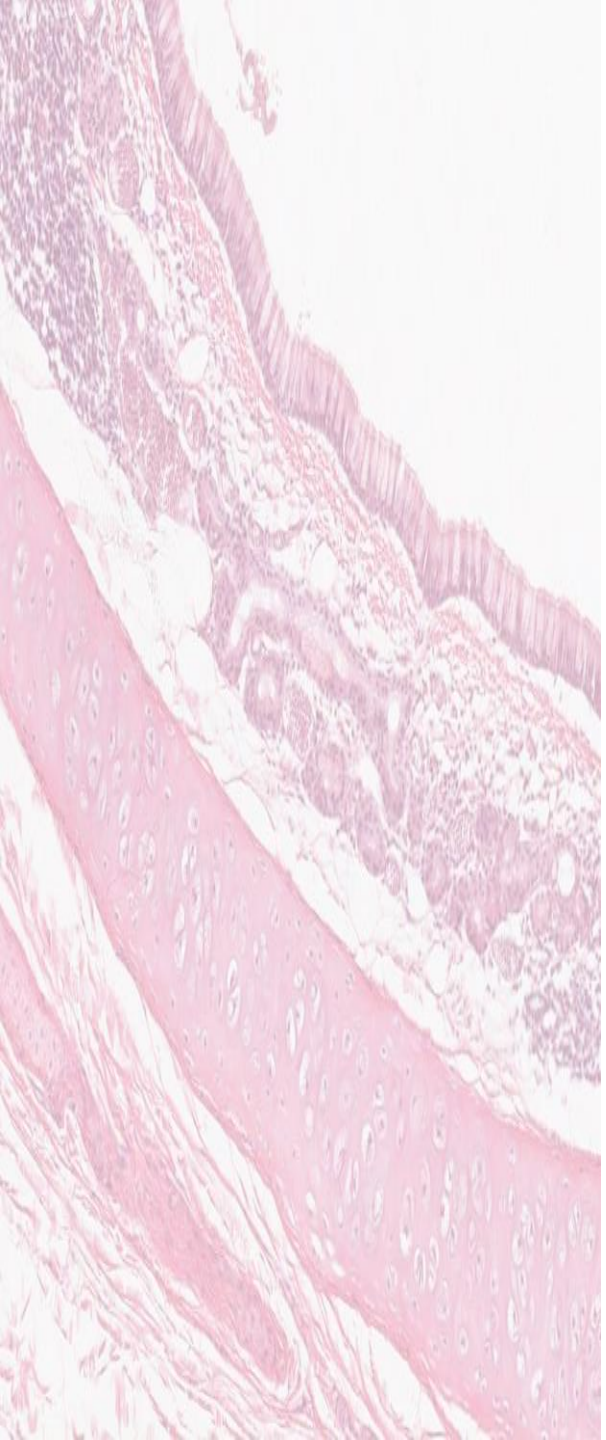


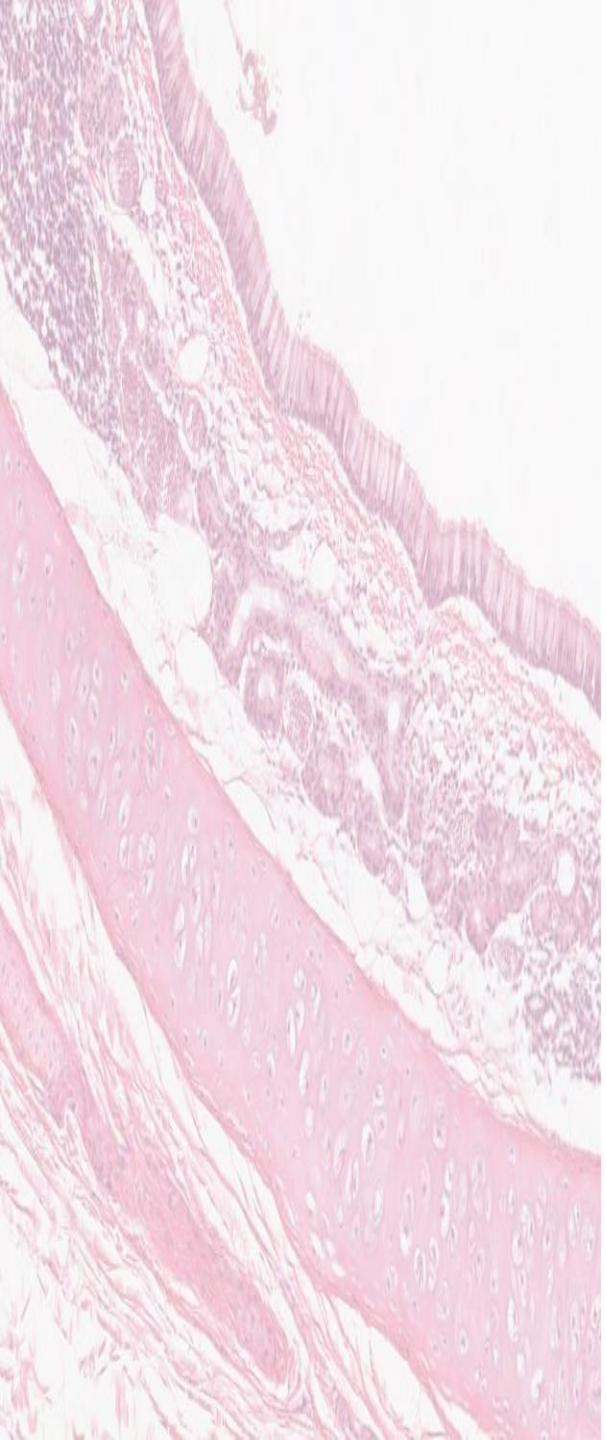
جامعة الملك سعود
King Saud University

436
MEDICINE
KING SAUD UNIVERSITY

Histology of the Lower Respiratory Tract (Trachea, Bronchi, Bronchioles) & the Lung

Color index:
Slides.. Important ..Notes ..Extra..

Revised by
شوق الأحمري & طراد الوكيل



وَمَن يَتَوَكَّلْ عَلَى ٱللَّهِ فَهُوَ حَسْبُهُۥٓ

Objectives :

The microscopic structures of the wall of:

- ✓ Trachea.
- ✓ Primary or extrapulmonary bronchi.
- ✓ Intrapulmonary (secondary and tertiary) bronchi.
- ✓ Bronchioles

The microscopic structures of :

- ✓ Interalveolar septum.
- ✓ Alveolar phagocytes.
- ✓ Pleura.

TRACHEA

The wall of trachea is formed of

* Adventitia is the outermost fibroblastic connective tissue+cartilage covering of an organ, vessel, or other structure

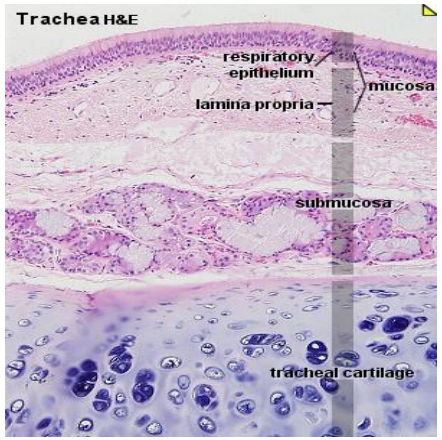
Mucosa

The mucosa **(MAINLY)** composed of 2 things :
- epithelium
- Lamina propria (connective tissue)

Epithelium: Respiratory epithelium

Lamina Propria

Elastic Lamina (membrane)



In the trachea the elastic **fibers** is so dense and form a membrane , this membrane separates the lamina propria form the submucosa.
Note : you MUST differentiate between the elastic **cartilage** and elastic **fibers** !

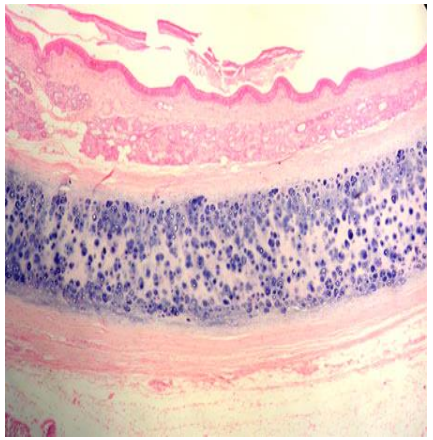
Submucosa

The trachea is highly humidified because not only does the mucosa has glands but also the submucosa leading to a high humidity

C.T

Lymphoid elements (cells)

Numerous Mucous and seromucous glands

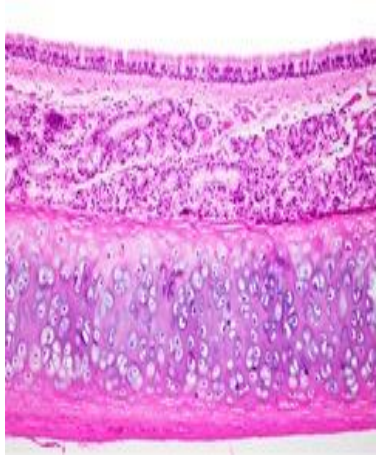


Adventitia*

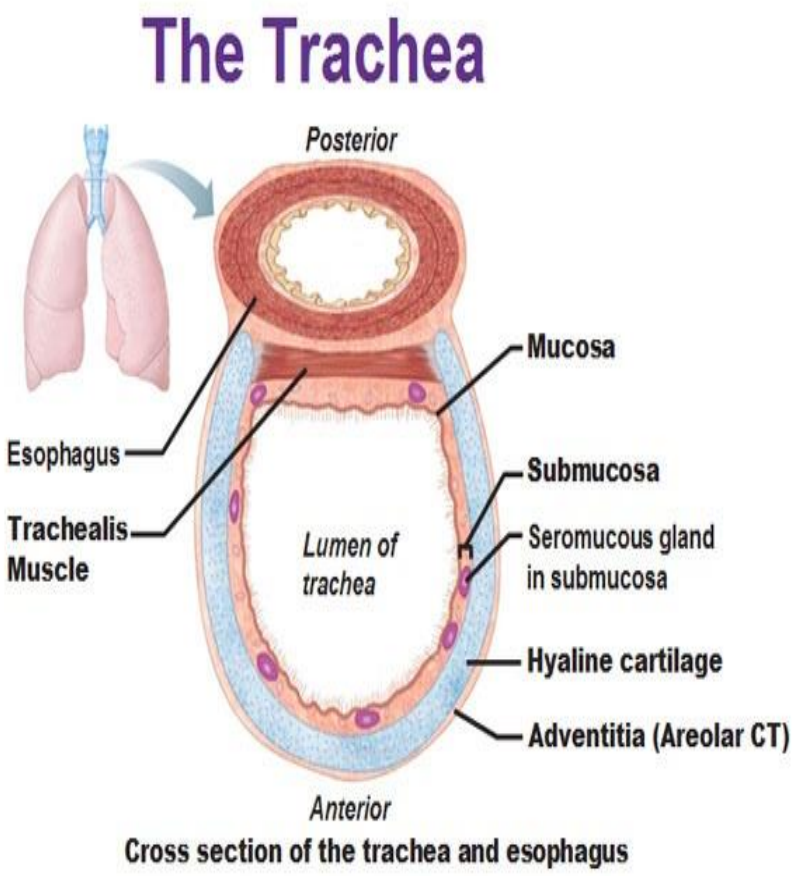
Fibroelastic C.T

Trachealis muscle (bundle of smooth muscle fibers) connects the 2 ends of each C-shaped (incomplete) rings of cartilage

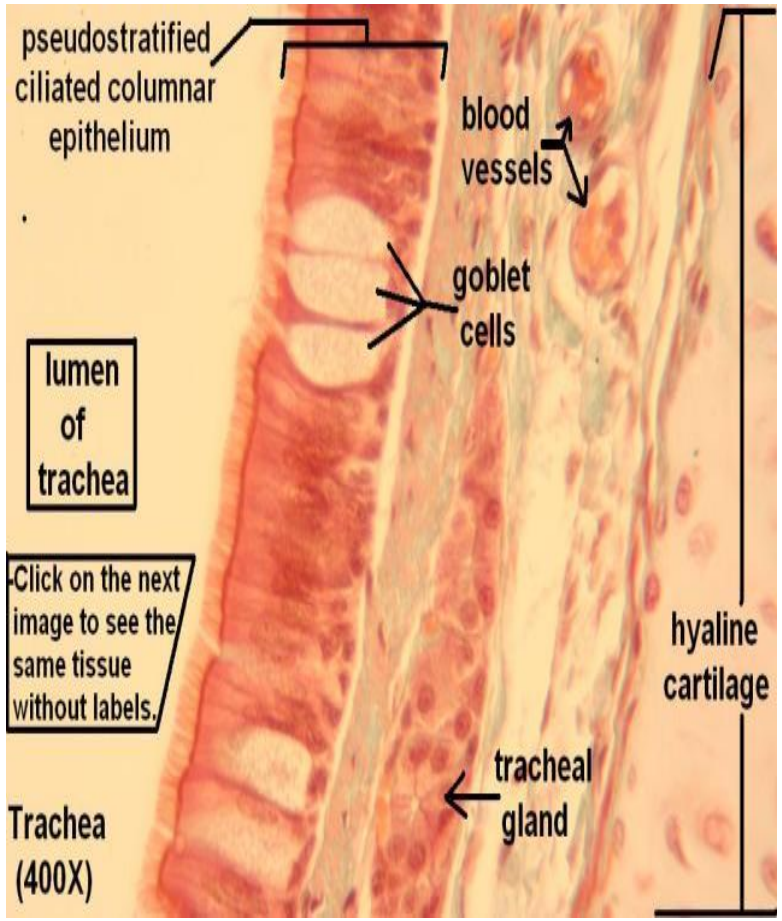
C-shaped rings (12-16) of hyaline cartilage (incomplete)



Pictures of the different layers of mucosa

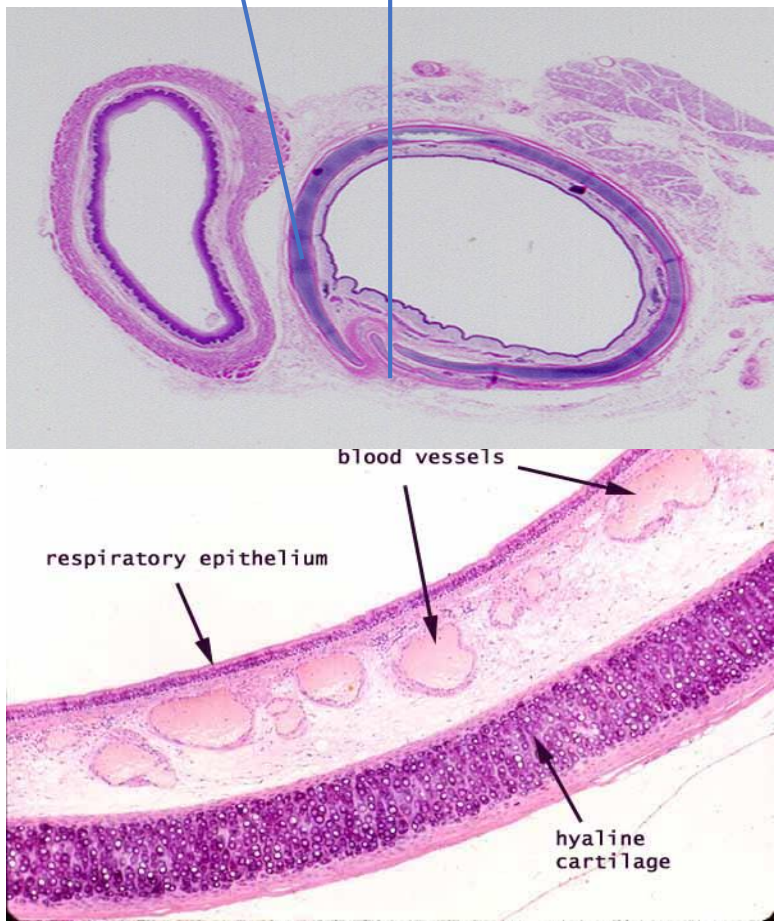


Cross section of the trachea and esophagus



The elastic lamina is not visible because it needs a special stain

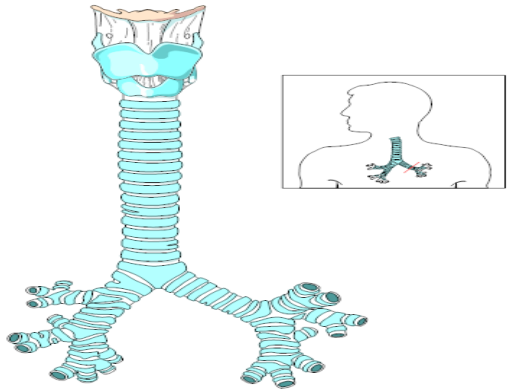
As you can see here the trachealis muscle enclosed the c-shaped hayline cartilage

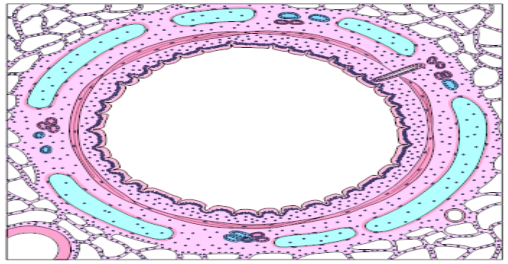


BRONCHI

1-EXTRAPULMONARY BRONCHUS(1ry BRONCHUS):

Generally have the same histological appearance as the trachea.





Cross-section of bronchus showing histological structure of inner wall. Orientation drawing (left) shows location of bronchus.

2-INTRAPULMONARY BRONCHI(2ry & 3ry BRONCHI):

1-Mucosa:

2 Layers:

A- Epithelium:

Respiratory epithelium

(pseudo-stratified **Ciliated** columnar Epithelium with goblet cell).

B- Lamina propria.

(It's narrow so it doesn't contain 1- glands 2- lymphoid follicles.)

N.B. No elastic lamina.

2-Muscle coat (complete)not like trachea:

Two distinct layers of smooth muscle fibers spirally arranged in opposite direction

(2 spiral shape crisscrossing layers one is clockwise and the other is anti-clockwise).

Note : all muscle after larynx are smooth muscles

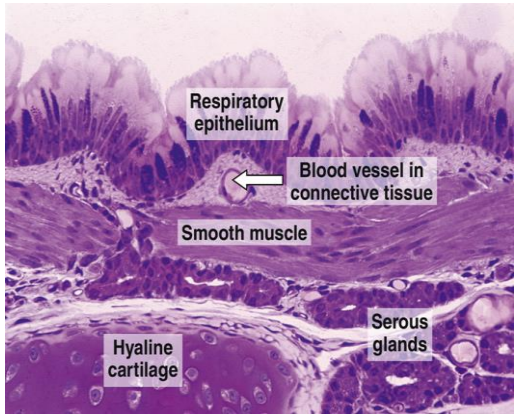
ليش هذا الجزء من التفرع بدأ يصير فيه عضلات ؟ عشان الرئه تمدد ف يقوم تتمدد معها الشعب الهوائية

Sub-mucosa:

C.T. contains:

A- Seromucous glands.

B- Lymphoid elements.



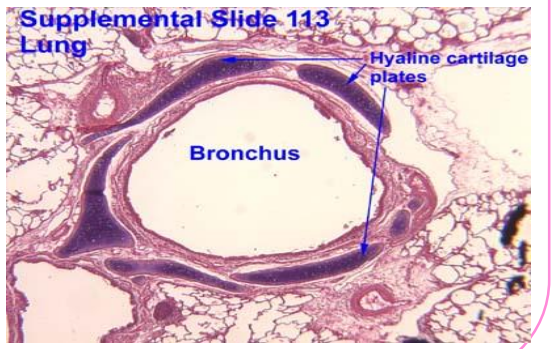
Adventitia:

Contents:

A- Loose C.T.

B- Irregular plates of hyaline cartilage (complete layer) hallmark .

C- Solitary lymphoid nodules.



BRONCHIOLES (DOESN'T CONTAIN CARTILAGE)

Preterminal Bronchioles(1ry):

less than 1mm in diameter.

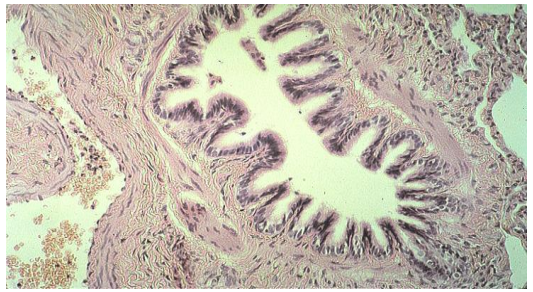
✓ Mucosa: (has longitudinal folds)

A- Epithelium:
Simple ciliated Columnar Epithelium **with** occasional goblet cells.
(The doctor said usually you will not find goblet cells)

B- Lamina propria :
C.T. rich in elastic fibers.
(although it's rich in elastic fiber but there's no membrane)

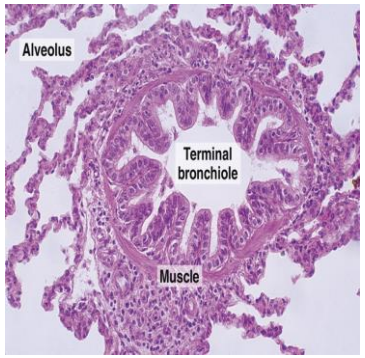
✓ Muscle coat:
2 helically arranged smooth muscle layers.

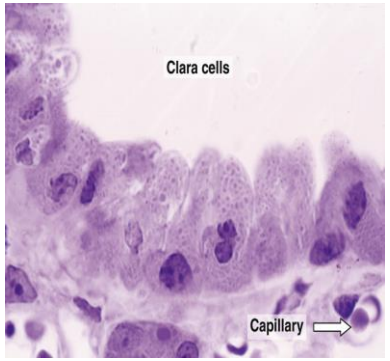
✓ Adventitia:
C.T.
No cartilage at all, No seromucous glands, No lymph nodules.



Terminal Bronchioles(2ry):

less than 0.5mm in diameter.
Similar structure to preterminal bronchioles, but:
Epithelium:
Simple cuboidal partially ciliated epithelium
With Clara cells (With NO goblet cells).





CLARA CELLS:

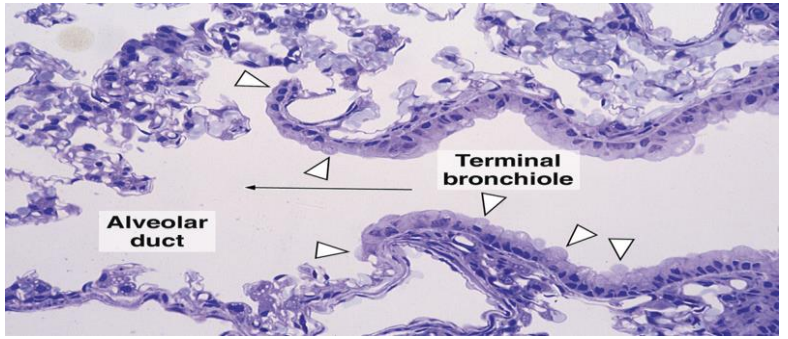
✓ Structure:
columnar cells (non ciliated).

✓ Function:
1- Degrade toxins in inhaled air. (immune cell like function)
2- Divide to regenerate the bronchiolar epithelium.
3- Produce surfactant-like material.

✓ Location:
Terminal bronchioles and respiratory bronchioles.

Respiratory Bronchioles(3ry):

Similar structure to terminal bronchioles, but:
their walls are interrupted by the presence of few pulmonary alveoli.

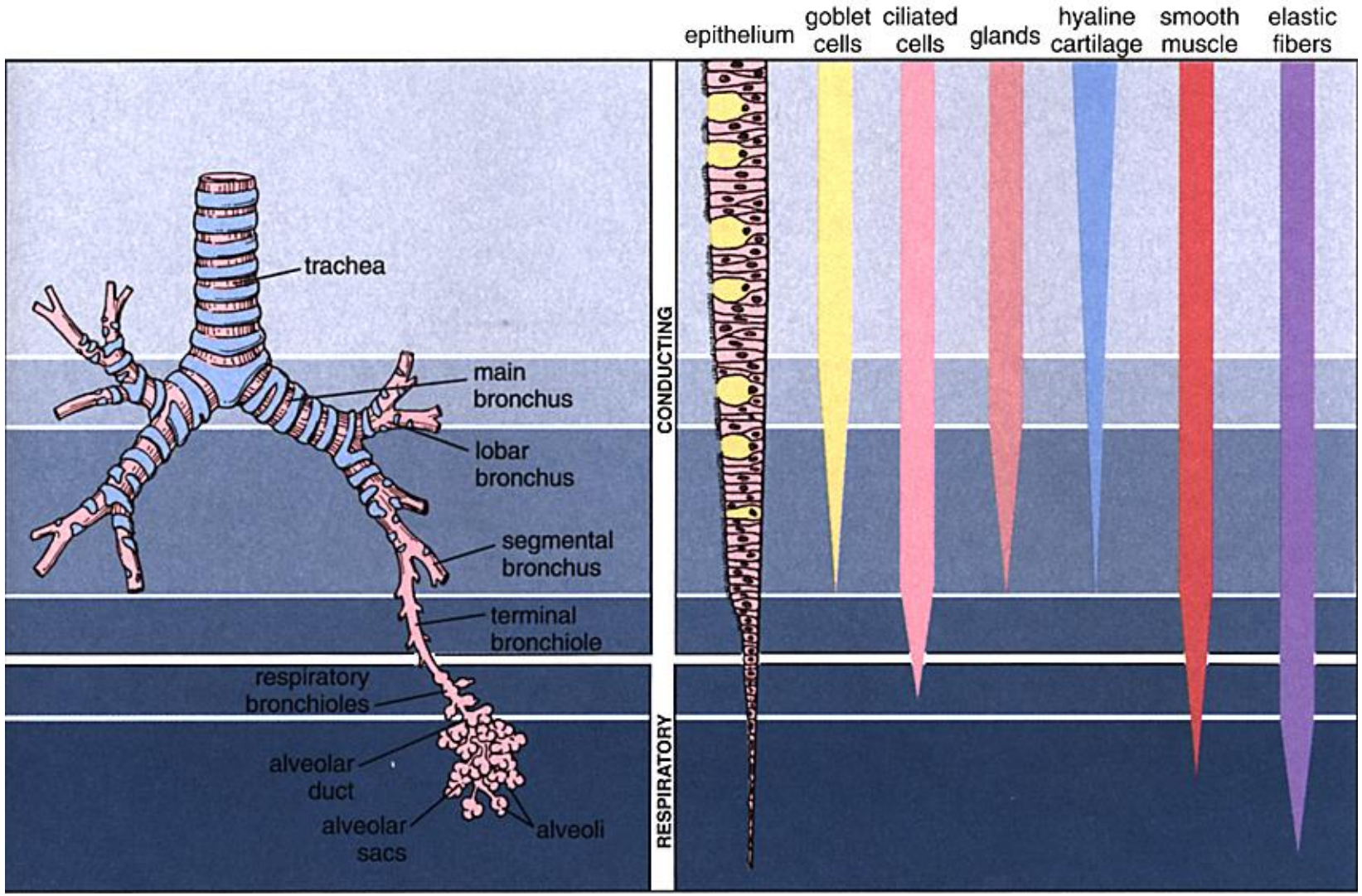


Why is the mucosa folded ? To give larger surface area for dilatation.

*Important notes :
•The Terminal Bronchioles are the last part of the conduction zone .
•The Respiratory Bronchioles are the first part of the respiratory zone.
• The main difference between the bronchioles and the bronchus is the absent of:
1- Cartilages 2- Seromucous glands 3- Lymph nodules 4- Goblet cells 5- Sub-mucosa

EXTRA

هنا يوضح لك كيف انه كل ما تعمقت و كلما زاد تفرع الشعب الهوائية تنقص عندك التراكيب و الاشياء الداخلة في تكوينها

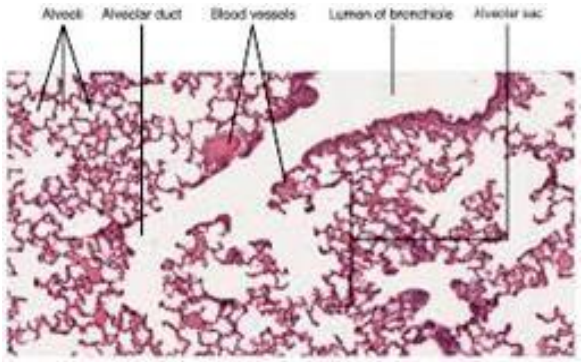


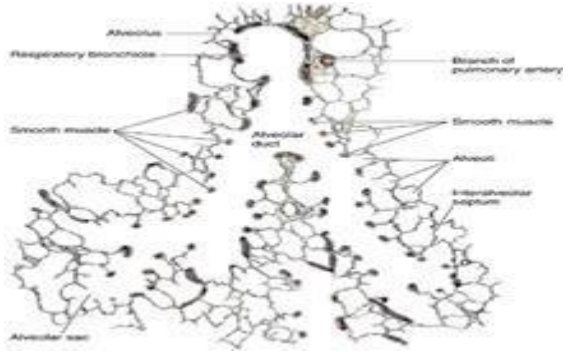
Note-team435-: Special features of everyone of them:
Pretermenal > Goblet cells
Terminal > NO goblet cells ,
Rispiratory > Alveoli
Bronchioles

Terminal bronchiole = end of conducting portion + end of goblet cells, Goblet cells are replaced by Clara cells

ALVEOLAR DUCTS

The wall of alveolar ducts consist almost of pulmonary alveoli.





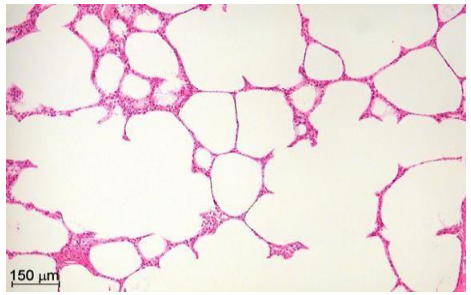
N.B. Alveolar duct → ends by: **atrium** → communicates with: 2-3 alveolar sacs

INTERALVEOLAR SEPTA

✓ Definition:

The region between 2 adjacent alveoli.

the alveoli are like rooms and the septas are like the walls in between



✓ Components:

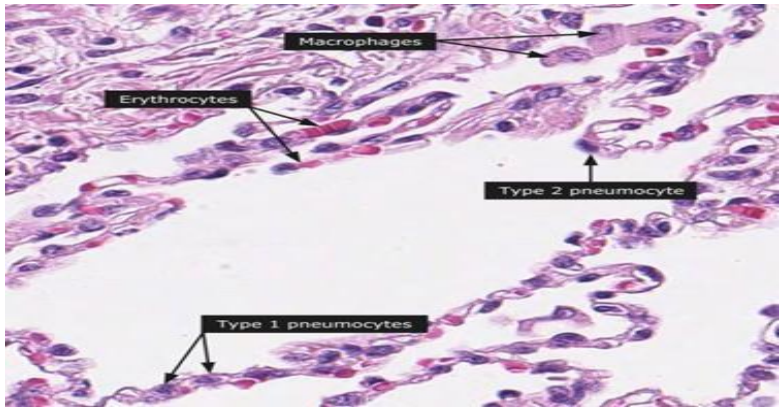
(A) Alveolar Epithelium:
lines both sides of interalveolar septum.

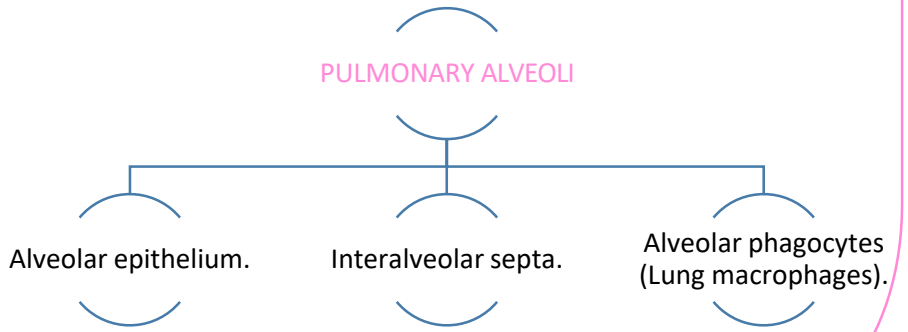
(B) Interstitium.

PULMONARY ALVEOLI

✓ Definition:

They are small out-pouching of respiratory bronchioles, alveolar ducts & alveolar sacs.



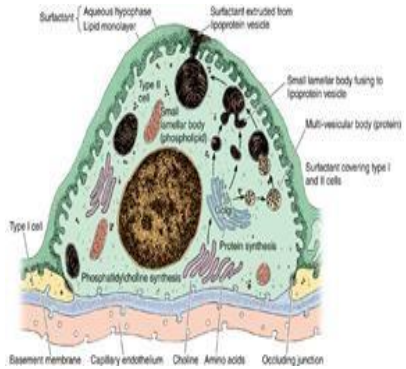


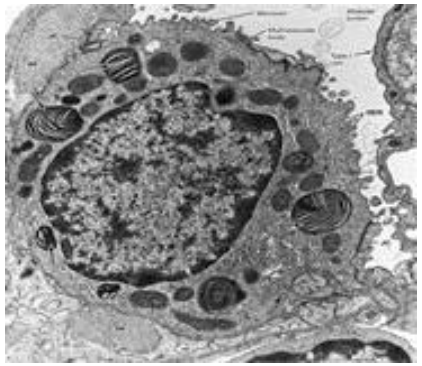
ALVEOLAR EPITHELIUM

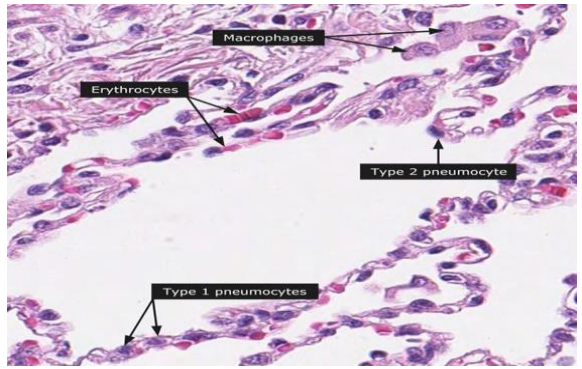
(1) Alveolar epithelium consist of two major cells :

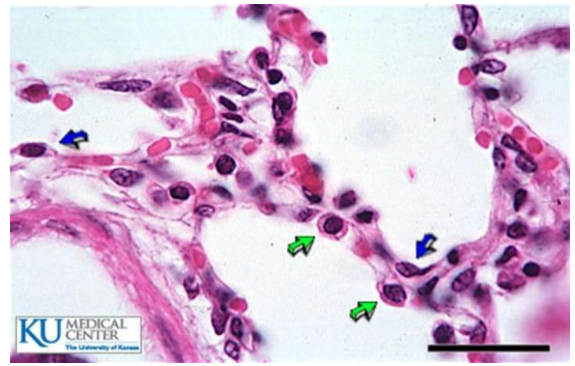
✓ **Type I Pneumocytes**

✓ **Type II Pneumocytes**







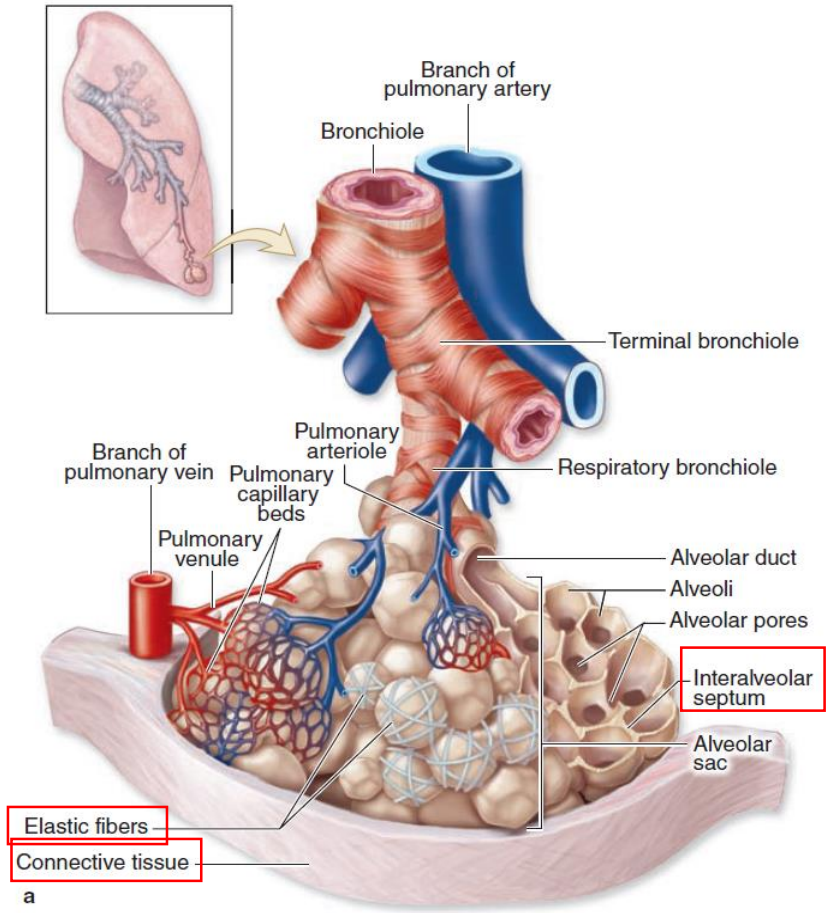


	Type I Pneumocytes	Type II Pneumocytes
Lining:	line 95% of the alveolar surface.	Line 5% of the alveolar surfaces.
Count:	less numerous than type II pneumocytes.	Are more numerous than type I pneumocytes.
L/M:	simple squamous epithelium. **The number of type I pneumocyte in alveolar epithelium is less then type 2 but its lining surface is greater , why ?** **Simply because the epithelium of pneumocyte type 1 is SIMPLE SAQUAMOUS and since it's SQUAMOUS it can fill the space with less number of cells ☺ .**	Are cuboidal or rounded cells, With Foamy cytoplasm. Nucleus: central & rounded. - The cytoplasm contains membrane-bound Lamellar bodies (contain pulmonary surfactant).
Function:	Exchange of gases.	1- Synthesis & secretion of pulmonary surfactant. 2- Renewal of alveolar epithelial cells (STEM CELL) : Type II cells can divide to regenerate both type I & type II pneumocytes.

Interstitium of interalveolar septa

* Interstitium of interalveolar septa

- Continuous Pulmonary Capillaries.
- Interstitial C.T.
  - C.T. Fibers:
    - elastic fibers
    - type III collagen (reticular fibers).
  - C.T. Cells:
    - Fibroblasts
    - Macrophages (Alveolar macrophage)
    - Mast cells
    - Lymphocytes



BLOOD-GAS BARRIER

(BLOOD-AIR BARRIER)

✓ **Definition**: It is the region of the interalveolar septum that is traversed by O2 & CO2 .

✓ **Components:**

1- Thin layer of surfactant. (from pneumocyte type II)

2- Type I pneumocyte . (Exchange of gases)

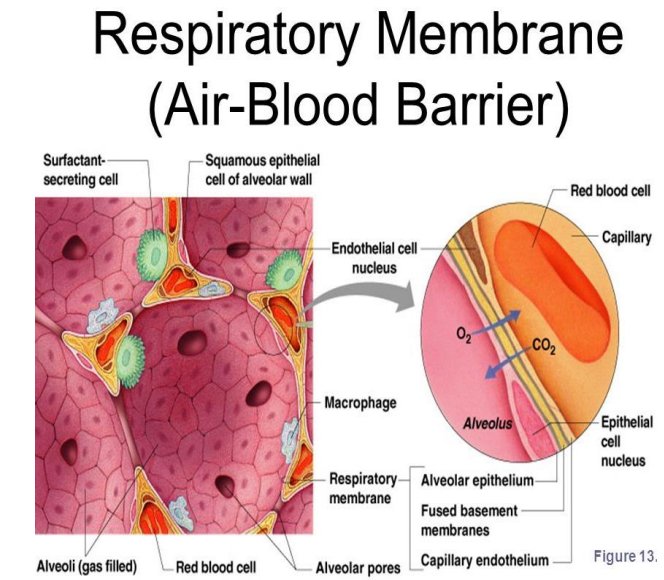
3- Fused basal laminae of type I pneumocytes & endothelial cells of the pulmonary capillary.

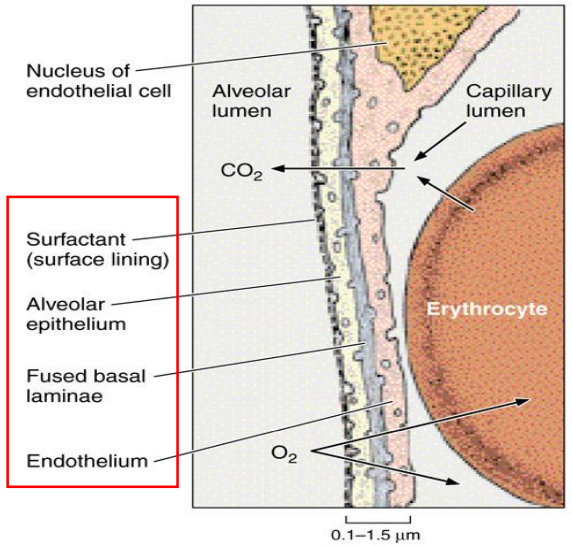
4- Endothelial cells of the pulmonary capillary.

* The wall of blood capillaries is continues .

When the O2 molecules diffuse to the capillaries it they pass the following structures respectively :

1. **surfactant (surface lining)**
2. **Alveolar epithelium**
3. **Fuesed basel lamnie (base)**
4. **Endothelium**





Alveolar phagocytes

(Alveolar Macrophages) (Dust Cells)

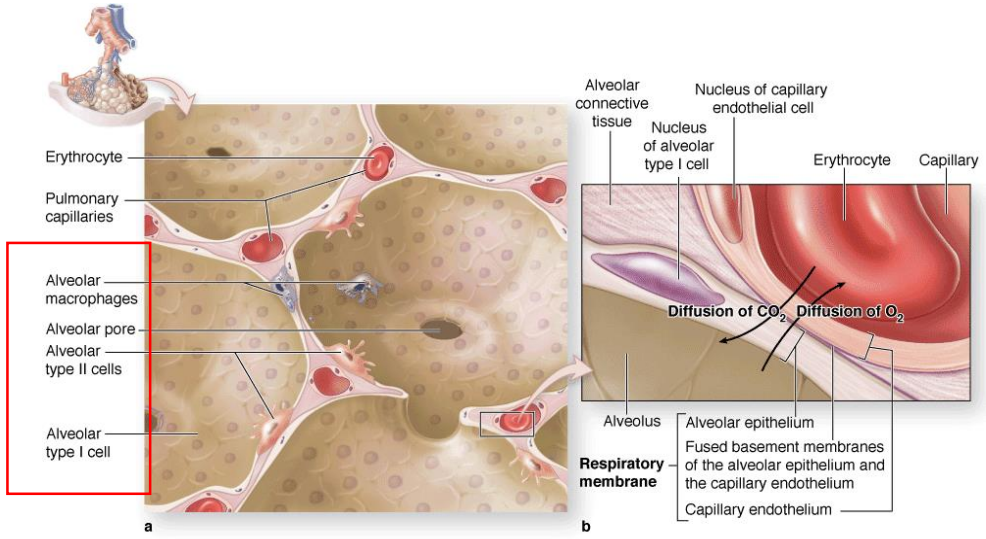
✓ **Sites:**

1- In the lumen of pulmonary alveoli.

2- In the interstitium of interalveolar septa.

✓ **Function:**

Phagocytose particulate matter (e.g. dust) & bacteria in the lumen of pulmonary alveoli and in the interstitium of interalveolar septa.



Pleura

✓ Is formed of two layers:

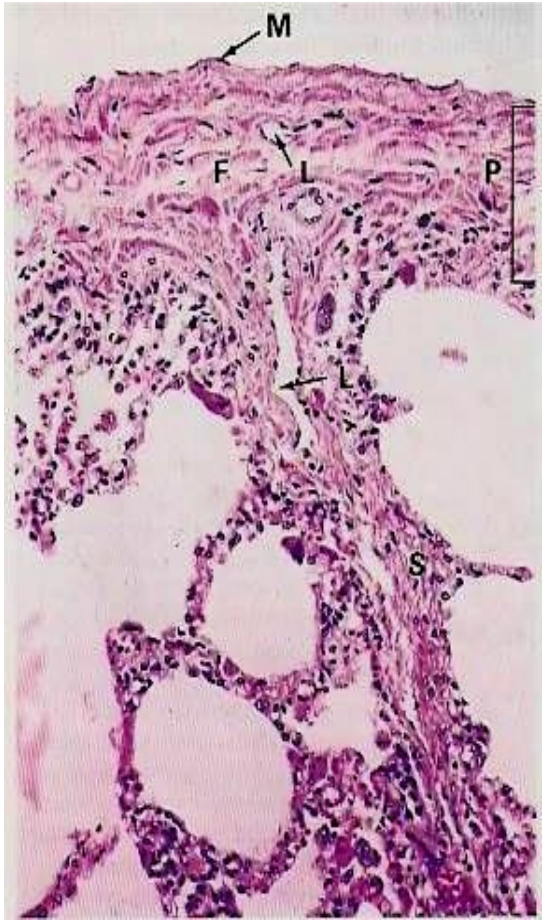
1- Parietal and visceral.

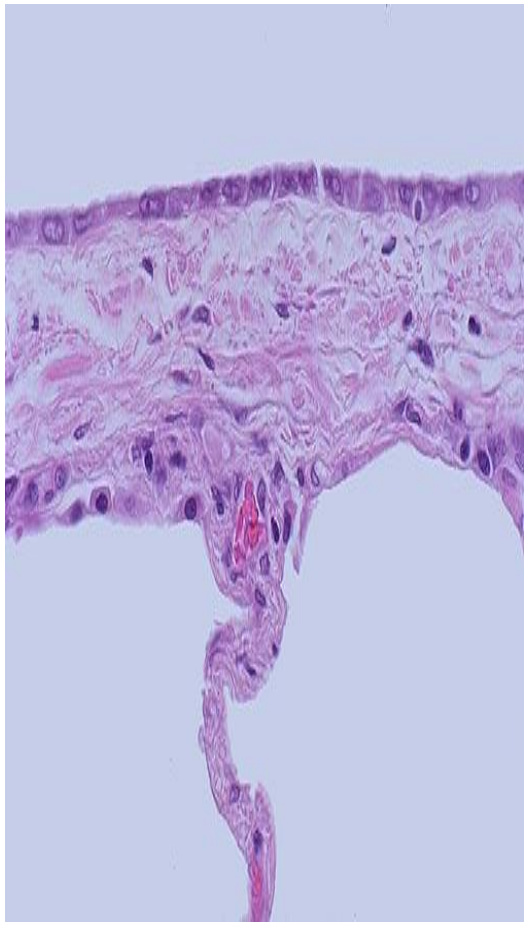
2- It is formed of simple squamous mesothelium .
(Mesothelium is the epithelium of serous membranes e.g. Pleura)

3- The two layers are separated by serous fluid .

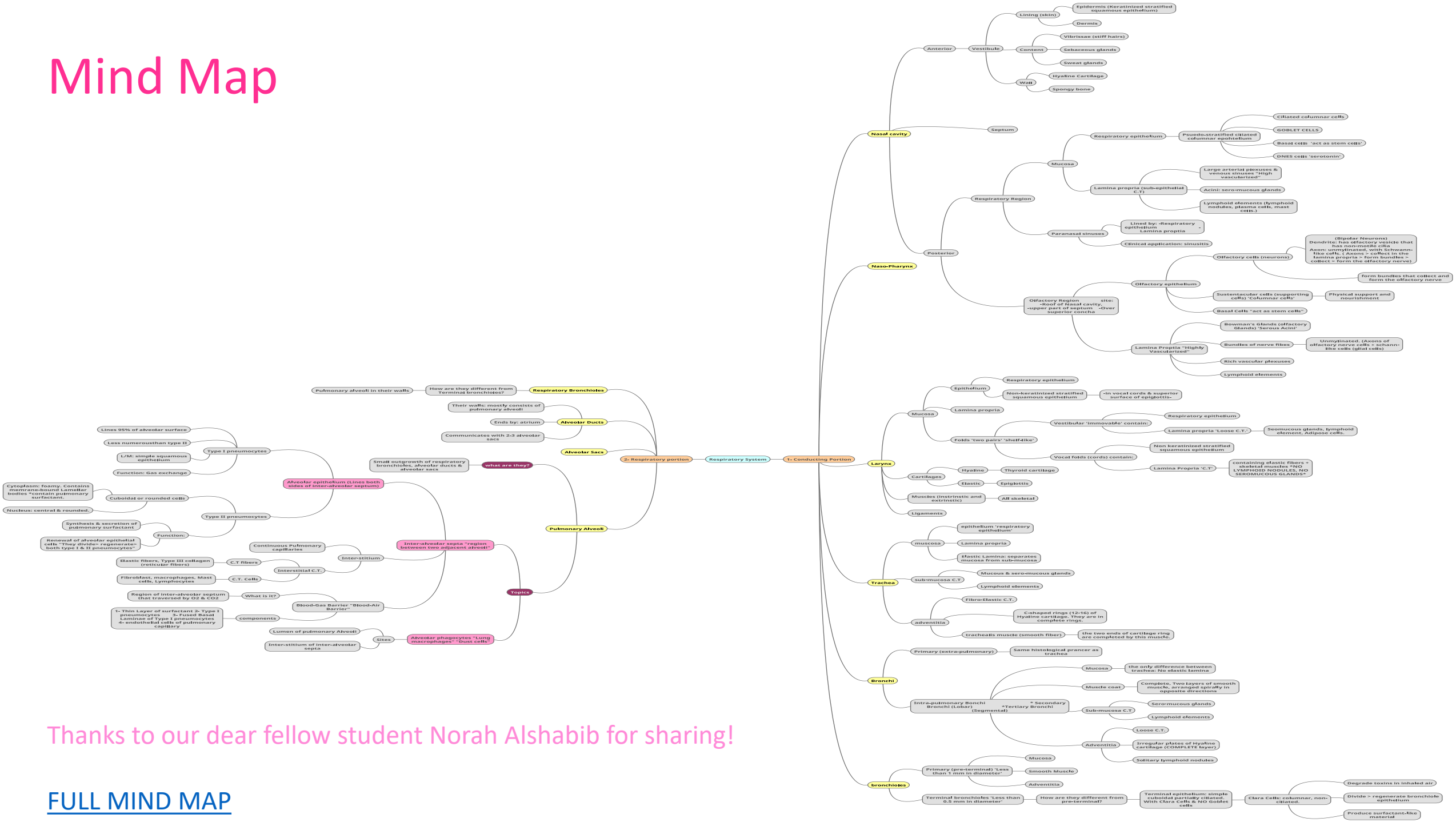
✓ Visceral Layer :

has sub-epithelium loose C.T that extends into the lung tissue .





Mind Map



Thanks to our dear fellow student Norah Alshabib for sharing!

[FULL MIND MAP]

Conducting Portion Comparison

	Trachea	Extra -pulmonary bronchi (1ry Bronchus)	Intrapulmonary bronchi (2ry &3ry Bronchi)	Preterminal Bronchioles	Terminal Bronchioles
Mucosa	1 - Respiratory epithelium 2- Lamina propria 3- Elastic Lamina		1 - Respiratory Epithelium 2 - Lamina propria (No elastic lamina)	1- Simple ciliated epithelium with occasional goblet cells 2- Lamina propria (C.T. is rich in elsatic fibers)	1 Simple cuboidal partially ciliated epithelium With Clara cells (NO goblet cells). 2 Lamina propria
Submucosa	1 - C.T. 2 - Numerous mucous & seromuscous glands 3 - Lymphoid elements		C.T. contains: A- Seromucous glands B - Lymphoid elements	here there's no submucosa , why ? Simply because the elastic fibres do not form a elastic lamina (membrane) and therefore ,there'll be no submucosal layer .	
Adventitia	1 - Fibroelastic C.T. 2 - C -shaped rings of hayaline cartilage (incomplete rings of cartilage)		A-Loose C.T. B.Irregular plates of hyaline cartilage (complete layer). C.Solitary lymphoid nodules	No cartilage No seromucous glands No lymph nodes	
Muscle coat	Only trachealis muscle to compete the C-shaped rings		(complete)	----------	

EXTRA NOTE –team435-
For the 1st & 2nd lectures

- The nose is responsible for the humidification and warming of the air and also for smelling , that is important because if very hot dry air reached the delicate alveoli then it would rupture.
- Mucosa: Epithelium + CT (Lamina Propria) in wet areas.
- The highly vascularized C.T is there to help warm the air.
- Sinusitis: When you have a flu the mucus membrane becomes edematous so the opening to the nasal sinus will close , the resonance of the voice will be lost also as a result of it closing stagnation of the fluids and secretions will occur and as a result we will have an inflammation it may be acute like in the case of the flue or chronic. then the first step of sterilizing it is by the abundant typhoid elements.
- Bowman's glands: they produce the serous to make the particles easily soluble
- The dendrites that have the non-motile cilia is there so it can cover more surface area and receive more particles.
- The vocal folds are non keratinized squamous epithelium because it is movable and because it can tolerate the friction that may occur.
- The vocal folds don't contain the lymphoid nodules or the seromucous glands because they limit its movement by making it heavier.
- The trachealis muscle is responsible for the involuntary control of the diameter of the trachea.

-The opening of the C-shaped rings in the adventitia of the trachea is directed posterior.

-The trachea and bronchi have similar histological structures, the difference is only in the diameter.

-The muscles in the intrapulmonary bronchi are oblique (spirally arranged), this facilitate the control of the diameter.

We can define the intrapulmonary bronchi from extrapulmonary bronchi histologically by:

- Muscle coat (exist only in the intrapulmonary bronchi)
- The cartilages of the intrapulmonary bronchi look like separated plates, not C-shaped as of those of trachea

-Intrapulmonary bronchi does not have cartilage plates, why?

To allow the expansion of the lung, because if it was C-shaped, The lung would expand horizontally only and then it would rupture!

But it is okay with trachea and bronchi, because they don't dilate all the time like the lungs, they only dilate when needed to.

-How to identify a bronchiole (what are the land marks of a bronchiole)?

1- there is no cartilage like in intrapulmonary and extrapulmonary bronchi

2- the epithelium is simple columnar (like preterminal bronchioles), but with branching it becomes simple cuboidal (like terminal bronchioles.)

The cilia is there in preterminal and terminal bronchioles epithelium to move out foreign bodies.

-The name "Terminal bronchioles" gives a hint that it is terminal for conducting portion and for goblet cells (there is no goblet cells there.)

-The bronchi and trachea are not formed completely by muscles, they have cartilage, this prevents the "complete obstruction" so in case of bronchial asthma, the complete obstruction doesn't happen in the bronchi, but in the bronchioles, because they don't have cartilage to splint it.

-The majority of the thickness in bronchioles is for the smooth muscles.

-Clara cells have anti toxins, which sterile air that enters the lung.

-we never find cilia in secreting cells like Clara and goblet cells.

- Alveoli are opened to each other for in case of destruction of one of them
- Some alveoli are separately open to the alveolar duct, not necessary forming sacs

The alveolar duct is like a potential duct (there is no wall), its wall is only formed by alveoli.

- "Atrium" in alveolar sacs, is a hole between an alveolar duct and an alveolus.

-We never find collagen 1 in healthy lung, but if so, this means that there is fibrosis.

-Type 1 pneumocytes have simple flat nuclei, because at there site the diffusion happens

-There are two types of capillaries: 1-Fenestrated, continuous and 2-discontinuous

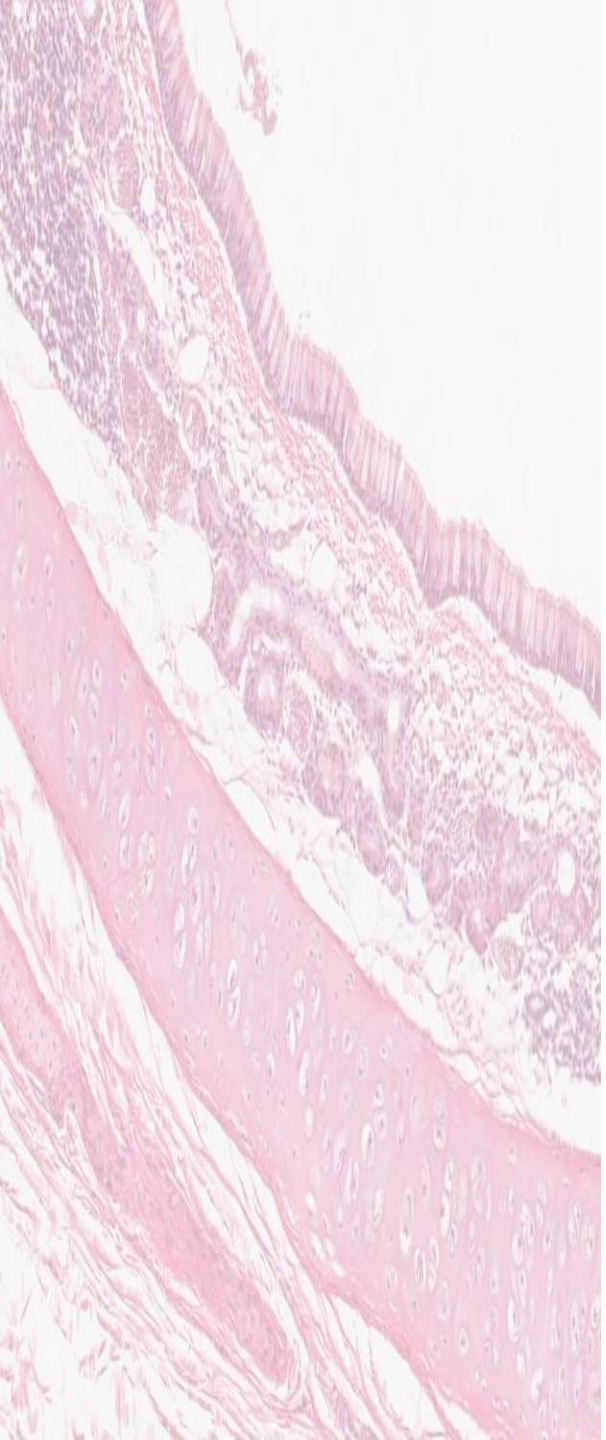
In the interstitium of interalveolar septa, the capillaries must not be fenestrated (the fenestrated causes the toxins of air to get into the circulation)

So the interstitium here has continuous pulmonary capillaries.

-Lung is covered by membranes, one of them is the pleura

Composed of: Visceral layer which is adherent to the lung, we can't separate it

Parietal layer is the outermost layer of the pleura, easy to separate.

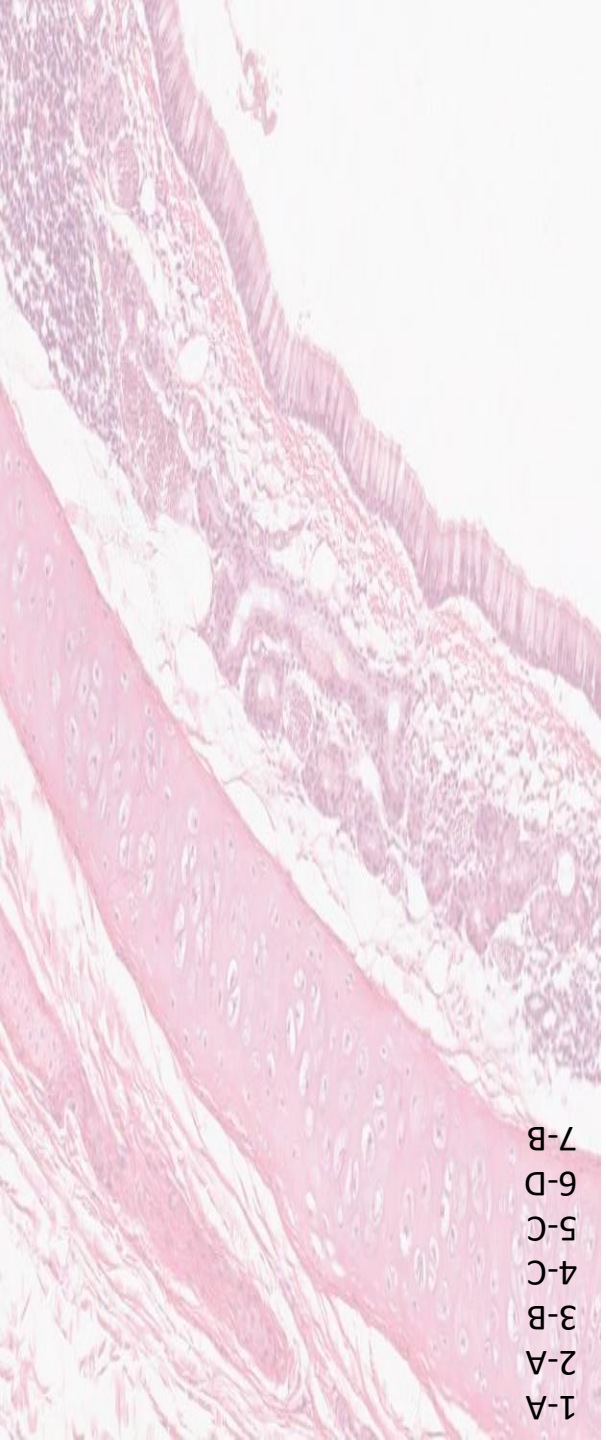


Links to help you !

Videos :

We recommend watching this 5min video:
https://www.youtube.com/watch?v=UDIgNteqVag

Full playlist for respiratory system :
https://www.youtube.com/watch?v=23_aHo4X2Vs&list=PLEf8wmJpS_1HmywDPF1Ve0zRhWfHCHCOy



MCQ :

1- which one of the following has an elastic lamina?
A-trachea
B-Intrapulmonay bronchi
C-preterminal bronchioles
D- Terminal bronchioles

2- the incomplete ring of hyaline cartilage in trachea completed by :
A-Trachealis muscle
B-Tendon
C- ligament
D-elastic cartilage

3- type of muscle coat found in intrapulmonary bronchus is :
A-cardiac muscle
B-smooth muscle
C- skeletal
D- All of them

4 -The preterminal bronchioles have no …
A-Mucosa ,cartilage and seromucous glands
B-lymph nodes, smooth muscle and cartilage
C-cartilage,seromucous gland and lymph nodes

5- which one of the following has clara cells?
A-trachea
B-extrapulmonary bronchi
C-terminal bronchioles
D-alveolar sacs

6- what is the type of epithelium found in both type I and II pneumocytes ?
A-simple columnar – simple squamous
B pseudo stratified columnar - simple squamous
C-Stratified squamous - simple cuboidal
D-simple squamous – simple cuboidal

7- which one of the following is responsible for the secretion and synthesis of pulmonary surfactant ?
A-type I pneumocytes
B-type II pneumocytes
C- alveolar ducts
D-trachea

1-A
2-A
3-B
4-C
5-C
6-D
7-B

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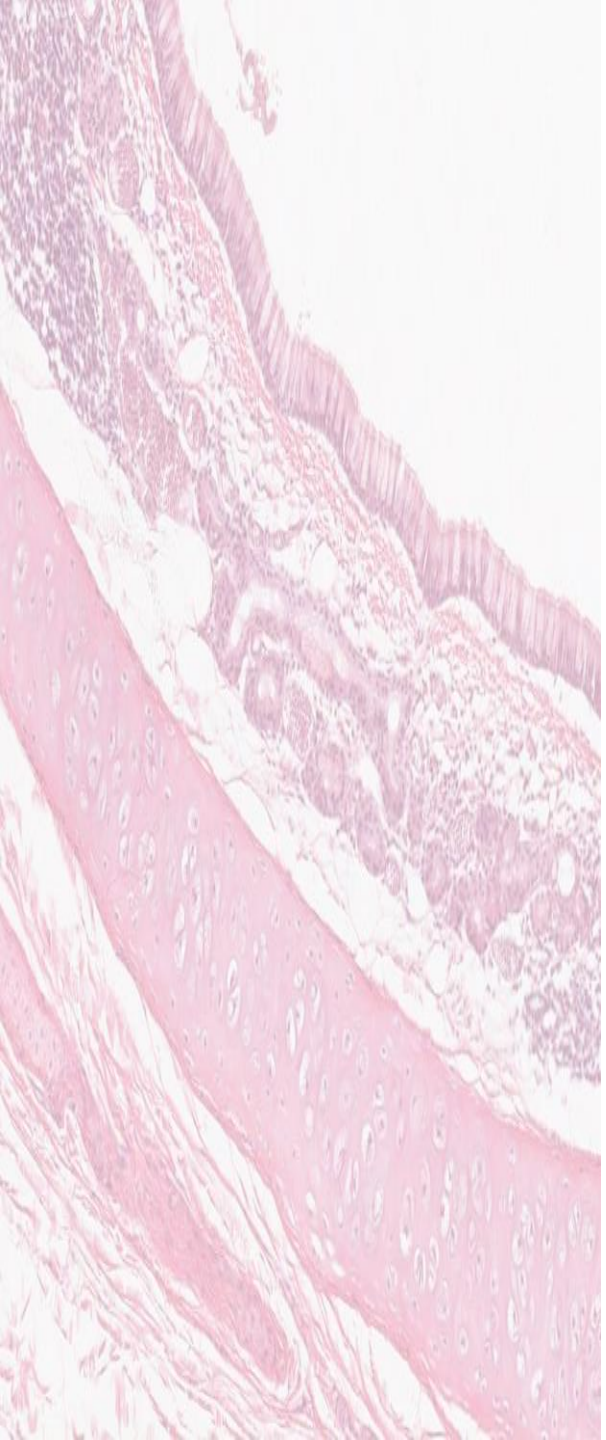

Thank you & good luck

- Histology team

Done by :

- ✓ Ahmed Badahdah
- ✓ Mutasem Alhasani
- ✓ Omar Turkistani
- ✓ Nawaf Aldarweesh
- ✓ Mohammed Khojah
- ✓ Shahad Alanzan

Team leaders:

Reema Alotaibi

Faisal Alrabaii

Please if you need anything or even further explanation contact us on :

HistologyTeam436@gmail.com

@histology436