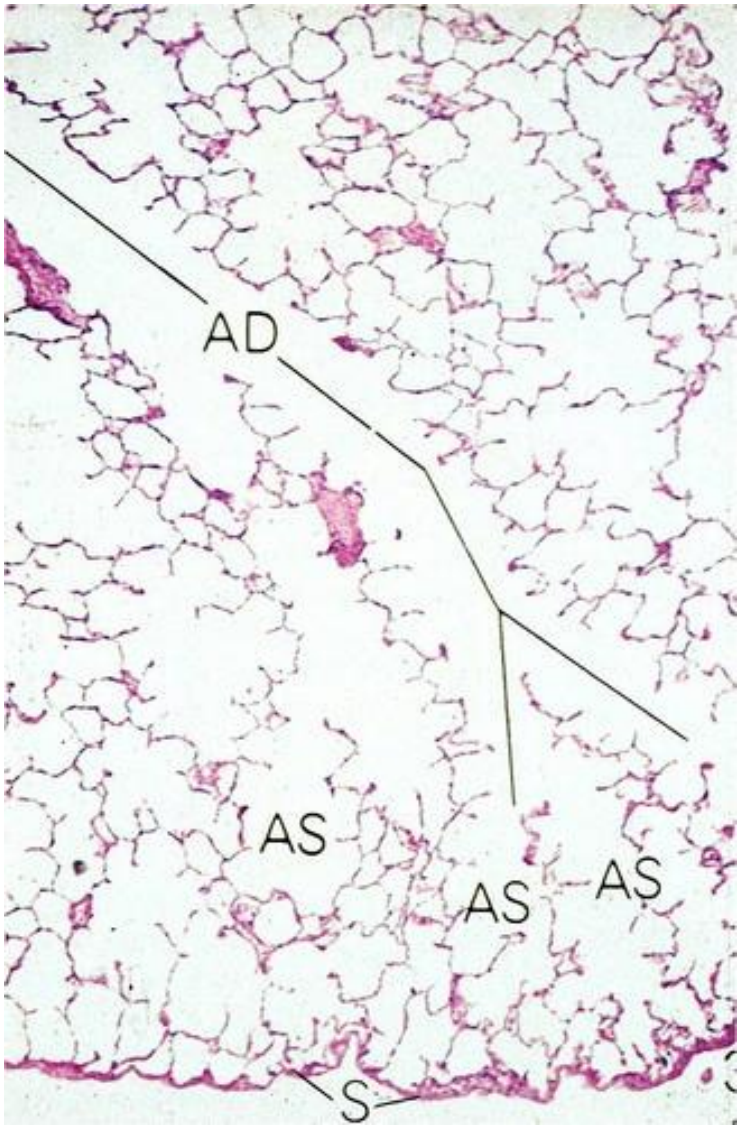

Lung H&E
smooth muscle
bronchiole
connective tissue

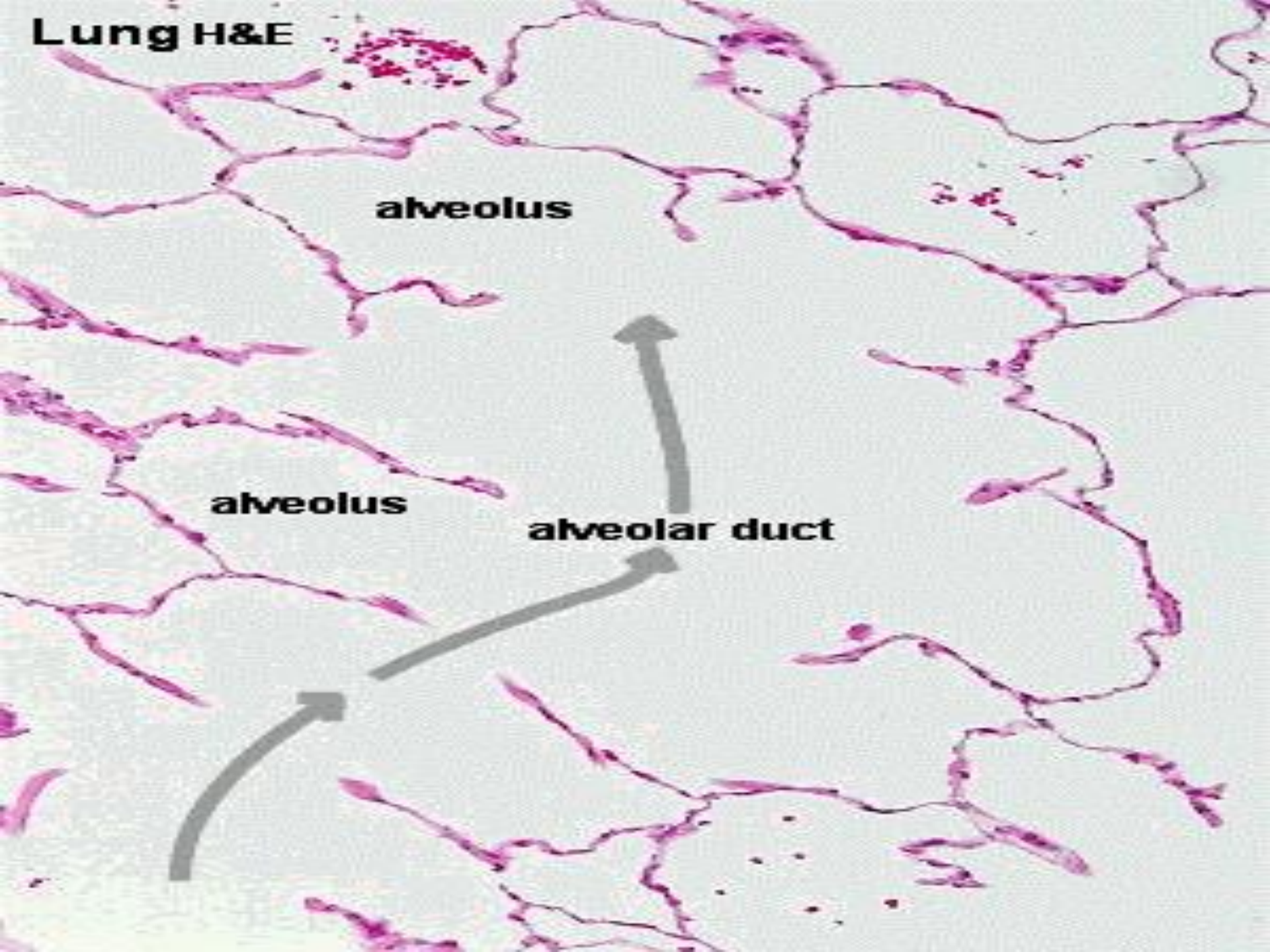

terminal bronchiole
alveolus
respiratory bronchiole
alveolar duct
alveoli

# Alveolar duct

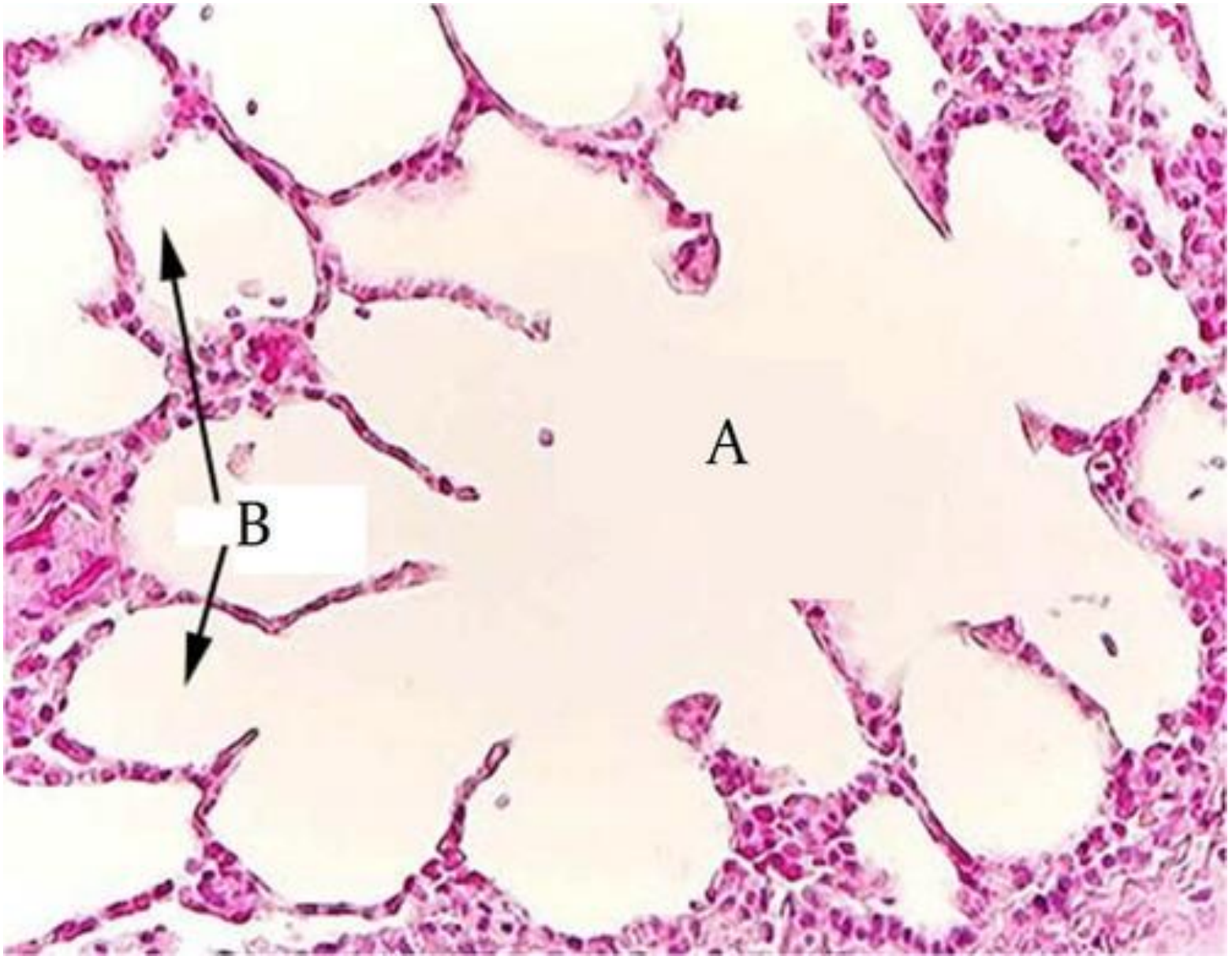
- The respiratory bronchioles terminate in elongated airways called alveolar ducts.
- In an alveolar duct there is no evidence of bronchial wall,however rings of smooth muscle fibers are present.
- The alveolar ducts terminate into alveolar sac.

# Alveolar Ducts and AlveolarSacs




Lung H&E
alveolus
alveolus
alveolar duct

# Alveolar Sac



# Alveoli

- The pulmonary alveoli are cup shaped structure having thin wall.
- Adjacent alveoli are separated from each other by interalveolar septa.
- The pulmonary alveoli are lined by two types of epithelial cells.

➢ Type I Pneumocytes

➢ Type II Pneumocytes

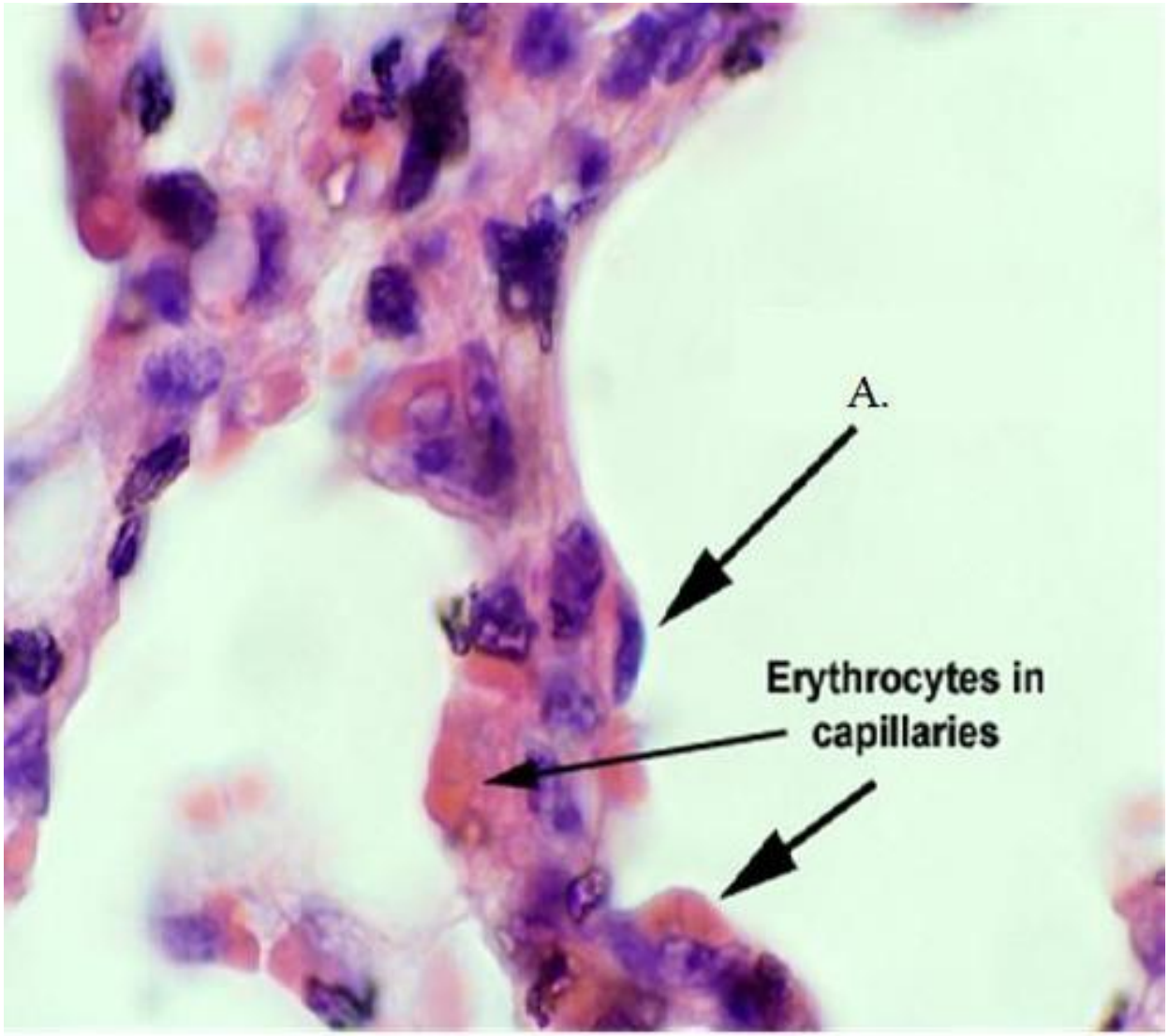
# Type I alveolar cell

- Also called type I pneumocytes or squamous alveolar cells.
- These cells cover 95% of the alveolar surface.
- The role of type l pneumocytes is to provide a barrier of minimal thickness that permits gaseous exchange.

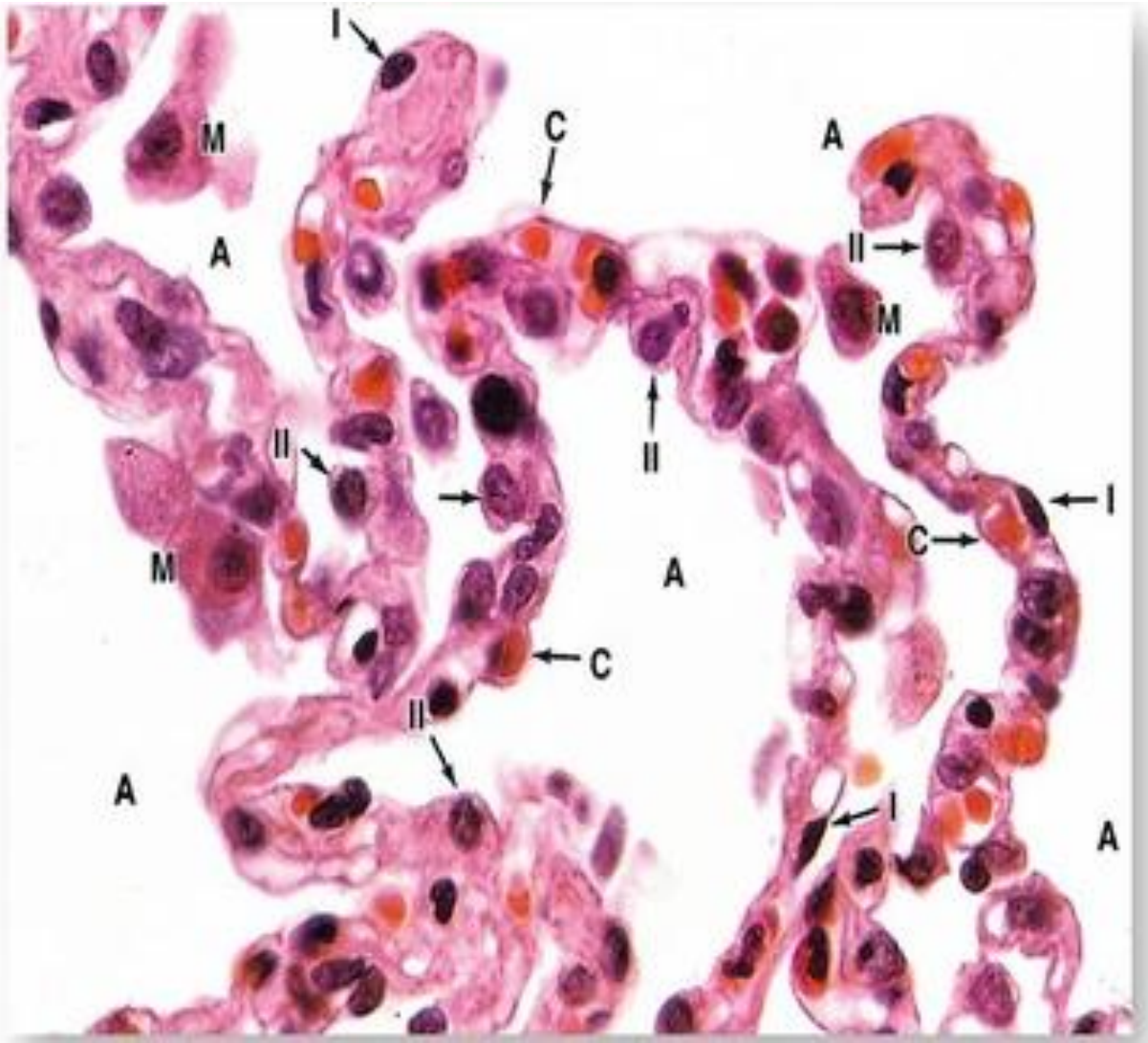
# Type II alveolar cells

- Also called type II pneumocytes or greater alveolar cells, are cuboidal in shape.
- These cells cover 5% of the alveolar surface.
- Type II cells secrete surfactant that reduce the surface tension of alveolar cells.
- The type II cells also serve as stem cells for alveolar epithelium.

# Type I Pneumocytes



# Type I and II Pneumocytes & capillaries



# Blood Air Barrier

- The blood air barrier includes those structures through which gases must pass during exchange between the blood and air.
- The barrier consists of following components:

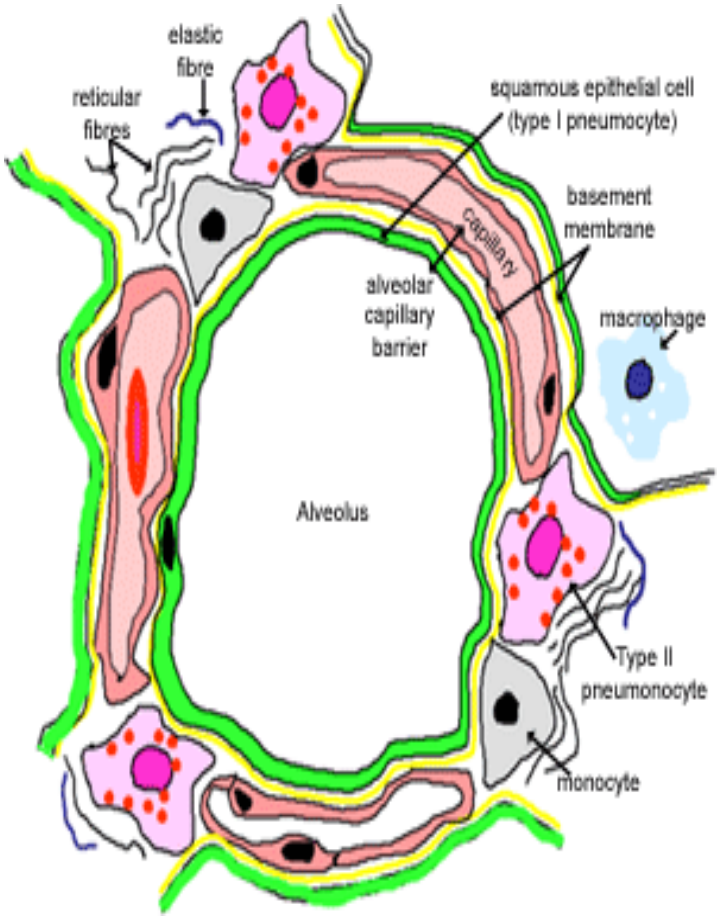
➢ A thin layer of pulmonary surfactant

➢ A type I alveolar cell and basal lamina

➢ A capillary endothelial cell and its basal lamina.

# Alveolar Macrophages or Dust cells

- Derived from Monocytes and are part mononuclear phagocytic system.
- Either seen in the septa or alveoli.
- The alveolar macrophages maintain a sterile enviroment within the lungs by ingesting the carbon particles,pollen,bacteria and dust.



- What is the first portion of the respiratory tree where gas exchange can occur?
  a. Alveolar duct
  b. Alveoli
  c. Alveolar sac
  d. Respiratory bronchiole
  e. Terminal bronchiole

What type of epithelium is found in the respiratory mucosa of man?

a. Non-ciliated pseudostratified columnar epithelium with goblet cells

b. Ciliated pseudostratified columnar epithelium with goblet cells

c. Simple columnar epithelium

d. Stratified squamous epithelium

e. Transitional epithelium

- In which structure does gas exchange NOT occur?
  a. Alveolar duct
  b. Alveoli
  c. Alveolar sac
  d. Respiratory bronchiole
  e. Terminal bronchiole

- What type of tissue makes up the rings of the trachea?
  a. Compact bone
  b. Spongy bone
  c. Hyaline cartilage
  d. Fibrocartilage
  e. Elastic cartilage

- Which cell is also called an alveolar phagocyte?
  a. Clara cell
  b. Type I pneumocyte
  c. Type II pneumocyte
  d. Dust cell
  e. Brush cell

# MCQ

Cartilage is seen in

- Bronchus
- Terminal bronchiole
- Respiratory bronchiole
- Alveolar duct

# MCQ

Cells of Clara are predominantly seen in

- Trachea
- Primary Bronchus
- Secondary Bronchus
- Bronchioles