

## Lec #2 histology.

Last lecture we talked about the upper respiratory tract histology, this one is about the lower part histology.

We will discuss the histology of:

- bronchioles
- respiratory bronchioles
- alveolar duct and sac
- septum & cells found there.
- nerves & lymphatics.

### Bronchioles:

- They are respiratory and conducting.
- But in histology we say terminal (large & small) + respiratory.
- The major difference is in the **lining epithelium** in **general** they change from pseudo stratified ciliated columnar epithelium to simple columnar ciliated epithelium then to simple cuboidal ciliated epithelium with the appearance of Clara cells and finally they end as simple squamous at the beginning of the alveolar duct.

Also they differ in the **diameter**: the large terminal bronchiole = 1mm, small = 0.5mm.

### Bronchioles are characterized with:

- No Cartilage, (remember the tertiary bronchus has 1-2 plates of cartilage after that they disappear).
- No glands (very few in the large terminal bronchioles then they disappear)
- No lymphatic nodules, but lymphocytes are found scattered.
- Goblet cells: in large terminal are scattered but in small they're absent.

The lining in the larger one is pseudo stratified ciliated columnar but in the smaller it becomes simple cuboidal or columnar ciliated (gradual change) and Clara cells (increase in respiratory bronchioles).

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| 2 types of cells play a role in the production of surfactant:<br><b>alveolar cell type II</b> and <b>Clara cells</b> . |
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“**Clara cells** (devoid of cilia):

In the small bronchioles are scattered then increase in the respiratory bronchioles they have secretory granules at their apex.

And produce one of the component of the surfactant (reduces tension).

Also contain neuroepithelial bodies (80-100) in number; involved in the local action of the gland they receive cholinergic nerve endings.”

- Bronchioles are involved in the etiology of asthma, due to the presence of smooth muscles (constriction).

In this case we give bronchodilators like adrenalin subcutaneously.

- The smooth muscles are **spiral** and continuous, giving it the folding appearance, they are innervated by:

vagus nerve (parasympathetic) = constriction.

Sympathetic = dilation.

(Opposite from the effect on blood vessels).

So in the case of narrowing we give sympathetic or anti parasympathetic.

## **Respiratory bronchioles:**

starts at the end of the terminal bronchiole.

-The lining epithelium changes from simple cuboidal ciliated with Clara cells (Clara cells here are common) to simple squamous by the end of it and the beginning of the alveolar duct.

-presents partially, not closed, lumen opens to the alveolar duct.

-many alveoli open into the alveolar duct, the site of the gas exchange.

- Smooth muscles disappear between the alveoli and become **knobs or tags**, present as pillars on the alveoli

- The elastic and collagen fibers and reticular fibres replace the smooth muscles and increase the elasticity so inflation and deflation can occur and they give the spongy appearance of the lungs.

-No goblet cells are present .

## **Alveolar duct and sac**

- site of gas exchange.

-The lining is simple squamous epithelium.

- When the alveolar ducts bifurcate they give atria that terminate as alveolar sacs .

- In the slides you can see the duct and the alveoli that open at the sac.

- tags of smooth muscles are seen.

- Rich elastic and reticular fibers are present.

- between the alveoli there is **Inter alveolar septum**, (imagine the alveoli as small balls in large numbers, the parts which they're in contact are the septum, the remaining ones are made of connective tissue, elastic, collagen fibers and cells).

- Inside the septum you might find the respiratory membrane between the alveolar wall and the endothelial wall. (Where the gas exchange exactly occurs).

The largest capillary network is present around the alveoli.

-alveolar sac is the terminal part of alveolar duct, alveoli are found all over.

## **Alveoli**

- are saclike invaginations, 200micrometer in diameter.

- Responsible for the spongy appearance (elastic and connective tissue) of the lung.

- Type I alveolar cell are found 97% and type II are 3% that's in the **wall (alveolar surface)**.

In the septum (in interstitium) it differs.

- Type I are flattened like simple squamous cells, type II are cuboidal and have a large nucleus.

### **Inter alveolar septum.**

- made of 2 layers of squamous cells in between lies capillaries, C.T, elastic and reticular fibers and cells.

- interstitium: composed of capillaries and C.T of inter alveolar septum.

- Cells found in the interstitium - in the septum :

\*endothelial cells(capillaries) 30%. \* Fibroblast and mast cells 36% \* macrophages (dust cells) 10% \* type I alveolar cells 8% \* type II alveolar cells 16% \* leukocytes.

- The septum contain pores that are 10-15 micrometer in diameter, they are responsible for equalizing the air pressure in neighboring alveoli and for the collateral air circulation when a bronchiole is obstructed.

- anastomosing pulmonary capillaries are found in the septum, supported by a meshwork of elastic and reticular fibers.

- These fibers are arranged to permit expansion and contraction of the septum.

### **Respiratory membrane (blood air barrier):**

as we said it's part of the septum (might be found or not),

- the air in the alveoli is separated from the capillary blood by 3 layers:

1) the surface lining of the alveolar cells (type I simple squamous).

2) The fused basal lamina of the endothelial and the alveolar cell type I (make the barrier thinner).

3) The endothelial cell and the erythrocyte membrane.

Total thickness varies from (0.1-1.5) micrometer.

**Note:** the respiratory membrane could be found in the WALL of the alveoli if there was fusion between the basal lamina of the endothelial cells and the epithelium of the alveolar cells type I

### **Gas exchange**

at the blood air barrier,

CO<sub>2</sub> leaves the erythrocyte to the alveoli, O<sub>2</sub> in the opposite direction.

- 300 million alveoli are found in the lungs, they increase their internal exchange surface, reaches 140 m<sup>2</sup>.

## Capillary Endothelial cells

- Simple squamous epithelium, lines the capillaries which are continuous capillaries (non-fenestrated).
- Its nucleus and the organelles are clustered on one side to give a space for gas exchange in the flattened portion.
- The cytoplasm in the flattened portion contains pinocytotic vesicles.

## Type I cells (called pneumocyte type I cells)

- Simple squamous cells.
- Present in the wall constitutes 97% of the wall cells while type II constitutes 3% and present in the septum constitute 8% of septal cells .
- Diameter: 25 nanometers.
- Organelles are clustered in the corner of the cytoplasm to reduce thickness of blood air barrier nucleus within the wall
- Play a role in the turn-over of surfactant.
- Have desmosomes \occluding junctions that connect it to type II.
- Important in gas exchange.

## Type II cells

- Large cuboidal cells with rounded central nucleus.
- Present in the corners of the septum called **septal cells** and found in groups (2 or 3 cell together).
- Mitotically active to give rise of type II cells AND type I cells.
- Contains lamellar bodies (12 micrometer in diameter) in the cytoplasm that secretes the surfactant.

**The surfactant:** lines the alveoli from inside to reduce the surface tension which is important in the inflation of the alveoli.

In the last month of pregnancy, surfactant is secreted in large quantities, if it was secreted in low quantities, the newborn lungs might not be able to inflate, a case called **Respiratory distress syndrome** (RDS) which is the most common cause of delivery deaths.

If the surfactant was low in quantity, injections of corticosteroids can be given which stimulate type II cells to increase secretion of surfactant to protect from RDS.

There are 4 types of the surfactant [A B C D].

The pulmonary surfactant contains some additional proteins and enzymes for example lysozymes which **gives the surfactant a bactericidal effect** , collagenase, which are from the alveolar macrophages mixed the surfactant produced from type II cells.

**Nitrogen dioxide (NO<sub>2</sub>)** is a toxic gas that destroys the cells lining of the alveoli (type I and type II cells) which causes an increase in the mitotic activity of the remaining type II cells to replace damaged cells.

### **Lung macrophages (dust cells)** (Black dots)

- Cells that originate from monocytes, present in all lung tissue even in the pleura (especially in the visceral pleura), hilum, septum, alveolar wall and surface.
- Considered the most numerous type of cells in the lungs, even more than type I and type II cells.
- Dust cells sometimes go to oropharynx to be diffused with the sputum to get out

### **Pulmonary blood vessels**

“Bronchopulmonary segment” contain a bronchiole, a pulmonary artery, lymph vessels, alveoli, connective tissue on both sides that contains the pulmonary vein which is a landmark for surgery and units of the lung(lobules).

Blood supply of lung tissue is from bronchial vessels, while the pulmonary artery contain deoxygenated blood to the alveoli for gas exchange then goes to the pulmonary vein in the connective tissue to carry the oxygenated blood to the apex of the segment, then together all bronchial vein tributaries in the lung segments eventually form the 4 pulmonary veins that enter the left atrium.

### **Lymph vessels**

There are two plexus 1- superficial on the visceral pleura and 2- deep inside the lung tissue that go eventually to the hilum then the lymph nodes present in the hilum become the paratracheal lymph nodes that eventually drains into the thoracic duct (on the left side of the body) or the right lymph duct (on the right side of the body) and both drains into the beginning of the brachiocephalic vein (junction of subclavian vein and the internal jugular vein).

### **Nerves**

- Parasympathetic innervation from the **Vagus nerve**. (secretomotor for the glands)
- Sympathetic from the **Cervical ganglia**.
- Sensory from the **visceral afferent nerves**.

Sensations from the lung and visceral pleura are stretch sensation only.

Sensations from the parietal pleura carries pain, touch and temperature sensations.

### **Pleura**

two layers : visceral and parietal:

both are formed of Mesothelium (simple squamous epithelium) and connective tissue.

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