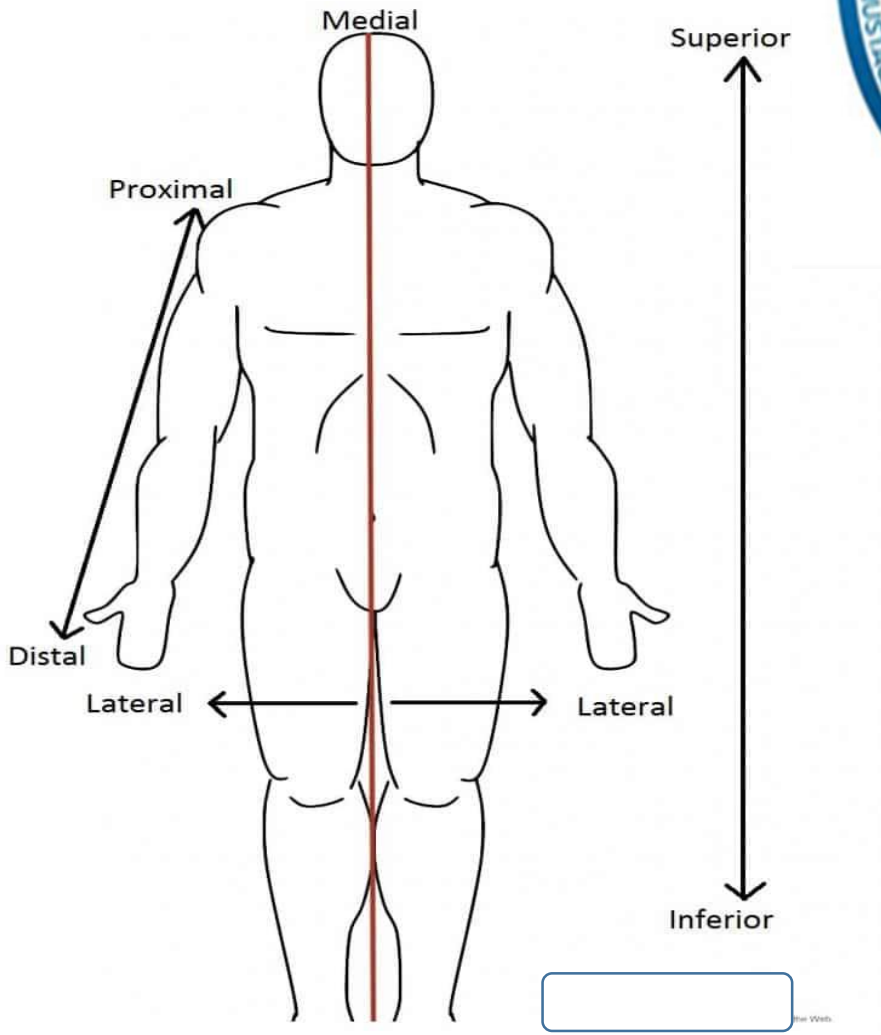
AL MUSTAQBAL UNIVERSITY

College of Pharmacy / First Stage



ANATOMY

(L6) Respiratory System

Dr. Abdulhusein Mizhir Almaamuri

Anatomy of respiratory system

- The **respiratory system** consists of all the tissue and organs designed to bring air to the gas exchange surface where O_2 is absorbed and CO_2 is released.
- The respiratory system can be divided into:
- **Upper respiratory system** that includes the nose, nasal cavity, paranasal sinuses and pharynx
- **Lower respiratory system** that includes the larynx, trachea, bronchi and lungs.

The respiratory tract can be divided into-

- **Conducting portion** from the nasal cavity to the terminal bronchioles through which no gas exchange occurs.
- **Respiratory portion** that includes the respiratory bronchioles and alveoli where gas exchange occurs.

Breathing (Pulmonary Ventilation)

Inhalation (inspiration) draws gases into the lungs.

Exhalation (expiration) forces gases out of the lungs.

Functions

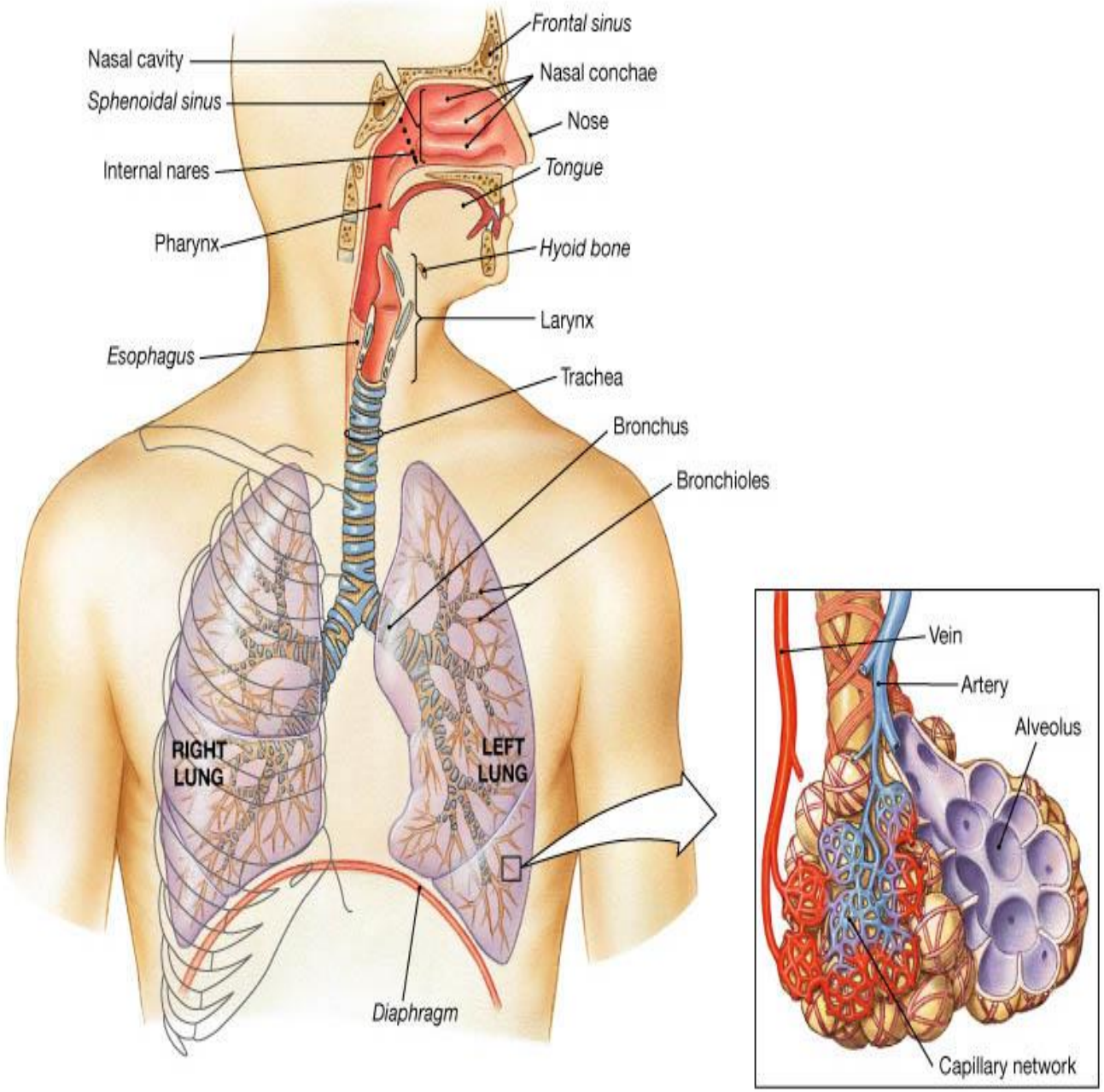
1. Provide a gas exchange surface
2. Move air to and from exchange surface
3. Protect respiratory surfaces from environment
4. Defend against invasion by pathogens
5. Production of sound
6. Involvement in regulation of blood volume and pressure, and control of body pH

- **Gas Conditioning**
- As gases pass through the nasal cavity and paranasal sinuses, inhaled air becomes turbulent.
- The gases in the air are
  - warmed to body temperature
  - humidified
  - cleaned of particulate matter

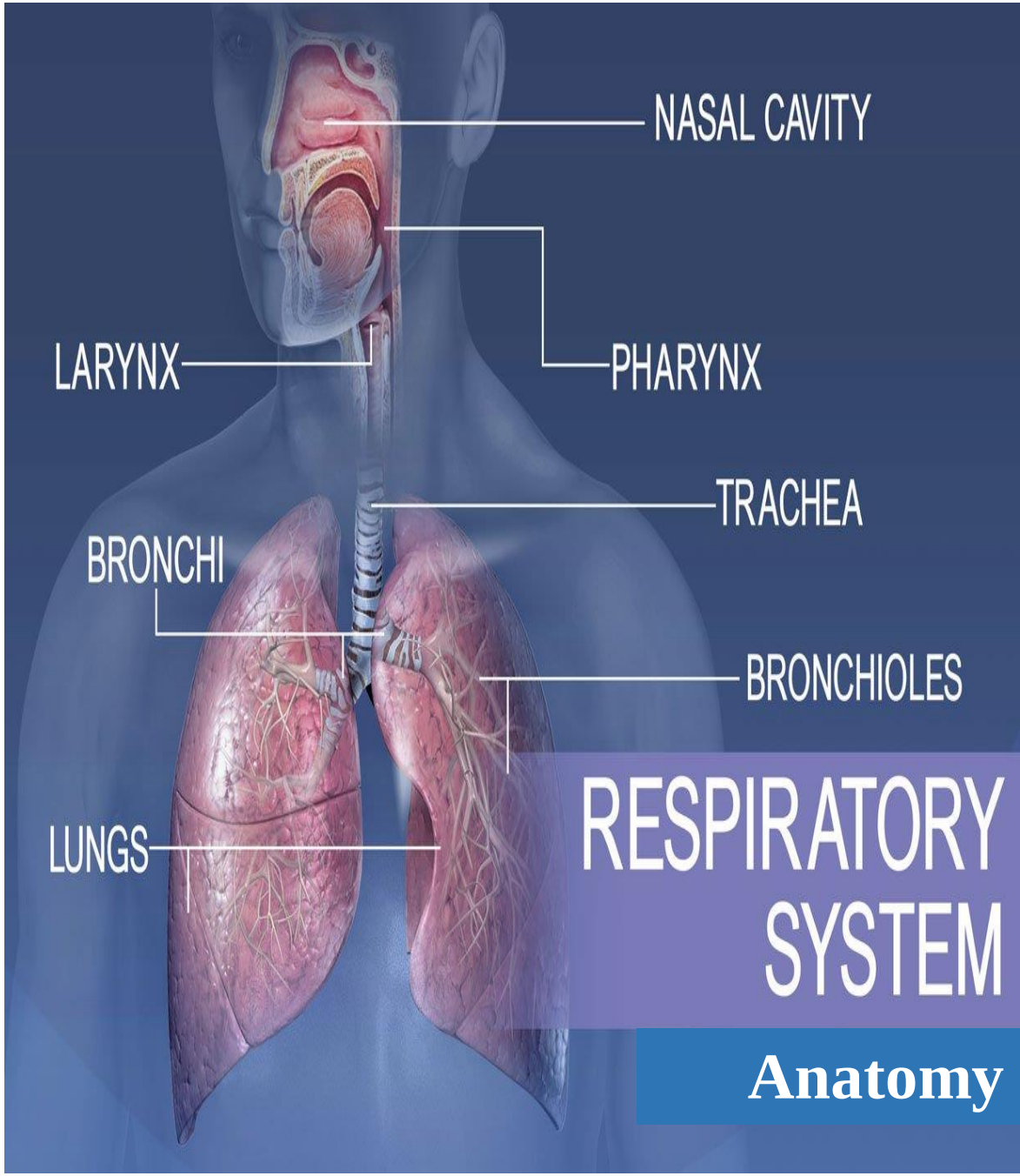
- **Produces Sounds**
- The larynx, nasal cavity, paranasal sinuses, teeth, lips, and tongue work to produce sound. Sound allows speech, singing, and nonverbal communication
- **Provides Olfactory Sensations**
- When airborne molecules are inhaled and dissolve in the mucus in the nose, the molecules can bind to receptors in the olfactory epithelium.
- **Protects the Body**
- Hairs, twisted pathways, goblet cells, mucous glands, lysozyme in the mucus all help defend the body against infection by airborne pathogens.

Pathway of Air

- nose ---> pharynx ---> larynx ---> trachea ---> primary bronchi ---> secondary bronchi ---> tertiary bronchi ---> bronchioles ---> terminal bronchioles ---> respiratory bronchioles ---> alveolar duct ---> alveoli


Frontal sinus
Nasal cavity
Nasal conchae
Sphenoidal sinus
Nose
Internal nares
Tongue
Pharynx
Hyoid bone
Larynx
Esophagus
Trachea
Bronchus
Bronchioles
RIGHT LUNG
LEFT LUNG
Diaphragm

Vein
Artery
Alveolus
Capillary network


NASAL CAVITY
LARYNX
PHARYNX
TRACHEA
BRONCHI
BRONCHIOLES
LUNGS
RESPIRATORY SYSTEM
Anatomy

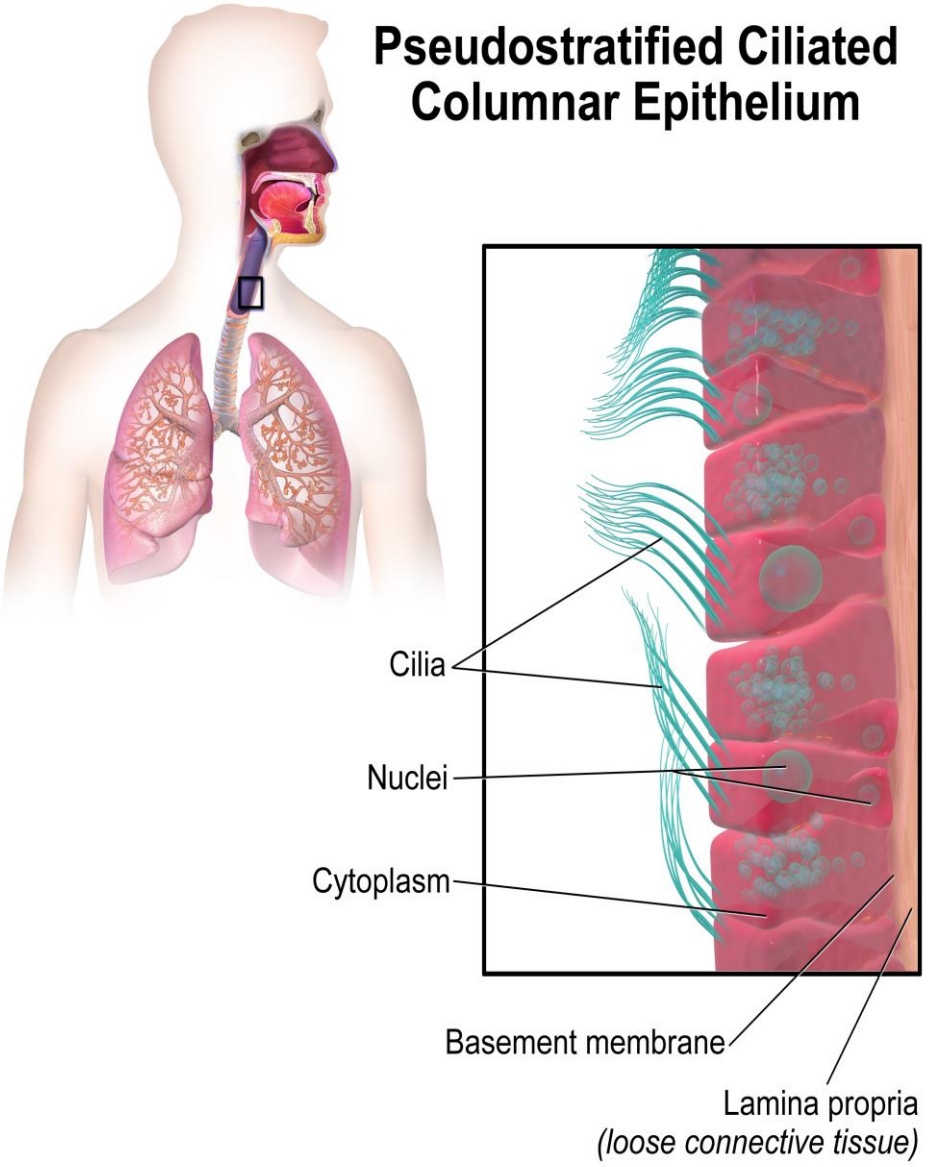
Respiratory Epithelium

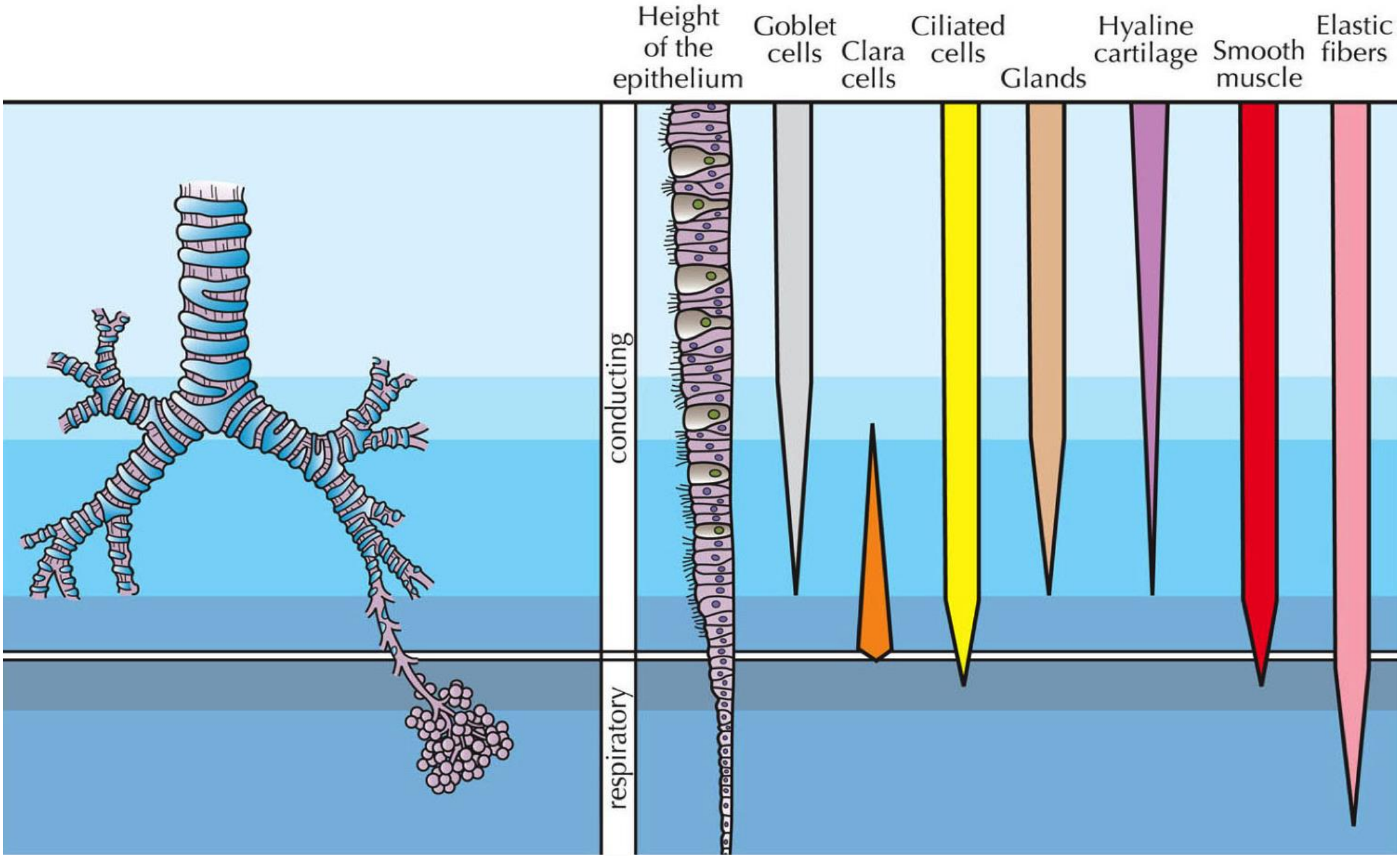
- Most of the mucous membrane lining the conducting portion of the respiratory tract is lined by **pseudostratified, ciliated, columnar epithelium (PCCE)**, which is also know as **respiratory epithelium.**

- PCCE serves the protective function of the respiratory system.

- **Goblet cells, and mucous glands found in the lamina propria, produce** mucus that traps particles on the surface.

- The cilia move sheets of mucus with trapped debris and pathogens out of the tract and toward the esophagus.

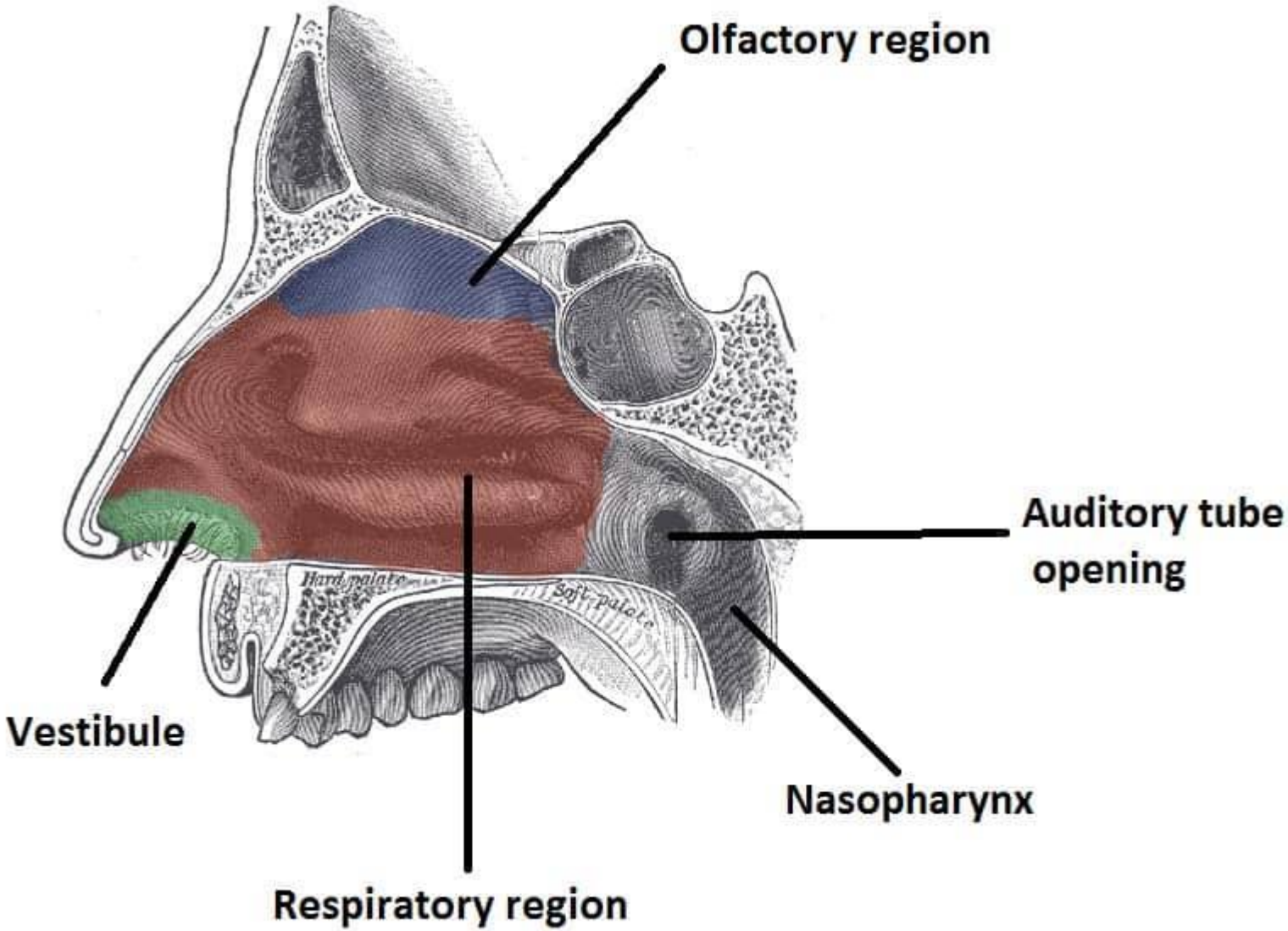



Height of the epithelium
Goblet cells
Clara cells
Ciliated cells
Glands
Hyaline cartilage
Smooth muscle
Elastic fibers
conducting
respiratory

The **nose** is an olfactory and respiratory organ. It consists of nasal skeleton, which houses the nasal cavity. The nasal cavity has four functions:
Warms and **humidifies** the inspired air.
Removes and traps **pathogens** and particulate matter from the inspired air.
Responsible for sense of **smell.**
Drains and clears the paranasal sinuses and lacrimal ducts

Divisions
The nasal cavity is the most superior part of the **respiratory tract**. It extends from the vestibule of the nose to the nasopharynx, and has three divisions:

Vestibule – the area surrounding the anterior external opening to the nasal cavity.
Respiratory region – lined by a ciliated psudeostratified epithelium, interspersed with mucus-secreting goblet cells.
Olfactory region – located at the apex of the nasal cavity. It is lined by olfactory cells with olfactory receptors.



Nasal Cavity Divisions

Nasal Conchae

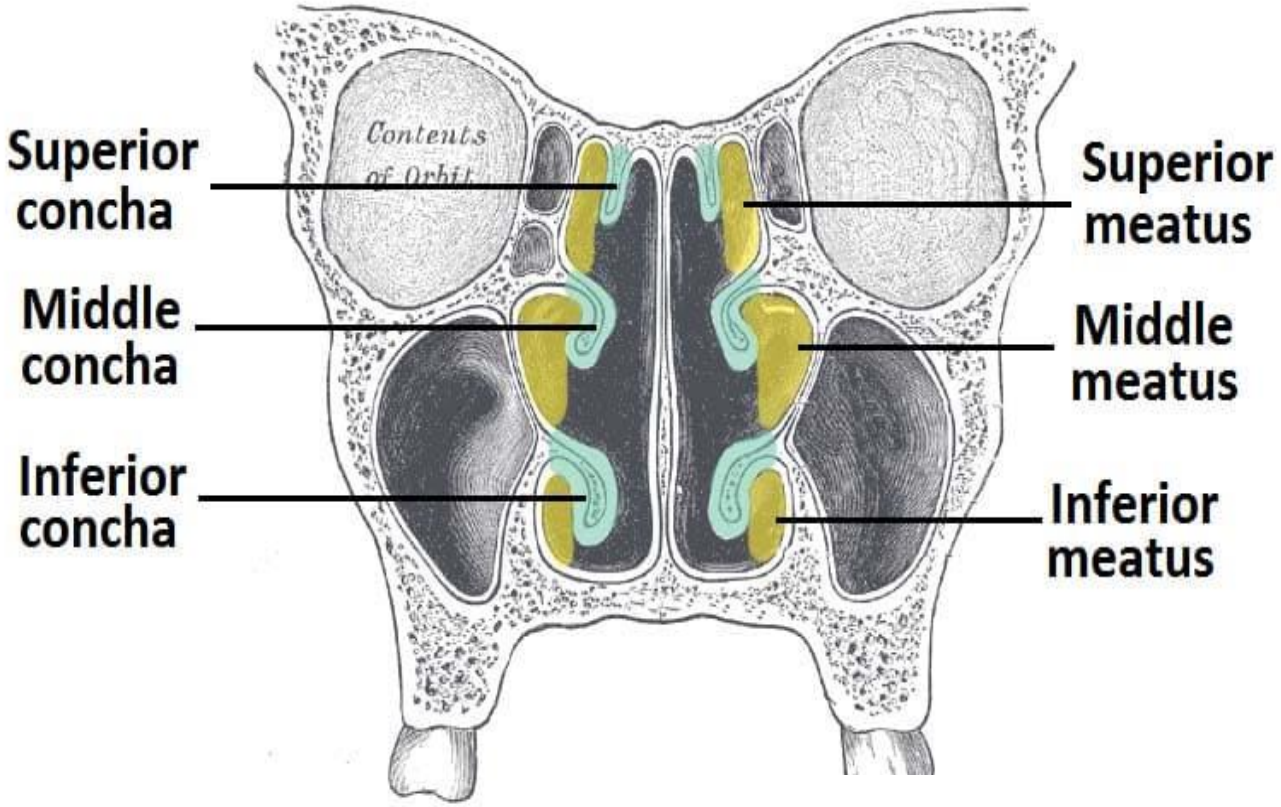
Projecting out of the lateral walls of the nasal cavity are curved shelves of bone. They are called **conchae** (or turbinates). The are three conchae – inferior, middle and superior. They **project** into the nasal cavity, creating four pathways for the air to flow. These pathways are called meatuses:

Inferior meatus: between the inferior concha and floor of the nasal cavity.

Middle meatus: between the inferior and middle concha.

Superior meatus: between the middle and superior concha.

The function of the conchae is to increase the **surface area** of the nasal cavity – this increases the amount of inspired air that can come into contact with the cavity walls.



Coronal section of the anterior nasal cavity.

Openings into the Nasal Cavity

One of the functions of the nose is to **drain** a variety of structures. Thus, there are many openings into the nasal cavity, by which drainage occurs.

The **paranasal sinuses** :The frontal, maxillary, ethmoidal and the sphenoid sinuses.

Nasolacrimal duct – acts to drain tears from the eye.

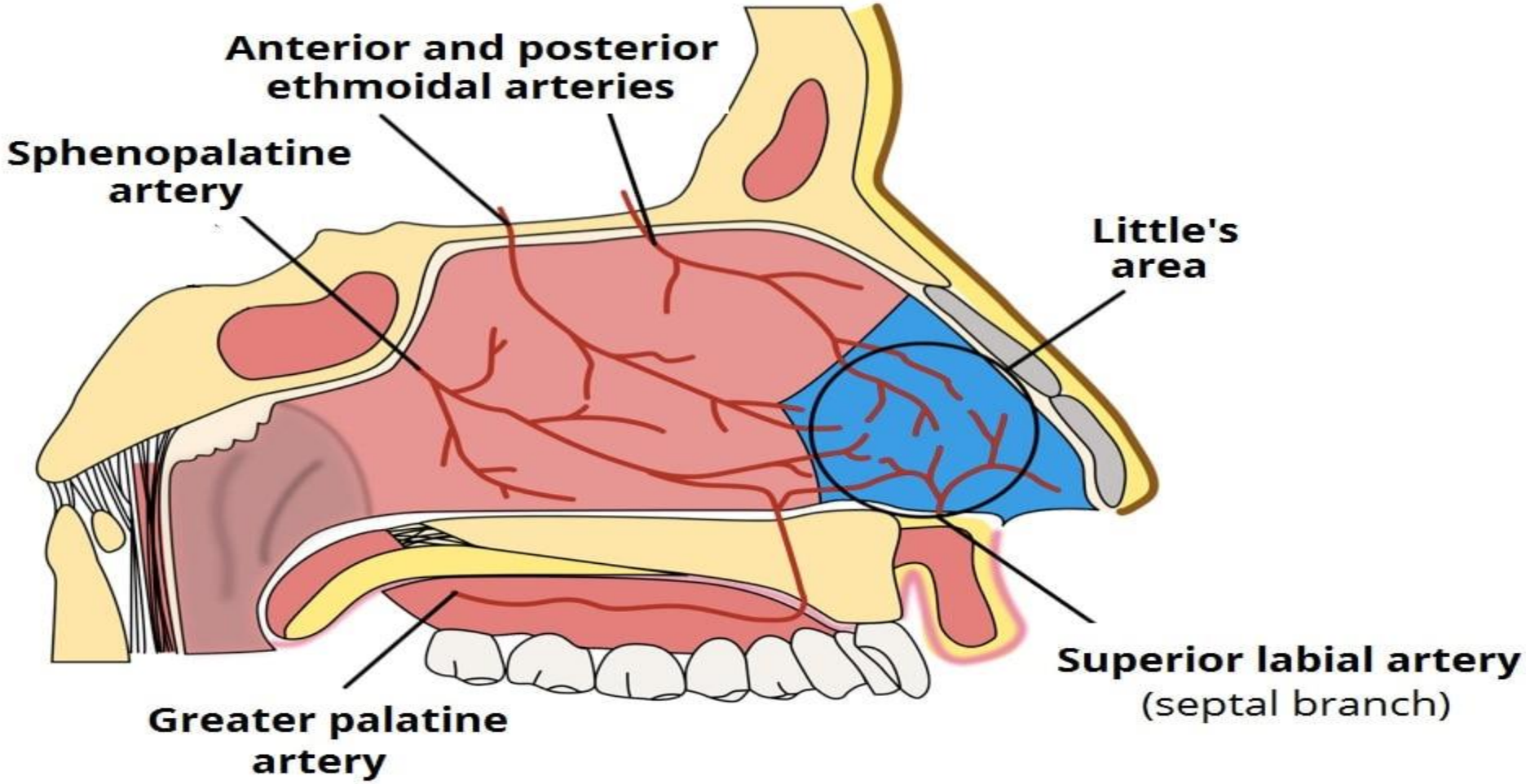
Auditory (Eustachian) tube – opens into the nasopharynx. It allows the middle ear to equalize with the atmospheric air pressure.

Spread of Infection: As the auditory tube connects the middle ear and upper respiratory tract, it is a path by which infection can spread from the upper respiratory tract to the ear. Infection of the auditory tube causes swelling of the mucous linings, and the tube becomes blocked. This results in diminished hearing.

Epistaxis

Epistaxis is the medical term for a nosebleed. Due to the rich blood supply of the nose, this is a common occurrence. It is most likely to occur in the anterior third of the nasal cavity – this area is known as the **Little's area.**

The cause can be local (such as trauma), or systemic (such as hypertension).

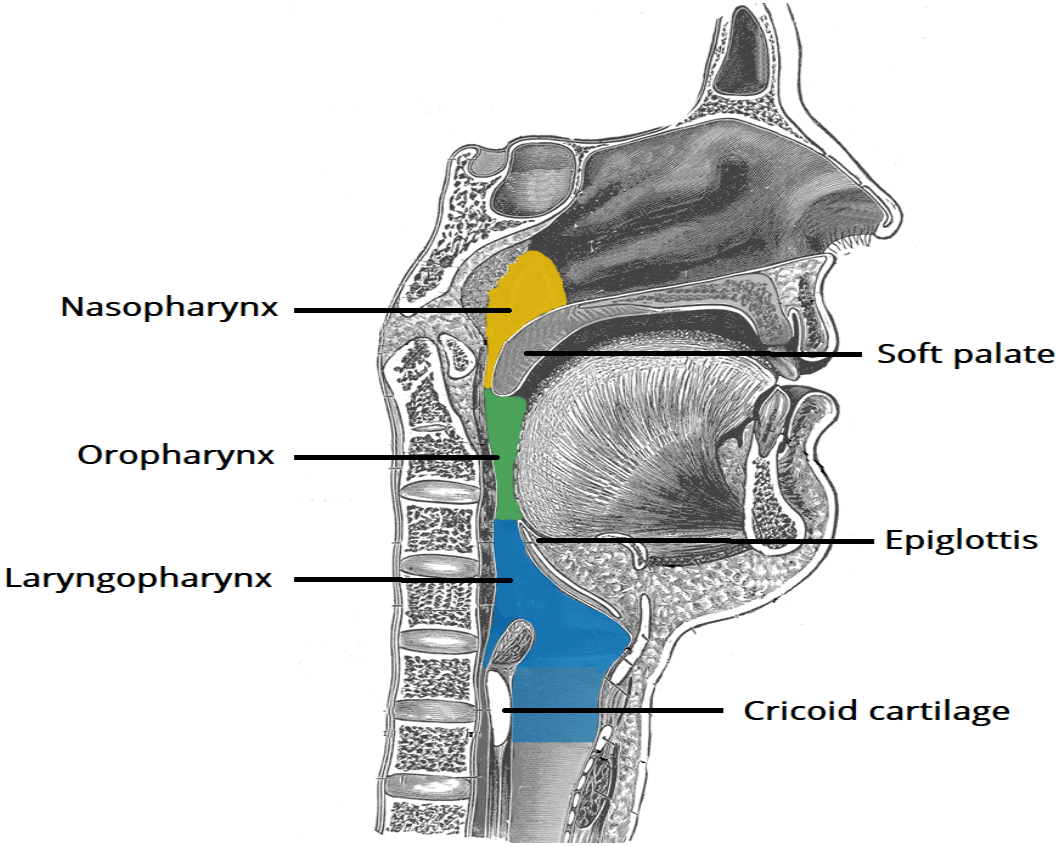


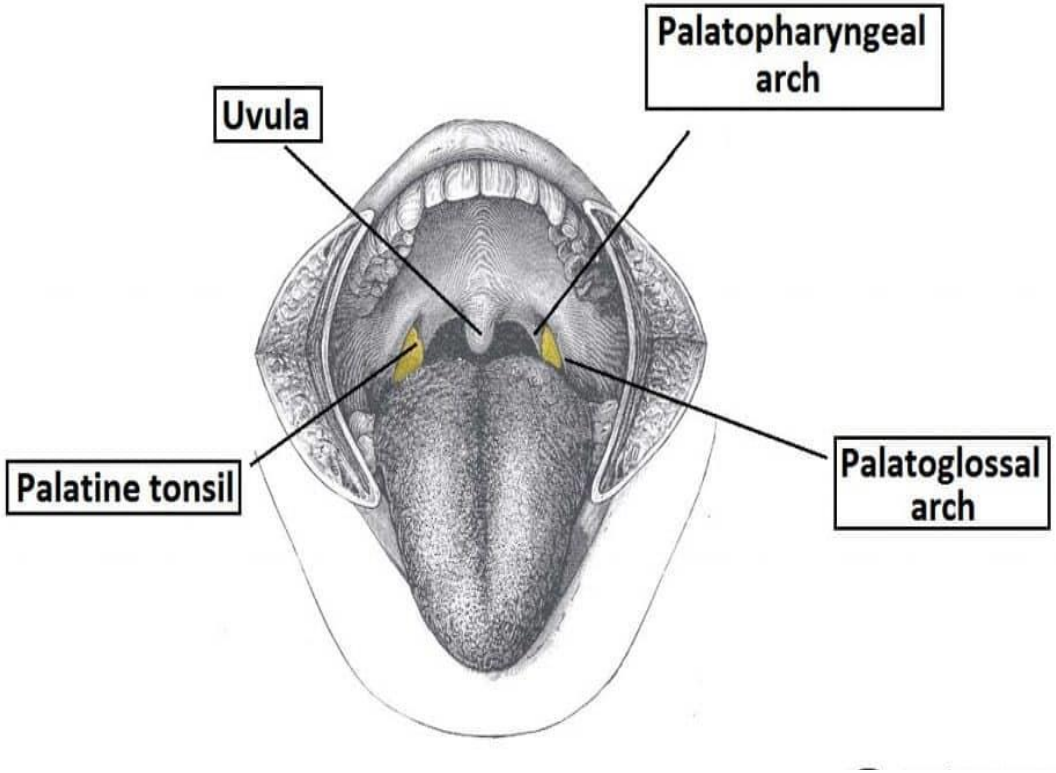
The **pharynx** is a muscular tube that connects the oral and nasal cavity to the larynx and oesophagus.

The pharynx is comprised of three parts (superior to inferior):
Nasopharynx Oropharynx Laryngopharynx

The nasopharynx is continuous with the nasal cavity and performs a respiratory function by conditioning inspired air and propagating it into the larynx. It is lined with respiratory epithelium; ciliated pseudostratified columnar epithelium with goblet cells. The nasopharynx contains the **adenoid tonsils**, which enlarge between 3-8 years of age and then regress.

The oropharynx It contains the following structures:
Posterior one-third of the tongue.
Lingual tonsils – lymphoid tissue at the base of the tongue.
Palatine tonsils – lymphoid tissue located in the tonsillar fossa.
The oropharynx is involved in the voluntary and involuntary phases of swallowing.





Location of the palatine tonsils in the oropharynx

Waldeyer's ring is the ring of lymphoid tissue in the naso- and oropharynx formed by the paired palatine tonsils, the adenoid tonsils and lingual tonsil.

The most distal part of the pharynx, the **laryngopharynx** which is continuous inferiorly with the esophagus. It is posterior to the larynx.

The larynx (voice box) is a component of the respiratory tract, located in the anterior neck. suspended from the hyoid bone, and spanning between C3 and C6.

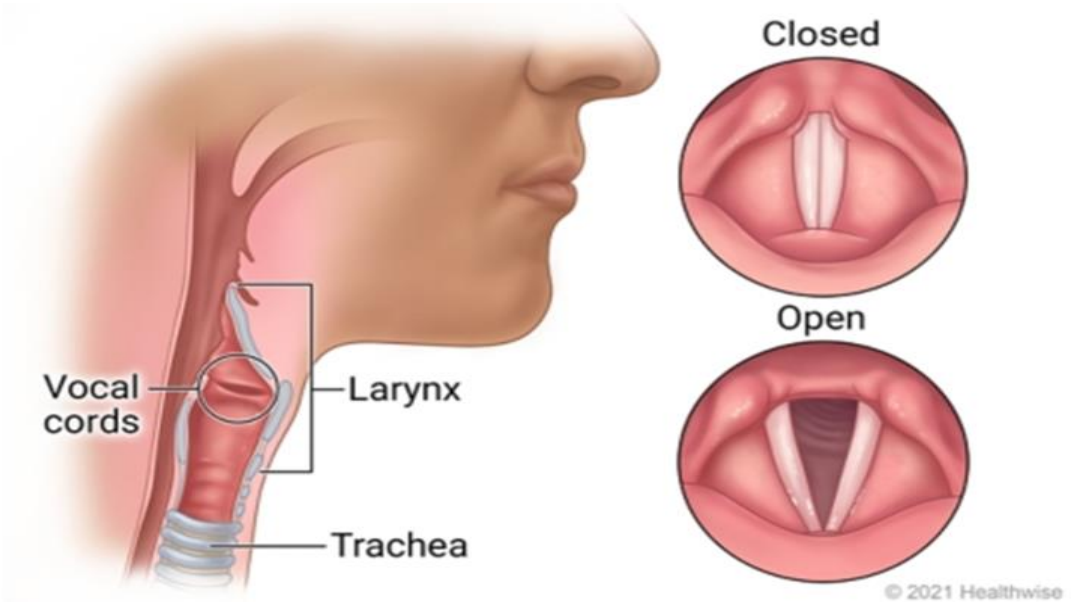
It is continuous inferiorly with the **trachea**, and opens superiorly into the laryngeal part of the pharynx. The larynx is formed by a cartilaginous skeleton, which is held together by ligaments and membranes. The laryngeal muscles act to move the components of the larynx for phonation and breathing.

Anatomically, the internal cavity of the larynx can be divided into three sections:

Supraglottis

Glottis: Contains vocal cords.

Subglottis



Innervation

The larynx receives both motor and sensory innervation via branches of the vagus nerve (CN X):

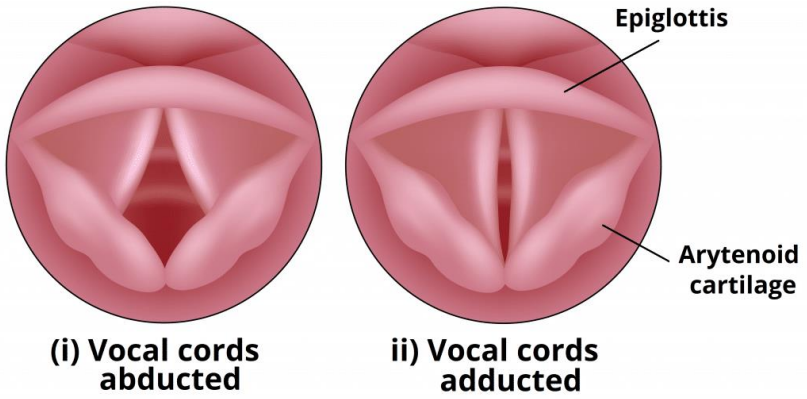
1.Recurrent laryngeal nerve

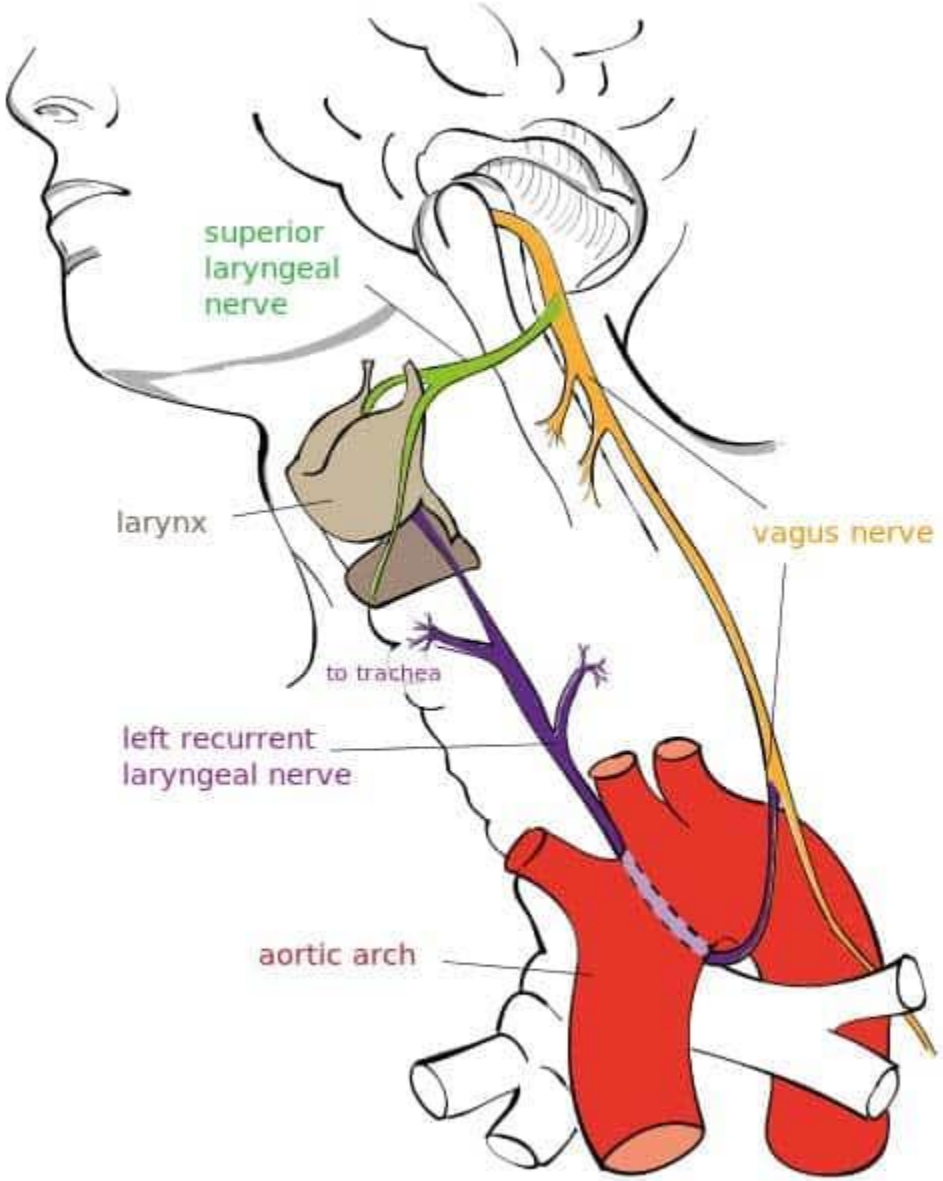
2.Superior laryngeal nerve

Vocal Cord Paralysis

The **vocal cords** are responsible for the production of speech. Their movement is controlled by the intrinsic muscles of the larynx – the majority of which are innervated by the recurrent laryngeal nerve. Due to its long course, the **recurrent laryngeal nerve** is susceptible to damage. Causes of RLN palsy include:

Apical lung tumor
Thyroid cancer
Aortic aneurysm
Cervical lymphadenopathy
Iatrogenic (particularly during thyroid surgery)

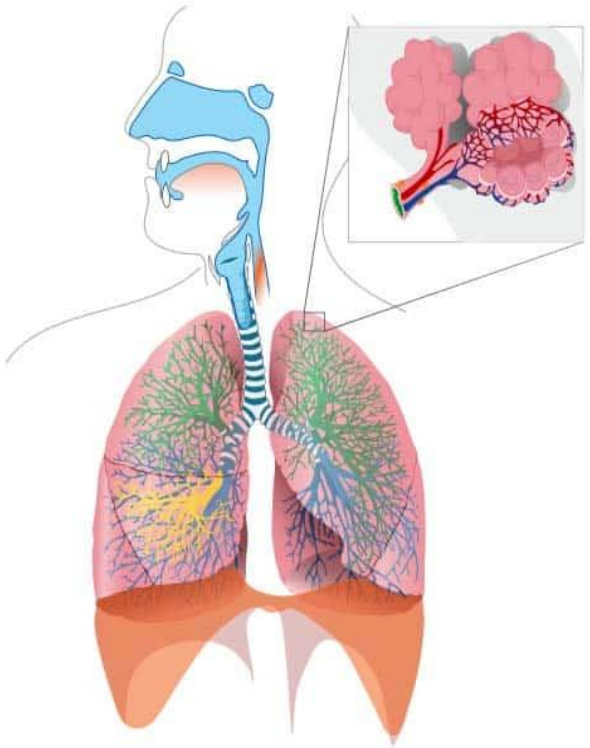




The Tracheobronchial Tree

The trachea, bronchi and bronchioles form the **tracheobronchial tree:** a system of airways that allow passage of air into the lungs, where gas exchange occurs. These airways are located in the neck and thorax.

The trachea marks the beginning of the tracheobronchial tree. It arises as a continuation of the larynx. It travels inferiorly into the superior mediastinum, bifurcating at the level of the sternal angle (forming the right and left main bronchi), at this bifurcation a ridge of cartilage called the **carina.** The trachea is held open by cartilage, here in C-shaped rings.



The trachea and bronchi are lined by ciliated pseudostratified columnar epithelium, interspersed by goblet cells, which produce mucus.
The combination of sweeping movements by the cilia and mucus from the goblet cells forms the functional mucociliary escalator. This acts to trap inhaled particles and pathogens, moving them up out of the airways to be swallowed and destroyed.

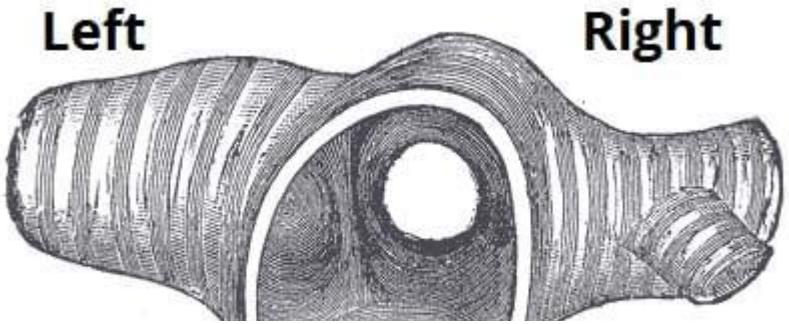
Bronchi

At the level of the sternal angle, the trachea bifurcates into the right and left main bronchi. They undergo further branching to produce the secondary bronchi. Each secondary bronchi supplies a lobe of the lung, and gives rise to several segmental bronchi.

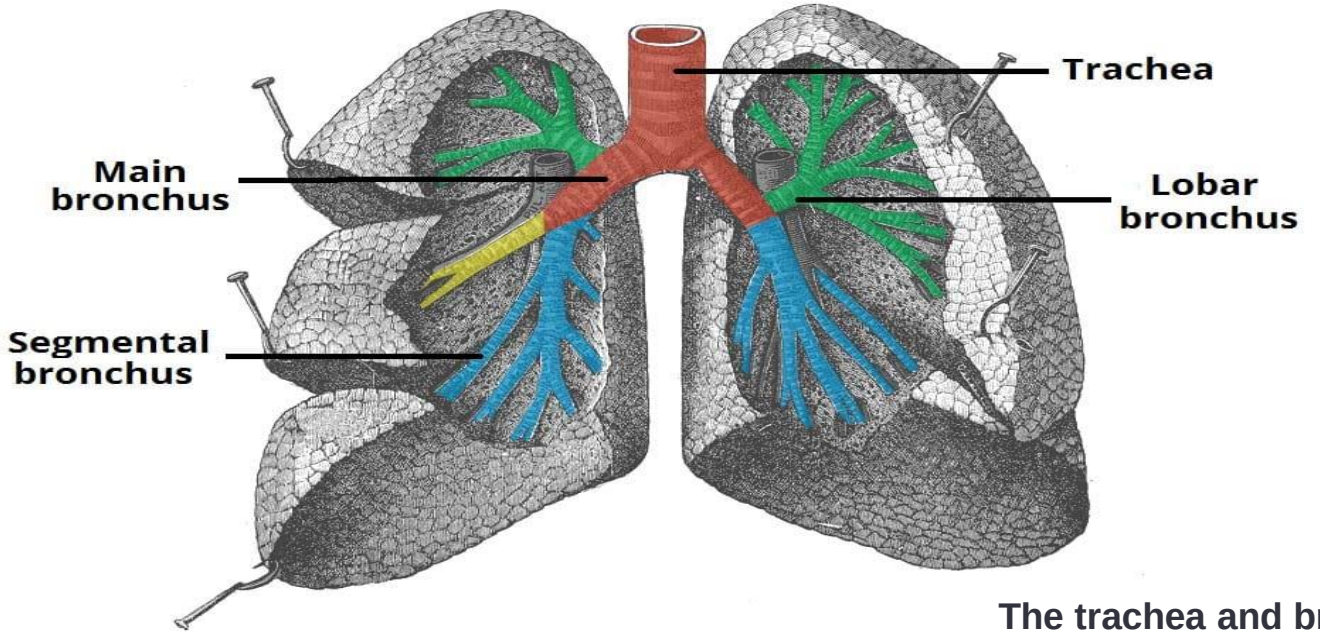
Right main bronchus: wider, shorter, and descends more vertically than its left-sided counterpart. Clinically, this results in a higher incidence of foreign body inhalation.

Within the lungs, **the main (primary)** bronchi branch into **lobar (secondary)** bronchi. Each secondary bronchi supplies a lobe of the lung, thus there are 3 right lobar bronchi and 2 left. The lobar bronchi then bifurcate into several **segmental (tertiary)** bronchi, each of which supplies a bronchopulmonary segment. **Bronchopulmonary segments** are subdivisions of the lung lobes, and act as the functional unit of the lungs.

The structure of bronchi are very similar to that of the trachea, though differences are seen in the shape of their cartilage. In the main bronchi, cartilage rings completely encircle the lumen. However in the smaller lobar and segmental bronchi cartilage is found only in crescent shapes.



Transverse section of the trachea, showing its bifurcation



The trachea and bronchi

Bronchioles

The segmental bronchi undergo further branching to form numerous smaller airways, called **the bronchioles.** The smallest airways, bronchioles do not contain any cartilage or mucus-secreting goblet cells. Instead, **club cells** produce a **surfactant lipoprotein** which is instrumental in preventing the walls of the small airways sticking together during expiration.

Initially there are many **conducting bronchioles**, which transport air but not involved in gas exchange. Conducting bronchioles then eventually end as **terminal bronchioles.** These terminal bronchioles branch even further into **respiratory bronchioles**, which are distinguishable by the presence of **alveoli** extending from their lumens.

Alveoli are tiny air-filled pockets with thin walls (simple squamous epithelium), and are the sites of gaseous exchange in the lungs. Altogether there are around 300 million alveoli in adult lungs, providing a large surface area for adequate gas exchange.

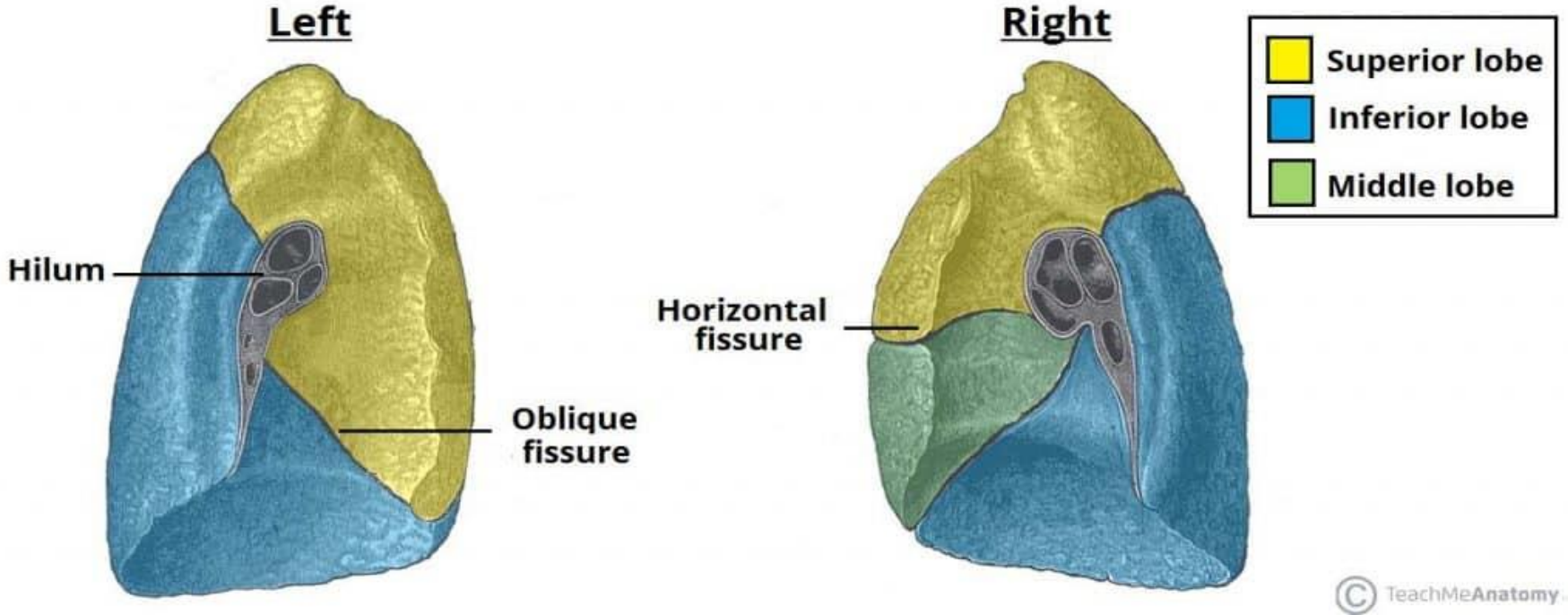
The **lungs** are the organs of respiration. The function of the lungs is to **oxygenate** blood. They achieve this by bringing inspired air into close contact with oxygen-poor blood in the pulmonary capillaries. The lungs lie either side of the mediastinum, within the thoracic cavity. Each lung is surrounded by a pleural cavity, which is formed by the visceral and parietal pleura.

Lobes

The right and left lungs do not have an identical lobular structure.

The right lung has; superior, middle and inferior. The lobes are divided from each other by two fissures: Oblique fissure and Horizontal fissure.

The left lung contains superior and inferior lobes, which are separated by oblique fissure



Vasculature

The lungs are supplied with deoxygenated blood by the paired **pulmonary arteries**. Once the blood has received oxygenation, it leaves the lungs via four **pulmonary veins** (two for each lung).

Pulmonary Embolism

A pulmonary embolism refers to the obstruction of a pulmonary artery by a substance that has travelled from elsewhere in the body. The most common emboli are:

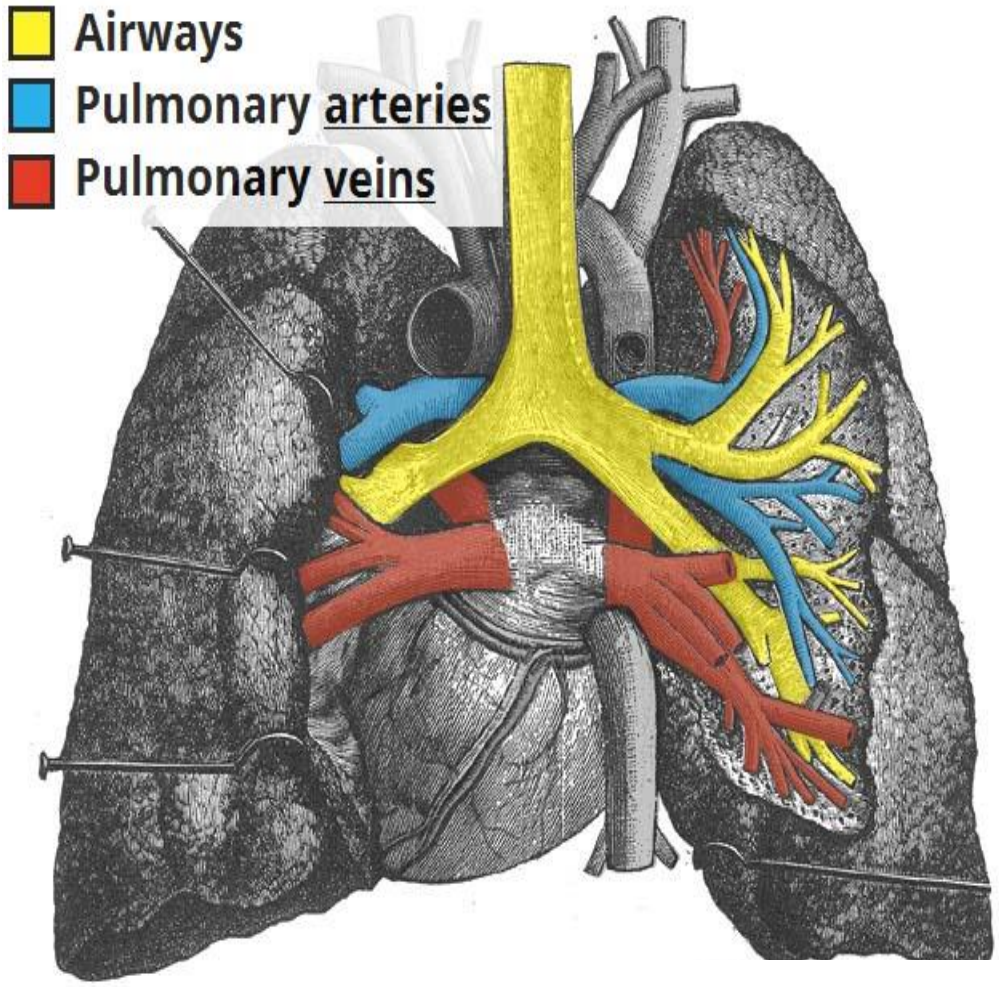
Thrombus: responsible for the majority of cases and usually arises in a distant vein.

Fat: following a bone fracture or orthopaedic surgery.

Air: following cannulation in the neck.

The effect of a pulmonary embolism is a **reduction in lung perfusion**. This results in decreased blood oxygenation, and the accumulation of blood in the right ventricle of the heart. Clinical features include dyspnoea, chest pain, cough, haemoptysis and tachypnoea.

Treatment: involves **anticoagulation** and **thrombolytic therapy**.



The pleurae refer to the **serous membranes** that line the lungs and thoracic cavity. They permit efficient respiration. There are two pleurae in the body: one associated with each lung.
Each pleura can be divided into two parts:
Visceral pleura: covers the lungs.
Parietal pleura: covers the internal surface of the thoracic cavity.
There is a potential space between the viscera and parietal pleura, known as the **pleural cavity**. It contains a small volume of serous fluid.

Mediastinum

The mediastinum, or mediastinal cavity, is a visceral compartment of the thoracic cavity. It completely separates the **two pleural cavities** by being placed longitudinally between them. It extends from the superior thoracic aperture to the diaphragm. The main mediastinal contents are the heart, esophagus, trachea, thoracic nerves and systemic blood vessels. The mediastinum can be split into the superior and inferior mediastinum. The inferior mediastinum itself can be further divided into the anterior, middle and posterior mediastinum, which all lie between the sternal angle and the diaphragm

THANK YOU!