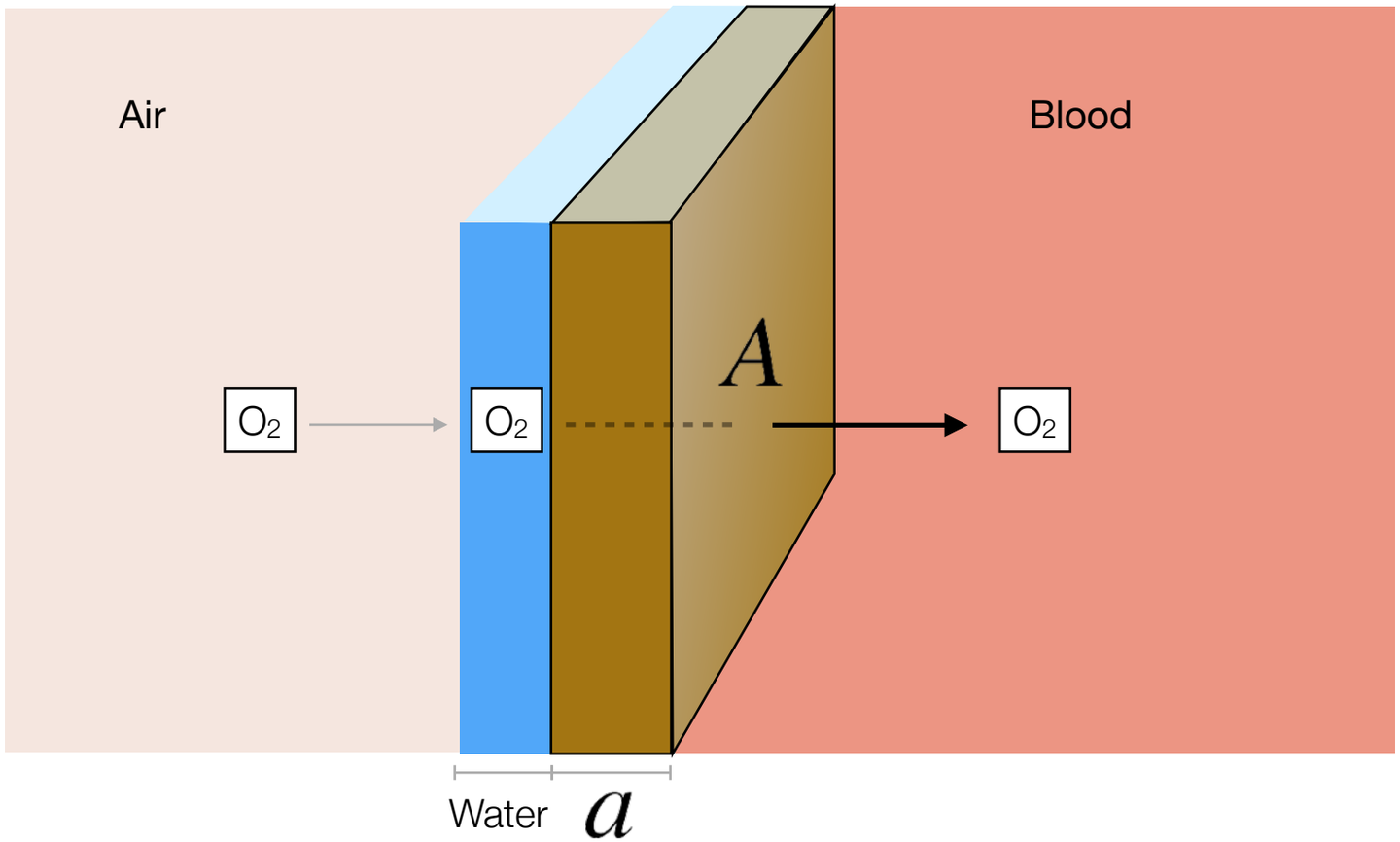
Respiratory System

Peter Takizawa
peter.takizawa@yale.edu

What we'll talk about…

- Histological structures of conducting airways
- Histological structures that facilitate gas exchange
- Properties of alveoli that control ventilation
- Macrophages and handling of foreign particles

Rate of gas diffusion between air and blood is related to the surface area and thickness of the interface.



Surface Area of Barrier

Rate of Diffusion

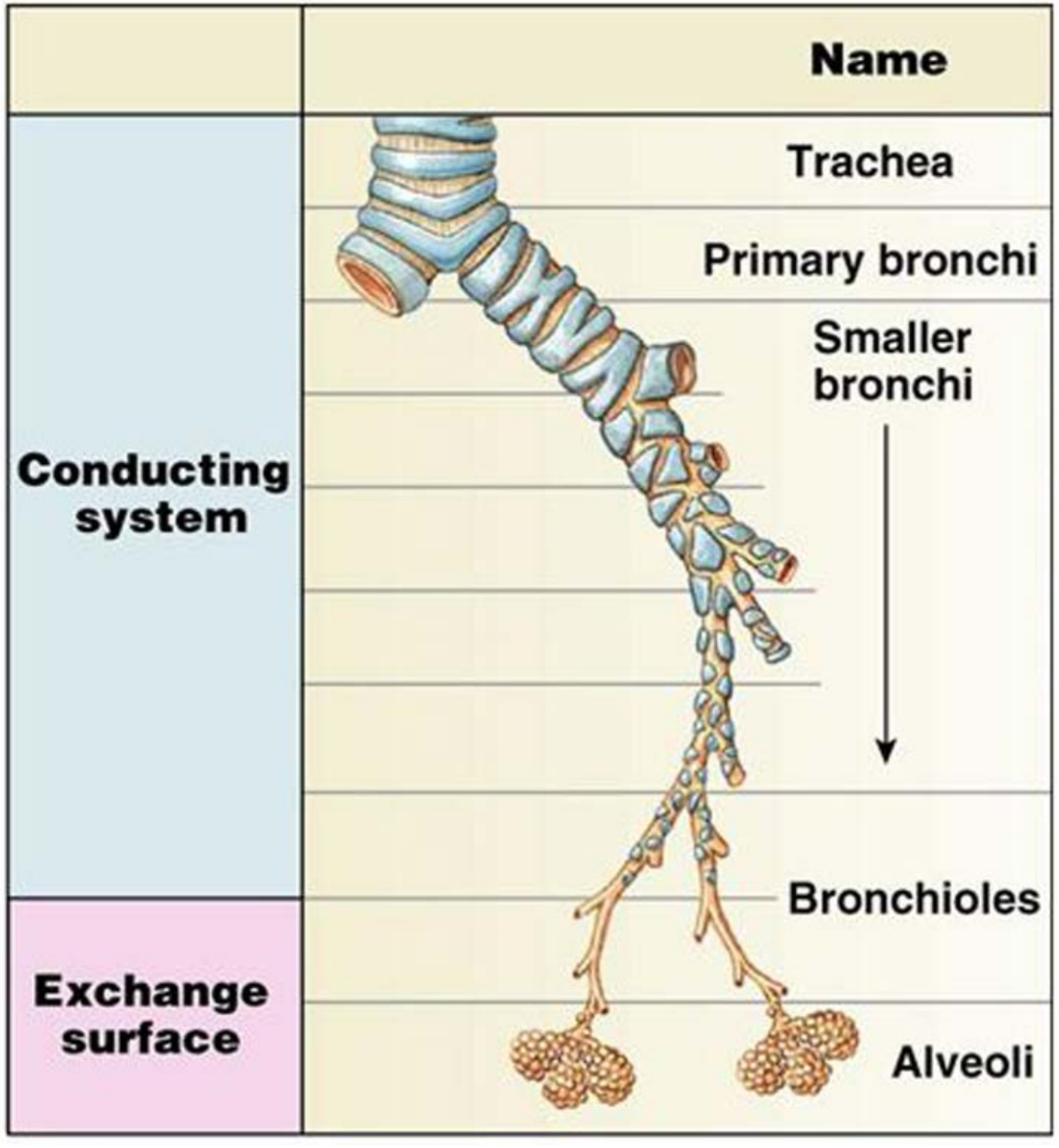
Pressure of Gas in Air

Pressure of Gas in Blood

$$\dot{V} = k\frac{\dot{A} \cdot s}{a \cdot \sqrt{MW}}\left(P_{Air} - P_{Blood}\right)$$

Thickness of Barrier

The respiratory system comprises conducting and gas exchange segments.

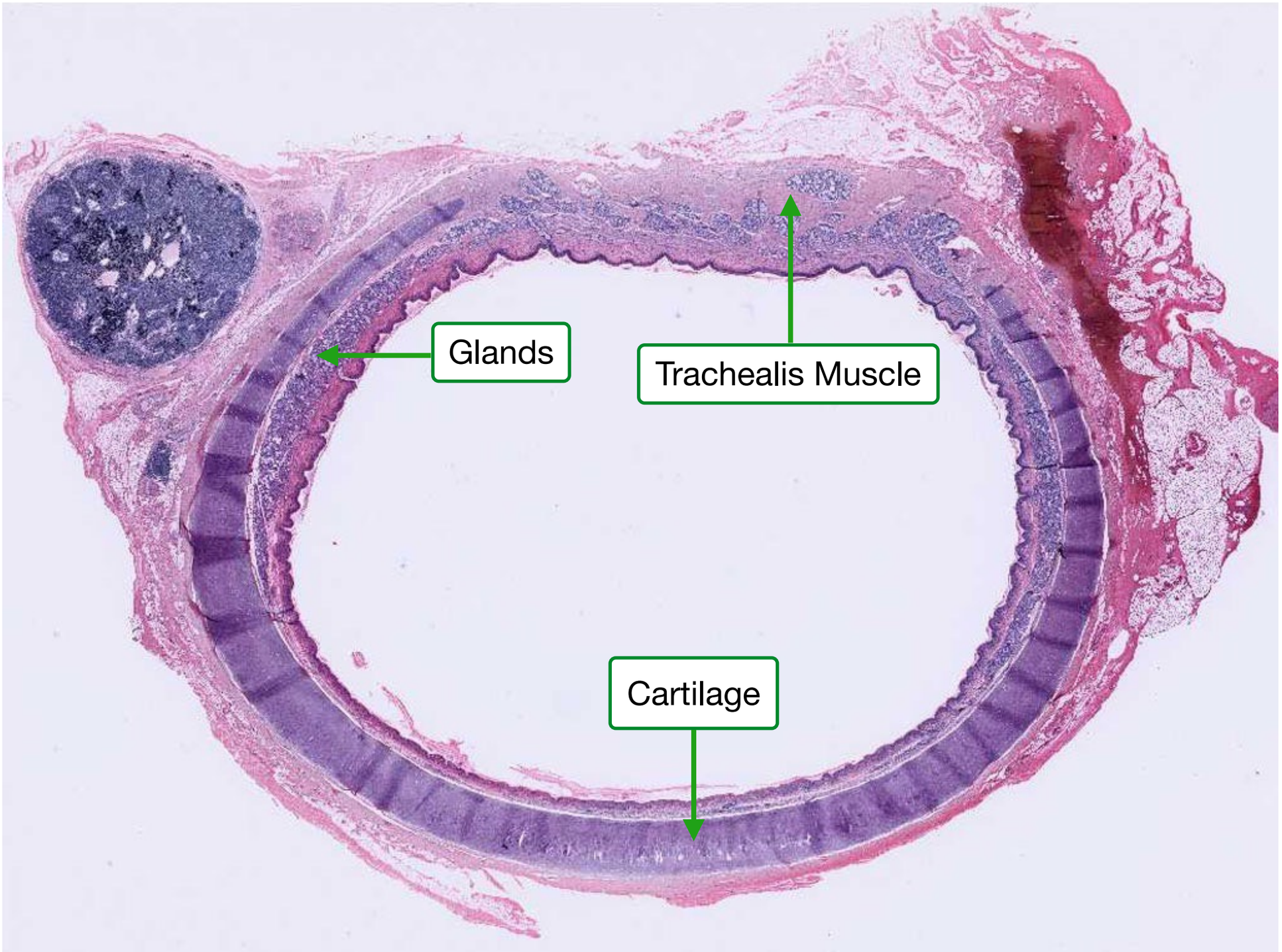


Functions of Conducting Airways

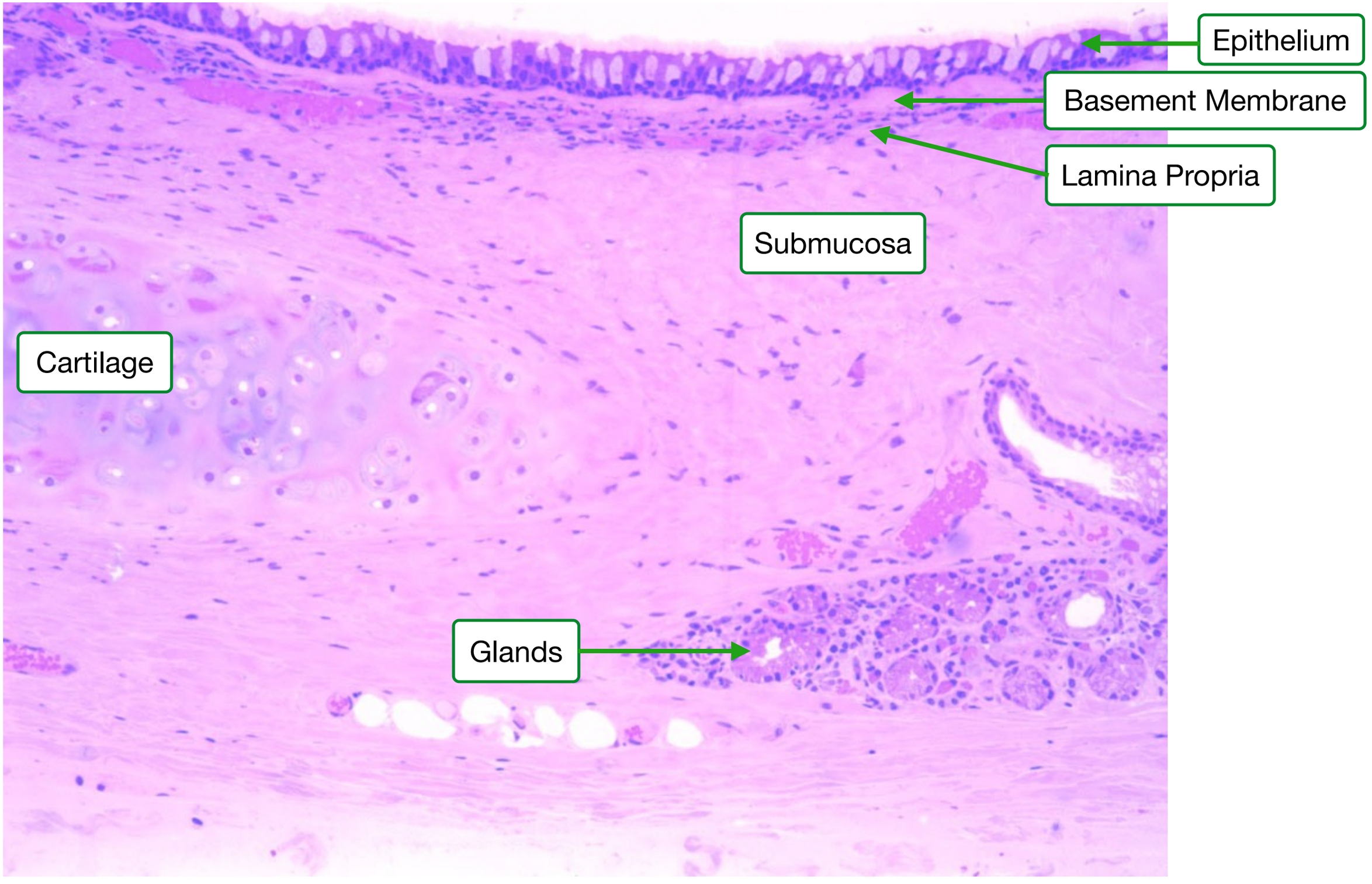
- Facilitate flow of air
- Condition air
- Clear air

Trachea

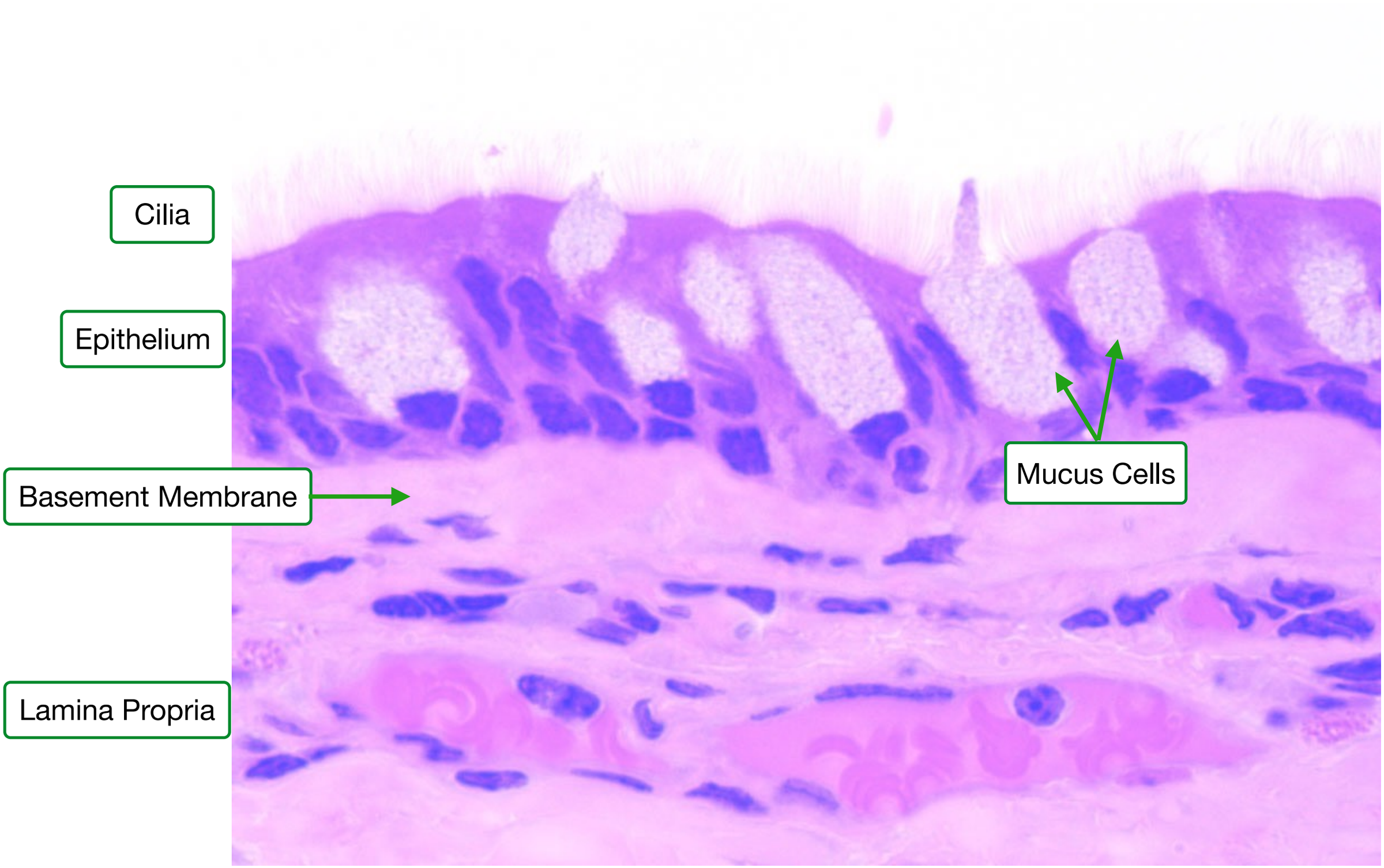
The trachea connects the larynx to primary bronchi and contains cartilage rings.



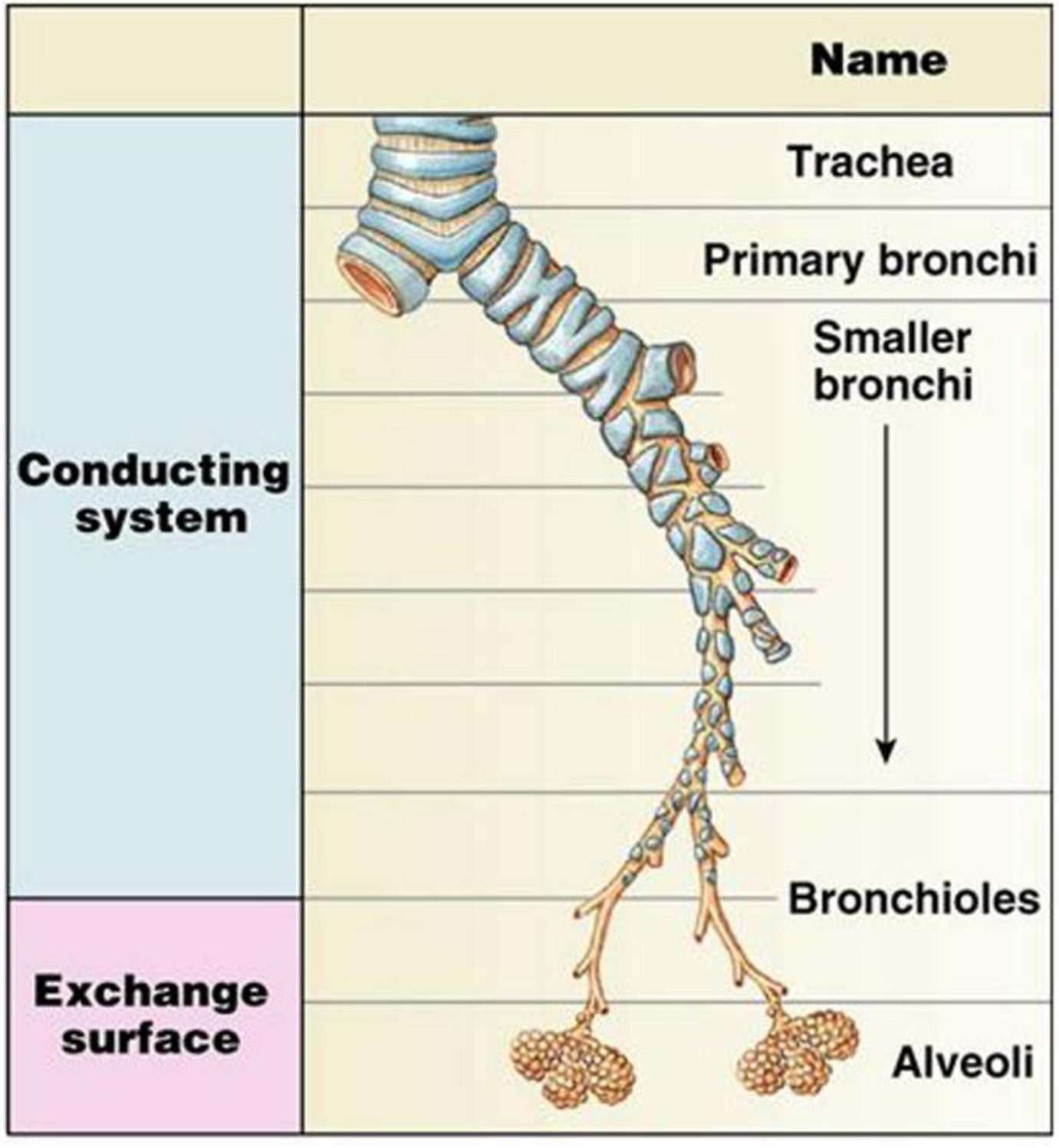
The wall of the trachea contains ciliated, pseudostratifed epithelium, cartilage and glands.



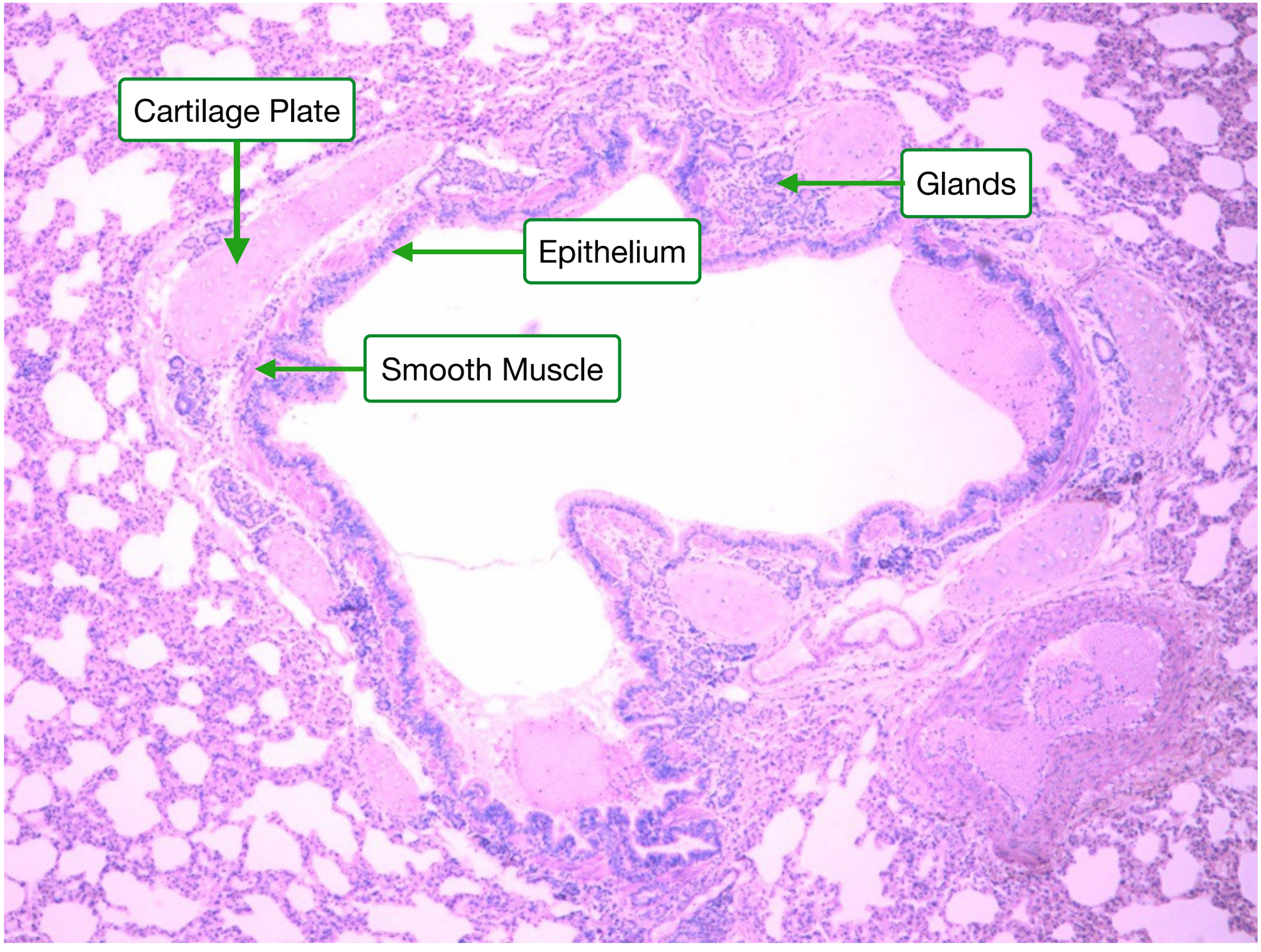
The mucosal layer of the respiratory tract consist of epithelia, basement membrane and lamina propria.



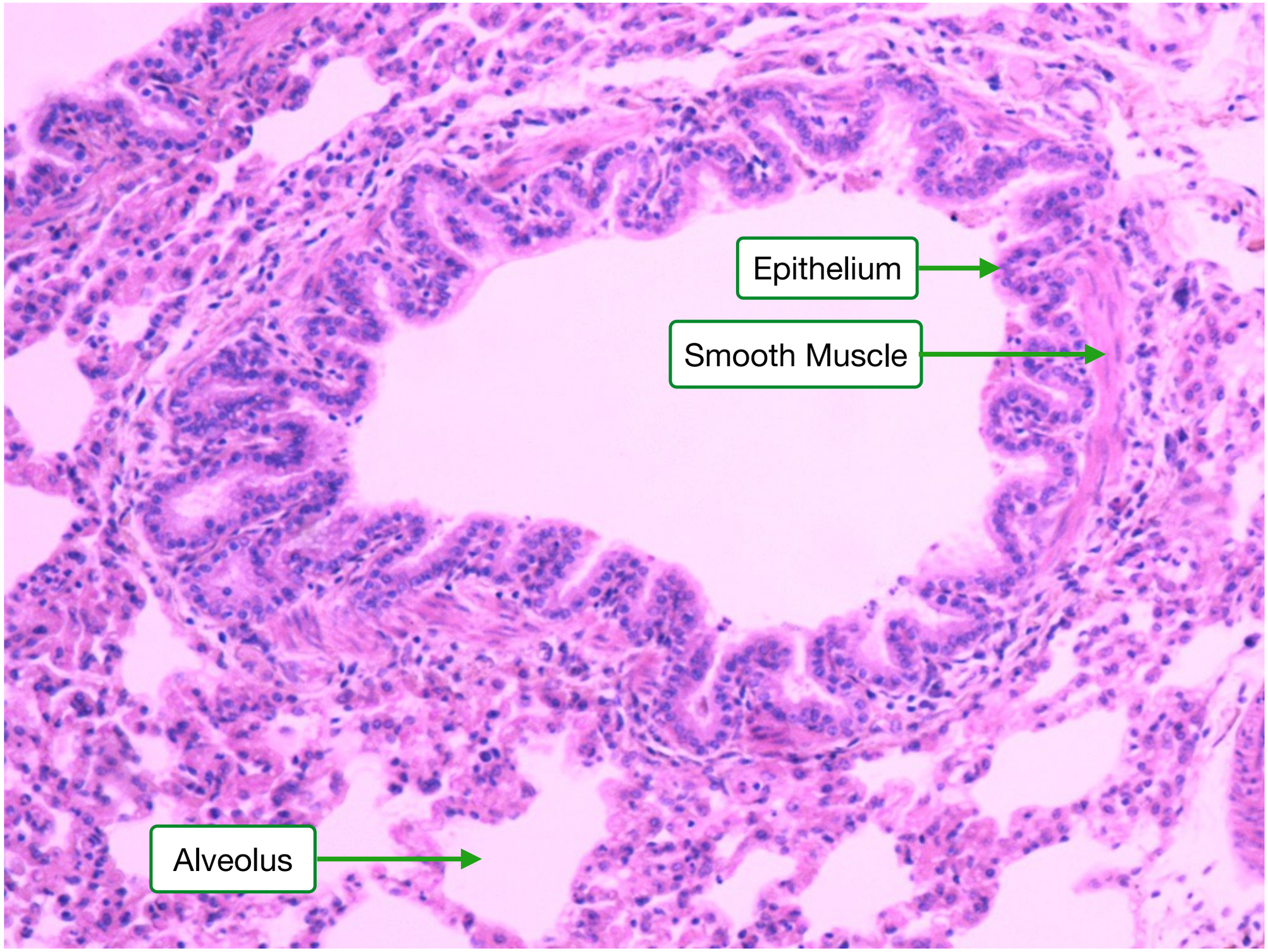
The respiratory system comprises conducting and gas exchange segments.



Bronchi contain pseudostratified epithelium and cartilage plates.

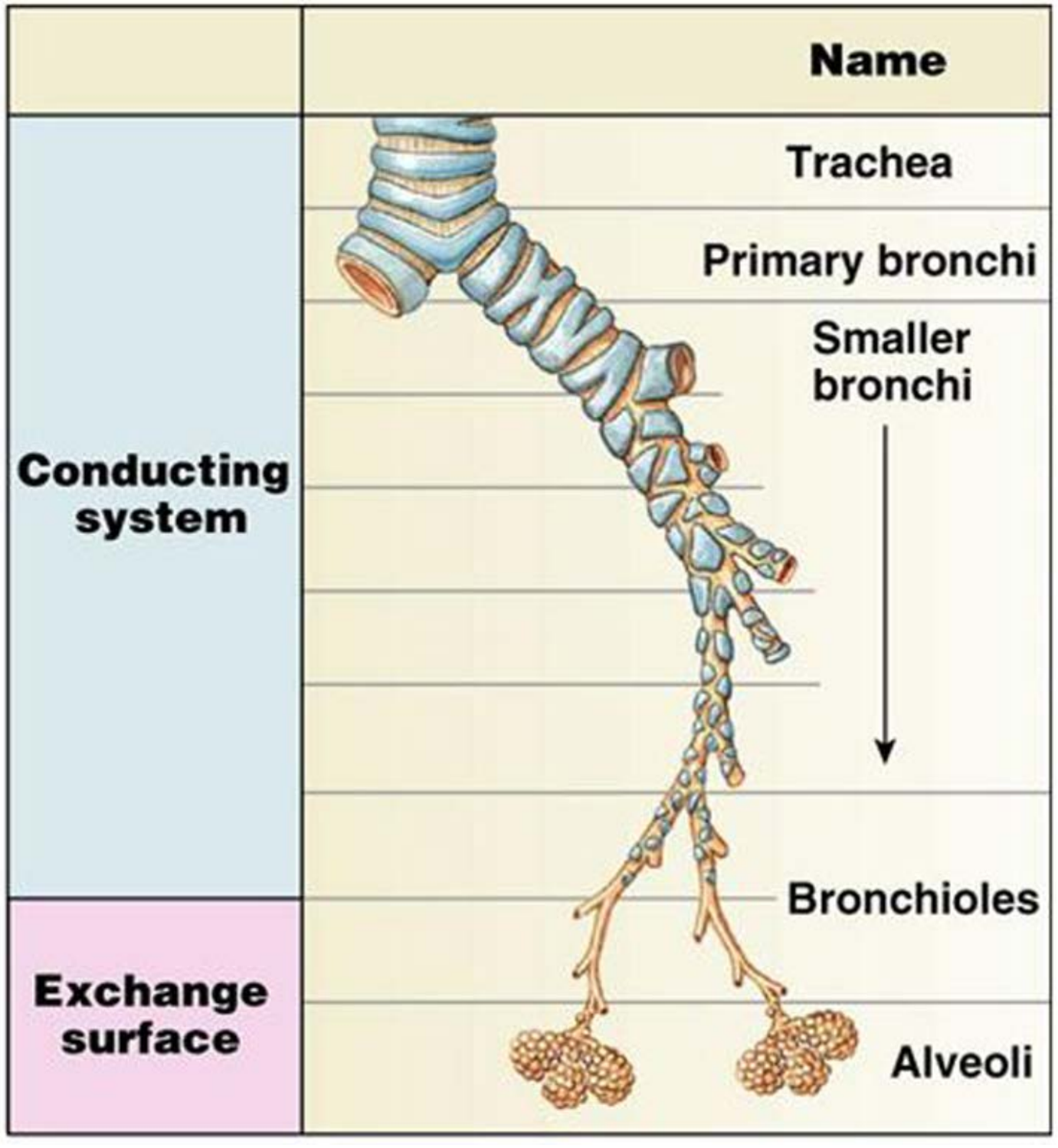


Bronchioles contain simple columnar epithelium and lack cartilage plates.

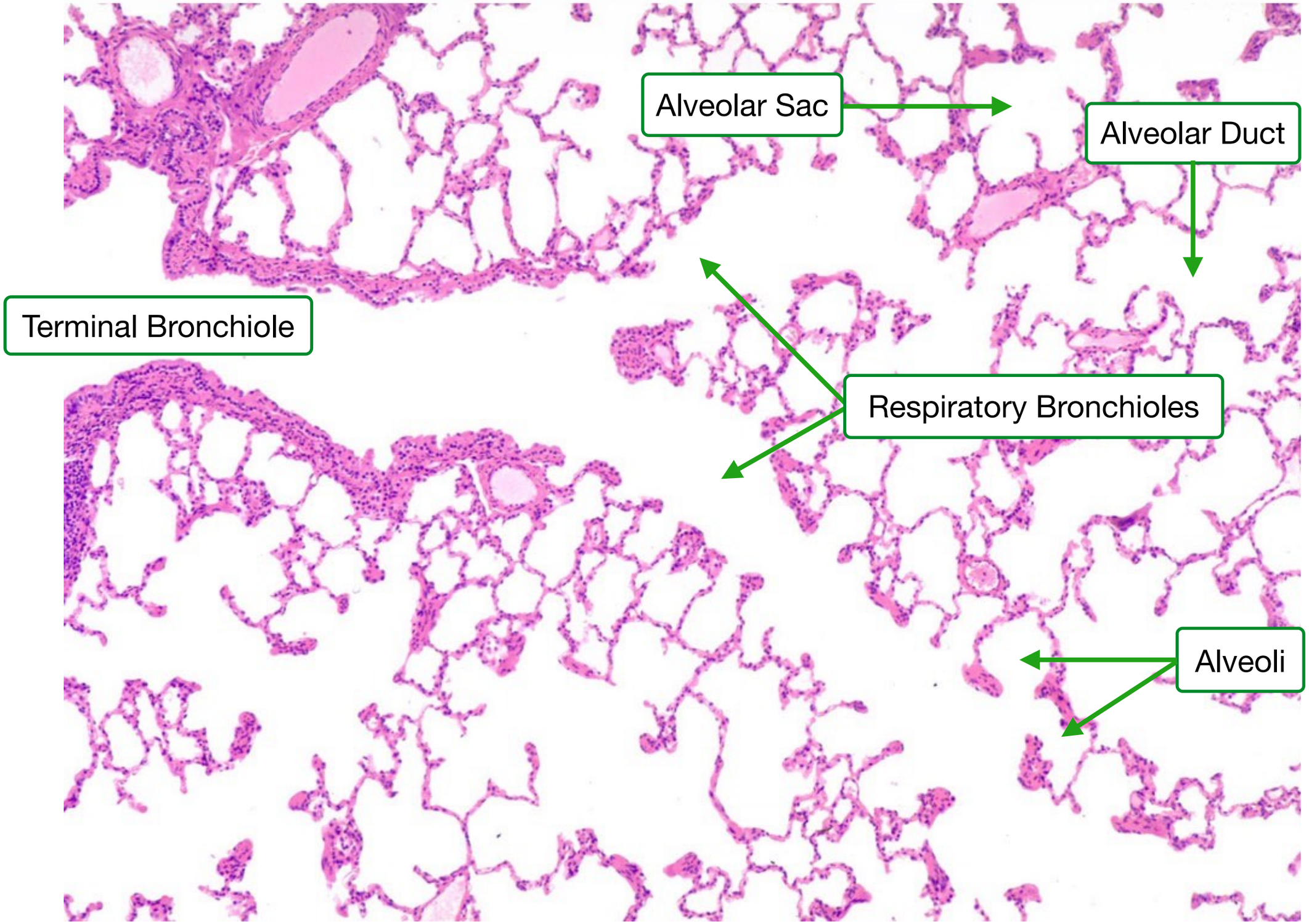


Respiratory Airways

Respiratory bronchioles and alveoli compose the gas exchange portion of the lung.

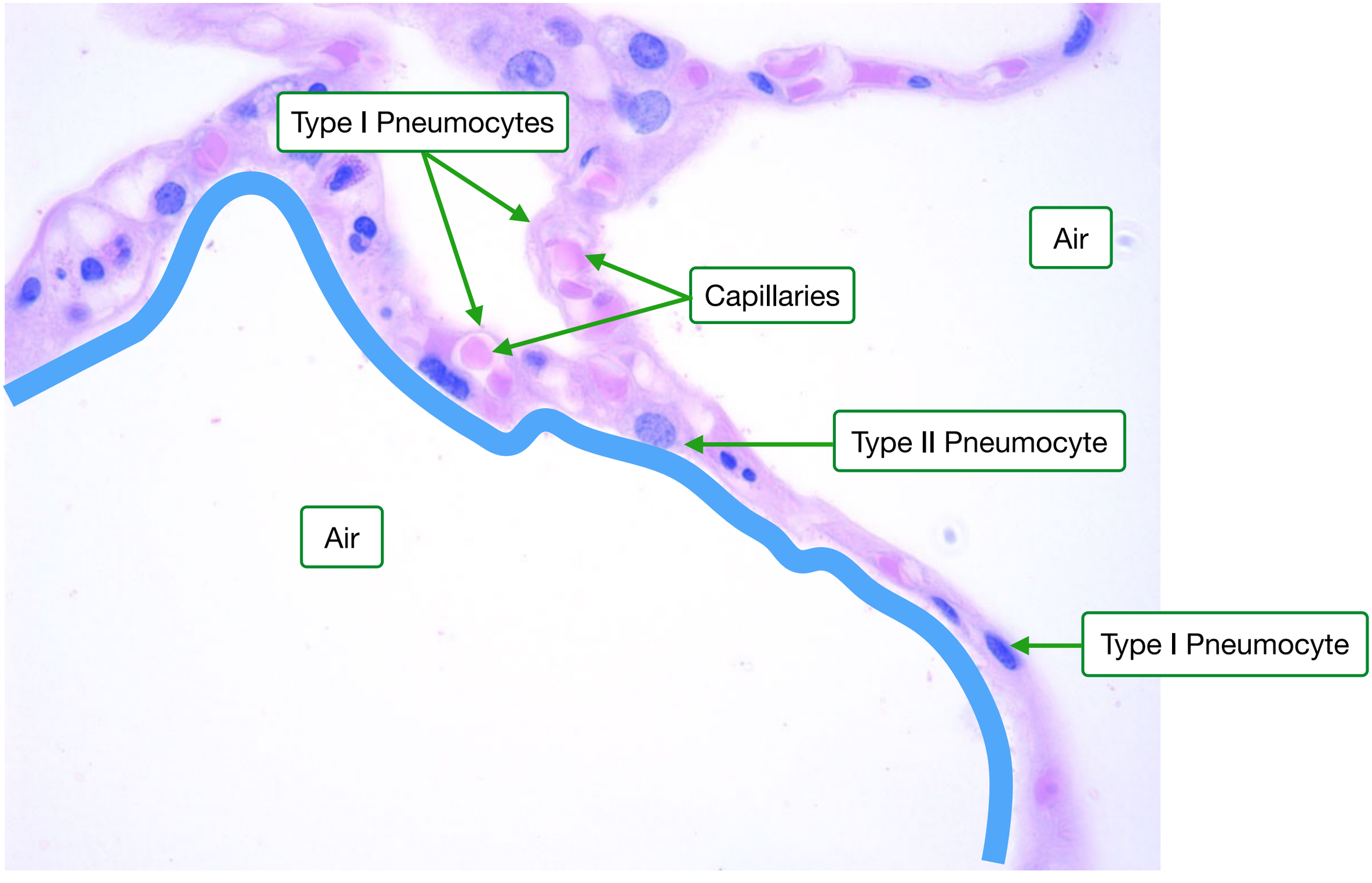


The gas exchange portion comprises respiratory bronchioles, alveolar ducts and sacs and alveoli.

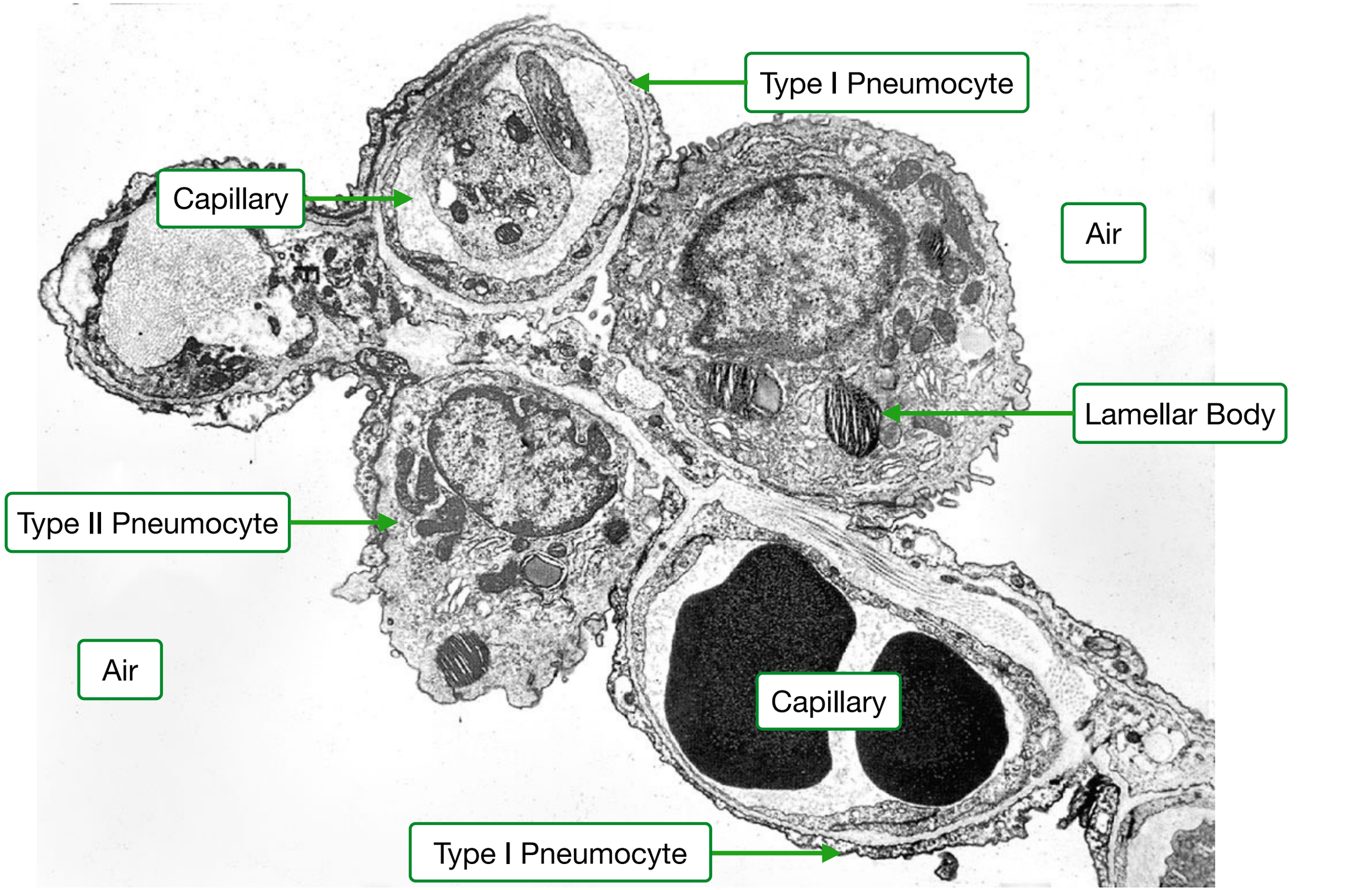


Alveoli

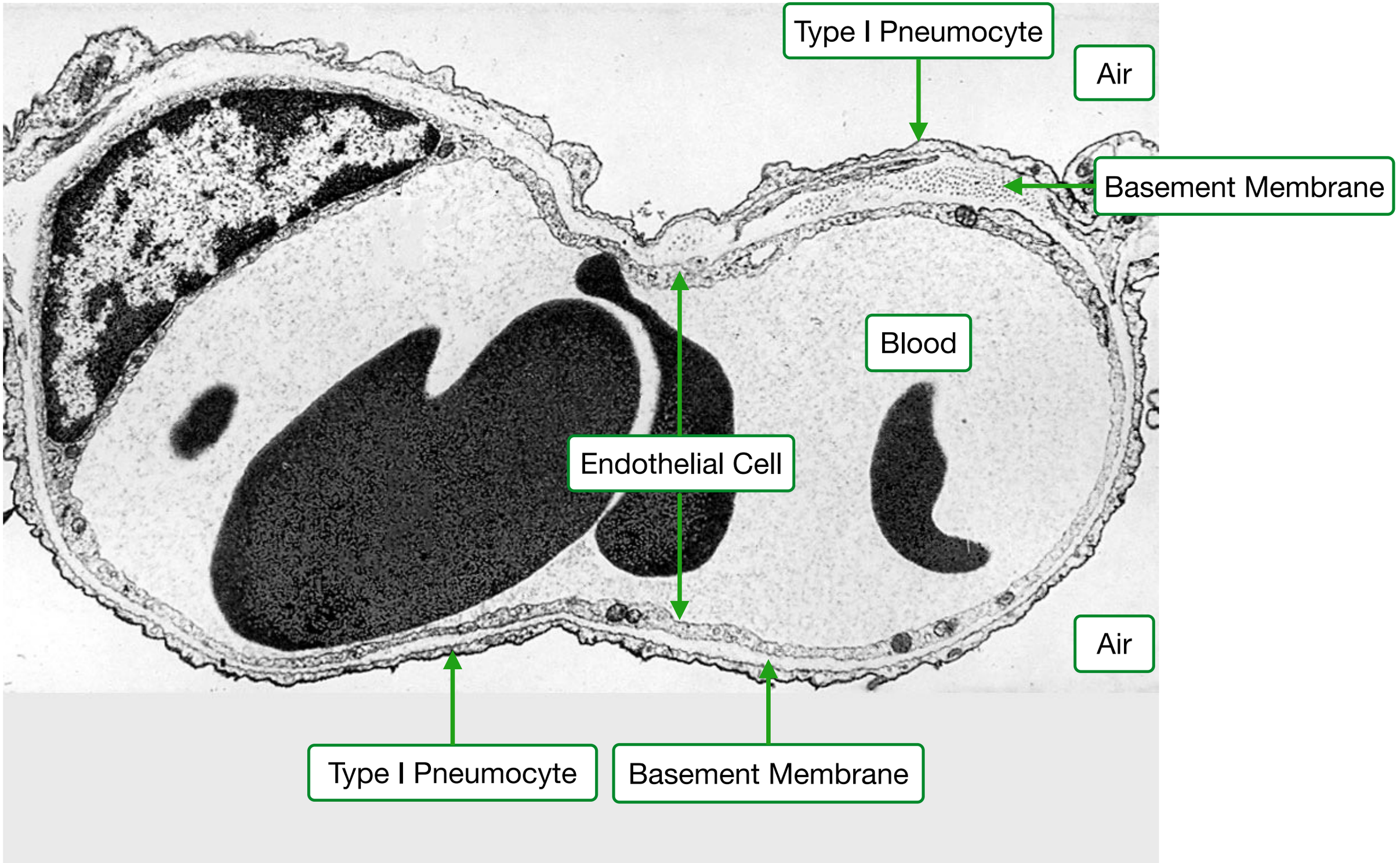
Walls of alveoli consist of pneumocytes, capillaries and connective tissue.



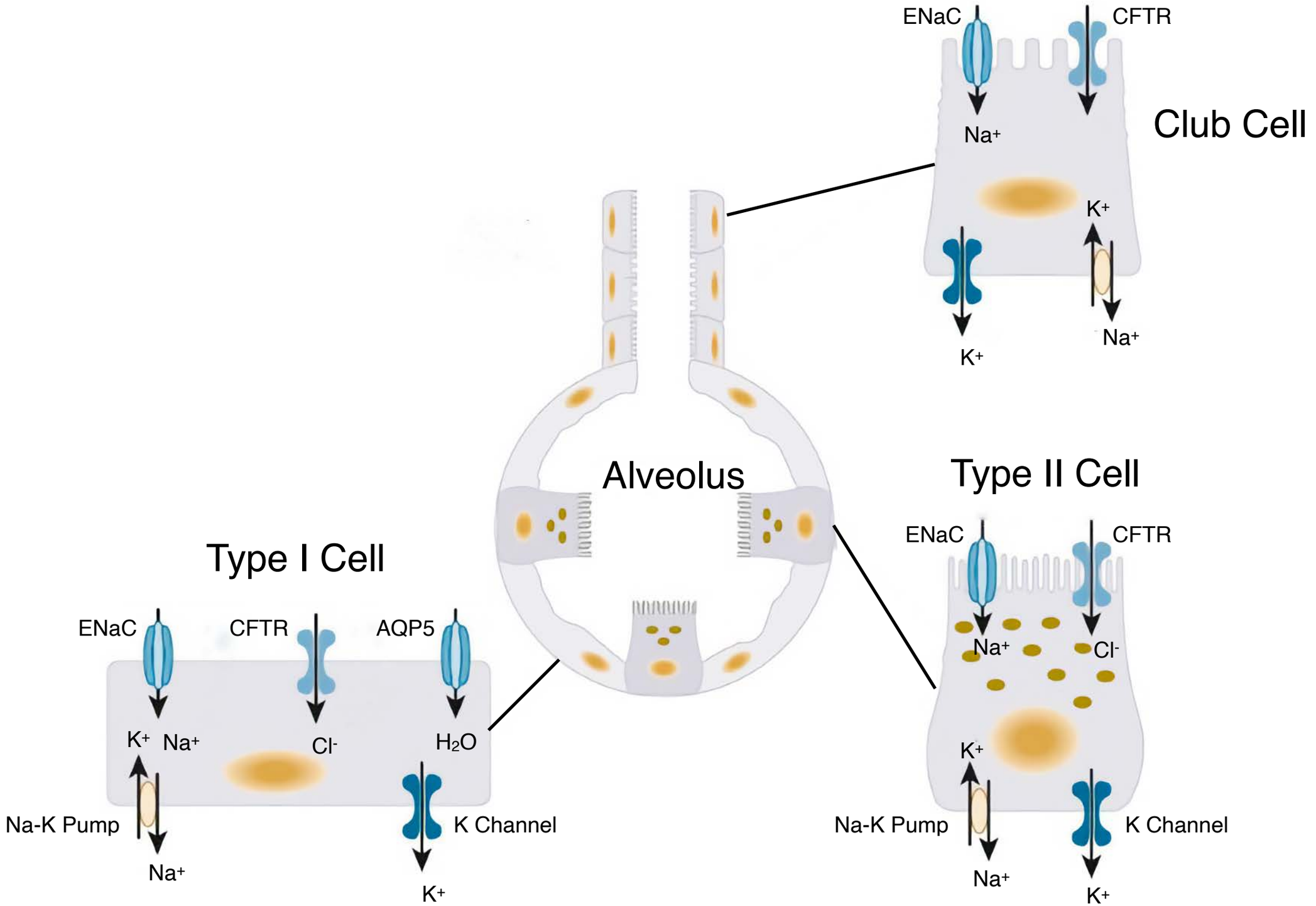
Type I pneumocytes are squamous and surround capillaries; type II pneumocytes are cuboidal.



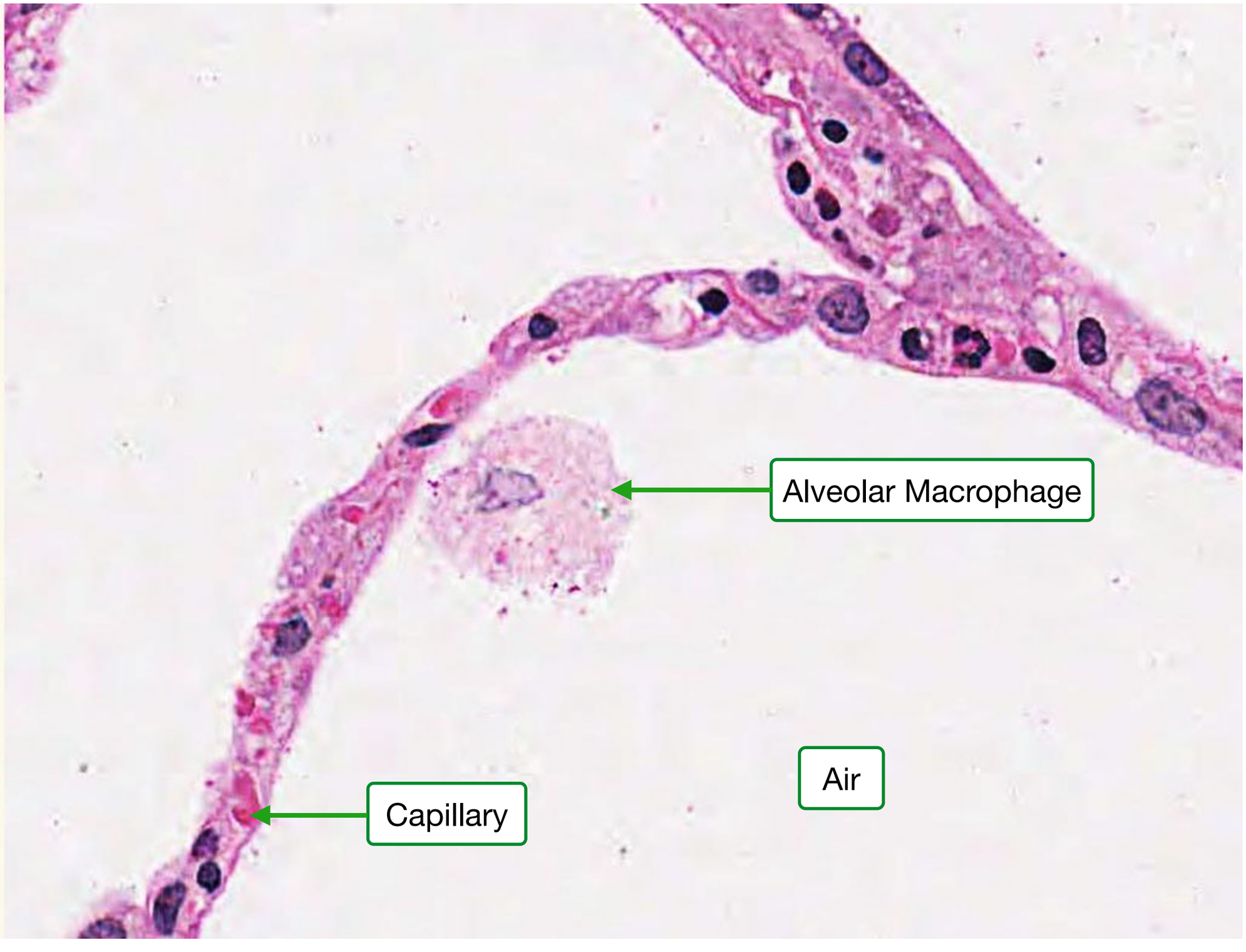
The gas exchange barrier comprises type I pneumocyte, basement membrane and endothelium.



Type I and type II pneumocytes absorb fluid from the lumen via vectorial transport of sodium and chloride.

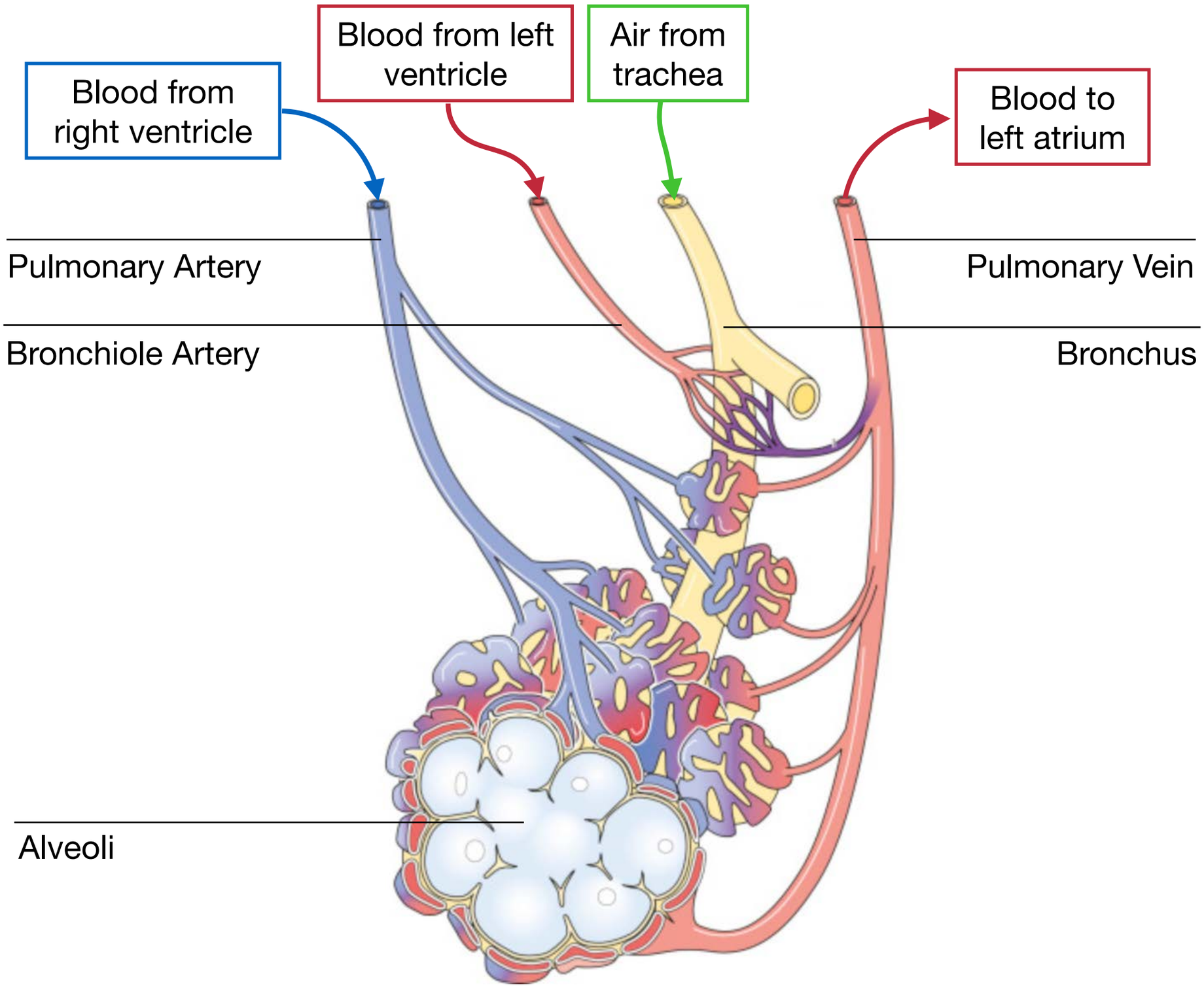


Alveolar macrophages (dust cells) reside in the airway and engulf particles and microorganisms.



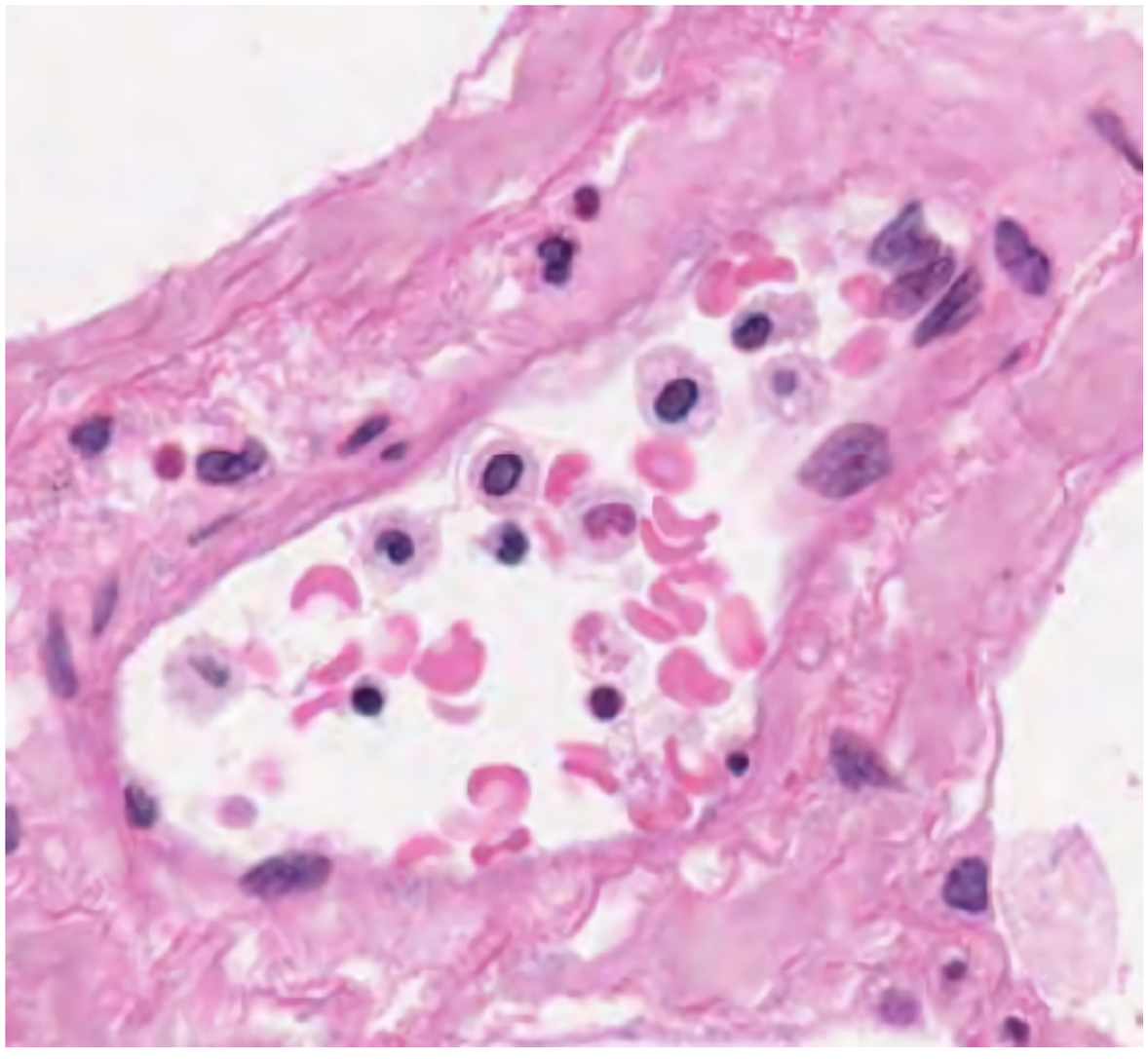
Pulmonary Circulation

Pulmonary system delivers deoxygenated blood and bronchial system delivers oxygenated blood.

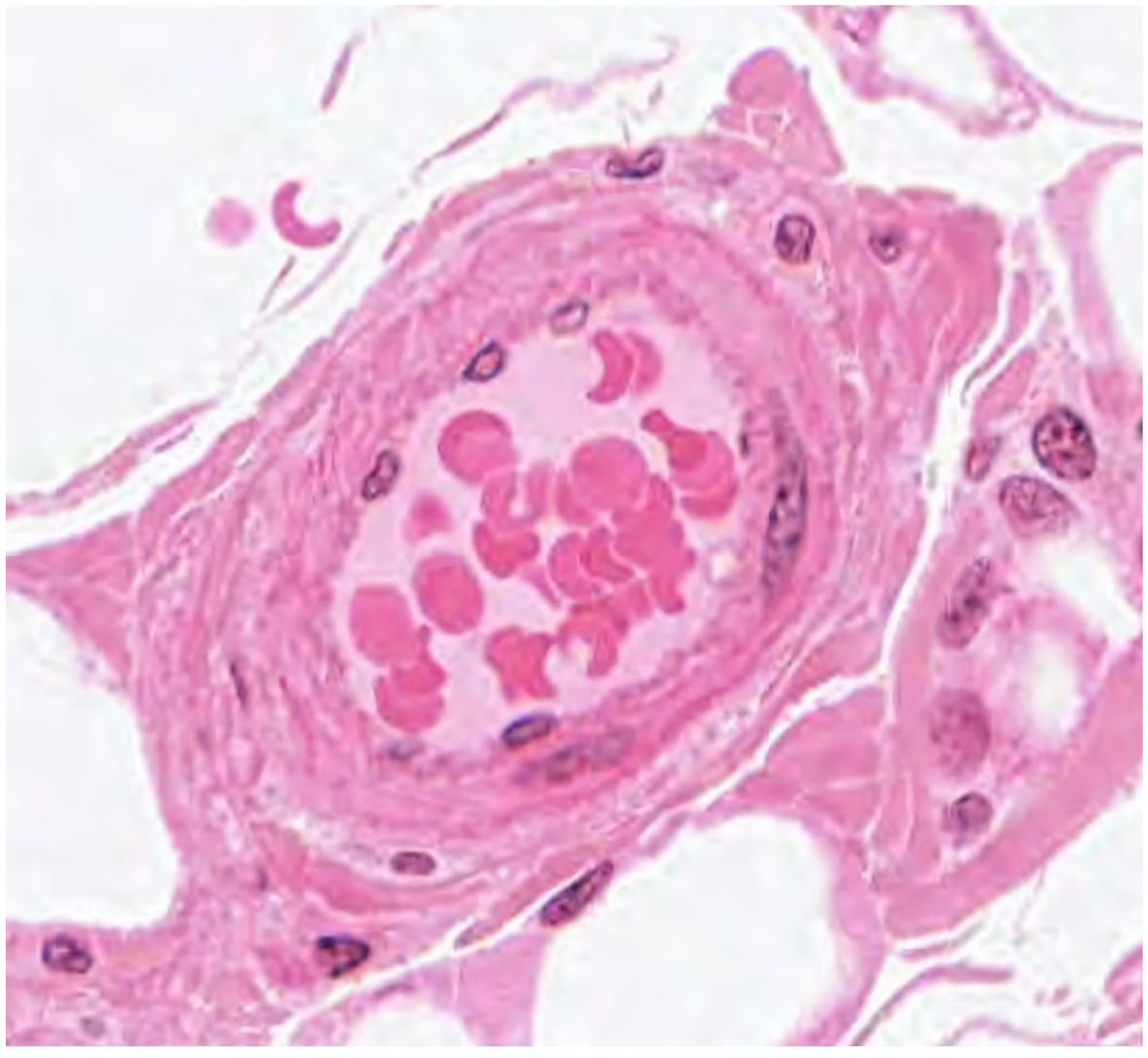


Pulmonary arterioles have thinner walls and generate less resistance than typical arterioles.

Pulmonary Arteriole

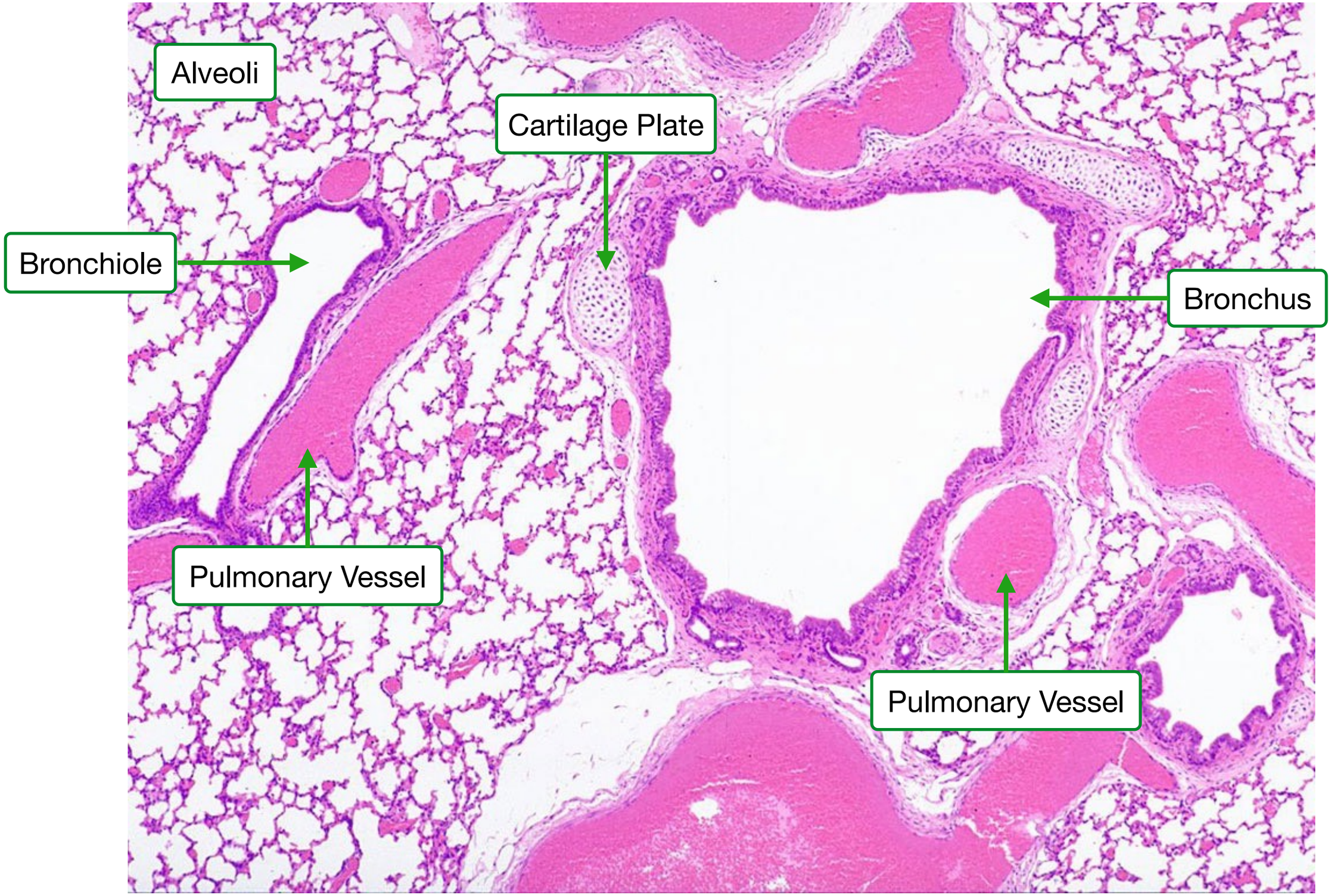


Typical Arteriole

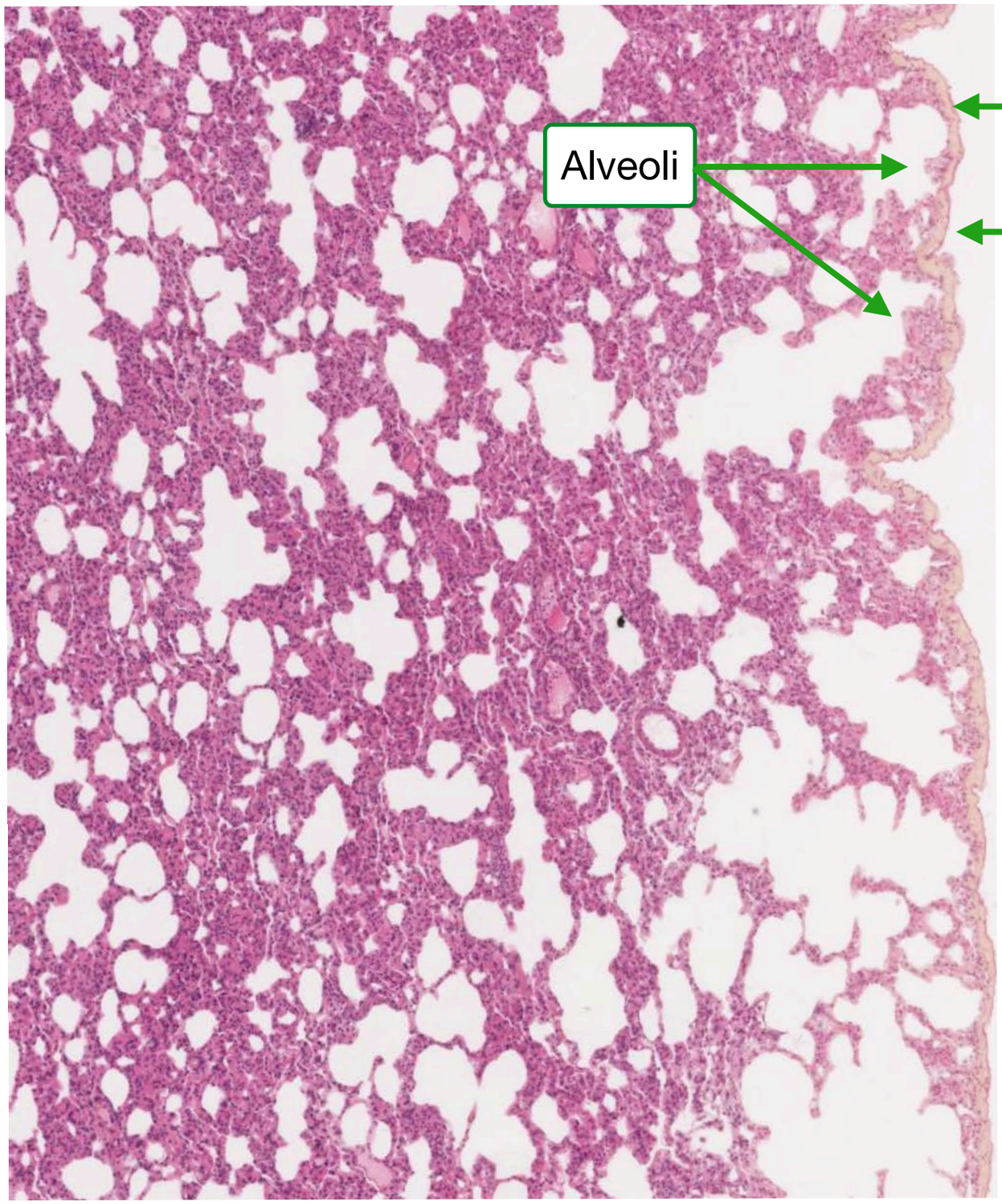


Structural arrangement of airways and rate of ventilation

Lung section reveals bronchus, bronchioles, alveoli and blow vessels.



Composition and structure of alveoli determine compliance of lung.



Lung Volume Change

Compliance

$$C = \frac{\Delta V}{\Delta P}$$

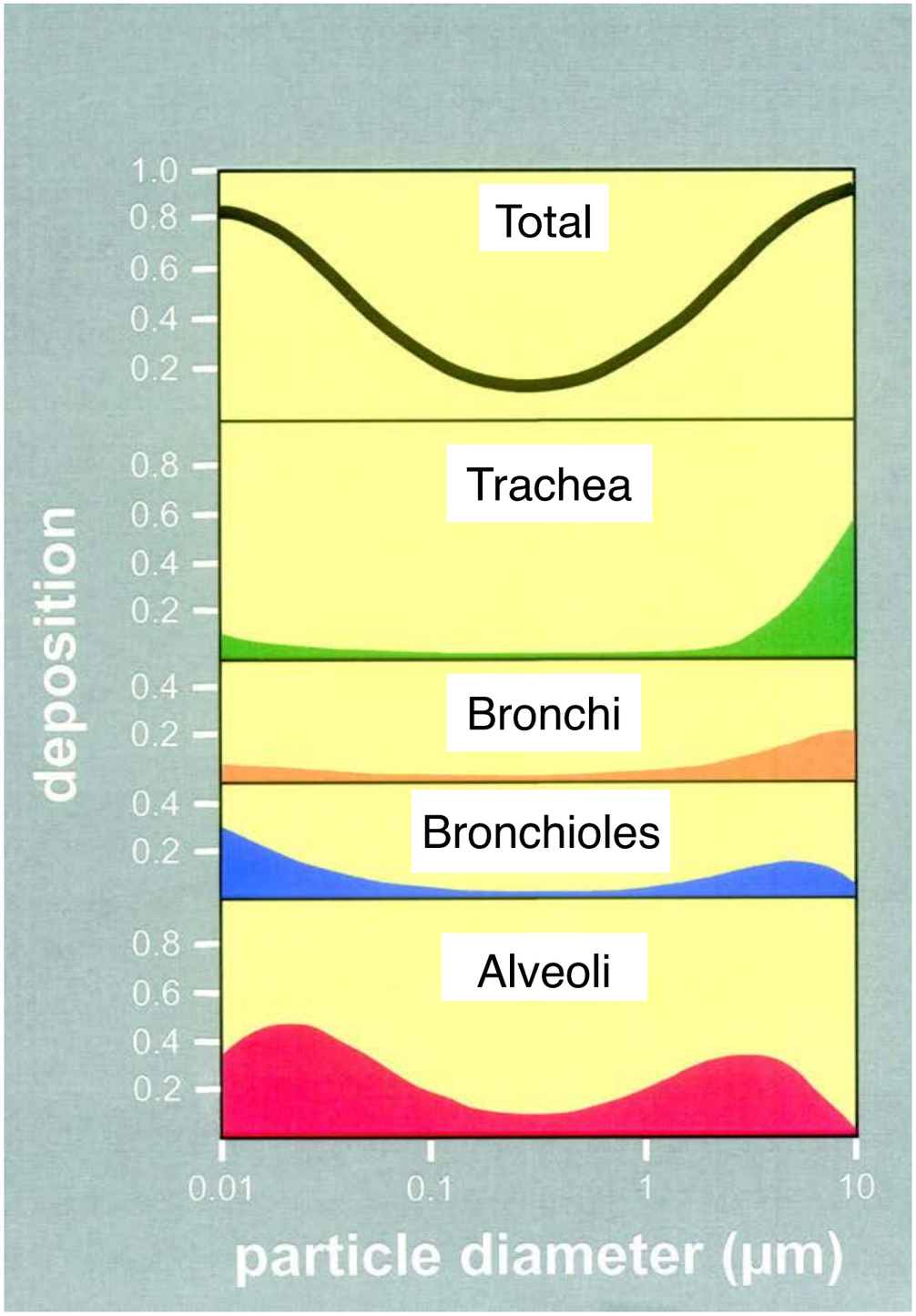
Intrapleural Pressure Change

Factors that Affect Compliance

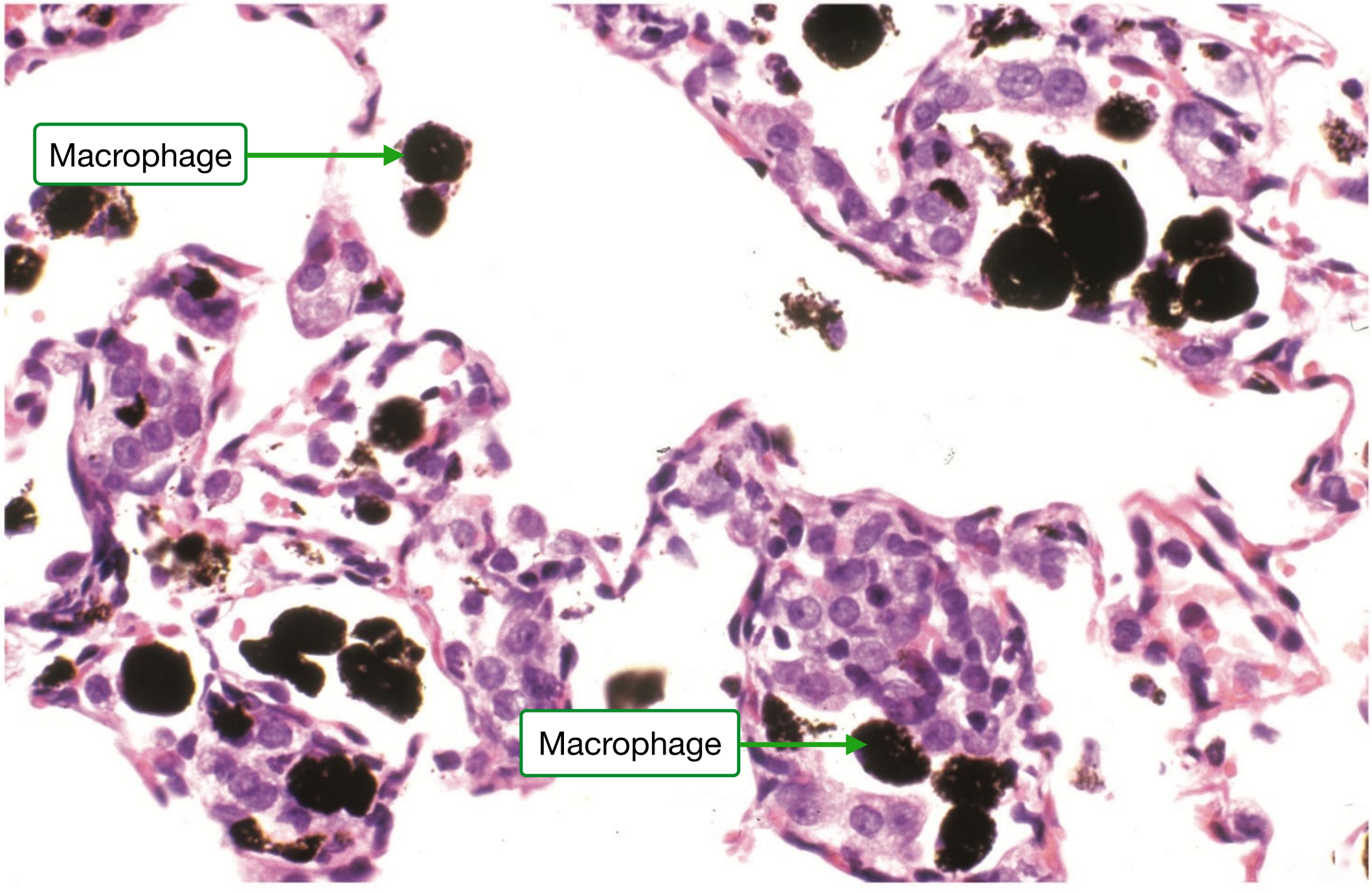
- Alveolar surface tension
- Alveolar elastic fibers
- Alveolar collagen fibers

Handling Inhaled Particles

The diameter of foreign particles determines their depth of penetration into lungs.



Macrophages engulf inhaled foreign particles.



Take home messages…

- Trachea and bronchi have ciliated, pseudostratified epithelium and cartilage to prevent collapse
- Bronchioles lack cartilage plates
- The gas exchange barrier consists of type I pneumocytes, endothelial cells and their shared basement membrane
- Pneumocytes facilitate fluid absorption from the airway
- Surface tension and connective tissue in alveoli resist expansion and facilitate expiration
- Macrophages (dust cells) engulf foreign particles and microorganisms