\*\***Trachea** divides into 2 parts : 2 primary bronchi ( right primary bronchus & left primary bronchus). The right one divides into 3 lobar bronchi or (secondary bronchi ), the left divides into 2 lobar bronchi or (secondary bronchi), and then each one divides into segmental bronchi or (tertiary bronchi ) , then it gives terminal bronchioles which divide into respiratory bronchioles, which divide and give alveolar ducts, finally unite to give alveolar sac.

The beginning of the **alveolar sac** is called **atrium**.\*\*

\*\*Trachea is supported **by c-shaped cartilage**, while primary bronchus, and lobar bronchi are supported by lesser amount of cartilage (which are not c-shaped), with higher amount of muscles in these structures . Then we reach the terminal bronchioles , here there is no cartilage support , so the tertiary bronchi is the last structure that has cartilage support .

**Slide #72** is so important for your understanding.

In this slide, from trachea to segmental bronchus: amount of cartilage decreases , while muscle increases.(muscles gradually replace the cartilage).

\*\*At terminal bronchiole, there is no cartilage, as same as: respiratory bronchioles, alveolar duct, atrium, and alveoli. (there is cartilage anywhere except in these)

\*\*The end of cartilage is at the tertiary (segmental) bronchiole (no cartilage).

We should differentiate between the primary and secondary/tertiary bronchi by:\*\*

**1. size 2. Amount of cartilage 3. Smooth muscles 4.wheather extra or intra-pulmonary.**

Ps (We can't differentiate between secondary and tertiary bronchi because both they are intrapulmonary , although there is sequential differences in size and cartilage amount ,but almost the same . )

\*\***Primary** bronchi are **extra**-pulmonary, which means that if we take a section of it, there wouldn’t be lung tissue around it. On the other hand, **secondary** bronchi are **intra**-pulmonary, there are lung tissues around it.

Slide #36: intra-pulmonary bronchus (2ry/3ry), because we have cartilage (fully dark purple shape above the circle) inside the lung tissue, inside the circle: muscular tissue.

At the left side of the picture there is an artery (thick wall), while at the right, there is a vein (thin wall). At the upper right and left, you can find lung tissues (alveoli).

\*\*At **terminal** bronchioles there is : no gland, no goblet cells, nor hyaline cartilage. So, there is **no** mucus.

Goblet cells secrete mucus, while the glands usually secrete both (mucus and serous ) mainly mucus .

\*\* have to keep this surface/environment wet by having **Clara** cells, which secrete **surfactants**, which are less viscous than mucus, less thick (because of the more watery and oily property they own) .

\*\***Alveolar ducts and alveolar sacs :** have type II Pneumocytes which secrete surfactants.

\*\*Respiratory bronchioles are similar to the terminal bronchioles, but :

1. interrupted by alveoli

2. we don't find cilia, but in the terminal we find cilia .

3. There are Clara cells that produce surfactant (then, its intermediate between the terminal and alveolar bronchioles).

\*\***Terminal bronchioles** have two types of cells: 1. Clara cells: secrete surfactants, also act as stem cells to replace the ciliated cells.

2.Ciliated cells.

\*\*At **alveolar ducts/sacs and in interruption areas of the respiratory bronchioles:**

-- Pneumocytes I : for gas exchange. Flat / stretched cells as the nuclei are. --Pneumocytes II : secrete surfactants, and also act as stem cells to replace Pneumocytes I. \_because there are no ciliated cells. Cuboidal bulging cells, with round nuclei.

Septal cells = pneumonia II = alveolar II : we ind it at corners of the septum (usually where more than one septum meet, also could be at the walls of alveoli).

\*\* pneumocytes II are more numerous than I, but pneumocytes I occupy much more of the surface covering area 90%.\_because they are stretched.

\*\* **respiratory epithelium** pseudo-stratified columnar ciliated with goblet cells , (except in terminal/respiratory bronchioles, 1ry/2ry/3ry bronchi, trachea, larynx, nasal cavity ) **.**

**And there is 3 types of cells :**

**1. Goblet cells .**

**2. Basal cells (stem cells which replace other types of cells like golet cells , ciliated , and brush cells ).**

**3. Ciliated cells ( columnar ).**

\*Each one of them occupy 30% of the total cells.

\*\*In the respiratory epithelium, the **minorities** of cells are:

**1. Brush cells**: extend from base to surface, don’t have cilia, although they look like cilia (Columnar in shape), they act as chemical receptors because they synapse with neurons at surface.( not well known function ) .

**2. DNES** (diffuse neuro-endocrine system cells) in the basal 3rd. they need special stain to appear (immunohistochemistry), they have secretory granules which secrete certain substances to control the functions of other types of cells. They appear to be clear cells (like Merkle cells).

\*Each one of them occupy 3% of the total cells.

\*\* **Goblet cells** are divided into:

**1. Theca** (cytoplasm-mucus vesicles) , Theca reaches the surface, but instead of cilia, we have small protrusions (microvilli).

**2. Stem** (dark nucleus).

--**Clara cells :** they start to appear at the(carina): bifurcation of the trachea **,** and increase in few numbers distally.

Mainly in terminal bronchiole, they secret surfactant and also They divide to regenerate ciliated cells .

\*things applied for interrupted areas of respiratory bronchioles, are applied for alveolar bronchioles

At the terminal bronchioles there are: ciliated cells, and clara cells to replace the ciliated.\*\*

\*\*People who have asthma, they have problems with the terminal bronchioles (destruction of the muscles there).

\*\***BAB (blood air barrier):** composed of **fused** basal lamina of endothelia and pneumocytes I, and surfactants.

\*\*Oxygen goes from alveolar lumen to the basement membrane of pneumocyte I, through the cytoplasm to the opposite basement membrane, to the capillary membrane(endothelial), to reach the lumen of the capillary, and binds to the RBCs or hemoglobin to the heart finally.

\*\*the opposite is for CO2.

\*\***Alveolar macrophages (dust cells):** at lumen of alveolus, originate from bone marrow (monocytes). \*\*They either migrate upward and exit with the mucus (carrier) to oropharynx, or they migrate to lymphatic vessels then to local lymph nodes. \*\*they phagocytose and digest any foreign, toxic, harmful substance to keep the environment sterilized. \*\*they assist in uptaking of surfactants. to let the renewing of them.

**Lung tissue** : 1ry/2ry/3ry---> cartilage is exist. \*\*If there is no cartilage: either in terminal or respiratory bronchioles.

\*\*in the respiratory bronchioles, there is interruption by alveolus, while in the terminal bronchioles, is not.

So, in slide #48 : from left to right : the dark line indicates the terminal, while the interrupted lines following it, indicate the respiratory, then at the end, this gives alveolar duct.

Alveolar duct: alveoli arranged in one line as a duct. (structure of duct=structure of alveoli). Alveolar sac: cluster of alveoli. (the opening of alveolar sac is called atrium)

\*\*frequent interruptions give line of alveoli (alveolar duct), which terminates into alveolar sac (cluster of alveoli).

\*By the end of terminal\\beginning of respiratory \*By the end of respiratory\\ beginning alveolar duct \*There is a septum between 2 alveoli. Slide # 42

\* There are 3 millions alveoli covering 150 m2.

Slide # 40: arrows indicate transition from terminal to respiratory bronchioles.

Slide # 41: each star indicates transition from respiratory bronchioles to alveolar duct.

\*\*Goblet and ciliated cells reach the surface toward the oropharynx, while basal cells are at the apical 3rd.

\*\*

In slide # 56: SEM, the 1st picture of ciliated and goblet cells, while the 2nd is for the summation of cilia, which is called brush border.

\*If you have a picture with no cilia, then it has these choises:1. Goblet cell 2. Brush cells 3. Clara cells. While goblet from the majority of cells, brush from the minority, finally it also depends on the area taken from.

Slide #57 : **basal / stem cells**: replace other types of cells

Slide #58 : **brush cells**: reach surface. Have no cilia, act as chemical receptors.

