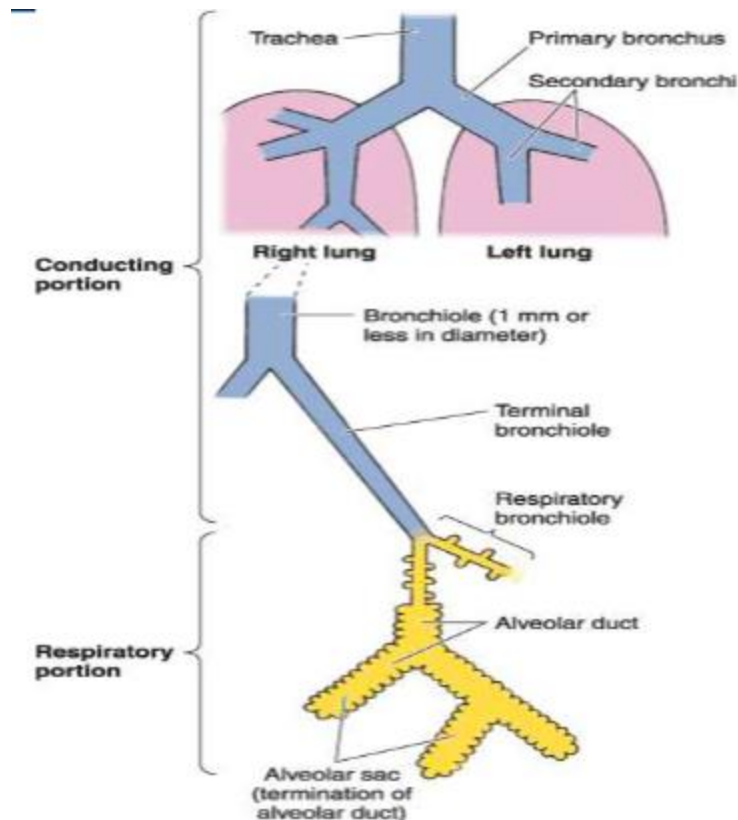


This is the first histology lecture for the respiratory tract system .

Respiratory tract starts with nose and ends with lungs , the respiratory tract is divided into upper part (conducting) like the nose , larynx , trachea and bronchi and lower part (respiratory) which include gases exchange like the bronchioles , alveoli .

As we said the respiratory tract is divided into :

- conducting : for passage of air only
- respiratory : for gases exchange , it starts by the respiratory bronchioles then alveolar duct , alveolar sac and alveoli (where largest capillary network is found around the alveoli)



we have also the transitional area separating the conducting from the respiratory and always the transitional areas are site of cancers ,the transitional area here doesn't appear suddenly , it appears gradually .

The common epithelium in the respiratory tract is pseudostratified ciliated columnar epithelium , but as we reach the bronchioles it is transformed to simple columnar ciliated and as we go distally it changes into simple cuboidal ciliated epithelium and more distally toward the lungs , it changes into clara cells (no cilia) and finally in the wall of the alveoli it becomes simple squamous (for gases exchange)

Goblet cells start with large number but as we go distally , the number is reduced , and once we reach the bronchioles , they become scattered and finally disappear . Also there are seromucous gland with the same story , they decrease in number as we go distally .

Cartilage also changes , in the nose there is some cartilage and bone (nasal bone) , and in the larynx there are hyaline cartilage and elastic cartilage , and in trachea there is C shaped hyaline cartilage to prevent the collapse to keep the passage of air , but when we go distally until we reach the bronchioles there are no cartilage , no goblet cells , no glands BUT the elastic fibers increase , and they are found with high amount at the lungs because they are needed for inflation and deflation .

In the lungs we have lobes (three lobes and two fissures in the right and two lobes with one fissure in the left) , primary and secondary bronchus enter the lobes , then the secondary becomes tertiary . Inside the lobes , there are lobules and each lobule is surrounded by connective tissue , which has it's own blood supply , venous drainage and lymphatics so these days the surgeon is able to remove the lobule only not the whole lobe .

the doctor is advising us not to SMOKE , 90% of lung cancers are due to smoking , because smoking affects a protein called dynein , which is responsible for the movement of cilia (from inside to outside) , so by affecting the dynein will lead to prevent this movement , leading to some disease like bronchitis and eventually to cancers .

again and again , the doctor is talking about the two parts of the respiratory tract , and he mentioned that as we go distally the diameter is decreasing , starting from the trachea which is like tip of the finger and reaching the large bronchioles which is 1 mm in diameter and eventually in terminal bronchioles .5 mm , in the respiratory part it is less than .5 mm and the wall here is simple squamous epithelium .

The conducting part :

1) Nose

2) Pharynx (which we have taken in the GI and it is required with it's three parts; oropharynx , nasopharynx and laryngopharynx (مشراح ارجعله)

3) Larynx which has true vocal cords that are responsible for the production of voice .

for your information :

the (inspiration) inhalation process is considered as an active process need energy and it is caused by stimulation of phrenic nerve so the diaphragm will decends downward with the result that the intrathoracic pressure will become less than the atmospheric pressure so this will cause gush of air through the nose filling the two lungs with oxygen .However , the expiration is a passive process ; the diaphragm ascends upwards increasing the intrathoracic pressure letting to deflation of lung so the air will goes outside the lungs through the larynx .

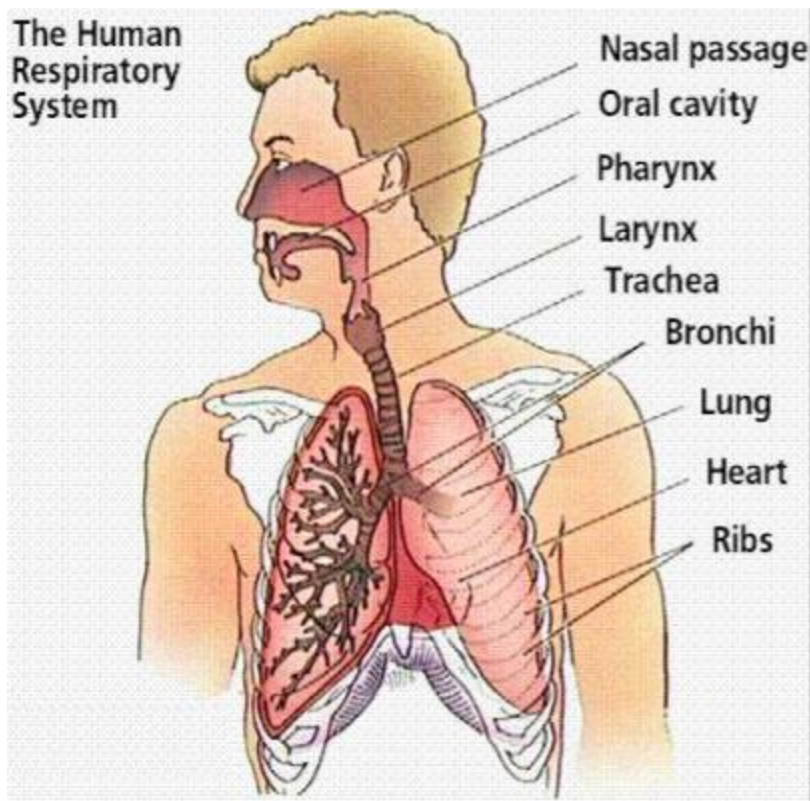
when the expired air is going outside through the larynx it faces the true vocal cords making a column of air under pressure under the vocal cords , and when it assends between them , it causes vibration and thus

production of voice . Sudden opening after closure of these cords will cause the coughing (a protection process)

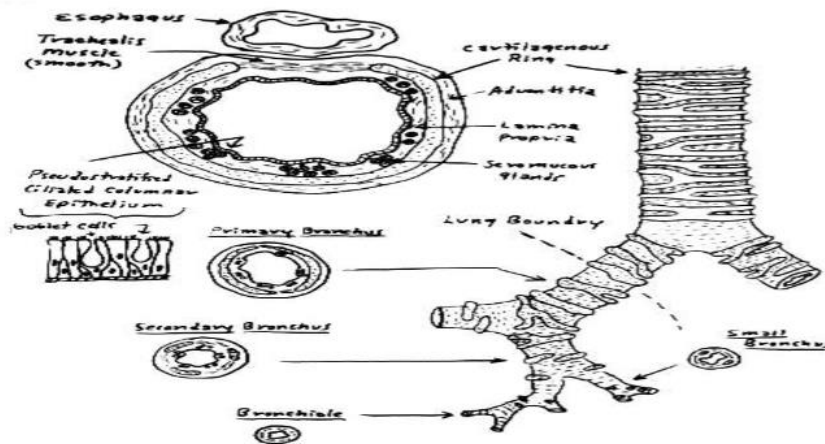
also when anyone tried to lift heavy object , the vocal cords will adduct to produce pressure column of air so he won't breath till putting it off .

4) Bronchi , and we have main bronchus on the right and other one on the left , each is going to it's lung - to the hilum - (extrapulmonary) , the main bronchus is the primary , the secondary is lobar , three in the right lung and two in the left lung (inside the lung > intrapulmonary) bronchi to the lobes , and then the tertiary (segmental or bronchopulmonary segment 10 on the right and 10 on the left but at birth , you will find 8 on the left and 10 on the right) which is also intrapulmonary .

5) Bronchioles , the diameter is smaller and they are intrapulmonary , no cartilage , no glands , no goblet cells and there is changes in epithelium , they are of two kinds , conducting ends with terminal and respiratory .



Section in the trachea :



any part of the respiratory tract has the following layers :

- 1) mucosa which has lining epithelium which is - pseudostratified ciliated columnar in general - , lamina propia muscularis mucosa also
- 2) submucosa which has connecting tissue , glands (seromucous) , blood vessels , nerves and lymphatics
- 3) supportive layer which has cartilage like the hyaline cartilage , elastic fibers , blood vessels , glands , smooth muscles and lymphatics

(smooth muscles increase as we go distally , and they are spiral in bronchioles - the doctor mentioned the cause of asthma that is contraction of the smooth muscles which will cause narrowing the lumen of bronchioles with the result that the patient will have difficulty in breathing and wheezing during breathing , treatment will be by taking smooth muscle relaxant like adrenaline)

4) adventitia which is connecting tissue and can be found as serosa in pleura which surrounds the lung which is simple squamous epithelium (mesothelium like the peritoneum) . there are more functions for the conducting part other than conduction of air , like cleaning , moistening and warming .

we will notice that at the beginning , in the nose there is hair which will clean the air from the dust , and also there is venous blood in the mucosa and submucosa which will cause warming and moistening to the air as a protecting mechanism .

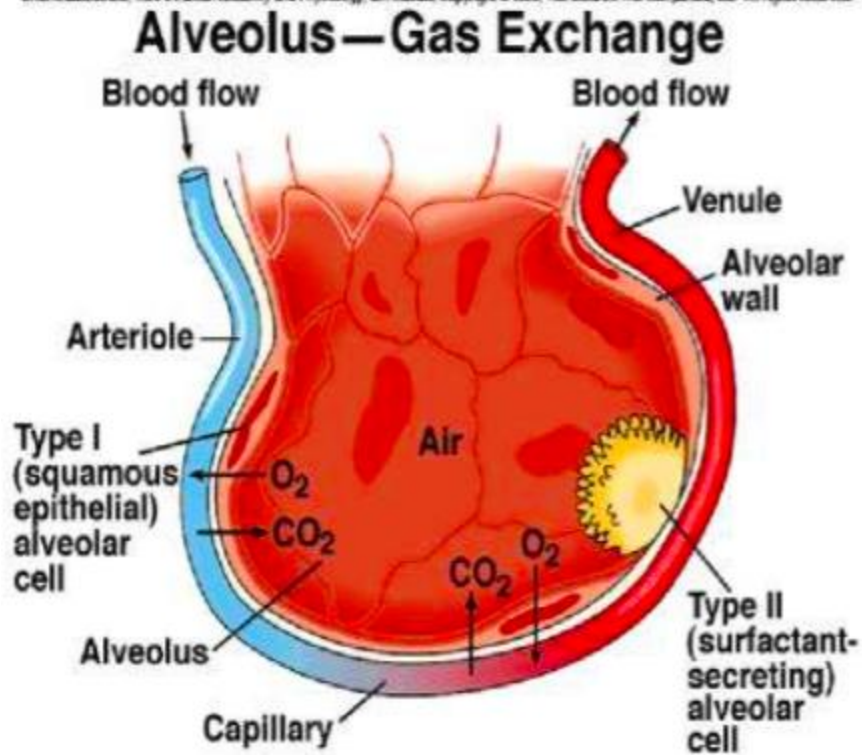
The doctor mentioned again the conducting and the respiratory part of the tract -,- and the alveolar duct will end with the alveolar sac , and the whole wall is the alvioli which do the principle function of the reparatory tract .

Gases Exchange :

The oxygen concentration which will reach the cappillary is low almost 40 , but after the gases exchange , the hemoglobin takes the oxygen ,so the oxygen concentration increase.

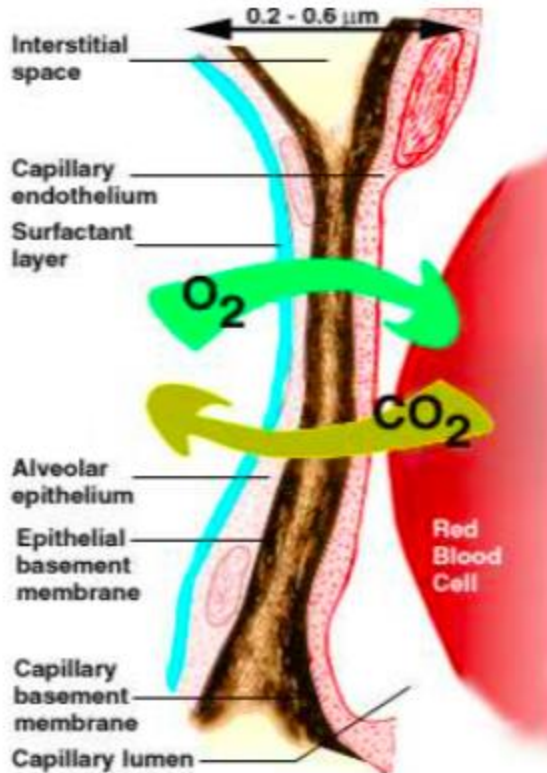
as we know from the cardiovascular system , the deoxygenated blood comes to the lung through the pulmonary artery and after the gases exchange it goes out through the pulmonary vein which has the highest oxygen concentration - saturated - (95 mm Hg to 105 mm Hg , whereas the concentration of CO₂ can reach 45 mm Hg in the alveoli .

Brian Bates/Lewis, *Hugh's Human Anatomy and Physiology*, 8th edition, Copyright © 2009, The McGraw-Hill Companies, Inc. All rights reserved.



We will take the alveoli in details later on , which has alveolar type one (simple squamous) and type two - which secretes surfactant factor which decrease the surface tension of the alveoli so it will be inflated as the baby is born and then the respiration starts - .

Between the wall of the capillary and the wall of the alveolus there is very thin layer of basal lamina ,and both walls (alveolar and capillary) are simple squamous epithelium for the gases exchange .



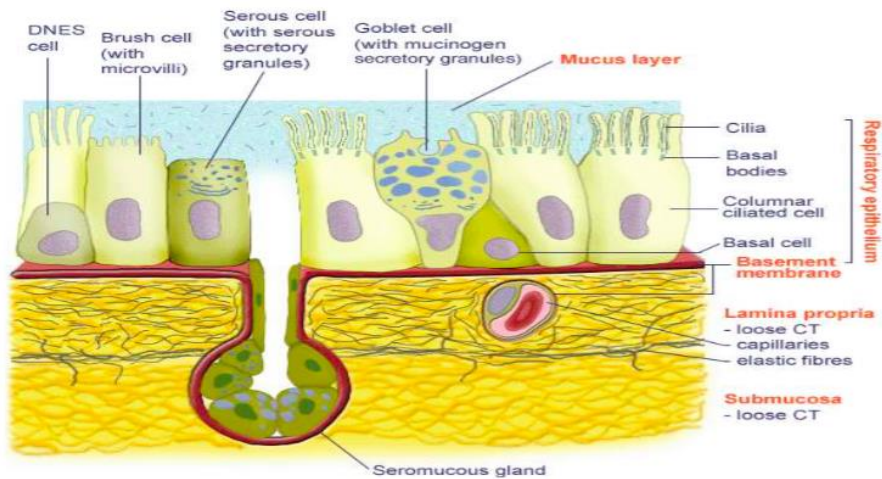
The carbon dioxide has three walls to pass to the capillaries :

- only 7% is dissolved in the plasma
- 23% is combined with hemoglobin forming carbaminohemoglobin
- 70% is converted to protons by carbonic anhydrase and combines to hemoglobin (reversible reaction) ($H_2O + CO_2 = H_2CO_3$)

Respiratory epithelium :

the most important layer is the lining epithelium that is pseudostratified ciliated columnar epithelium and it has five types of cells laying on the thick basement membrane (it is not necessary to reach the surface) as we said the major part is pseudostratified ciliated columnar cells , but there are also other types of cells :

- goblet cells which is unicellular gland found also in GI , and it's most important function that it's secretion will cause the stuck of the dust , bacteria and viruses and also it moistening to the respiratory tract .
- Brush cell (called Brush because it has microvilli and receptors)
- serous cells with serous secretory granules
- Diffuse Neuroendocrine cells (DNES) kluchitsky cells , found on the base
- stem cells (or basal cells) reservoir with mitotic division to replace other cells .



Glands are found in the submucosa and have ducts which open at the surface .

Each cell has special characteristics for example the ciliated cells , each cell has about 300 cilia found on the surface connected with basal bodies , also cilia is surrounded by mitochondria, so at the apex of the cells there is a large number of mitochondria for the production of ATP , also there is Dynein which is important for ciliary movement , nicotine that we get during smoking will cause damage and prevent the formation of dynein and the disease in this case is Immotile cilia syndrome (Kartagener syndrome) which includes immobility of cilia and infection (chronic respiratory tract infection) , we also found that it causes infertility and sterility in males not females (unlike the mumps affecting the parotid gland which causes sterility in females not males)

- Goblet Cells (Apical mucous droplets) : they are unicellular , includes polysaccharides and glycoprotein .
- Brush cells : called like this because they have microvilli, and there is sensory receptors there.
- Basal (short) cells - stem cells - : small rounded cells, and considered as reserve cells , for mitotic activity .
- Cells of the DNES (diffuse neuroendocrine system) : small granule cells , also called Kulchitsky Cells , regulates locally the excretions or secretions of mucous and serous glands in the respiratory tract

layers :

mentioned before (mucosa , submucosa , supporting and adventitia)

NASAL cavity :

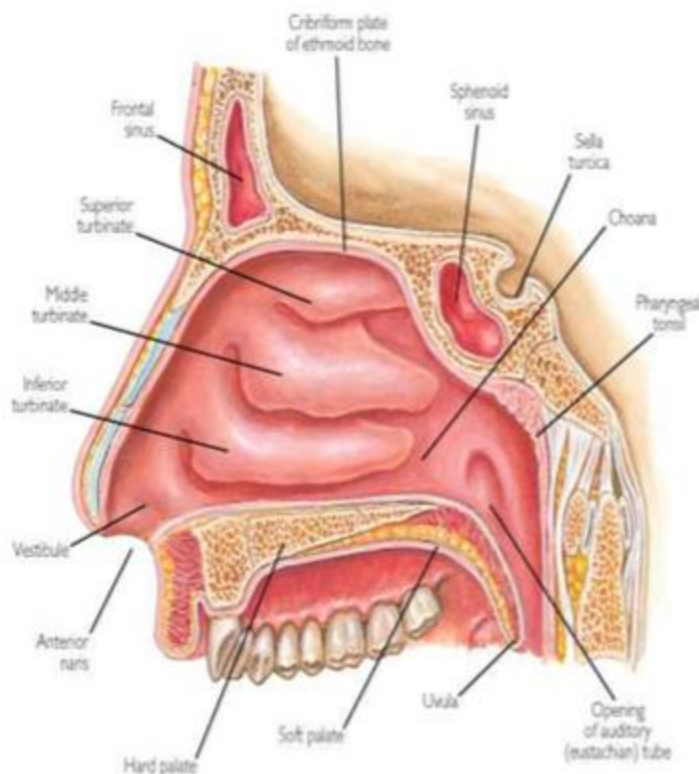
if we take section in the nose , we will find it's beginning as vestibule (anterior nares , the space directly after the opening) it is characterized by having thick and short hair (vibrissae) for air filtration , the

epithelium is stratified squamous non keratinized , and has sebaceous and sweat gland (like the skin) ONLY the vestibule .

P.s : the doctor said that it is non keratinized , but according to Wikipedia , it is keratinized .

Then the respiratory area , three conchae like shelf (process) , three meatuses (groove under them) and one recess “ lateral wall “

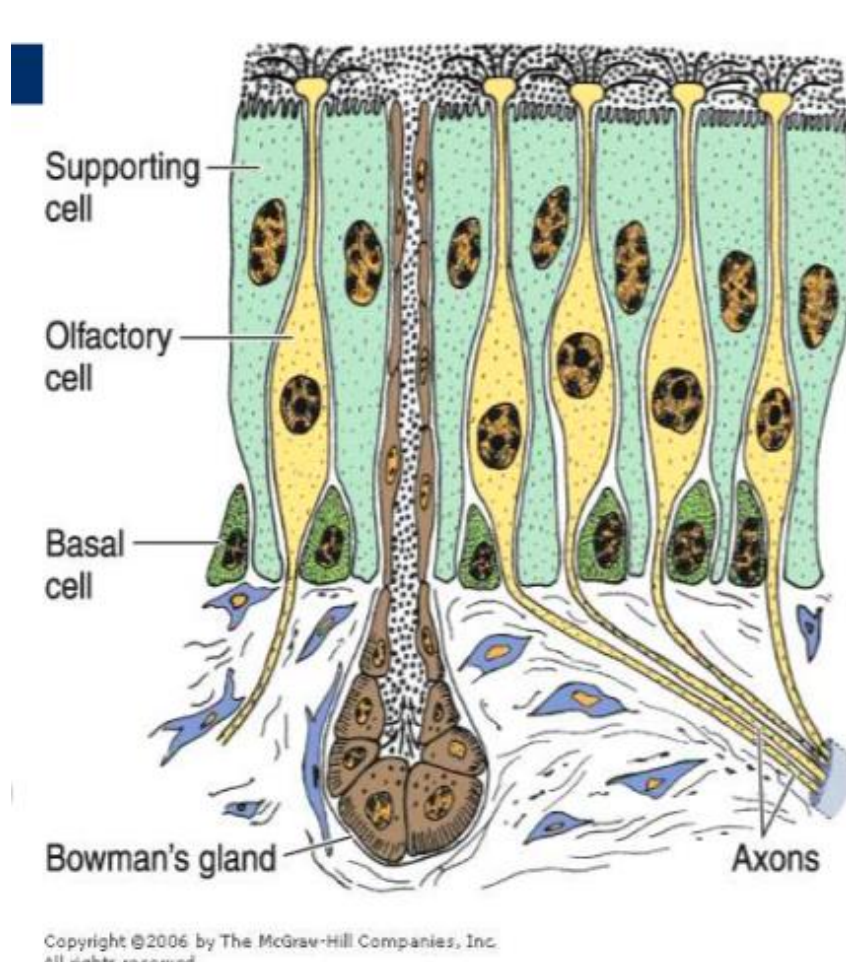
The respiratory area is were the respiration occurs , the epithelium is pseudostratified ciliated columnar with seromucos gland , and what characterize it is having venous blood plexus within the submucosa for warming the air for protection.



The last area is olfactory which is responsible for smell sensation found under the cribriform plate of ethmoid (called like this because olfactory filaments enter through it) plate of ethmoid , on the roof and septum . And there is respiratory mucosa in addition to olfactory epithelium with bipolar cells which are responsible to convert the odor stimulus from chemical to mechanical then to electrical impulse .

bipolar means it has two poles - two ends - , one has hair leads and the other is nerve fibers forming olfactory filaments - appear from the base - then olfactory bulb then tract , around them there is supportive or sustentacular cells supporting the bipolar , also there is gland called bowmans glad secrete

watery seromucous to dissolve the odor .



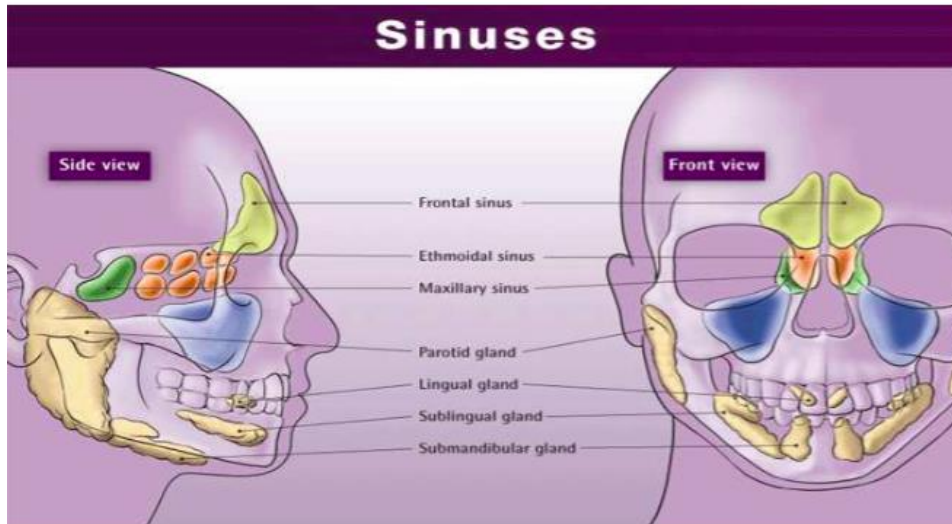
what we are concerned about is knowing that there is a center in the base of the temporal lobe responsible for the sensation of smell , so all odors we smell since birth are saved in this center .

Sinuses :

in the nose there are air sinuses which are spaces in some bones of the skull like in the frontal bone (frontal air sinuses) , in the maxilla (maxillary air sinuses - the largest-) , in the ethmoid (ethmoidal air sinuses) , sphenoid (sphenoidal air sinuses) all are pairs except the ethmoid are six (3+3)

they are spaces covered by thin mucosa and contain air , their most important function is resonance of the air to determine the tone of the voice , that's why all air sinuses have ducts which open in the lateral wall of the nose . When there is sinusitis (infection) , the secretion of the duct increases , and in chronic cases it becomes yellow with bad odor .

the nasal sinuses as we said have mucosa but it is thin and contains few goblet cells , and also submucosa also thin connected with periosteum . The lamina propria contains only a few small glands continuous with the underlying periosteum .



the last four words in the lecture :P

the most important thing the respiratory tract is knowing the histological changes along the tract ;

we started in the nasal vestibule as non keratinized (skin) then it becomes respiratory , and then olfactory where we added bipolar cells .

When we go downward to the trachea :

as we go distally :

- goblet cell number decreases
- gland number decreases
- cartilage is absent in bronchioles
- smooth muscles increase
- elastic fiber number increases
- lymphocyte becomes nodules after being scattered

trachea ends at the level of sternal angle .

- Each large bronchiole (1 mm) gives 5 to 7 terminal ones with smaller diameter
- the trachea has C shaped hyaline cartilage and closed posteriorly by brachialis muscle which is smooth muscle separate it from esophagus and if the trachea was complete ring it will stop the bolus .
- trachea has seromucus gland and all type of cells
- when we go to bronchi , it the same like trachea but the cartilage is plates (pieces of hyaline cartilage) and spiral smooth muscle increases when we go distally , also has the five parts of cells .

PLEASE REFER TO the slides especially the last parts , the doctor didn't mention everything .

P.S : excuse me for the bad editing but I have done this sheet online and the editing options are not enough .

Done by : Mohammad Abu Dosh .

