

RESPIRATORY SYSTEM



Human Anatomy
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Respiratory System: Learning Objectives

Describe Respiratory System

Explain how breathing happens

Functions of Respiratory System

Components of Respiratory System

Describe the anatomy and histology of the nose, pharynx and associated structures.

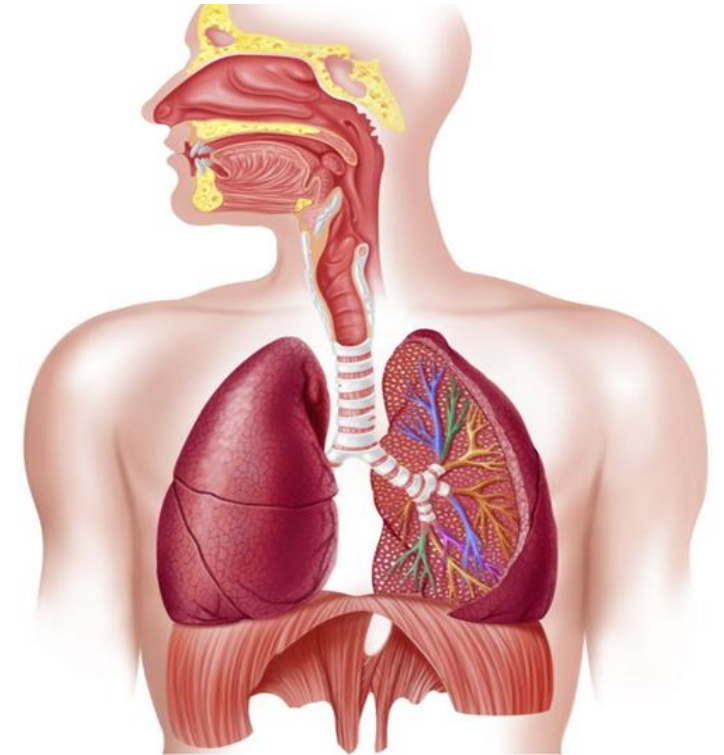
Identify the functions of these respiratory structures.

Identify the features and purpose of the larynx.

List the structures of voice production

What is the respiratory system?

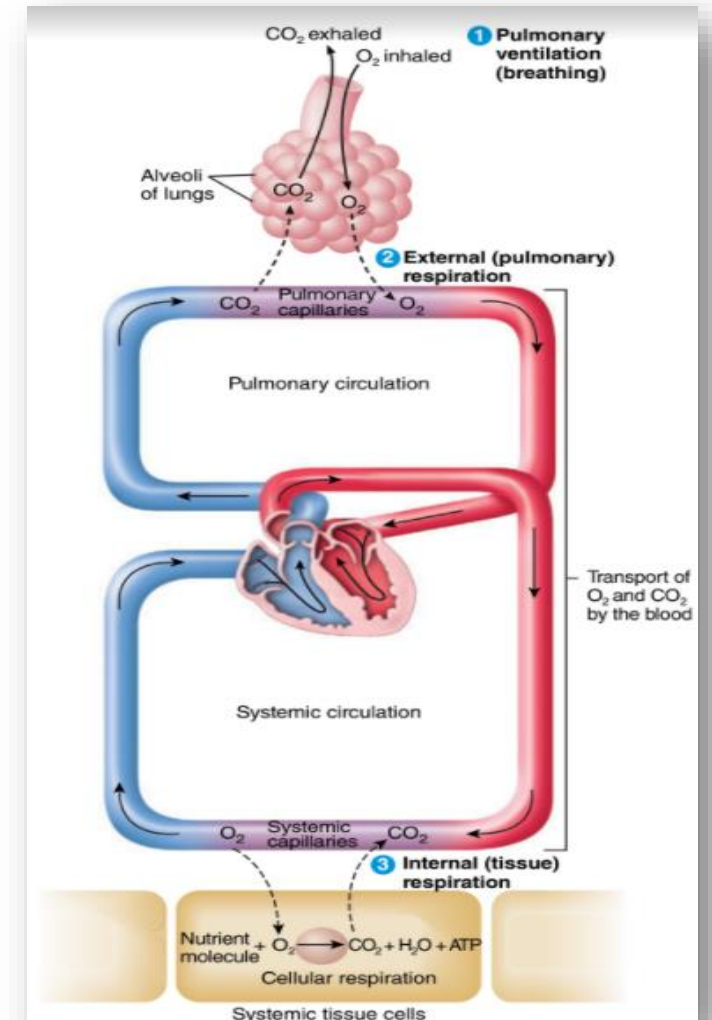
- The respiratory system is the network of organs and tissues that help you breathe. It includes your airways, lungs and blood vessels. The muscles that power your lungs are also part of the respiratory system. These parts work together to move oxygen throughout the body and clean out waste gases like carbon dioxide.



The Steps Involved in Respiration

The process of supplying the body with O₂ and removing CO₂ is known as respiration, which has three basic steps:

- **1. Pulmonary** ventilation (pulmon- = lung), or breathing, is the inhalation (inflow) and exhalation (outflow) of air and involves the exchange of air between the atmosphere and the alveoli of the lungs. Inhalation permits O₂ to enter the lungs and exhalation permits CO₂ to leave the lungs.
- **2. External (pulmonary)** respiration is the exchange of gases between the alveoli of the lungs and the blood in pulmonary capillaries across the respiratory membrane. In this process, pulmonary capillary blood gains O₂ and loses CO₂.
- **3. Internal (tissue)** respiration is the exchange of gases between blood in systemic capillaries and tissue cells. In this step the blood loses O₂ and gains CO₂. Within cells, the metabolic reactions that consume O₂ and give off CO₂ during the production of ATP are termed cellular respiration



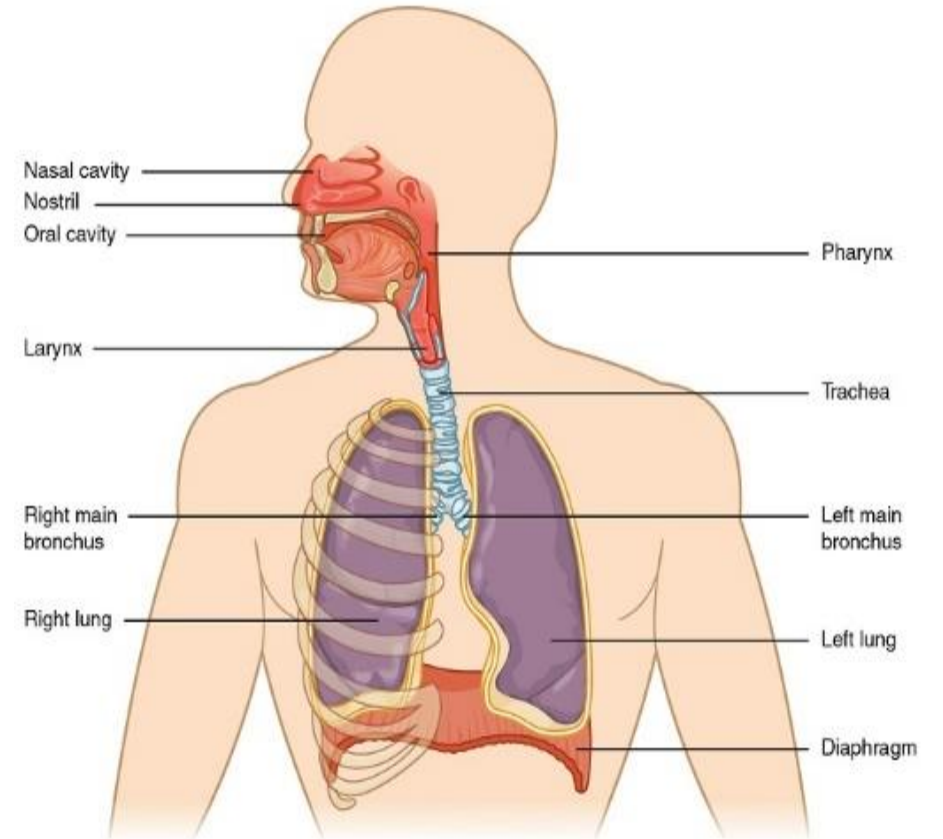
What does the respiratory system do?

The respiratory system has many functions. Besides helping you inhale (breathe in) and exhale (breathe out), it:

- Allows you to talk and to smell.
- Warms air to match your body temperature and moisturizes it to the humidity level your body needs.
- Delivers oxygen to the cells in your body.(intaking CO₂)
- Helps regulate blood pH.
- Removes waste gases, including carbon dioxide, from the body when you exhale.
- Protects your airways from harmful substances and irritants.

Parts of the Respiratory System

- The respiratory system consists of:
- Nose
- Pharynx (throat)
- Larynx (voice box)
- Trachea (windpipe)
- Bronchi
- Lungs



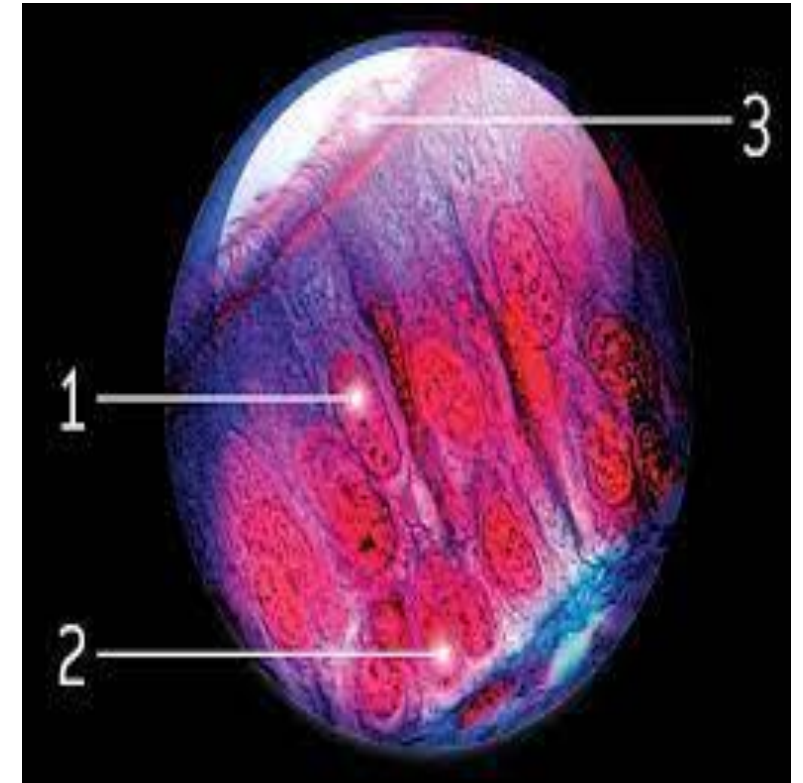
Components of the Respiratory System

- Structurally, the respiratory system consists of two parts:
- The **upper** respiratory system includes the nose, nasal cavity, pharynx, and associated structures; These structures allow us to breathe and speak. They warm and clean the air we inhale: mucous membranes lining upper respiratory structures trap some foreign particles, including smoke and other pollutants, before the air travels down to the lungs.
- The **lower** Respiratory system includes the larynx, trachea, bronchi, and lungs. These structures pull in air from the upper respiratory system, absorb the oxygen, and release carbon dioxide in exchange.

Respiratory epithelial cells

They line the respiratory tract from trachea to bronchi into bronchioles and alveolar sacs. The primary functions of the respiratory epithelium, depending on their origin, is to moisten, protect the airway tract from potential pathogens, infections and tissue injury, and facilitate gas exchange. The respiratory epithelium in trachea and bronchi is pseudostratified and primarily consists of three main cell types – cilia cells, goblet cells, and basal cells. The ciliated cells are located across the apical surface and facilitate the movement of mucus across the airway tract. The goblet cells produce and secrete mucous to trap pathogens and debris within the airway tract. Basal cells are progenitor cells that differentiate into cells types found within the epithelium. Basal cells respond to injury of the airway and subsequently differentiate to restore a healthy epithelial cell layer.

- **1. Goblet cells** – Secrete mucus to maintain epithelial moisture and trap pathogens or particulates
- **2. Basal cells** – Differentiate into other cell types to restore a healthy epithelial cell layer
- **3. Cilia cells** – Move back and forth, carrying mucus up and out of the respiratory tract

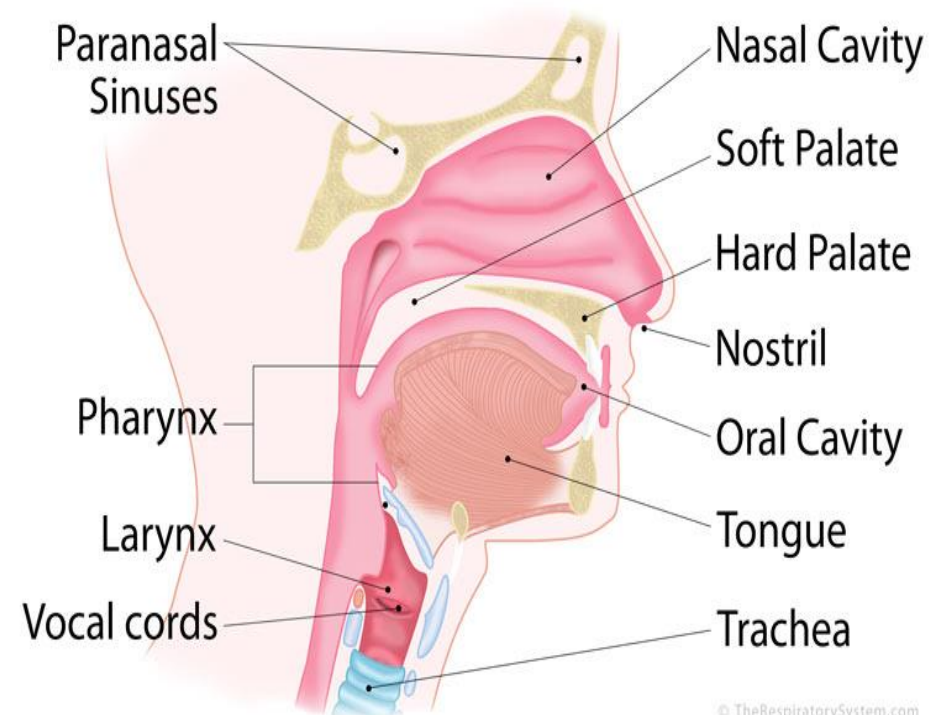


Upper Respiratory System

Upper Respiratory System includes

- Nose
- Pharynx (throat)

Upper Respiratory Tract

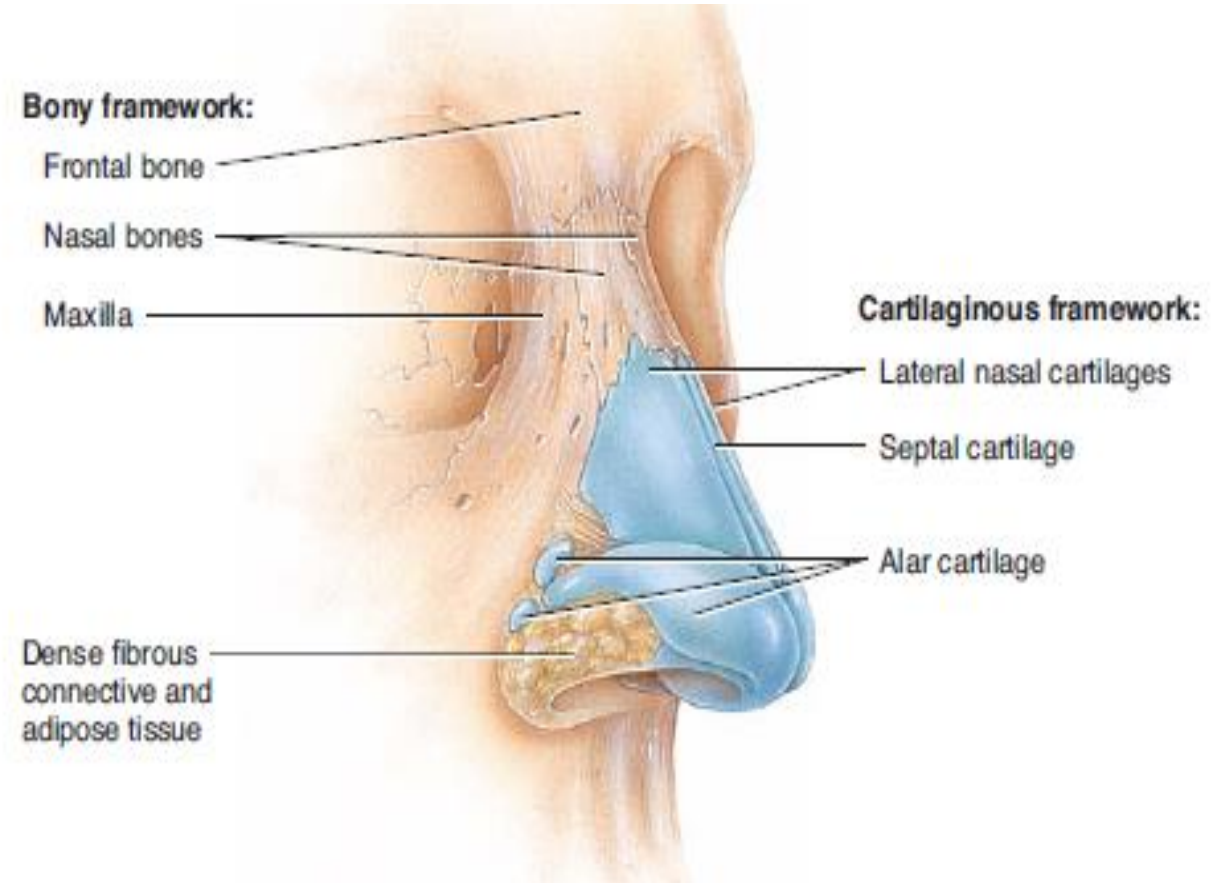


1) Nose: The nose is a specialized organ at the entrance of the respiratory system.

-**External nose:** consists of both bone and cartilage framework covered with muscle and skin and lined by a mucous membrane.

The frontal bone, nasal bones, and maxillae form the bony framework of the external nose.

The components of the cartilaginous framework are the septal nasal cartilage, the lateral nasal cartilages inferior to the nasal bones; and the alar cartilages (Alar), which form a portion of the walls of the nostrils.

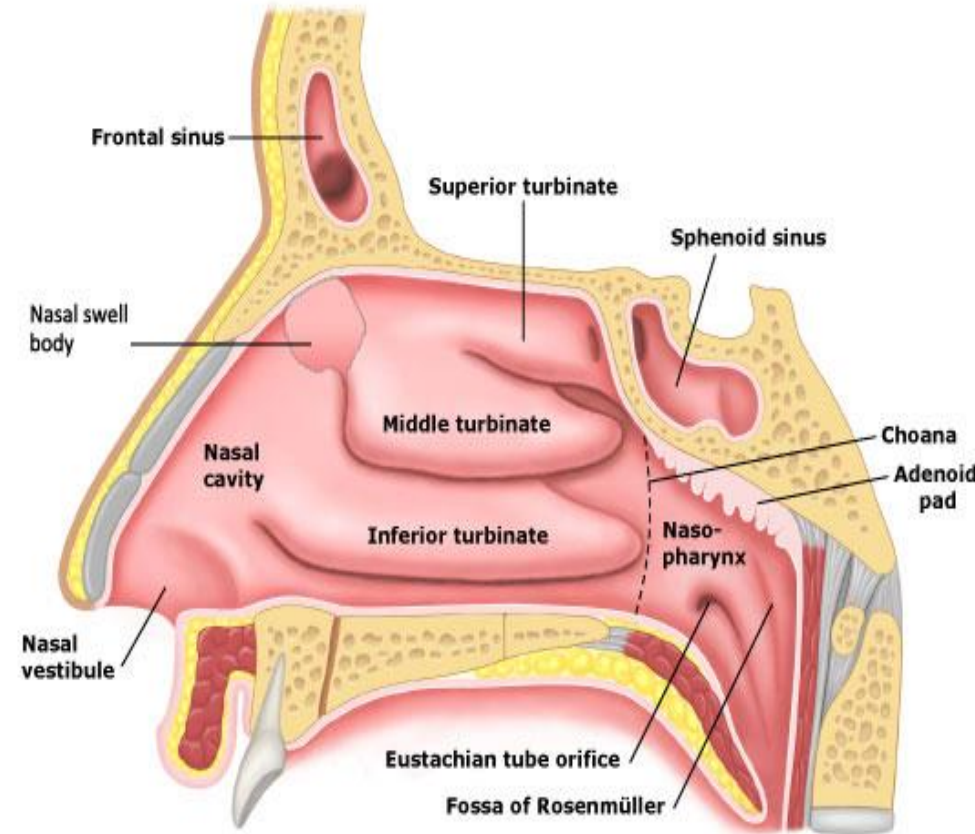


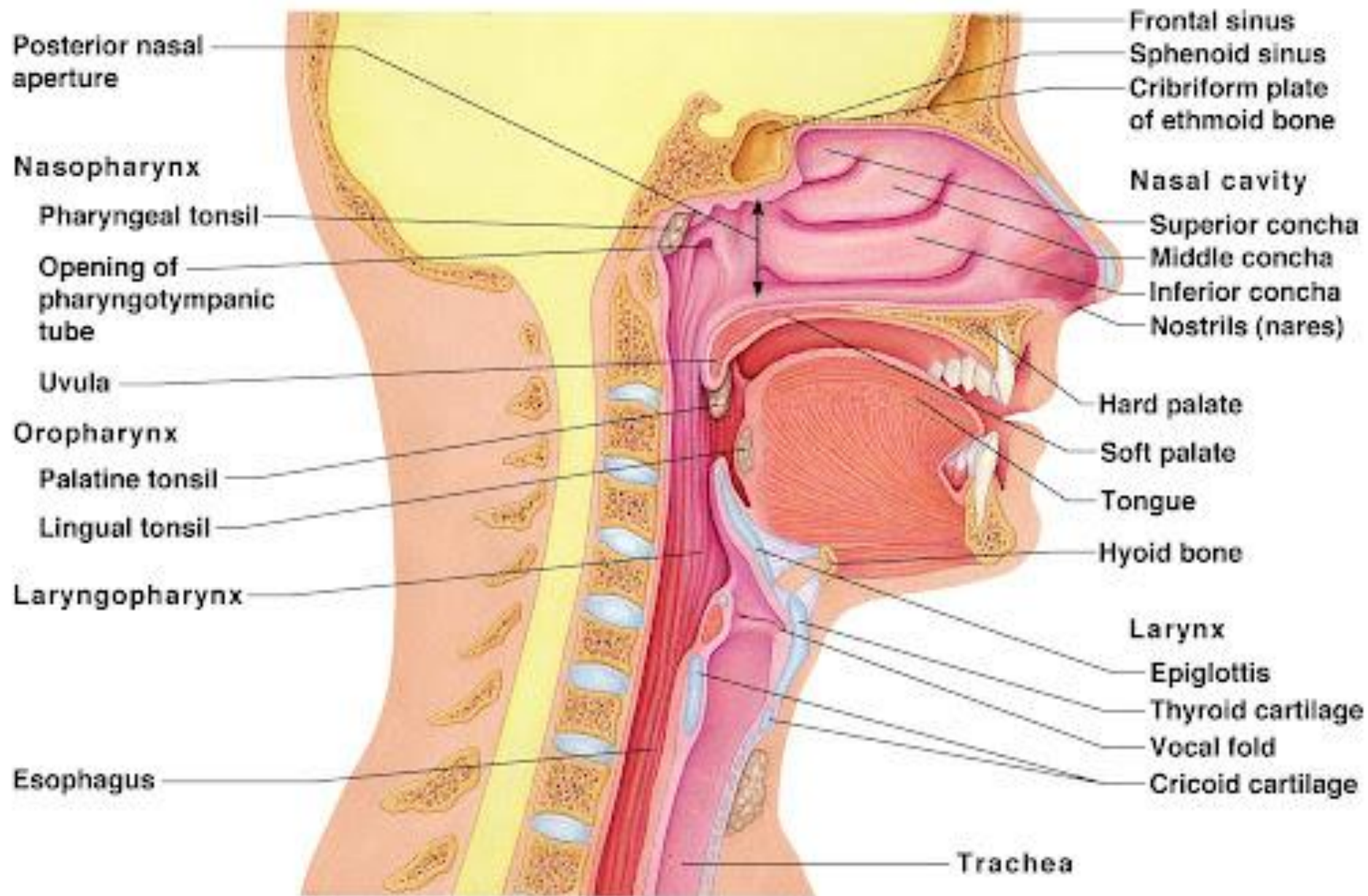
- **The nasal cavity (internal nose)** is a large space in the anterior aspect of the skull that lies inferior to the nasal bone and superior to the oral cavity; it is lined with muscle and mucous membrane.
- Anteriorly, the nasal cavity merges with the external nose, and posteriorly it communicates with the pharynx through two openings called the internal nares.

Along with the superior and middle nasal conchae, the inferior nasal concha works to **filter, humidify, and warm the air** that we breathe preventing cold air from reaching the lungs.

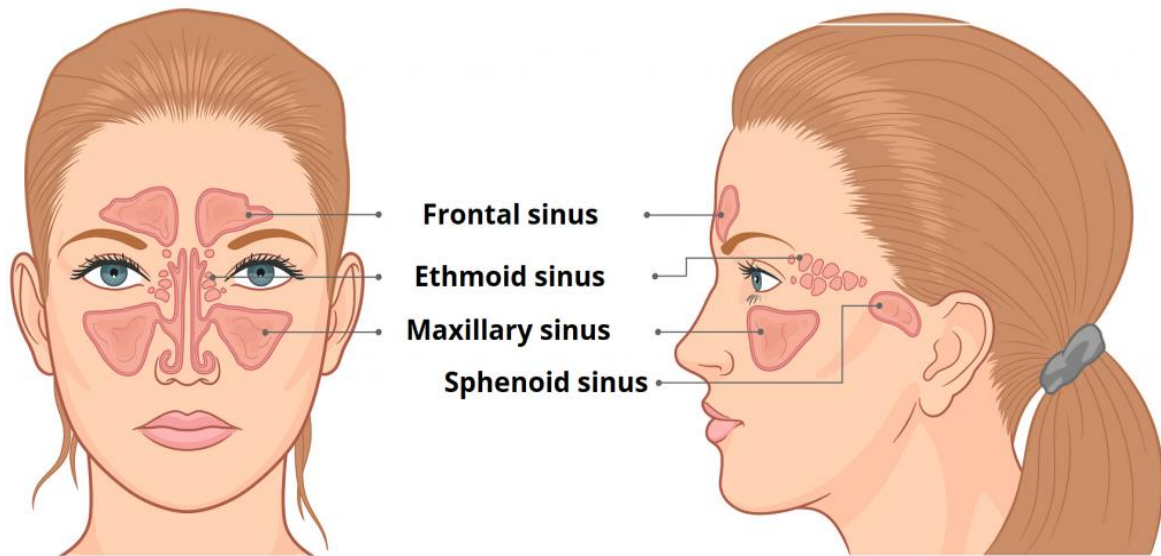
When air enters the nostrils;

- it passes first through the **vestibule**, then to
- Three shelves formed by projections of the **superior, middle and inferior nasal conchae** extend out of each lateral wall of the nasal cavity.





- The paranasal sinuses are air-filled extensions of the nasal cavity. There are four paired sinuses – named according to the bone in which they are located – **maxillary, frontal, sphenoid and ethmoid**. Each sinus is lined by a ciliated pseudo stratified epithelium, interspersed with mucus-secreting goblet cells.



Functions of sinuses;



- Lightening the weight of the head
- Supporting immune defense of the nasal cavity
- Humidifying inspired air

- 2) Pharynx

- **Nasopharynx:** Pseudo- stratified ciliated columnar.

Passageway for air; contains internal nares, openings for auditory tubes, and pharyngeal tonsil.

- **Oropharynx:** Non- keratinized stratified squamous. Two pairs of tonsils the palatine and lingual tonsils are found in oropharynx.

Passageway for both air and food and drink; contains opening from mouth(fauces).

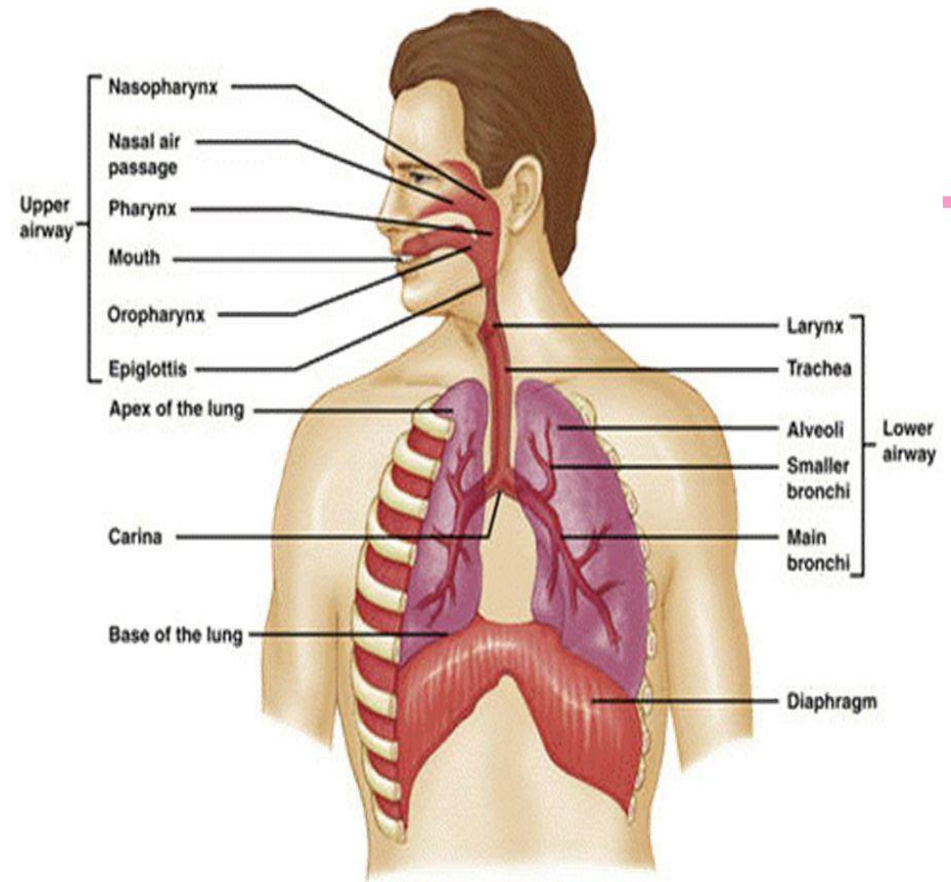
- **Laryngopharynx:** Non-keratinized stratified squamous. It is opened to esophagus like oropharynx.

Passageway for both air and food.

Lower respiratory system

Lower respiratory system includes :

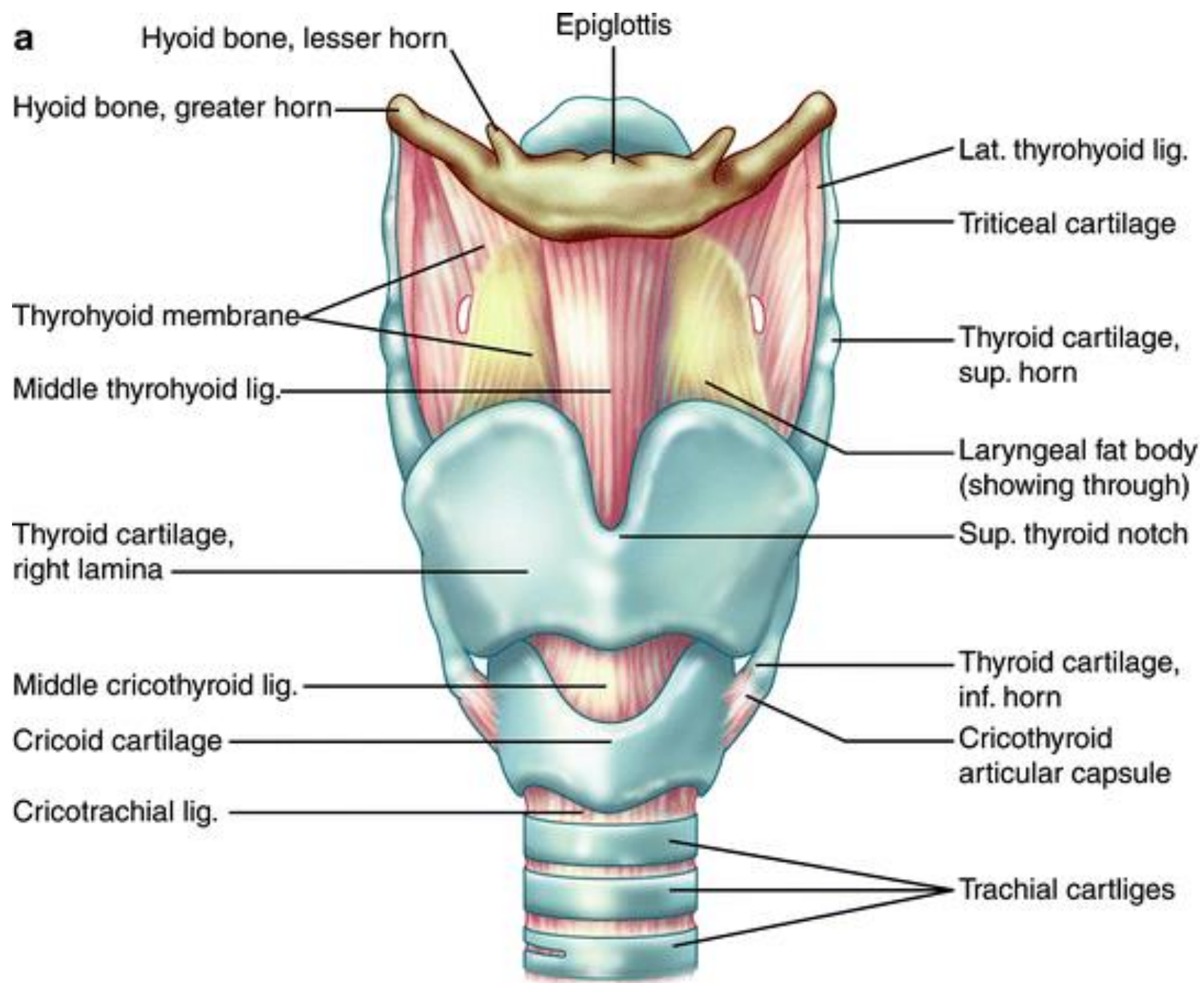
- Larynx
- Trachea
- Bronchi, and lungs



3)Larynx (or voice box)

Is a short passageway that connects the laryngopharynx with the trachea.

- It lies in the midline of the neck anterior to the esophagus and the fourth through sixth cervical vertebrae.
- The wall of the larynx is composed of nine pieces of cartilage .
- Three occur singly(thyroid cartilage, epiglottis, and cricoid cartilage), and three occur in pairs(arytenoid, cuneiform , and corniculate cartilages).
- Of the paired cartilages, the **arytenoid** cartilage are the most important because they influence changes in position and tension of the vocal folds(true vocal cords for speech).
- The extrinsic muscles of the larynx connect the cartilages to other structures in the throat.
- The intrinsic muscles connect the cartilages to one another.



The structure of voice production

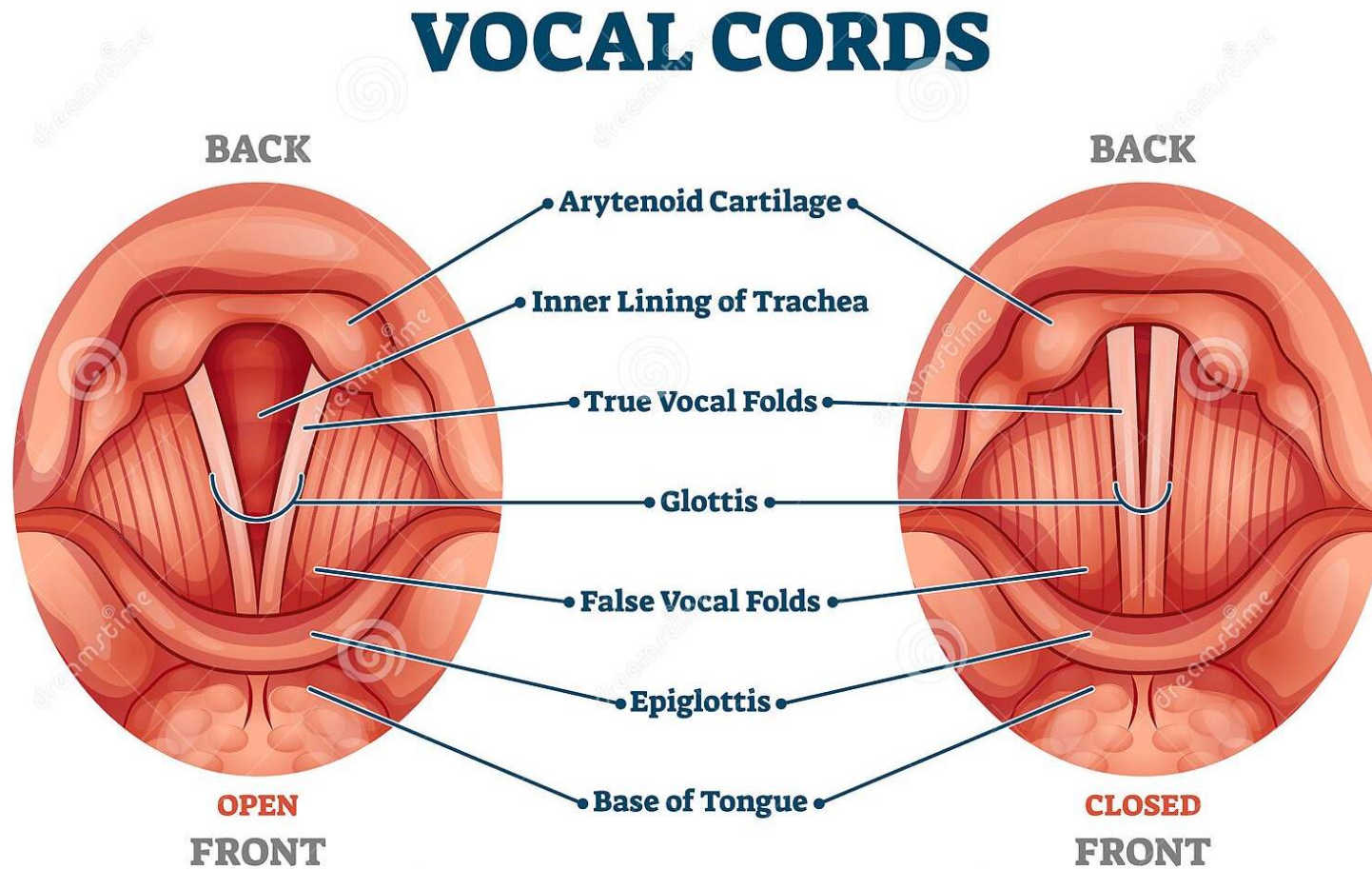
The mucous membrane of the larynx forms two pairs of folds :

1. A superior pair called the **vestibular folds** (false vocal cords).
 2. An inferior pair called the **vocal folds** (true vocal cords).
- The space between the vestibular folds is known as the Rima vestibuli.
 - The vocal folds are the principal structures of voice production.

Intrinsic laryngeal muscles attach to both the rigid cartilages and the vocal folds. When the muscles contract they move the cartilages , which pulls the elastic ligaments tight and this stretches the vocal folds out into the airway so that the rima glottidis is narrowed. Contracting and relaxing the muscles varies the tension in the vocal folds. Air passing through the larynx vibrates the folds and produces sound by setting up sound waves in the column of air in the pharynx, nose, and mouth.

- The variation in the pitch of the sound is related to the tension in the vocal folds.

The greater the pressure of air, the louder the sound produced by the vibrating vocal folds.



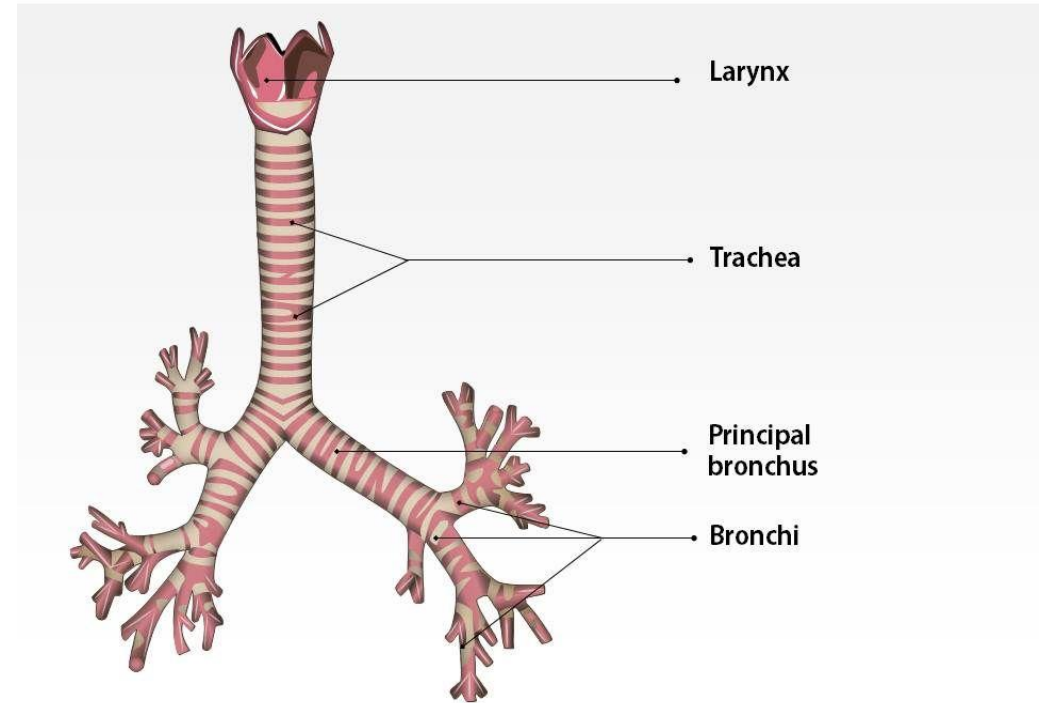
4) Trachea, or (windpipe), is the main airway to the lungs

- Covered by cartilaginous rings.
- It extends from the bottom of the larynx down behind the sternum, until it branches into smaller tubes, the bronchi.
- During inhalation ,air filtered and warmed by the upper respiratory system
Passes from the pharynx and larynx into the trachea, then down to the bronchi and into the lungs.

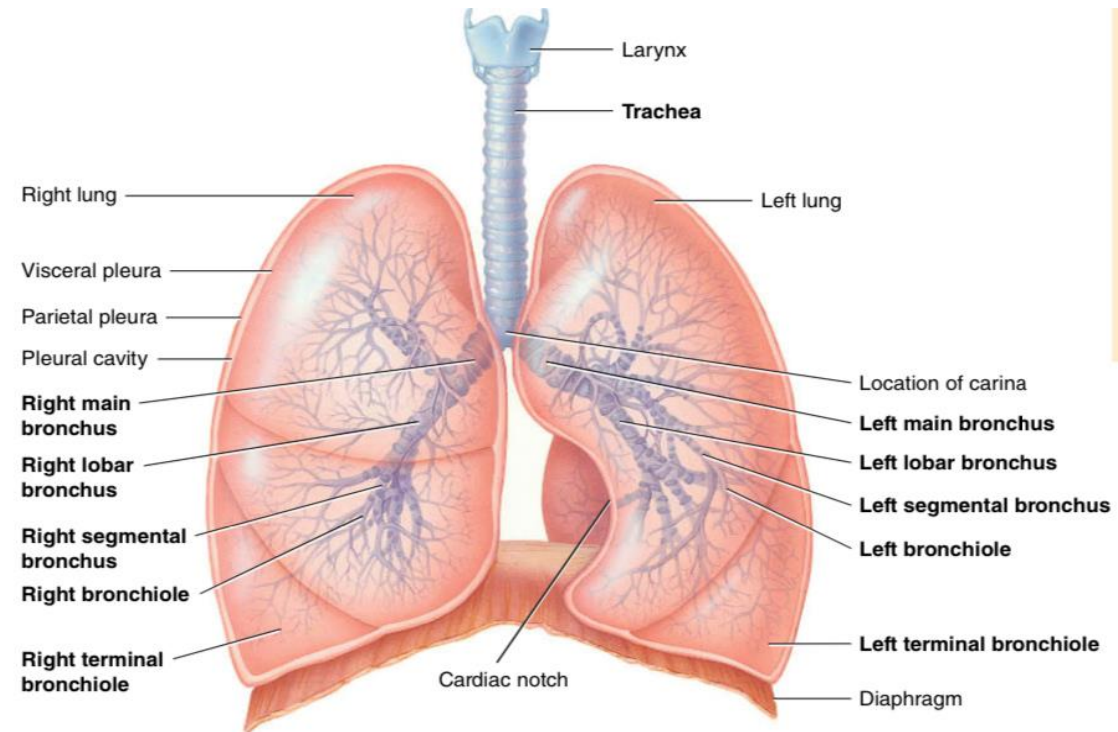
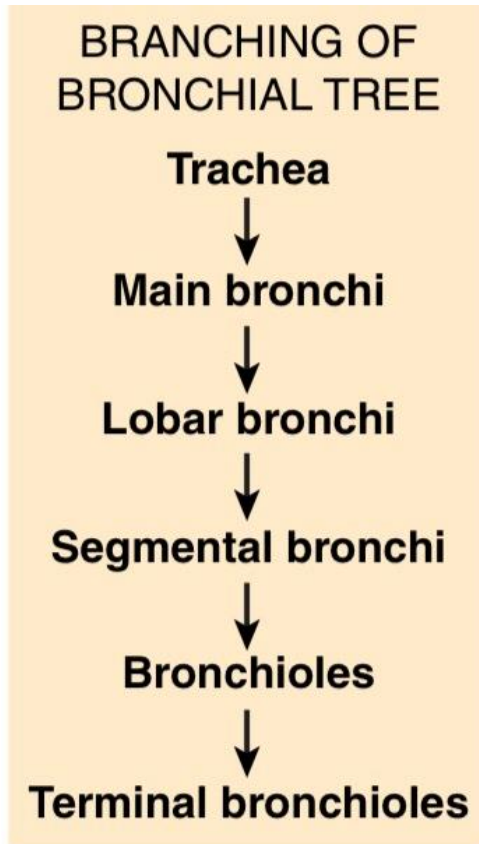
Deoxygenated air from the lungs passes back up through the trachea during exhalation.

- They are C- shaped , with a gap on the posterior side. This allows the trachea to bend when the esophagus presses against it as food is swallowed .

Anatomy of Trachea



The bronchi are passageways that bring air in and out of the lungs



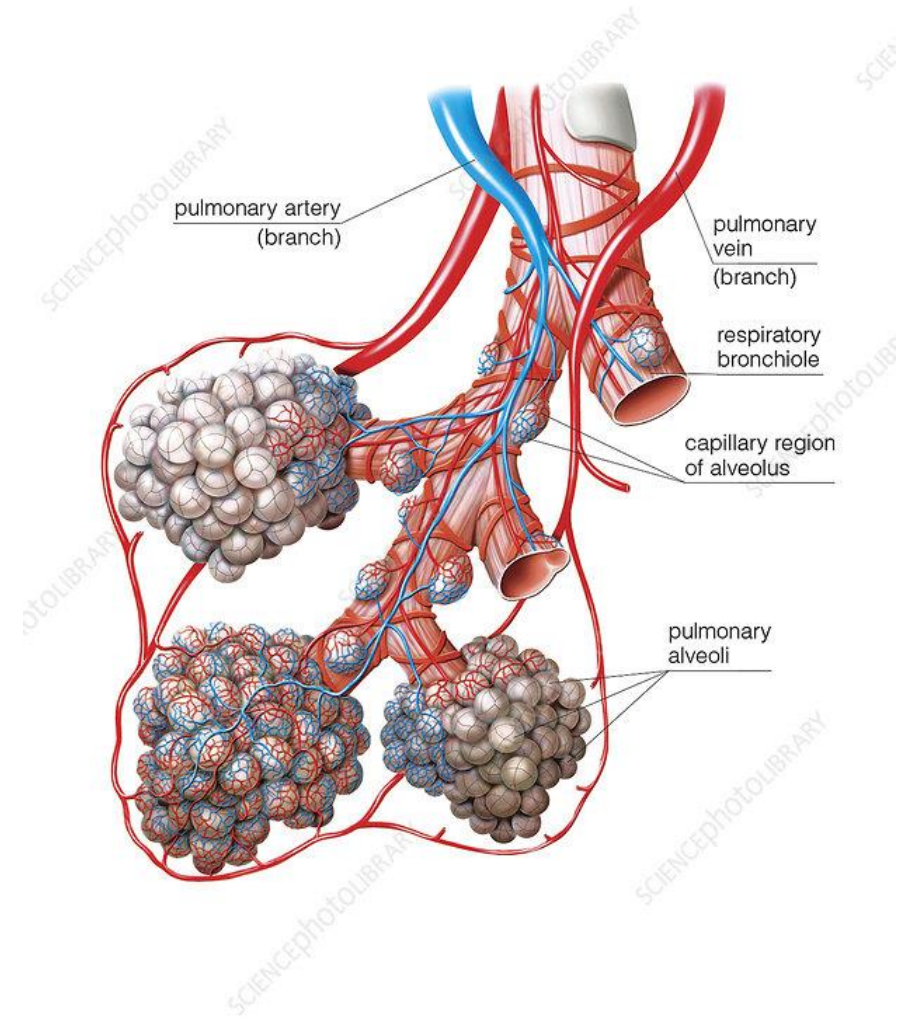
These small airways deliver oxygen –rich air from the trachea to the lungs. Deoxygenated air leaves the lungs by the reverse route. When we exercise, relaxation of smooth muscle in the bronchioles causes them to dilate. This bronchodilation allows greater ventilation.

5)The lungs are the essential organs of the respiratory system

- The lungs are responsible for gas exchange between the air we breath and our bodies.
- They are protected by inside the thoracic cage.
- The left lung has two lobes and is slightly smaller in volume than the right. It curves in at the cardiac notch to accommodate the heart. The right lung has three lobes. It is slightly shorter, because the diaphragm muscle sits higher below it to accommodate the liver. During inhalation air flows into the lungs through the bronchi and bronchioles.
- Oxygen from the air is then absorbed in to the blood stream : it passes through millions of microscopic sacs, the alveoli, into surrounding capillaries .
- Carbon dioxide waste diffuses the opposite way, from the capillaries to the alveoli.
- The lungs expel the deoxygenated air during exhalation.

External respiration

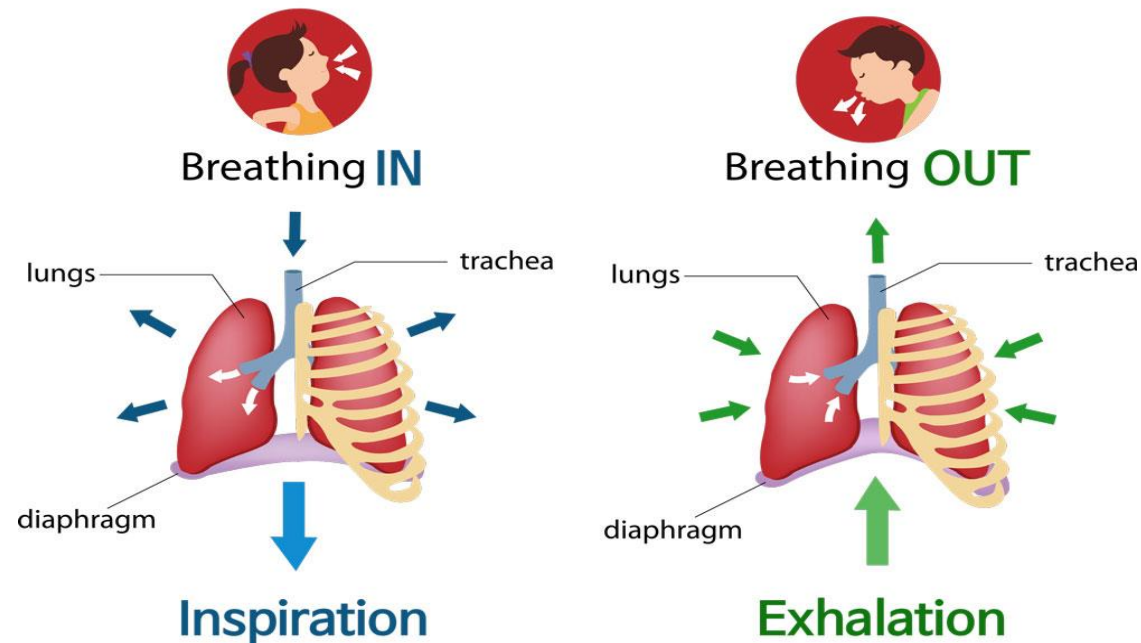
- Alveoli are microscopic air sacs served by the bronchioles. Hundred of million of alveoli exist inside each lung. They are the terminal ends of the respiratory tract and the sites of external respiration – the exchange of gases between the air and the bloodstream.
- Oxygen diffuses through the alveoli into network of pulmonary capillaries that surround them, and is pumped through the bloodstream. Carbon dioxide from deoxygenated blood diffuses from the capillaries into the alveoli.



6)Diaphragm

- The lungs sit atop the diaphragm , a muscle that forms the floor of the thoracic cavity. The action of the diaphragm is key to the physical process of breathing .
- The diaphragm contract and move inferiorly, toward the abdominal cavity. This allows the volume of the thoracic cavity and lungs to increase.
- When diaphragm relax, the thoracic cavity and lungs decrease, and air is expelled.

Breathing



QUESTIONS

1. How does the larynx function in respiration and voice production?
2. Describe the location, structure, and function of the trachea.
3. Describe the structure of the bronchial tree.
4. What are the three basic steps involved in respiration?
5. What are the components of the respiratory system?

Source

- Principles of Human Anatomy Physiology /Wiley

Teach me Anatomy:

<https://teachmeanatomy.info/thorax/organs/lungs/>

Cleveland Clinic:

<https://my.clevelandclinic.org/health/articles/21205-respiratory-system#:~:text=The%20respiratory%20system%20is%20the,waste%20gases%20like%20carbon%20dioxide.>

Britannica:

<https://www.britannica.com/science/human-respiratory-system/The-pharynx>