Histology
RESPIRATORY SYSTEM

BRONCHEAL TREE

The trachea divides into two main bronchi, each enters the lung through the hilum, where arteries, veins, and lymphatics enter and leave the lungs, where they are invested by dense connective tissue. Each primary bronchus course downwards dividing into three bronchi in the right lung, and two in the left lung, each supply a pulmonary lobe. These lobar bronchi divide repeatedly into bronchioles, then 5-7 terminal bronchioles.

BRONCHUS:
Primary bronchus has the same histological structure as trachea, except that the cartilage is a complete ring. At the level of secondary bronchus, the cartilage become as an isolated plates. Lamina propria is rich in elastic fibers, mucous and serous glands, lymphocytes, and lymphatic nodules. Well developed smooth muscle fibers also present.

BRONCHIOLES:
They are an intralobular air ways with a diameter of 1-5mm or less. They are lined by respiratory epith., with few goblet cells. No glands and no cartilage present in their wall.

TERMINAL BRONCHIOLES:
They are lined by simple columnar or simple cuboidal cells, ciliated with Clara cells. Clara cells are non ciliated, -and have an apical secretory granules that secrete glycosaminoglycans, which has a protectiye function against oxidative agents and inflammation, and has a detoxifying effect on noxious inhaled particulate matters. Goblet cells disappear above the level where ciliated cells disappear. Lamina propria has smooth muscle fibers and elastic fibers arranged in a helical crisscrossing pattern. Bronchioles also exhibit specialized regions called neuroepithelial bodies. These are formed by groups of 80-100 cells that contain secretory granules and receive cholinergic nerve endings. Their function is poorly understood, but they are probably chemoreceptors that react to changes in gas composition within the airway. They also may involved in the reparative process of airway epithelial cell renewal after injury.

The increase in bronchiole diameter in response to stimulation of the sympathetic nervous system explains why' epinephrine and other sympathomimetic drugs are
frequently used to relax smooth muscle during asthma attacks. When the thickness of
the bronchial walls is compared with that of the bronchiolar walls, it can be seen that
the bronchiolar muscle layer is more developed. Increased airway resistance in
asthma is believed to be due mainly to contraction of bronchiolar smooth muscle.

RESPIRATORY BRONCHIOLES:
Each terminal bronchiole gives two or three respiratory bronchioles. These are lined
by simple ciliated cuboidal cells, with non ciliated Clara cells.
Lamina propria is rich in smooth muscle fibers and elastic fibers. The wall of
respiratory bronchioles is interrupted by the alveolar sacs and alveolar ducts, where
the epith. changes into simple seq. epith

ALVEOLAR DUCT:
It is a tubular structure that is connected to the respiratory bronchioles. It is lined by
simple seq. epith.
Lamina propria has smooth muscles which disappear distally, and replaced by
elastic and reticular fibers.

ALVEOLAR SAC:
It is a space where a group of alveoli open at each other. It is lined by simple seq. epith.,
and invested by elastic and reticular fibers. The elastic fibers are for the
expansion and contraction, while reticular fibers prevent over distention.

ALVEOLI:
Sac like evaginations of respiratory bronchioles, alveolar ducts, and sacs. They are
about 200 um in diameter, and are specialized for O₂ and CO₂ exchange between air
and blood.
Each alveolus is lined by simple seq. epith., and is separated from adjacent alveolus
by the inter-alveolar septum. Within this septum, we have the Blood- Air Barrier
which separates the air in the alveolus from blood in the capillaries.

Blood-Air barrier consists of the following structures:
1- Cytoplasm of the alveolar cell wall.
2- Fused basal laminae of alveolar and capillary endothelial cells.
3- Cytoplasm of endothelial cells.
   This barrier is about 0.1-1.5 μm in thickness.

There are four types of cells'in the inter-alveolar septum:
1 - Endothelial cells: extremely thin, where the nucleus and organelles are clustered in
one side to increase the efficiency of gas exchange. It is of the continuous type, with
no fenestrae. The cytoplasm contains large number of pinocytotic vesicles.
2- Type I (sequamus alveolar cell): extremely thin cells, and constitute about 97% of the alveolar surface. The organelles are grouped around the nucleus, leaving large area of free cytoplasm with large number of pinocytotic vesicles, to remove contaminants. These cells act as a barrier with minimal thickness.

3- Type II (great alveolar cells) or septal cells: they form only 3% of the alveolar surface, found in between type I cells, and connected to them by desmosomes and occluding junctions. They are cuboidal in shape, and found in groups at the angles of alveolar wall. These cells are rich in mitochondria, RER, well developed Golgi apparatus, with microvilli on their apical surface. Their cytoplasm contains lamellar bodies of 1-2um in diameter, that contain concentric or parallel lamellae limited by a membrane. These bodies contain phospholipids, glycosaminoglycans, and proteins, which are continuously synthesized and released at the apical surface. The lamellar bodies produce the pulmonary surfactant, which spread over the alveolar surface as a coating to lower their surface tension, so, less inspiratory force is needed to inflate the alveoli, and also to prevent alveolar collapse during expiration. Type II cells divide by mitosis to replace their own type and typel cells.

4- Macrophage: They are called dust cells, and seen on the surface of alveoli, also in the connective tissue around major blood vessels or in the pleura. These cells phagocytize debries that passed from alveolar lumen by pinocytotic vesicles of type l cells. Macrophages that found on the outer surface of the surfactant are carried to the pharynx and swallowed. These macrophages originate from circulating monocytes in adjacent capillaries.

In congestive heart failure, the lungs become congested with blood, and erythrocytes pass into the alveoli, where they are phagocytosed by alveolar macrophages. In such cases, these macrophages are called heart failure cells when present in the lung and sputum; they are identified by a positive histochemical reaction for iron pigment (hemosiderin).

Alveolar pores: These are pores of 10-15 µm diameter, found at the inter-alveolar septum. They equalize the pressure between alveoli and act as collateral of air if a bronchiole is obstructed.

**Pulmonary blood vessels**

They include two systems:

**Systemic circulation:** is the nutrient circulation for the lung. The vessels follow the bronchial tree up to the respiratory bronchioles, where they will anastamose with small branches of the pulmonary artery.

**Pulmonary circulation:** represents the functional circulation. Pulmonary arteries are thin walled, because of the low pressure(25mmHg/5mmHg). Within the lungs, these arteries branch, up to the level of alveolar ducts, where they will give off capillary network in the inter-alveolar septum. Venules collect blood from capillaries. They
have thin wall of connective tissue, and they follow the bronchial tree towards the hilum.

**lymphatic vessels**

Superficial network: present at the visceral pleura, and it drains lymph into hilum. **Deep network:** follow the bronchi and pulmonary vessels, drain into the hilar lymph nodes. Lymphatic vessels are absent in the terminal bronchioles and alveolar ducts.

Pleura

Serous membrane that covers the lungs. It consists of two layers; *parietal* and *visceral*. Pleura consists of mesothelial cells that rest on fine connective tissue layer of collagen and elastic fibers. There is a cavity between parietal and visceral pleurae which is lined by mesothelial cells, called **pleural cavity**. It contains a thin film of liquid act as a lubricant for smooth sliding during respiration. Lungs lie protected by the thoracic cage. Each lung is invaginated into its own pleural cavity, which is accordingly reduced to a narrow potential space. This cavity is lined with simple squamous serosal mesothelium, which together with a subserosal layer of dense fibroelastic connective tissue constitutps a lining layer known as the pleura. At the hilum of the lung, the site at which major blood vessels, air passages, lymphatics, and nerves enter or emerge, the parietal pleura lining the walls of the pleural cavity is continuous with the visceral pleura investing the lung.